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Weather Glossary

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PREFACE

The need for a weather glossary has been felt by American meteorologists for some time. This is especially apparent when it is considered that some meteorological terms have different meanings in other countries; and, on the other hand, a variety of names is applied to the same thing or phenomenon. In this work, the terms are defined as they are used by American writers in meteorology and climatology, but attention is called to the different meanings given them in other countries when such are known.

The basic collection of terms for a weather glossary was made by Charles F. Talman, late librarian (1908-1936) of the United States Weather Bureau, who accumulated in his time an enormous number of weather terms gleaned from popular and scientific literature. In his search for terms, he covered the period from Aristotle to the present time, and included dialectical weather words. While he wrote no formal definitions, he appended copious references, citations, and personal notes which have been found invaluable. This great accumulation of terms was available for use in the present work, and it is hoped that it will always be preserved for investigators and students throughout the English speaking world.

From the Talman list, terms were selected for this book which were found in common use in meteorological writings of the past one hundred years. To these were added the important and commonly used terms found in publications since Talman's time. Finally, terms were chosen from suggestions contributed by many meteorologists who had reviewed those terms already selected. Many terms included belong to other fields of science, but are considered useful because they are also often found in meteorological works.

This work was designed to meet the general requirements for an American weather glossary. It is not intended as a dictionary but simply defines the words as used in relation to meteorology. The terms, whether single words or phrases, are arranged alphabetically; the parts of speech, spelling, and capitalization follow usages found in standard American dictionaries. The references attached to the definitions indicate either sources of quotations or locations of more extended discussions of terms.

Most of the definitions have been revised since the first writing, some several times, but it would be presumptuous to assume that there are no errors. Criticisms will be gratefully received, for it is hoped that this work may be the basis for a more exhaustive glossary of the weather. There may also be some who will desire to make suggestions as to terms which should be added; but the contributor will add greatly to their value if references are included.

To the Chief of the United States Weather Bureau, Dr. F. W. Reichelderfer, who initiated and gave unfailing support to the work, are due many thanks. Appreciation is also extended to several members of his staff for assistance in many particulars.

Adequate acknowledgment for much assistance in the preparation of this book cannot be made because many suggestions came by way of informal discussions. Formal and sincere thanks are given to Drs. C. W. Thornthwaite and H. R. Byers for reviewing many of the definitions; to Dr. H. C. Willett, Mr. L. P. Harrison, and Mr. N. C. Gerson, for supplying several definitions; and to Dr. H. W. Norton and Mr. G. W. Brier for reviewing and writing definitions of statistical terms. Special thanks are due to Ens. J. K. McGuire for enthusiastic aid in rewriting many definitions.

Finally, to Dr. E. W. Woolard grateful acknowledgement is made for suggestions, valuable criticisms, and review of the entire work.

ALFRED H. THIESSEN

WEATHER GLOSSARY

A

A., *abbr.*—1. Abbreviation for ABSOLUTE TEMPERATURE, q. v. 2. Abbreviation for alto, as in As. for the cloud form of ALTOSTRATUS, q. v.

A. A., *abbr.*—Abbreviation for approximate absolute (temperature). *See:* APPROXIMATE ABSOLUTE THERMOMETRIC SCALE.

ablation, *n.*—The process by which ice and snow waste away due to melting and evaporation.

The ablation factor measures the rate of this wasting away. According to H. W. Ahlmann, in the case of glaciers this factor amounts to 2.3 mm. per hour during the day, and 1.8 mm. per hour during the night. He determined these values from observations on glaciers taken during the months of July and August. He also found that "the ablation of the glacier reacts very sensitively in relation to the meteorological elements, and especially in the matter of sun radiation (degree of cloudiness), the temperature, the wind, and the precipitation." *See:* H. W. Ahlmann, Geografiska Annaler, vol. 9, 1927, pp. 35–66; Geographical Journal, vol. 86, 1935, p. 98.

abnormal, *adj.*—1. Deviating from the normal by a considerable amount. In meteorology, the term is applied to those values of the weather elements, such as temperature, which deviate from the normal values by amounts so much greater than usual that the deviations deserve comment. The term does not carry any quantitative meaning, since its employment depends on good judgment based on consideration of the past records of similar occurrences. 2. Also used in the sense of above or below the normal value of an element, regardless of the degree of deviation.

abnormality, *n.*—The state or condition of the weather or climate at a time when abnormal values of any element occur. *See:* ABNORMAL.

ab-polar current, *n.*—An air current moving away from either pole in the direction of the equator. *See:* Robert FitzRoy, Weather Book, 1863, Ch. V; passim.

Abraham's tree, *n.*—The popular name given to a cloud form consisting of an assemblage of long feathers and plumes of cirrus, which seem, by an effect of perspective, to radiate from a single point on the horizon. According to popular tradition, it is a sign of rain if the base of this cloud has the appearance of touching a sheet of water. It is said, in effect, that it will rain when Abraham's tree has its foot in the water. In the Uckermark, a district of Prussia, a common saying is: "Abraham's tree is blooming; it is going to rain."

abroholos, *n.*—Name for a SQUALL, q. v., frequent on the coast of Brazil between Cape St. Thome and Cape Frio in the months of May through August.

absolute, *adj.*—1. Applied in climatology to the extreme highest and lowest values of any given meteorological element which occur during a particular period at the place of observation. For example, the extreme highest temperature recorded during the years 1872–1940 at Washington, D. C., is 106° F., and the extreme lowest is −15° F. These are called the absolute maximum and the absolute minimum temperatures, respectively, for the place and period. 2. Also applied to the difference between the absolute extremes defined above. Thus, the absolute range of temperature at Washington, D. C., during the period 1872–1940 is 121° F. 3. In the U. S. Weather Bureau, this term is also used to designate the greatest monthly range of temperature at a given place; that is, the difference between the highest and lowest temperatures recorded during a month is called the monthly absolute range. 4. Used in several other special senses, as ABSOLUTE CEILING, ABSOLUTE HUMIDITY, etc.

absolute altitude, *n.*—The height of an aircraft above the earth. *See:* Nomenclature for Aeronautics, Report No. 474, National Advisory Committee for Aeronautics, 1937, p. 10.

absolute ceiling, *n.*—"The maximum height above sea level at which a given airplane would be able to maintain horizontal flight under standard air conditions." (Nomenclature for Aeronautics, Report No. 474, National Advisory Committee for Aeronautics, 1937, p. 11.) *See:* CEILING; BALLONET CEILING; SERVICE CEILING; STATIC CEILING.

absolute extremes, *n.*—*See:* ABSOLUTE.

absolute humidity, *n.*—1. The mass of water vapor present per unit volume of space, i. e., the density of water vapor; usually expressed in grams per cubic meter or grains per cubic foot. This quantity decreases with adiabatic expansion and increases with adiabatic compression. *See:* ADIABATIC PROCESS. 2. The gas pressure exerted by the water vapor per unit area, expressed in barometric units. Definitions 1 and 2 are equivalent, since at any given temperature, vapor pressure varies directly as vapor density. 3. The term is sometimes applied by heating engineers to the number of grains of moisture per pound of moist air. This usage corresponds to the meteorological definition of SPECIFIC HUMIDITY, q. v.

absolute instability, *n.*—1. The condition of a parcel of moist air, the lapse rate in which is greater than the dry-adiabatic rate. Conversely, absolute stability is characterized by a lapse rate less than the moist-adiabatic. 2. Sometimes restricted to the state of a layer of air in which the lapse rate exceeds that needed for AUTOCONVECTION, q. v. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937 p. 25; STABILITY.

absolute maximum, *n.*—*See:* ABSOLUTE.

absolute minimum, *n.*—*See:* ABSOLUTE.

absolute stability, *n.*—*See:* STABILITY.

absolute temperature, *n.*—"Temperature as reckoned from a zero corresponding to the entire absence of transitional molecular motion, on either the hydrogen constant volume or the Kelvin scale." (L. D. Weld, Glossary of Physics, 1937, pp. 1–2.)

absolute temperature scale, *n.*—A temperature scale defined by the thermodynamic scale of Lord Kelvin, and hence also known as the Kelvin scale, which is independent of the specific properties of any substance, and is the fundamental or ultimate standard of reference to which all other temperature scales are referred.

This scale is based on the average kinetic energy of a molecule of an Ideal Gas, q. v. The zero point on the absolute scale is, accordingly, that temperature at which molecular motion of the gas is entirely absent. The equal intervals of temperature reckoned from this Absolute Zero, q. v., "correspond to equal quantities of work derived from a working substance performing in perfect Carnot cycles between the respective isothermals." (L. D. Weld, Glossary of Physics, 1937, p. 120.)

Since an ideal gas is not found in nature, the absolute scale is in practice determined from such gases as hydrogen, helium, argon, oxygen, and nitrogen, whose temperature scales depart from that of an ideal gas to a very small degree, especially between certain limits. The degree of deviation is more or less accurately ascertainable by experiment. Such gas thermometers are not used in practical work, but the gas scale is transferred to substandards of other construction.

The absolute temperature scale is almost universally used in the physical sciences, including dynamic meteorology, though the Centigrade and Fahrenheit Scales, q. v., are generally employed in recording temperatures for daily weather and climatological purposes. *See:* R. B. Lindsay, General Physics, 1940, pp. 219–221; Physics, ed. A. W. Duff, 8th ed., 1937, pp. 196–207.

absolute zero, *n.*—That point on the Absolute Temperature Scale, q. v., at which the linear velocities of the random molecular motions of an ideal gas become zero, i. e., at which the molecules are at rest. This occurs, according to recent experimental determinations, at −273.18° C. ±0.03° C.

absorption, *n.*—In meteorology, a general term for the depletion which radiant energy undergoes in traversing the earth's atmosphere (either from sun to earth or from earth to space), and also in penetrating the oceans or other bodies of water and the solid earth.

Radiant energy may be depleted by Scattering, q. v., by irregular reflection, or by being actually taken into the molecules of the permanent gaseous constituents of the atmosphere as well as into the molecules of water vapor and the liquid and solid particles of fog, haze, or dust suspended in the atmosphere. Strictly speaking, however, the application of the term should be limited to that part of the depletion of radiant energy which results from true molecular absorption and transformation into heat or other forms of energy, and should be distinguished from mere diversion through scattering and diffuse reflection. It is estimated that, of the total radiant energy incident at the top of the earth's atmosphere, 5 percent is absorbed by the permanent gases, dust, and clouds in the atmosphere, 12 percent is absorbed selectively by the atmospheric water vapor, and 40 percent is absorbed at the surface of the earth. *See:* C. L. Pekeris, The Development and Present Status of the Theory of the Heat Balance of the Atmosphere, Massachusetts Institute of Technology, Meteorological Course, Professional Notes 5, 1932; SELECTIVE ABSORPTION; RADIATION; SCATTERING.

absorption bands, *n.*—Dark bands in the spectrum of radiant energy resulting from the absorption of particular wave lengths of the radiation by the constituents of the medium through which it passes.

The amount of absorption varies with rays of different wave length or refrangibility, and is in general highly selective, producing lines or bands according as the absorption is by atoms or molecules; bands consist of aggregates of lines.

In meteorology, absorption bands in the sun's spectrum are studied mainly for the information they give regarding the depletion of solar radiation by the earth's atmosphere, and the effects of such depletion on the earth's HEAT BALANCE, q. v. *See:* ABSORPTION; RADIATION; SELECTIVE ABSORPTION.

absorption coefficient, *n.*—The quantity k_λ in the equation,

$$I_\lambda = I_{\lambda 0} e^{-k_\lambda u}$$

for the intensity I_λ of radiation of wave length λ, initially of intensity $I_{\lambda 0}$, after passing through a thickness u of an absorbing medium. There is a definite absorption coefficient for each wave length of radiant energy and for each medium. *See:* BEER'S LAW OF ABSORPTION.

absorption spectrum, *n.*—The spectrum which results after any radiation has passed through an absorbing substance.

absorptivity, *n.*—The ratio of the radiant energy absorbed during transmission through a medium to the incident amount, which ratio varies from unity for a black body to zero for a perfectly transparent body:

$$A = \frac{I_a}{I_0}$$

where A=absorptivity; I_a=intensity radiant energy absorbed; and I_0=intensity of incident radiant energy.

Absorptivity has a different meaning from that of COEFFICIENT OF ABSORPTION, q. v., which is the value of k in the equation,

$$I_\lambda = I_{\lambda 0} e^{-km}$$

where I_λ=intensity of incident radiation of wave length λ after passing through the mass m of the medium; $I_{\lambda 0}$=intensity of incident radiation of wave length λ; e=Napierian base; m=mass of medium passed through. *See:* AIR MASS; H. R. Byers, General Meteorology, 1944, p. 15; Richtmeyer and Kennard, Introduction to Modern Physics, pp. 158, 162–164.

Ac., *abbr.*—Abbreviation for ALTOCUMULUS cloud.

Acc., *abbr.*—Abbreviation for ALTOCUMULUS CASTELLATUS cloud.

acceleration, *n.*—The time rate of change of velocity, either linear or angular; it may be either positive or negative. Expressed algebraically, linear acceleration is

$$a=\frac{dv}{dt}=\frac{d^2l}{dt^2},$$

where l=distance, v=linear velocity, t=time; and angular acceleration is

$$\alpha=\frac{d\omega}{dt}=\frac{d^2\theta}{dt^2}$$

where θ=angle, expressed in radians, ω=angular velocity. The angular acceleration of a body may also be described by the associated linear acceleration of any point of the body along the tangent to its path. Meteorology frequently involves linear accelerations of pressure centers, fronts, centers, troughs, wedges, etc.

acceleration potential, *n.*—A scalar function of space and time $\Omega(x, y, z; t)$ whose negative gradient at any point is equal to a force per unit mass. Thus, if $b.f.$ is a force per unit mass,

$$b.f.=-\text{grad}\ \Omega,$$

where $$[\Omega]=L^2/T^2$$

This is equivalent to

$$X=-\frac{\partial\Omega}{\partial x},\ Y=-\frac{\partial\Omega}{\partial y},\ Z=-\frac{\partial\Omega}{\partial z},$$

where X, Y, Z are the Cartesian components of force per unit mass; i. e., the partial derivatives of the acceleration potential give the components of the acceleration. The force is perpendicular to the surfaces Ω=constant.

In meteorology the term acceleration potential has been applied to quantities such as $\psi=C_pT+gz$, and related functions. In a hydrostatically balanced atmosphere, the quantity ψ possessed the property that

$$-\frac{1}{\rho}\frac{\partial p}{\partial x}=-\left(\frac{\partial\psi}{\partial x}\right)_{y,\theta};\quad -\frac{1}{\rho}\frac{\partial p}{\partial y}=-\left(\frac{\partial\psi}{\partial y}\right)_{x,\theta};$$

where the derivatives in the right members represent the rate of variation of ψ in an individual θ (potential temperature) surface, with respect to variations in the horizontal co-ordinates of this surface. Although the physical distribution of ψ does not strictly satisfy the requirements for potential, it is possible to imagine an apparent or derived distribution which does. If the distribution of ψ in the θ surface is projected vertically into a horizontal plane x, y (as it would in fact be, on a map), the distribution so obtained possesses the property that its (horizontal) gradient is equal to the (horizontal) pressure force per unit mass.

acclimate, *v. t., v. i.*—To habituate or to cause habituation to a different climate, spontaneously and naturally; not synonymous with acclimatize, which refers to the habituation of animals to a foreign climate through the application, at least in part, of artificial means.

acclimation, *n.*—The process of becoming acclimated or spontaneously accustomed to a different climate; not synonymous with acclimatization, by which is meant becoming accustomed to a different climate through the intervention of man, a distinction recognized by several dictionaries. *See:* P. Topinard, Anthropology, London, 1878, p. 393.

acclimatization, *n.*—The adaptation of animals or plants to a different climate, through a process in which nature is assisted by the intervention of man.

acclimatize, *v. t.*—To bring about the adaptation of animals or plants to a different climate, in part by the intervention of man.

accumulated excess (or **deficiency**), *n.*—A phrase used in the U. S. Weather Bureau to indicate the total excess or deficiency from the normal of either temperature or precipitation from any stated time, as the beginning of the month or of the calendar year to date.

The accumulated excess (or deficiency) of temperature since January 1st of the current year to any date for any station is the difference between the sum of the daily means since January 1st and the sum of the daily normals. The average daily excess (or deficiency) of temperature is the result obtained by dividing the accumulated excess (or deficiency) by the number of days in the period considered.

The accumulated excess (or deficiency) of precipitation at any time is the difference between the sum of the daily normals and the accumulated amount from the beginning of the period.

An accumulated excess is indicated by a plus sign, and a deficiency by a minus sign.

accumulated temperature (or **cumulative temperature**), *n.*—An index to both the amount and the duration of an excess or deficiency of air temperature above or below an adopted standard, or base temperature; usually expressed by means of the total of Day Degrees, q. v., for a given period.

An index of this type was first introduced primarily for agricultural purposes, and 42° F. has been adopted in England and most European countries as the base temperature. This standard was suggested by A. de Candolle (Géographie botanique, 1855) as the critical temperature, above which the sun's heat is effectual in starting and maintaining plant growth and in completing the ripening of crops in a European climate. The summation of day degrees may begin with the first of January, the first of December, or the date of sowing the seed, according to the special crop or plant. It has been ascertained, by calculation from a considerable series of hourly observations at various places, that the accumulated temperature may be computed, with a very close approximation to the truth, from the observed difference between base temperature and the mean of the daily maximum and minimum temperatures. *See:* J. W. Moore, Meteorology, 2d ed., 1910, pp. 35–36, 351; J. Hann, Handbook of Climatology, tr. R. D. Ward, Pt. I, 1903, pp. 26–28.

aclinic line, *n.*—*See*: Magnetic Equator.

acoustic cloud, *n.*—A cloud occurring at a boundary between two air layers, where there is a sharp difference between the densities of the air masses (owing to differences in temperature or humidity, or both), so that sound waves are reflected from the interface.

"If the change in density is gradual through a distance of many wave lengths . . . reflection is practically absent. . . . For instance, there can be no reflection of sound from the gradually attenuating upper layers of the atmosphere, as demonstrated by Lord Rayleigh." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 425.)

acoustics, *n.*—*See*: ATMOSPHERIC ACOUSTICS.

actinic, *adj.*—1. Applied to light capable of initiating or causing chemical changes, as in photography or the fading of colors. 2. Applied to wave lengths of light too small to affect our sense of sight, such as the ultraviolet rays.

actinic balance, *n.*—Another name for the BOLOMETER, q. v., an instrument designed to measure the distribution of radiant energy in the solar spectrum.

actinogram, *n.*—The record of an ACTINOGRAPH, q. v.

actinograph, *n.*—A self-registering ACTINOMETER, q. v.

actinometer, *n.*—A general name for any instrument used to measure the intensity of radiation. The following classes of actinometers, all used in connection with solar radiation, are of particular interest in meteorology: (1) Pyrheliometers, which measure the intensity of the sun's radiant energy by means of its heating effects; (2) Photometers, which measure its intensity in terms of the brightness of visible radiation; (3) Chemical actinometers, which measure its intensity by means of the chemical action of the sun's rays. *See:* BOLOMETER; PHOTOMETER; PYRHELIOMETER; SUNSHINE RECORDER.

actinometric, *adj.*—Pertaining to ACTINOMETRY, q. v.

actinometry, *n.*—The science of measuring radiant energy, particularly that of the sun, in its thermal, chemical (actinic), and luminous aspects.

action center, *n.*—*See:* CENTER OF ACTION.

actual elevation, *n.*—A phrase used in the U. S. Weather Bureau to denote the height above mean sea level of the zero point of a weather station barometer. For detailed information, read Circular F, Instrument Division, U. S. Weather Bureau, 7th ed., 1941, pp. 65–68. *See:* STATION ELEVATION.

actual pressure, *n.*—The atmospheric pressure obtained from the observed reading of the barometer by applying the necessary corrections for temperature, gravity, and instrumental errors. *See:* Circular F, Instrument Division, U. S. Weather Bureau, 7th ed., 1941, p. 68.

adiabat, *n.*—A line of constant potential temperature on an Adiabatic CHART, q. v., or the path along which a thermodynamic change takes place in a system when there is no exchange of heat with the environment.

In the case of the atmosphere, two kinds of adiabats are distinguished: the dry and the wet (or moist). A dry adiabat is a temperature-height or temperature-pressure curve along which a rising or sinking air parcel will move, provided no saturation occurs and provided, of course, that no heat is given to or taken from the air during its motion. Similarly, a wet adiabat (saturation or condensation adiabat) is a temperature-height or temperature-pressure curve along which a parcel of saturated air will travel. *See:* ADIABATIC; ADIABATIC GRADIENT (or LAPSE RATE); ADIABATIC PROCESS.

adiabatic, *adj.*—Applied to a thermodynamic process during which no heat is communicated to or withdrawn from the body or system concerned. In the atmosphere, adiabatic changes of temperature occur only in consequence of compression or expansion, accompanying an increase or decrease of atmospheric pressure. Thus, a descending body of air undergoes compression and adiabatic heating, while an ascending air parcel experiences expansion and adiabatic cooling. Such changes are also described as dynamic heating and cooling. *See:* ADIABATIC GRADIENT (or LAPSE RATE).

The use of the term "adiabatic" seems to antedate 1876, as Guldberg and Molin, in their "Studies on the Movements of the Atmosphere" (dated 1876, revised 1883) say: "The equation between the pressure and the volume represents a line that has been called the *adiabatic line.*" (The Mechanics of the Earth's Atmosphere, collection of translations, by C. Abbe, 3d collection, 1910, p. 129.)

Rankine first used the expression, "curves of no transmission of heat," which contains the idea of an adiabatic curve, in his article, "On the Geometrical Representation of the Expansive Action of Heat and the Theory of the Thermodynamic Engines," in Philosophical Transactions of the Royal Society of London, vol. 144, p. 115. Schmid (Lehrbuch der Meteorologie, Leipzig, 1860, p. 38) gives the adiabatic equation, but does not use the term "adiabatic" anywhere in the book.

adiabatic chart (or **diagram**), *n.*—A thermodynamic diagram with pressure and temperature as co-ordinates, which shows "the thermodynamic states of atmospheric air over a wide range of conditions and by which the changes of state and the energy transformations during any prescribed process may be traced out." (E. W. Woolard, Physical Interpretation of the Weather, Journal of Applied Physics, Vol. IX, 1938, p. 12.)

On an adiabatic chart, the abscissa is temperature in centigrade degrees, increasing towards the right; the ordinate is pressure on a logarithmic scale, decreasing upward. The dry adiabats are represented as solid curves running from the upper left-hand corner to the lower right; the moist adiabats are similar diagonal curves, whose slope approaches that of the dry adiabats near the top of the chart, but deviates greatly near the bottom. Dotted lines, whose slope is close to the vertical, give values of the saturation SPECIFIC HUMIDITY, q. v. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 34–37; B. Haurwitz, Dynamic Meteorology, 1941, pp. 49–54; L. P. Harrison, Meteorology, 1942, pp. 81–86; R. H. Weightman, Forecasting from Synoptic Weather Charts, U. S. Department of Agriculture, Miscellaneous Publication 236, Washington, 1936.

By plotting on this chart the values of temperature, pressure, and specific humidity at various levels in the atmosphere, as obtained from a SOUNDING, q. v., the conditions in the vertical with respect to stability, available energy, etc., may be determined. Furthermore, many of the weather phenomena to be anticipated from the existing meteorological circumstances may be inferred.

adiabatic equilibrium, *n.*—The state prevailing within a layer of the atmosphere when the prevailing LAPSE RATE, q. v., equals the dry-adiabatic rate of cooling, i. e., when the air is in neutral equilibrium. *See:* ADIABATIC; STABILITY.

adiabatic expansion, *n.*—An expansion during which no heat enters or leaves the substance. Air that rises in the atmosphere expands under the decreased pressure practically adiabatically because the process is so rapid. *See:* ADIABATIC PROCESS.

adiabatic gradient (or **lapse rate**), *n.*—A LAPSE RATE, q. v., equal to the rate of decrease of temperature of a sample of adiabatically ascending air. For dry (i. e., unsaturated) air it is approximately 1° C. per 100 meters. After saturation is reached, the rate of cooling, now called the saturated-adiabatic lapse rate, is less than the dry-adiabatic, since it is decreased by the heat of vaporization that is released in the formation of liquid droplets from the water vapor. This saturated-adiabatic rate depends upon temperature and to some extent upon pressure, and therefore has no fixed value. It varies from 0.04° C. to 1° C. per 100 meters. *See:* ADIABAT; ADIABATIC; ADIABATIC PROCESS.

adiabatic heating, *n.*—*See:* ADIABATIC PROCESS.

adiabatic process, *n.*—A thermodynamic process in which no heat exchange occurs between the working system and its environment; closely approximated in the atmosphere by an element of air in a rapidly ascending or descending current. If an unsaturated air parcel whose temperature is above the freezing point moves upward, the resulting adiabatic process may be divided into four successive stages. These are: (1) Dry (unsaturated) stage, in which the air cools at practically the dry-adiabatic rate, that is, at about 1° C. for every 100 meters of lifting, until it reaches the temperature at which saturation occurs; (2) Rain stage, in which it continues to ascend and cool, but now at the saturated adiabatic rate, until it reaches the freezing point; (3) Hail stage, in which it continues to rise, but remains at the freezing temperature until all its liquid water content is changed to ice, since the adiabatic cooling is balanced by the heat of fusion given out by the water; (4) Snow stage, in which the air, still saturated, continues to cool as it rises; condensation takes place as in the rain stage, though now the water forms directly into ice crystals. This part of the process continues until the air is dry, after which it cools at the dry-adiabatic rate.

It is assumed that in each of these stages the products of condensation, in any form whatsoever, are carried along with the element of air. If the adiabatic process just described were now reversed, the four stages would take place in reverse order, and the air would arrive at its starting point with the same temperature and moisture content it had in the beginning. This type of process, accordingly known as the reversible-condensation-adiabatic process, seldom occurs in nature, for the products of condensation inevitably drop out, at least in part, as rain, hail, or snow, and the process is really intermediate between an adiabatic and a PSEUDO-ADIABATIC PROCESS, q. v. *See:* D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 59–60, 63–65; B. Haurwitz, Dynamic Meteorology, 1941, pp. 47–49; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 30–34.

adiabatic region, *n.*—The TROPOSPHERE, q. v.; that part of the atmosphere below the TROPOPAUSE, q. v.

adiabatic temperature change, *n.*—*See:* ADIABATIC PROCESS.

adret, *n.*—A sunny slope in the Alps; also called the "sonnenseite." *See:* UBAC; W. G. Kendrew, Climate, 1930, p. 226.

advection, *n.*—1. Horizontal flow of air at the surface or aloft; one of the means by which heat is transferred from one region of the earth to another. 2. In a more restricted sense, the drawing in of air in a horizontal direction; as in the case in the surface layers of a cyclone; its opposite is divection. *See:* ADVECTIVE.

advection fog, *n.*—A type of fog due to the transport of warm air over a cold surface, either land or water, or to the transport of cold air over a warm-water surface. Since many fogs are caused by the joint action of two or more processes, fogs that are classified as of the advection type may have been formed in part in other ways. H. C. Willett, in his article on "Fog and Haze, their Causes, Distribution, and Forecasting," Monthly Weather Review, vol. 56, 1928, pp. 435–468, classifies advection fogs as follows:

A. Types due to the transport of warm air over a cold surface.
1. Monsoon fog.
2. Sea fog occurring near contrasting water temperatures.
3. Tropical air fog.
4. Tropical air haze.

B. Types due to the transport of cold air over a warm-water surface.
1. Arctic sea smoke.
2. Autumn early morning steam mists over lakes, rivers, etc.

advective, *adj.*—1. Pertaining to atmospheric phenomena or conditions in which advection, or the transfer of air by horizontal motion, is the dominating influence. *See:* ADVECTION. 2. Also used in a sense complementary to divective, that is, to denote a flowing in of air toward one point, as in the case of the surface winds in a cyclone. "Advective influence upon a surface is the influence which causes air to cross the line of a closed curve drawn on the surface, from without to within, and divective influence is an influence which causes air to cross the line of a closed curve drawn on the surface, from within to without." (N. Shaw, Manual of Meteorology, Vol. III, 1940, p. 398.)

advective region, *n.*—1. The name proposed by Gold and Harwood in 1909 for the upper region of the atmosphere, now known as the stratosphere, in which the motion of the air is assumed to take place mainly by ADVECTION, q. v., as distinguished from the lower, or convective region, of the atmosphere. 2. Also used by Sir Napier Shaw, as follows: "The boundaries of regions of normally heavy rainfall can designate for us the 'advective regions' to which air must normally flow in order to make good the loss by convexion (sic), and contrariwise the boundaries of the regions where there is no rainfall, or next to none, will identify the 'divective regions' from which air must normally flow to meet the convective requirements of the advective regions." (Manual of Meteorology, Vol. III, 1930, p. 404.)

advective thunderstorm, *n.*—A thunderstorm resulting from instability produced by horizontal advection of colder air at higher levels or by horizontal advection of warmer air at lower levels, or by a combination of both.

aeolian, *adj.*—Pertaining to the action or effect of the wind on strings and wires, which produces musical tones, the so-called AEOLIAN TONES, q. v.

aeolian tones, *n.*—Musical sounds produced by the wind flowing past a stretched wire or a cylinder; first explained in 1878 by Strouhal, who found that the tones were caused by vortices produced on the leeward side of such objects; the vortices are unstable and vibrate from side to side in a manner similar to the flapping of a flag in a breeze. Their vibrations are communicated to the stationary air, thence to the ear. The object itself may not vibrate; but the tones are loudest when they are reinforced by its vibration, which occurs when its natural periods of vibration or harmonics correspond with those of the vortices.

aerobiology, *n.*—The science which treats of the small organisms, both plant and animal, that are borne aloft by the air; and investigates their behavior in the air and their effects on other organisms.

aerodynamic, *adj.*—Pertaining to the laws of motion of air or other gases.

aerodynamic balance, *n.*—An instrument used to measure wind pressure on surfaces. *See:* Hunsaker et al., Report on Wind Tunnel Experiments in Aerodynamics, Smithsonian Miscellaneous Collections, vol. 62, No. 4, pl. 3.

aerodynamic laboratory (or **observatory**), *n.*—A laboratory in which the essential object is research on the resistance of the air to moving bodies and the application of this research to the progress of aerial navigation. *See:* AERODYNAMICS.

aerodynamics, *n.*—A branch of physics which "may be defined broadly as the science of motion of air or an aeriform fluid. Commonly, air alone is implied in the word. This is especially true when the name is used by engineers. With them it is the analogue of hydraulics, which is the science of motion of water. Both sciences treat not only of the motion of their peculiar media, but also of its effect on objects or machinery connected with the fluids." (A. F. Zahm, Elements of Theoretical Aeromechanics, Pt. II, Journal of the Franklin Institute, 1912, vol. 173, p. 251.)

aerogram, *n.*—1. The record traced by an AEROGRAPH, q. v. 2. A THERMODYNAMIC DIAGRAM, q. v., devised by Refsdal, in which the abscissa is the logarithm of temperature and the ordinate is temperature times the logarithm of pressure. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 51–54; E. W. Hewson and R. W. Longley, Meteorology, Theoretical and Applied, 1944, p. 65.

aerograph, *n.*—An instrument used with kites and balloons to record automatically and simultaneously several meteorological elements, such as barometric pressure, temperature, and humidity. *See:* METEOROGRAPH.

aerographer, *n.*—A term used in the United States Navy and applied to enlisted men who have taken a course of study in aerography and who perform aerological duties, such as taking observations of all kinds, recording and charting data, making weather maps and energy diagrams, and forecasting the weather.

aerography, *n.*—The science of the atmosphere, but dealing especially with the description of the atmosphere as a whole and its various phenomena.

aerology, *n.*—1. A term often used synonymously with meteorology, and thus meaning the science of the atmosphere. The fundamental principles of meteorology and aerology are the same. *See:* METEOROLOGY. 2. As a subdivision of meteorology, the study of the free atmosphere throughout its vertical extent, distinguished from studies confined to the layer of the atmosphere adjacent to the earth's surface. Aerological investigations are made directly by means of pilot balloons, sounding balloons, and airplanes. They are also made indirectly by visual observations from the ground, including observations of clouds, meteor trails, the aurora, etc.

aerometeorograph, *n.*—1. An instrument specially adapted for use on airplanes and dirigibles for the simultaneous recording of atmospheric pressure, temperature, and humidity. *See:* Instructions for Making Aerological Observations, U. S. Weather Bureau, 1930, p. 69. 2. An AEROGRAPH, q. v.

aeronautical meteorology, *n.*—The branch of METEOROLOGY, q. v., concerned with weather insofar as it affects aviation. It uses the techniques of SYNOPTIC METEOROLOGY, q. v., with special attention to conditions in the atmosphere that are important for flight, such as upper winds, icing, turbulence, thunderstorms, etc.; and also the data of climatology relevant to planning airways, laying out airports, etc.

aerosol, *n.*—1. A dispersed system in which the dispersion medium is a gas. 2. An aggregation of dispersed particles suspended in the atmosphere. 3. The special type of colloid, formed by the liquid or solid particles, organic and inorganic, and the gases of the atmosphere in which these particles float. *See:* W. J. Humphreys, Colloid Meteorology, Colloid Chemistry, ed. J. Alexander, 1926, Vol. I. p. 424.

aerostatic balance, *n.*—An instrument for weighing air. *See:* AIR POISE.

aestival, *adj.*—Pertaining to summer. *See:* AESTIVATION; HIBERNAL; HIBERNATION.

aestivation, *n.*—A state of dormancy of certain animals, fishes, reptiles, and insects during the summer. This summer state of torpidity is due, it is thought, to lack of either food or water, or both. *See:* HIBERNATION.

afterglow, *n.*—1. A broad high arch of radiance or glow seen occasionally in the western sky above the highest clouds in deepening twilight, caused by the scattering effect exerted upon the components of white light by very fine particles of dust suspended in the upper atmosphere. 2. The name of one stage in the ALPENGLOW, q. v.

afterheat, *n.*—The warm weather of INDIAN SUMMER, q. v.

aftersummer, *n.*—A recurrent mild period in autumn; INDIAN SUMMER, q. v.

agonic line, *n.*—A line passing through points on the earth's surface at which the magnetic declination is zero, that is, where the magnetic needle points to true north.

agricultural climatology, *n.*—The branch of climatology which deals with climate in its relation to agriculture.

The climate of a place largely determines its natural vegetation (though other factors, such as its soil, are important), the kind of crops that can be profitably raised, and, therefore, the types of farming in which the inhabitants engage.

Agricultural climatology and agricultural meteorology cannot easily be differentiated, and by many the terms are used interchangeably. However, some relations of weather and farming, such as the cumulative effect of the weather of a particular summer on a certain crop, are obviously meteorological, while others, such as the average length of the growing seasons in various parts of a country, are clearly climatological.

air, *n.*—1. The mixture of gases comprising the earth's ATMOSPHERE, q. v.

PHYSICAL CONSTANTS FOR AIR

Weight of dry air at standard pressure and temperature=0.001293 gm cm^{-3}.

Critical constants:

pressure	=37.2 atmospheres
temperature	= −140.7° C.
volume	=0.00468

Specific heat of dry air at constant volume=0.1707 cal gm^{-1} deg^{-1}.
Specific heat of dry air at constant pressure=0.2396 cal gm^{-1} deg^{-1}.
Characteristic gas content for dry air, $R_i=2.87\times10^6$ cm^2 sec^{-2} deg^{-1}

2. A breeze; for example, in the BEAUFORT WIND SCALE, q. v., a breeze of from one to three miles per hour is designated a light air.

air conditioning, *n.*—A branch of engineering, the function of which is to devise and install within buildings equipment for controlling the humidity, temperature, motion, and purity of the air, and for maintaining proper pressure; also the operation of such control and maintenance. The objective may be to secure either maximum human comfort or the best conditions for handling such materials as lumber, paper, textiles, tobacco, etc., in manufacturing processes.

air current, *n.*—A stream of air moving in any direction other than the horizontal, especially in the vertical. Air flowing in a nearly horizontal direction is ordinarily called WIND, q. v.

Vertical motions in the atmosphere are usually small in comparison with the horizontal motions, and "there has been a tendency until comparatively recent years, among many meteorologists, to neglect in large measure the third or vertical dimension in the atmosphere and to consider the motions to be almost entirely horizontal. . . .

"The modern application of the principles of physical hydrodynamics to the weather has given conclusive evidence that the vertical components of air motions are the principal factors in producing the more important meteorological phenomena." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 17.)

air drainage, *n.*—The flow of air down a slope or channel. Air tends to flow downhill, due to gravity, when its density is greater than that of the adjacent air at the same level.

"During clear nights when there is but little or no general wind, there usually is a flow of the surface air, commonly most pronounced in ravines, down the sides and along the basin of every valley. At most places this movement is gentle to very slow, but in those exceptional cases where the valley is long and rather steep, especially if covered with snow and free from forest, and still better if fed by a gently sloping plateau, the down-flowing air current may attain the velocity of a gale and become a veritable aerial torrent. This drainage flow is known indifferently as the mountain breeze, or mountain wind; also canyon wind, katabatic wind, and gravity wind." (W. J. Humphreys, Physics of the Air, 1940, pp. 159-60.) *See:* KATABATIC WIND.

air light, *n.*—The common atmospheric phenomenon in which "dark objects such as woods or houses appear lighter in tone, the farther they are away. The effect is known to artists as 'aerial perspective' or 'atmosphere,' and is a powerful aid to geometric perspective in creating the illusion of three dimensions in a picture. Indeed, it is one of our normal means of estimating distance, and its comparative failure in the clear air of arctic latitudes often results in really surprising errors by the inexperienced. The effect is due to the scattering of light into the eyes of the observer from the pyramid of air between him and the distant object, which light is added to the intrinsic brightness of the object to make it appear brighter than it would look if observed close at hand." (W. E. K. Middleton, Visibility in Meteorology, 2d ed., 1941, pp. 29–30.)

air mass, *n.*—1. A wide-spread body of air which approximates horizontal homogeneity: that is, its physical properties, level for level, are about the same over a wide area. The region where an air mass acquires its original characteristics is called its SOURCE REGION, q. v.

When a large portion of the atmosphere comes to rest or moves slowly over a uniform surface it tends to assume the thermal and moisture properties of the surface. Then, when it again comes into motion under the action of pressure gradients, the air mass will tend to retain these properties or, at least, will be modified in a definite way, depending on the surface over which it moves. Hence, it is possible to distinguish four main types of air masses, depending on the geographical positions of their sources: (1) Equatorial air masses (*E*), originating in the equatorial part of the trade-wind zone; (2) Tropical air masses (*T*), formed in the subtropical anticyclones; (3) Polar air masses (*P*), typical of the subpolar anticyclones; (4) Arctic air masses (*A*), formed over the arctic fields of ice and snow.

This main classification is further refined by subdividing the air masses into maritime (*m*) or continental (*c*) masses, depending on whether their source is oceanic or continental. Since the properties of equatorial air are the same no matter whether it originates over land or sea, it is usually referred to as *E* alone. Similarly, arctic air, originating over an ice or snow surface, is called *cA* or *A*, but not *mA*. The others are referred to as *cT*, *mT*, *cP*, and *mP* respectively.

In addition, two other types of air masses are distinguished: Monsoon air (*M*), a transition form between *cP* and *E*, and supérieure air (*S*), which is unique in that it is formed in the free atmosphere.

Bergeron, who is the author of this system of air-mass identification, finally makes a thermodynamic subclassification, using the terms cold (*k*) and warm (*w*) to state whether the air is colder or warmer than the underlying surface. This classification indicates, however imperfectly, the stability conditions of the air, for, obviously, a *k* air mass will undergo surface heating and tend to develop a state of unstable equilibrium, whereas a *w* mass will be cooled from below and its stability enhanced.

The following table summarizes the main types of air masses. A fuller treatment of each type will be found in this glossary under its appropriate heading. *See:* SOURCE REGION; FRONT; FRONTAL SURFACE.

SYMBOL	DENOMINATION
A	Arctic air.
cPk, *cPw*	Polar continental air, colder or warmer than the underlying surface.
mPk, *mPw*	Polar maritime air, colder or warmer than the underlying surface.
cTk, *cTw*	Tropical continental air, colder or warmer than the underlying surface.
mTk, *mTw*	Tropical maritime air, colder or warmer than the underlying surface.
E	Equatorial air.
M	Monsoon air.
S	Supérieure air.

2. The relative length of the path of solar rays through the atmosphere as compared with the extent of the path when the sun is in the zenith; or approximately the secant of the sun's zenith distance. In this sense, the air mass is defined by the quantity m in the following equation:

$$I_\lambda = I_0 \ a^m$$

I_λ = the measured intensity of a ray of wave length λ.
I_0 = the intensity before depletion in the earth's atmosphere.
a = the atmospheric transmission coefficient, or the proportion of I_0 that would reach the earth's surface with the sun in the zenith.
m = the air mass. Its value is taken as unity when the sun is in the zenith, and increases to about 32 times this unit when the sun is on the horizon. The following table gives approximate values for varying zenith distances:

RELATIVE AIR MASSES TRAVERSED BY SUN'S RAYS

Zenith Distance of the Sun	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Air mass	1. 00	1. 02	1. 06	1. 25	1. 31	1. 56	1. 99	2. 90	5. 56	32. 0

(D. Piston, Meteorology, Philadelphia, 1941, Table V.) *See:* Bull. 79, National Research Council, Physics of the Earth, Vol. III, p. 36; Smithsonian Physical Tables, 1934, Table 778, p. 611.

air-mass analysis, *n.*—1. The analysis of a synoptic weather map in respect to: (a) the extent and physical properties of each of the air masses over the region covered by the map, (b) the relations of the different air masses to each other, and (c) the location, structure, and movement of the fronts along which the different masses meet. *See:* T. A. Blair, Weather Elements, 1937, p. 236; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 1 and 446 ff. 2. Also a general name applied to the so-called Norwegian methods of synoptic meteorology.

air-mass classifications, *n.*—The systems which have been devised by various meteorologists to characterize and identify different air masses. Bergeron's classification has been generally accepted, and is the one discussed under AIR MASS (1), q. v. Local classifications, based on his principles, have been devised for North America and Europe by Willett and Schinze, respectively. *See:* T. Bergeron, Uber die dreidimensional Verknupfende Wetteranalyse, Geofysiske Publikasjoner, vol. 5, Oslo, 1928; Outline of a Dynamic Climatology, tr. of Richtlinien einer dynamischen Klimatologie, Meteorologische Zeitschrift, vol. 47, 1930; G. Schinze, Die praktische Wetteranalyse, Archiv deutsche Seewarte, band 52, 1932; H. C. Willett, American Air Mass Properties, Papers in Physical Oceanography and Meteorology, vol. 2, 1934; A. K. Showalter, Further Studies of American Air-Mass Properties, Monthly Weather Review, vol. 67, 1939, pp. 204–218.

air-mass climatology, *n.*—The study of climate from a dynamic and thermodynamic point of view, with particular reference to the air masses involved. This viewpoint was suggested by Bergeron, who pointed out that "extra-tropical climatology has consisted essentially of the compilation of statistical tables and the construction of distribution charts of the separate meteorological elements," among which the wind has come to be considered of primary importance. In the tropics, however, "the wind system cannot always be described as an entirely uniform analytical process, nor can it always be explained in dynamic or thermodynamic terms. Further studies of climatology may extend the latter type of explanation eventually to embrace all latitudes and all climatic phenomena." (T. Bergeron, Outline of a Dynamic Climatology, tr. from Meteorologische Zeitschrift, vol. 47, 1930, p. 1.)

air-mass meteorology, *n.*—Roughly synonymous with AIR-MASS ANALYSIS, q. v.; the study of the current weather over a region in terms of the air masses affecting it and their interactions. This subject should therefore be distinguished from AIR-MASS CLIMATOLOGY, q. v., in which the mean weather over a long period of years is analyzed from the same viewpoint.

air-mass modifications, *n.*—The alterations in physical characteristics that occur in an air mass once it has left its SOURCE REGION, q. v. The modifying influences, which seldom act singly, but usually in combinations of two or more, may be classified as follows:

A. Thermodynamic.
1. Heating from below.
   a. By passing from a cold to a warm surface.
   b. By solar heating of the ground.
2. Cooling from below.
   a. By passing from a warm to a cold surface.
   b. By radiation cooling of the earth's surface.
3. Addition of moisture by evaporation.
   a. From a water or ice and snow surface or from moist ground.
   b. From raindrops or other precipitation forms which fall through the air mass out of an overrunning saturated air current.
4. Removal of moisture by condensation and precipitation.

B. Mechanical.
1. Turbulent mixing.
2. Sinking.
   a. In subsidence and lateral spreading.
   b. Movement down from above colder air masses.
   c. Descent from high elevations to lowlands.
3. Lifting.
   a. Over colder air masses.
   b. To compensate for horizontal convergence.
   c. Over elevations of the land.

(H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 51–52; cf. Ibid., pp. 51–56.)

air-mass property, *n.*—Any quality or quantity the nature or value of which can be used in a characterization of the physical state or condition of an air mass.

air-mass showers, *n.*—Showers which result when a cold air mass (as polar-pacific air) follows a cyclone; the air is then colder than the surface, resulting in INSTABILITY SHOWERS, q. v.

air-mass thunderstorm, *n.*—A thunderstorm that occurs in an air mass whose chief characteristics are instability and high moisture content. A thunderstorm is simply an intense variety of instability shower; and any air mass in which convection is active may produce a thunderstorm, especially if the moisture content is high. An air mass particularly productive of thunderstorms is the tropical-maritime during summer in the eastern United States. *See:* E. W. Hewson and R. W. Longley, Meteorology, Theoretical and Applied, pp. 252, 258, 259, 260, 378.

air-mass-type diagram, *n.*—A diagram on which are curves indicating the normal distribution of potential pseudo-wet-bulb temperatures in the principal types of air masses; when a curve has been plotted on it, indicating the actual distribution of potential pseudo-wet-bulb temperatures in an observed air mass, it may be used to show what type of air mass is above the station in question. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, p. 203; ROSSBY DIAGRAM.

air meter, *n.*—A portable instrument which indicates the number of linear feet or meters of air passing the instrument, and which is suitable for the measurement of speeds from 50 to 10,000 feet per minute. It is used to investigate air currents in mines, buildings, etc.

air pocket, *n.*—A term introduced in the early days of aviation to account for the sensation of being suddenly lifted or dropped that was occasionally experienced by the occupants of an airplane. The air is called "bumpy" under such conditions, and is said to contain "pockets" or "holes"; but the use of these terms should be discouraged, since in reality there are no holes or pockets in the atmosphere. The sensation of being lifted is explained by the plane meeting a rising column of air, or by passing into an air mass with greater wind speed directed toward the plane; either of these conditions would give the plane greater lift. The sensation of dropping is explained by the plane meeting a falling stream of air, or by entering an air mass whose direction of motion is with the plane; these conditions give the plane less lift than it formerly had. The condition of "bumpiness" is encountered in air blowing over obstacles or surface irregularities, and in connection with the turbulence of thermal convection and thunderstorms. *See:* TURBULENCE.

air poise, *n.*—An instrument for weighing air.

air pressure, *n.*—*See:* ATMOSPHERIC PRESSURE.

air resistance, *n.*—The frictional resistance offered by air to the motion of bodies passing through it.

The speed of falling bodies in a vacuum is easily determined from well-known physical laws; but bodies falling through air have various rates of fall, depending upon the amount of resistance encountered because of their different shapes and densities. All bodies falling through air finally reach a speed such that the air resistance acts as an equilibrant to the force of gravity; when the two forces are balanced, the bodies cease to be accelerated and fall with a uniform speed. Heavier bodies take longer to reach this stage, but even they finally attain a maximum speed or terminal velocity of fall. For small raindrops, the terminal velocity may be computed from STOKES' LAW, q. v.

air sickness, *n.*—*See:* MOUNTAIN SICKNESS.

air-speed meter, *n.*—An instrument used on an aircraft to measure its speed relative to the air. This instrument should be clearly distinguished from the ground-speed indicator, which measures the speed of the aircraft relative to the ground.

air thermometer, *n.*—A THERMOMETER, q. v., in which temperature is measured by the expansion and contraction of air under constant pressure. Sir Napier Shaw describes such a thermometer, called a gramme-joule air thermometer, in his Manual of Meteorology, 1930, Vol. III, p. 219. A tube containing one gram of air dips into a larger tube containing mercury, and constant pressure is obtained by a counterpoise chain passing over a pulley to which the first tube is attached. The tube rises through one centimeter for every degree increase of temperature, corresponding to the addition of one joule of heat. The temperature is read off a scale on the tube at the level of the mercury.

air trajectory, *n.*—The path followed by a particle of air for a given time. *See:* Meteorological Office, The Meteorological Glossary, 3d ed., London, 1939, p. 197; N. Shaw, Forecasting Weather, 2d ed., 1923, pp. 255–258.

air trap, *n.*—A funnel or pipette inserted somewhere between the range of the column and the neck of the cistern of a mercurial BAROMETER, q. v., the object being to prevent the ascent into the Torricellian vacuum of any air or moisture which may work its way out from the cistern between the glass and the mercury. *See:* J. W. Moore, Meteorology, 2d ed., 1910, p. 125.

albedo, *n.*—1. The rates of the light reflected by a planet or satellite to that received on its whole illuminated hemisphere. The average albedo of the moon is 7.3 percent; the remaining 93 percent of the incident light is absorbed. The albedos of the planets, as given in the Smithsonian Physical Tables, 8th revised edition, 1934, p. 607, are as follows:

Earth	43 percent
Mercury	6.9 to 5.5 percent
Venus	59 percent
Mars	15.4 percent
Jupiter	56 percent
Saturn	63 percent
Uranus	63 percent
Neptune	73 percent

2. The reflectivity of one of the different materials forming the surface of the earth. *See:* REFLECTIVITY.

albedometer, *n.*—An instrument for measuring the reflecting factor, or ALBEDO, q. v., of a surface; used, for example, to obtain the albedos of the many varieties of surface coverings on the earth, such as grass, snow, plowed land, etc.

Alberta low, *n.*—A name formerly applied by the forecasters of the U. S. Weather Bureau to an extratropical cyclone that was first definitely charted in the Alberta Province of Canada. This name was no longer applied after the enlargement of the area of observation indicated that the so-called "Alberta" lows did not originate there.

alcyon days, *n.*—*See:* HALCYON DAYS.

Aleutian low, *n.*—The semi-permanent cyclone or low that is usually located near the Aleutian Islands. It represents one of the CENTERS OF ACTION, q. v., into which the low and high pressure zones of the planetary circulation break up.

In the southern hemisphere there is, throughout the year, a continuous belt of low pressure at 60–70° S. lat. In the northern hemisphere, however, at 60–70° N. lat., the pressure distribution is much more complicated. The counterpart of the southern hemisphere belt of low pressure is not a continuous belt of low pressure but individual lows. One is centered near the southeastern coast of Greenland, and the other near the Aleutian Islands.

The Aleutian low is not a fixed or permanent feature, however; An actual study of the year-round weather over this region, as carried out during the past year, indicates clearly that the "average" pressure, as compiled in all monthly and yearly normals, is of little value in actually understanding the weather over this area.

A truer picture of the actual pressure variations which go toward making up the "average" pressure, will give, not one single "Low" pressure area of a certain depth centered over or near the (Aleutian) Islands, but a great number of large or small "Lows" with a like number of large or small "High" pressure areas distributed over the northern portion of the Pacific Ocean and the bordering Aleutian Islands, some moving, others stagnant.

Normally the depth or itensity of the Low pressure areas will exceed the height of the High pressure areas which follow them, in which case, the average will indicate exactly what the "average" shows—a region of low pressure over the Aleutian Islands and the bordering ocean.

alidade, *n.*—A stationary instrument, mounted on a stand and carefully leveled, used in conjunction with a CEILING LIGHT, q. v., or projector to measure cloud heights at night. An instrument serving the same purpose, used in the U. S. Weather Bureau, is called a CLINOMETER, q. v. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 173.

All-hallown summer, *n.*—"A season of fine weather in the late autumn. Apparently obsolete, but worthy of revival, as much superior to its equivalents, St. Martin's Summer (from French) and Indian Summer of America." (Oxford Dictionary.) *See:* ALL SAINTS' SUMMER; INDIAN SUMMER.

allobar, *n.*—An area over which the barometric pressure has changed (risen or fallen) within some specified time. *See:* ANALLOBAR; KATALLOBAR.

All Saints' summer, *n.*—Indian summer; mentioned in H. W. Longfellow's "Evangeline": "Then followed that beautiful season, called by the pious Acadian peasants the summer of All Saints." *See:* ALL-HALLOWN SUMMER; INDIAN SUMMER.

almanac, *n.*—A book or table containing a calendar of the days, weeks, and months of the year, a register of ecclesiastical festivals and Saints' days, predictions of various astronomical phenomena, etc. Many almanacs also contain weather prognostications of doubtful merit for a year in advance.

alpenglow, *n.*—A reappearance of sunset colors on a mountain summit sometimes observed after the original colors have faded; also a similar phenomenon preceding the regular coloration at sunrise.

The term is best applied to the whole series of optical phenomena attending the illumination of mountain summits at sunrise and sunset. Three phases have been distinguished: (1) The ordinary evening colorations of the peaks, when the sun is still a little above the horizon (zenith distance about 88 degrees). (2) The alpenglow proper, which occurs a few minutes after the first color has faded, the sun's zenith distance being a little over 90°. The peaks are still in direct sunlight, and the coloration is deeper and often more flesh-pink; it begins often many hundred meters below the summit and spreads upward, and is extinguished by the rise of the earth's shadow. (3) The AFTERGLOW, q. v., which occurs at the time of the "first-purple light." The peak is not now in direct sunlight, and the illumination is now much more diffused and its boundary more ill-defined than in the preceding stages. The color varies from yellow to purple. The third stage is of longer duration than the other two, corresponding to a depression of the sun below the horizon of 4° to 9°. A faint second afterglow has been witnessed.

The alpenglow appears to be a much less common phenomenon at sunrise than at sunset. The morning colors are more pink and purple; those of evening more orange and red.

altigraph, *n.*—A recording ALTIMETER, q. v.

altimeter, *n.*—An aneroid barometer graduated to show height instead of pressure. The scale is uniformly divided into equal parts, and hence may be rotated in order to make the setting zero at the start of the flight.

Altimeter scales are based on the assumption of a certain distribution of temperature with altitude. If the current distribution is different from the adopted one, the elevations indicated by the instrument are only approximate.

All American and British altimeters are in substantial agreement. American altimeter dials are graduated in accordance with the formula:

$$h = 62900 \log_{10} \frac{29.90}{p}$$

where h=height, and p=the atmospheric pressure. A strictly uniform temperature of 50° F. (10° C.) is assumed for the air column.

altimeter corrections, *n.*—These are: (1) Horizontal pressure gradient error, resulting from horizontal changes in existing "altimeter settings" at the surface. (2) Air-temperature error, resulting from difference between the actual mean temperature at the air column extending beneath the aircraft and the standard mean temperature of the appropriate corresponding air column in the standard atmosphere. *See:* B. C. Haynes, Meteorology for Pilots, Civil Aeronautics Bull. No. 25, 1943, pp 203–206.

altimeter setting, *n.*—A barometric pressure in inches for setting a pressure-scale-type altimeter when a pilot takes off, and as often as possible during the entire flight; the readings for altimeter settings are given with the meteorological messages, and the pilot uses the altimeter setting of the station nearest to him while in flight.

altimetry, *n.*—The art of measuring altitudes. *See:* HYPSOMETRY.

altitude, *n.*—1. A term used in meteorology to denote height above ground; the term elevation is used to refer to height above sea level. These two terms are often used interchangeably, however, and no sharp distinction can be said to exist at present between them. Engineers use the word elevation with reference to the height of an object relative to sea level or to some fixed datum. 2. Angular elevation above the horizon.

altocumulus, *n.*—A form of middle cloud, family B, in the international CLOUD CLASSIFICATION, q. v. It is a layer (or patches) composed of laminae or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without shading. These elements are arranged in groups, in lines, or waves, following one or two directions, and are sometimes so close together that their edges join.

The limits within which altocumulus is met are very wide. At the greatest heights, altocumulus made up of small elements resembles cirrocumulus; altocumulus, however, is distinguished by not possessing any of the following characteristics of cirrocumulus: (1) Connection with cirrus or cirrostratus; (2) An evolution from cirrus or cirrostratus; (3) Properties due to physical structure (ice crystals) enumerated under CIRRUS, q. v. At lower levels, where altocumulus may be derived from a spreading out of the tops of cumulus clouds, it may easily be mistaken for stratocumulus; the convention for distinction is that the cloud is altocumulus if the smallest, well-defined, and regularly arranged elements which are observed in the layer (leaving out the detached elements which are generally seen on the edges) are not greater than 10 solar diameters in their smallest diameters, i. e., approximately the width of three fingers when the arm is held extended.

The thin and translucent edges of the elements show irisations which are rather characteristic of this class of cloud, as distinguished from cirrocumulus or stratocumulus. Irisations are phenomena of the same type as the CORONA, q. v., which also appears when the edge of a thin semitransparent patch of altocumulus passes in front of the sun or moon. This phenomenon is infrequent in the case of cirrocumulus, and only the higher forms of stratocumulus show it.

Altocumulus clouds often appear at different levels at one and the same time. Often, too, they are associated with other types of clouds; when the elements of a sheet of altocumulus fuse together and make a continuous layer, altostratus or nimbostratus is the result; on the other hand, a sheet of altostratus can change into altocumulus. It may happen that these two aspects of a cloud sheet may alternate with each other during the whole course of a day. It is also not rare to have a layer of altocumulus coexisting with a veil resembling altostratus at a height very little less than that of the altocumulus.

It is interesting to note, too, that one may often observe filiform descending trails from altocumulus, to which the name VIRGA, q. v., has been given.

altocumulus castellatus, *n.*—A variety of altocumulus which, when near the zenith, presents to an observer on the ground the typical appearance of masses arranged in lines and showing a pronounced cumuliform development with little turrets formed in lines resting on a common horizontal base. These clouds often precede thunderstorms.

altocumulus cumulogenitus, *n.*—A species of altocumulus cloud formed by the spreading out of the tops of cumulus, the lower portions of the cumulus clouds having melted away; the layer in the first stages of its growth has the appearance of ALTOCUMULUS OPACUS, q. v.

altocumulus floccus, *n.*—A variety of altocumulus consisting of scattered tufts, of which some resemble small cumulus or fractocumulus clouds without bases and are more or less ragged in structure; others are partially so; and still others are ill-developed globular masses, rather white and resembling cumulus heads.

altocumulus lenticularis, *n.*—A variety of altocumulus composed of lens-shaped masses. When this cloud is formed over a mountain peak by air passing over the peak, the cloud remains stationary while the air passes through it. *See:* CLOUD CREST.

altocumulus opacus, *n.*—A subgenus of altocumulus, consisting of a thick sheet of this cloud which is continuous, at least over the greater part of the layer, and is also made up of dark and more or less irregular elements. These elements show in real relief on the lower surface of the cloud sheet and give it the pendant appearance which, together with the dark color and menacing appearance of the cloud sheet, is characteristic of this form of altocumulus.

altocumulus translucidus, *n.*—A subgenus of altocumulus formed of elements whose color—from dazzling white to dark gray—and whose thickness vary much from one example to another, and even within the same layer, while the elements are more or less regularly arranged and distinct. In the definition of the elements it is the variation in the transparency of the layer from one point to another that plays the essential part. In the interstices between the elements there appears either the blue of the sky, or at least a marked brightening of the layer of cloud due to its thinning out.

altocumulus undulatus, *n.*—A variety of altocumulus having big roll clouds, separated by streaks of blue sky. Near the horizon the rolls appear to be joined together: this is the effect of perspective. In a subvariety of this cloud, called altocumulus undulatus radiatus, may be observed a very regular formation of the rolls in two directions, crossing one another.

altostratus, *n.*—A form of middle cloud, family B, in the CLOUD CLASSIFICATION, q. v. It is a striated or fibrous veil, more or less gray or bluish in color. Every form is observed between high altostratus and cirrostratus on the one hand, and low altostratus and nimbostratus on the other. Altostratus may result from the transformation of a sheet of altocumulus or may break up into altocumulus.

This cloud is like thick cirrostratus, but it is distinguished from it by the rule that halo phenomena are not seen in altostratus, nor are the shadows of objects on the ground visible. The sun or moon shows through it only vaguely, with a faint gleam, as though through ground glass. Sometimes the sheet is thin, with forms intermediate with cirrostratus. Sometimes it is very thick and dark, even completely hiding the sun or moon. In this case differences of thickness may cause relatively light patches between very dark parts; but the surface never shows real relief, and the striated or fibrous structure is always seen in places in the body of the cloud. If the cloud layer is continuous but without fibrous structure and shows rounded masses, it is classed as altocumulus or stratocumulus.

Careful observation may often detect VIRGA, q. v., hanging from altostratus; these may even reach the ground and cause slight precipitation. If the sheet still has the character of altostratus, it will then be called ALTOSTRATUS PRECIPITANS, q. v. Thus rain or snow may fall from altostratus, but when rain is heavy, the cloud layer will have grown thicker and lower, becoming nimbostratus. A sheet of low altostratus may be distinguished from a somewhat similar sheet of nimbostratus by the following characteristics; nimbostratus is of much darker and more uniform gray, and nowhere shows any whitish gleam or fibrous structure; one cannot definitely see the limit of its undersurface, which has a wet look due to the falling rain (or snow) which may not reach the ground. The convention is also made that nimbostratus always hides the sun and moon in every part of it, while altostratus only hides them in places behind its darker portions so that they reappear through the lighter parts.

altostratus opacus, *n.*—A subgenus of altostratus; it is an opaque layer of variable thickness which may entirely or partially hide the sun and shows a fibrous structure in some parts.

altostratus precipitans, *n.*—A subgenus of altostratus; it is an opaque layer which has not yet lost its fibrous character, and from which there are light falls of rain or snow, either continuous or intermittent. In case this precipitation does not reach the ground, it forms VIRGA, q. v.

altostratus translucidus, *n.*—A subgenus of altostratus, consisting of a cloud sheet resembling thick cirrostratus; the sun and the moon show as through ground glass.

amafa, *n.*—A term composed of the initial letters of *air mass and frontal analysis.* It is used to designate the messages containing analyses of synoptic charts by means of air mass and frontal analysis. *See:* AIR-MASS ANALYSIS.

amorphous, *adj.*—1. Used to describe a sky with a more or less continuous cloud layer of fractostratus or fractocumulus of bad weather, distinguished by its ragged appearance and complete absence of regular undulations. 2. A term applied to uncrystallized bodies.

amplitude, *n.*—1. A climatic term. The diurnal amplitude of temperature is the diurnal range; it "is expressed by the difference between the mean temperature of the warmest and the coldest hours of the day, and is then called the periodic amplitude; or, it is expressed by the difference between the mean minima and the mean maxima of the month, obtained from the readings of a maximum and minimum thermometer, or from hourly observations. The latter, known as the non-periodic amplitude is always greater than the former, or periodic amplitude, especially in winter." (J. Hann, Handbook of Climatology, Pt. I, tr. R. D. Ward, 1903, p. 13.) *See:* RANGE. 2. In simple harmonic motion, the greatest distance from the center reached by a particle during its vibration. In the case of a pendulum bob, its amplitude is the distance from its point of rest to the greatest distance reached, to the right or to the left, in the course of its vibration; or one-half of the complete range of motion. 3. When a motion is asymmetric, the amplitude is the maximum displacement from the neutral position.

anabatic, *adj.*—A term applied to local winds moving up a hillside due to surface heating, and not in response to the general pressure distribution.

This term was probably first used in "Barometric Manual for the Use of Seamen" (8th ed., 1916, p. 24), where it is applied to all upward-moving air; to vertical currents in the upper air, as in the case of the formation of cumulus clouds; and also to air currents moving up a mountainside on clear, warm days, as in a VALLEY BREEZE, q. v. *See:* KATABATIC.

anallobar, *n.*—An area over which the pressure has risen within a given time. *See:* ALLOBAR; KATALLOBAR.

analysis, *n.*—In meteorology, a detailed study based on actual observations of any of the atmospheric phenomena. Thus one may speak of air-mass analysis, isobaric analysis, isentropic analysis, etc.

anaphalanx, *n.*—Synonymous with steering surface or cold frontal surface in the BJERKNES CYCLONE MODEL, q. v. It is the boundary surface, cutting the earth's surface along the STEERING-LINE, q. v., and inclined toward the cold air, which thus forms a flat wedge under the warm air above the steering surface.

anchor ice, *n.*—Ice formed on the bottom of rivers; also known as GROUND ICE (1), q. v. "In America the ice goes by the name of anchor ice from its being attached or anchored to the bottom, and has been so called since 1830. It has been observed in all countries where river ice is formed and has been called ground ice, bottom ice, ground gru (a name given it by the inhabitants of Aberdeenshire), lappered ice, by the common people of South Scotland, glace de fond, by the French, and grundeis, by the Germans. The French-Canadian expression is moutonnée, from its resemblance to the white backs of sheep at rest. The phenomenon of ice forming on the bottom of rivers has been known for a very long time, and although the majority of the early philosophers of France denied its existence it was perfectly well known to every peasant." (H. T. Barnes, On the Formation of Anchor Ice, Monthly Weather Review, vol. 34, 1906, p. 466.)

"This form of ice grows on the bottom of the river wherever nothing protects the bed from excessive nocturnal radiation on cold clear nights.

"Of all the ice on the upper St. Lawrence in the early winter, anchor ice is the most abundant, and when released during the day forms by far the greatest bulk of the ice flowing down. It forms on points or rocks when the water is in a state of supercooling during the hours of 2 and 6 a. m. and sometimes attains a depth of five feet or more. It is of loose structure formed of large crystalline plates and is easily distinguished from frazil or snow blown into the water. Immediately on the advent of dawn, when the scattered radiation from the approaching sun glows in the eastern sky, the anchor ice begins to rise and floats in the stream. When the sun is actually up, and his rays are directed into the water, the bottom becomes quite clear of ice, until the following early morning hours when it grows again. Undoubtedly the deposition of ice comes from the contact of the supercooled water with the rocky bed, and the most copious growth takes place on the up-stream side of the rocks where the cooling would be most intense. During periods of intense nocturnal radiation, anchor ice is found abundantly, but on dull cloudy nights with high humidity no ice is produced." (H. T. Barnes, "Colloidal Water and Ice," in Colloid Chemistry, ed. by J. Alexander, 1926, p. 438.)

John Aitken, however, believes that anchor ice is formed by FRAZIL ICE, q. v., or ice crystals adhering to the cooled bottoms of the rivers. He points out that if the ice formed on the rocks or elsewhere it would be clear, hard ice, and that the part played by radiation in the process is to keep the bottom cold enough for the ice to adhere to it. *See:* John Aitken, Ground-Ice, Scottish Meteorological Society Journal, vol. 18, No. 38, 1918, pp. 13–18.

Andes lighting (or **lights**), *n.*—A series of silent electric discharges observed not only on some of the peaks of the Andes but generally all over the world under favorable conditions; often intense enough to be observed hundreds of miles away. *See:* C. F. Talman, Our Weather, p. 149.

anemobiagraph, *n.*—A type of pressure-tube anemometer for measuring wind speed. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, p. 139.

anémo-cinémograph, *n.*—An instrument for automatically recording wind speed. *See:* J. Moore, Meteorology, 2d ed., 1910, pp. 285–287.

anemoclinograph, *n.*—Also called anemoclinometer or inclinometer; an instrument for the continuous recording of the vertical component of the wind or its inclination to the horizontal. *See:* C. Abbe, Treatise on Meteorological Apparatus and Methods, Annual Report of the Chief Signal Officer, app. 46, Washington, 1888, pp. 194–195.

anemoclinometer, *n.*—*See:* ANEMOCLINOGRAPH.

anemograph, *n.*—An instrument which records the speed or pressure of the wind, or both.

anemometer, *n.*—An instrument for measuring the speed or force of the wind. Some of the many different types of anemometers have been classified as follows: (1) Rotation anemometers, the most notable of which are the AIR METER, q. v., and the cup anemometer; (2) Pressure-plate anemometers, either the pendulum anemometer, in which the plate is free to swing in response to the wind, or the normal-plate anemometer, excellent for studying wind gusts; (3) Bridled anemometers, a modification of rotation anemometers; (4) Pressure-tube anemometers, such as the Dines anemometer, the Dines float manometer, the ANEMOBIAGRAPH, q. v., and the diaphragm manometer. (5) Anemometers utilizing the cooling power of the air, e. g., the hot-wire anemometer, the katathermometer, and the heated-thermometer anemometer. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 123–144; C. Abbe, Treatise on Meteorological Apparatus and Methods, Annual Report of the Chief Signal Officer, app. 46, Washington, 1888, pp. 201–309.

anemometry, *n.*—The science of measuring, recording, and studying the direction and speed (or force) of the wind, including its vertical component.

Since the horizontal component of air flow, which is generally called the wind, is of primary importance, it was measured first. Systematic records of wind direction as indicated by wind vanes were begun in 1650 in Italy and in 1667 in England. The speed of the wind was first observed by noting the rate at which light substances are carried along by the air; it is now determined by means of an ANEMOMETER, q. v.

anemoscope, *n.*—An instrument for indicating the existence of wind and showing its direction. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 178–179.

anemovane, *n.*—A combined contact anemometer and wind vane, so called in the Meteorological Service of Canada.

aneroid, *adj.*—Applied to a kind of barometer which contains no liquid. *See:* ANEROID BAROMETER.

aneroid barometer, *n.*—An instrument for measuring atmospheric pressure, first built in 1843 by Vidie. An aneroid barometer operates as follows: A flat receptacle is partially exhausted of air; to keep it from collapsing an internal or external spring is used, though some aneroids are so formed as to require no spring. One receptacle may be used or several in tandem; the more used, the greater will be the movement effect as the air pressure increases or decreases, which effect is further magnified by a train of levers. Aneroids are made either of the indicating or recording type. The latter is generally called either a "barograph" or "aneroidograph," and sometimes a "sea barometer" (not to be confused with MARINE BAROMETER, q. v.).

Due to its portability, the aneroid is preferable to the mercurial barometer, but it has inherent errors due to the imperfect elasticity of the evacuated vessels and springs. When the aneroid is properly graduated, it becomes an ALTIMETER, q. v. The best aneroids are compensated for temperature. This is done by leaving some air in the receptacle, or by employing a bimetallic arrangement somewhere in the design. Some of the instruments bear legends, indicating the weather supposed to result from high or low pressure and changes of pressure, but these legends are of little value for forecasting the weather.

Aneroid barometers should be graduated only in pressure units, except in the case of altimeters, which are graduated in some altitude scale.

aneroidogram, *n.*—The record of an ANEROIDOGRAPH, q. v.

aneroidograph, *n.*—An aneroid barometer provided with a mechanism for automatically and continuously recording the atmospheric pressure.

angstrom, *n.*—A unit used in the measurement of the wave lengths of light. One angstrom equals 1/100,000,000 centimeter. The wave length of the yellow sodium light, or D line, is 5,896 angstroms or 0.00005896 centimeter.

anhyetism, *n.*—Lack of rain.

annual range of temperature, *n.*—1. The difference between the highest and lowest temperature for a year: the average annual range of temperature is the difference between the averages of the yearly extremes for a suitable number of years. 2. The difference between the average temperatures of the coldest and of the warmest month of the year. The objection to giving the term such signification is that it then places a different meaning on RANGE, q. v., when used in the phrases daily and monthly ranges.

annual variation, *n.*—The general march of a particular climatological element throughout the year, obtained by plotting the normal values of the element for each month and connecting these points by a smooth curve. This procedure indicates the annual march of rainfall, temperature, or any other element. *See:* VARIATION; VARIABILITY.

anomalous, *adj.*—Exceptional, varying from the usual or mean. *See:* ANOMALOUS WEATHER.

anomalous weather, *n.*—A term used by Alexander Buchan to describe the weather for any particular month or season which departs far from the average. *See:* Bartholomew's Physical Atlas, vol. 3, Atlas of Meteorology, ed. A. Buchan, 1899, pp. 31–36, pl. 31.

anomaly, *n.*—The departure of the local mean value of a meteorological element from the mean value for the latitude.

For instance, the difference between the mean temperature of a place and that of its latitude is called its thermal anomaly. "For January the north-eastern Atlantic and north-western Europe are regions of excessive warmth for their latitude, being about 35 Fahrenheit degrees (19.5 Centigrade degrees) in excess of their normal. North-eastern Siberia is the region of the most excessive cold in the world, having a January temperature of 30 Fahrenheit degrees (16.7 C. degrees) below its normal." (S. F. Batchelder, Bartholomew's Physical Atlas, vol. 3, Atlas of Meteorology, ed. A. Buchan, 1899, p. 8.)

Antarctic Zone, *n.*—One of the climatic divisions of the earth, according to an old classification based on the altitude of the sun; also called the South Frigid Zone. It is that area comprised within the Antarctic Circle, which is at 66°33′ S. lat.

anthelion, *n.*—1. A rare kind of HALO, q. v., which appears as a white luminous spot opposite the sun and at the same altitude above the horizon as the sun. 2. A luminous colored ring or glory sometimes seen around the shadow of one's head on a cloud or fog bank, as in the BROCKEN SPECTER, q. v.

anthropoclimatology, *n.*—The study of the mutual relations of climate and man. This term was adopted by R. D. Ward, in "Science," 1896, pp. 749–50.

anticrepuscular arch, *n.*—Same as ANTITWILIGHT, q. v.

anticrepuscular rays, *n.*—Beams of light radiating from the sun through rifts in clouds and rendered luminous by the dust of the atmosphere, which cross the sky, seem to arch on the way, and converge towards the antisolar point. They were first described and explained by Robert Smith in 1783. *See:* CREPUSCULAR RAYS.

anticyclogenesis, *n.*—The sum of the processes which create and develop a new ANTICYCLONE, q. v., or intensify an already existing one. The result of anticyclogenesis is, in the first case, the formation of an anticyclonic circulation, resulting in closed isobars surrounding a center of high pressure, or, in the second instance, the crowding of the isobars around the pre-existing high, causing a strengthening of its circulation. *See:* H. Wexler, Formation of Polar Anticyclones, Monthly Weather Review, vol. 65, 1937, pp. 229–236; and his, Some Aspects of Dynamic Anticyclogenesis, Miscellaneous Reports, No. 8, University of Chicago, 1943.

anticyclolysis, *n.*—Decrease of the circulation around an anticyclone center.

anticyclone, *n.*—An area of relatively high pressure with closed isobars, the pressure gradient being directed from the center so that the wind blows spirally outward in a clockwise direction in the northern hemisphere, counterclockwise in the southern. Francis Galton, in 1861, when plotting wind and pressure charts, noted that regions of high pressure were associated with clockwise rotation of the wind around calm centers. He named such a system an "anticyclone," and the term came rapidly into general use.

There are two kinds of anticyclones, cold and warm. Cold anticyclones are formed when air over a restricted area is cooled from below. Since pressure decreases rapidly with height in cold air, the isobaric surfaces over the area where the cooling is occurring are lowered relative to the surrounding (non-cooled) air. This lowering of the isobaric surfaces means that a low center is undergoing DEEPENING, q. v., at some level above the anticyclone; and the high surface pressure in the cold anticyclone is due to convergence, or piling up of air, in the cyclone aloft. Cold anticyclones, consequently, are comparatively shallow, and are capped by an upper cyclone. Thus the cold winter anticyclone over Siberia, for example, is not discernible above the 6,000-foot level.

Warm anticyclones, on the other hand, are deep systems, and high pressure prevails far up into the atmosphere. Though, as the name implies, they are warmer than their environment in the lower atmosphere, they are actually colder in the stratosphere. The excess of surface pressure, therefore, is due to the excess of cold, dense, relatively heavy air at high levels. Just how this air is accumulated over a warm anticyclone has not yet been completely explained. For some tentative explanations, *see* D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 377–381; B. Haurwitz, Dynamic Meteorology, 1941, pp. 337–340; H. Wexler, Some Aspects of Dynamic Anticyclogenesis, Miscellaneous Reports, No. 8, University of Chicago, 1943, pp. 1–4, 25.

anticyclonic, *adj.*—Pertaining to an ANTICYCLONE, q. v.

antitrade, *n.*—A wind blowing over the trades in a direction opposite to them; hence, sometimes called the countertrade.

The trade winds are surface winds which blow toward the equator in both the northern and southern hemispheres; and as they approach they equator, they ascend and flow toward either pole, forming the antitrades. When these latter reach 30° N. lat. and 30° S. lat., they descend to the earth's surface. Part of the air flows again toward the equator and part flows to the east to form a portion of the prevailing westerlies of both hemispheres. The antitrade winds are observed between 3,000 and 12,000 feet, since their height varies with the season.

antitriptic, *adj.*—A term applied to winds driven by the pressure gradient, the velocity of which is limited by friction. This term was first employed by Dr. H. Jeffreys, "On the Dynamics of Wind," Quarterly Journal of the Royal Meteorological Society, vol. 48, 1922, pp. 29–47. *See:* EULERIAN; GEOSTROPHIC.

antitwilight, *n.*—The pink or purplish zone of illumination bordering the shadow of the earth in the part of the sky opposite the sun after sunset and before sunrise; also called the antitwilight arch or the anticrepuscular arch. *See:* H. H. Kimball, The Duration and Intensity of Twilight, Monthly Weather Review, vol. 44, 1916, pp. 614–625.

anvil cloud, *n.*—Popular name of a heavy cumulus or cumulonimbus having an anvil-like form especially in its upper portions. If a thundercloud is seen from the side, the anvil form of the cloud mass is very noticeable.

aperiodic, *adj.*—Used in meteorology to designate a phenomenon not occurring regularly, but taking place at unequal intervals of time. For example, the Brückner cycles are aperiodic, the maxima occurring, on the average, at an interval of 36 years, while the time between the actual maxima may vary from 20 to 50 years.

aperwind, *n.*—Thawing wind of the Alps.

aphelion, *n.*—The point on the earth's orbit which is farthest from the sun. It is now reached about July 1st, but the time varies irregularly by a few days from year to year, and also has a slow secular variation. *See:* PERIHELION.

apob, *n.*—A word abbreviated from and meaning, an "airplane observation," usually restricted to observations taken by means of an AEROMETEOROGRAPH, q. v. The elements observed are pressure, temperature, and humidity.

Appleton layer, *n.*—An ionized layer of the atmosphere, also called the F layer. It is the highest of the recognized layers of the ionosphere; its mean elevation appears to be about 150 miles, but is variable and has been recorded as low as 93 miles in Australia and as high as 250 miles in England. It reflects radio waves of about 100 meters wave length.

applied meteorology, *n.*—The branch of METEOROLOGY, q. v., which seeks to apply the principles derived from PHYSICAL and DYNAMIC METEOROLOGY, q. v., to the solution of the actual daily problems encountered by the weather analyst or forecaster.

approximate absolute thermometric scale, *n.*—A temperature scale which approximates the true absolute temperature scale and satisfies the general requirements of science. "Many problems in physics and meteorology call for the use of the absolute scale; but it is not convenient, and in many cases not necessary, to adhere strictly to the true thermodynamic scale. In fact, the general requirements of science will very largely be met by the use of an approximate absolute scale which for the centigrade system is defined by the equation:

$$T = (273° + t°\ C.).$$

The observed quantity, $t°$, may be referred to the normal hydrogen centigrade scale or be determined by any acceptable thermometric method." (Smithsonian Meteorological Tables, 5th rev. ed., 1939, p. xv.)

aqueous vapor, *n.*—The vapor state of water; more commonly called WATER VAPOR, q. v. It comprises about $\frac{1}{400}$ of the total mass of the atmosphere. It is odorless, colorless, and is locally variable in amount, from 5 percent to zero, depending upon the season, air temperature, and other conditions. The weight of a cubic foot of saturated water vapor at 32° F. is 2.118 grains, and of a cubic meter at 0° C. is 4.847 grams. The specific heat of water vapor is 0.4655 at 0° C., and of air, 0.2377.

arched squall, *n.*—A type of squall characterized by an arched cloud, and apparently a variant of the LINE SQUALL, q. v.; it may or may not be accompanied by thunder and lightning.

Archimedes' principle, *n.*—The law of buoyancy, or upward force exerted upon a body immersed in or floating on a fluid.

The resultant force of a fluid on a body immersed in it, or partially so, acts vertically upward through the center of mass of the displaced fluid, and is equal to the weight of the displaced fluid. If the immersed body rises, the buoyancy is positive; and if it sinks, the buoyancy is considered negative.

Arctic air (A), *n.*—An air mass originating over the ice-covered Arctic, which, due to the conduction of heat through the ice from the relatively warm water below, does not have such frigid surface temperatures as prevail in POLAR AIR, q. v. On the other hand, it is colder and drier than polar air aloft, and extends up to greater heights. *See:* AIR MASS (1).

Arctic climate (or **polar climate**), *n.*—A term applied to the north and south polar regions where the isotherm of 50° F. for the warmest month forms the southern and northern limits respectively. Similar conditions may be encountered in lower latitudes at high altitudes.

Polar or Arctic climates are usually divided into two types with the warmest-month isotherm of 32° F. serving as the boundary between them. The warmer has a tundra climate, while the colder is a region of perpetual frost. *See:* A. Austin Miller, Climatology, 1931, pp. 220–231; G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 329-341.

Arctic front, *n.*—The line of discontinuity between very cold air flowing directly from the arctic regions and polar air. As the Arctic front migrates southward, it becomes the polar front, which is the line of discontinuity between polar and tropical air; a new Arctic front is then usually created, at least in winter.

Arctic sea smoke, *n.*—Same as frost smoke; in the Arctic it occurs over open water in winter.

Arctic Zone, *n.*—One of the climatic divisions of the earth, according to an old classification based on the altitude of the sun; more generally called the North Frigid Zone. It is that area comprised within the Arctic Circle which is at 66°33′ N. lat.

Arcs of Lowitz, *n.*—These are rarely seen, and are oblique and downward extensions of the parhelia of 22°, concave toward the sun and with red inner borders. They are formed by refraction through ice crystals oscillating about the vertical, as they obviously do in the case of snowflakes. *See:* W. J. Humphreys, Physics of the Air, 1940, p. 513.

arcus, *adj.*—A term used to describe a casual variety of cumulonimbus cloud when the lower edges form an arch or arches.

argon, *n.*—An inert, invisible gas: one of the constituents of air. Its mass is about 1/80 of the total atmosphere. In spite of its relative abundance it was not discovered until 1894 by Lord Rayleigh and Sir William Ramsey, 100 years after all the elements of the air were thought discovered. This was due, however, to its chemical inertness, which had caused it to be confused with nitrogen. (Argon has one property, however, very different from nitrogen: it is 2½ times more soluble in water.) Its presence was not suspected until the removal of oxygen from the air by two different methods resulted in the discovery that the remaining gases in the two cases had different densities and hence different identities.

arid, *adj.*—In climatology, a term applied to climates which have insufficient rainfall to support vegetation. Two divisions of dry climates are commonly recognized: (a) the arid, or desert type, and (b) the semiarid, or steppe type. *See:* DESERT; STEPPE; SEMIARID; ARIDITY; G. T. Trewartha, An Introduction to Weather and Climate, 1937, p. 226.

aridity, *n.*—The state of a region in respect to its dryness or lack of moisture. Dry regions are classed in this respect as desert, arid, and semiarid, with a desert representing the extreme type of aridity. These are, however, not quantitative terms, and again one's idea as to whether a region is arid or not depends upon one's point of view: a region may be too arid for vegetation but not so for certain occupations, since sufficient water may be imported by natural or artificial means. The amount of rainfall is not a sure index, for the aridity of a region depends in part on temperature.

Various attempts have been made to formulate an index of the degree of aridity for purposes of climatic classification, but none have been generally accepted. The difficulty, in part, is the insufficiency of data, principally data concerning evaporation. Therefore, the most usable indices are those that use temperature and precipitation data. W. Köppen and R. Geiger use the following formula:

Rainfall mainly in cold season---------------- $R=2t$
Rainfall evenly distributed throughout year-- $R=2t+14$
Rainfall mainly in hot season----------------- $R=2t+28$

where t is the mean temperature in centigrade, and R is the rainfall in centimeters. If the annual rainfall in centimeters is less than R and greater than $\frac{1}{2}R$, the climate is steppe or semiarid; if it is less than $\frac{1}{2}R$, the climate is desert or arid.

ascendent, *n.*—A term used by V. Bjerknes to denote a vector representing the rate of increase of a scalar quantity; he restricts GRADIENT, q. v., to a vector representing the rate of decrease. *See:* V. Bjerknes, Dynamic Meteorology and Hydrography, Carnegie Institution of Washington, 1910.

aspect, *n.*—A term used in meteorology when referring to the appearance or outlook of many phenomena. For instance, one may speak of the aspect of the sky, the aspect of the weather map, or the barometric or thermal aspect. One may say in a forecast, "there is no aspect for rain"; or, in reference to isothermal lines, the "aspect of the thermal slope."

aspiration meteorograph, *n.*—An instrument for the continuous recording of two or more meteorological elements, in which a motor-driven mechanism causes air to be rapidly drawn by suction past the devices which measure the desired elements. *See:* ASPIRATION PSYCHROMETER; ASPIRATION THERMOGRAPH.

aspiration psychrometer, *n.*—A form of wet- and dry-bulb hygrometer in which air is forcibly drawn past the two bulbs. In the Assmann type, invented in 1886, the wet bulb is kept moist by a muslin sheath soaked in water. A fan operated by clockwork draws air over the two bulbs at a suitable speed and causes evaporation to take place from the wetted muslin, which has the effect of lowering the temperature of the wet-bulb thermometer. The bulbs of both thermometers are protected from radiation by highly polished metal tubes, so that the instrument can be used in bright sunshine. *See:* PSYCHROMETER.

aspiration thermograph, *n.*—An instrument for the automatic and continuous recording of air temperature. Its thermometric element is ventilated by means of a fan usually driven by a motor or by clockwork.

aspirator, *n.*—A revolving fan, usually driven by clockwork, for producing a current of air by suction. It is used in connection with thermometers and hygrometers.

astraphobia, *n.*—A morbid fear of thunder and lightning.

atmidometer, *n.*—An instrument for measuring the rate of evaporation; sometimes called ATMOMETER, q. v.

atmidometry, *n.*—A term used synonymously with ATMOMETRY, q. v., and applied to the science of measuring the rate of amount of evaporation of water.

atmidoscope, *n.*—An instrument to indicate changing humidity.

atmometer, *n.*—An instrument for measuring the rate of evaporation; also called an atmidometer or evaporimeter. The term atmometer was coined by Sir John Leslie in 1813, and is the oldest name for this kind of instrument. Four main classes of atmometers may be distiguished: (1) Large evaporation tanks sunk in the ground or floating on protected waters; (2) Small open evaporation pans, discussed under EVAPORATION GAGE, q. v.; (3) Porous porcelain bodies, mainly used by plant physiologists in studying evaporation from plants; (4) Atmometers with wet paper surfaces, represented by the Piché EVAPORIMETER, q. v. *See* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 113–114.

atmometry, *n.*—The science of measuring the rate and amount of evaporation of water.

atmosphere, *n.*—1. The gaseous envelope surrounding the earth; the highest of the layers in its structure, the lowest being the lithosphere (the solid portion), then the hydrosphere (the water portion), and lastly the atmosphere, which is again divided into the TROPOSPHERE and STRATOSPHERE, q. v.

The atmosphere is odorless, colorless, tasteless; very mobile, flowing readily under even a slight pressure gradient; elastic, compressible, capable of unlimited expansion, a poor conductor of heat, but able to transmit vibrations with considerable velocity. Its weight has been calculated as 5.9×10^{15} tons. One-half the mass of the atmosphere lies below 3.46 miles. It has no definite upper limit. If its density were constant throughout, it would be the so-called "homogeneous atmosphere," only about five miles deep. But, since its density decreases with elevation, and since, being a gas, it can expand indefinitely away from the earth, it grows "thinner and thinner with elevation until it merges with whatever traces of gases there must be in interplanetary space. It is quite certain that the atmosphere could not extend to more than about 20,000 miles and remain and turn with the earth as it rotates on its axis. At this distance the centrifugal force due to the earth's rotation approaches the magnitude of that due to gravity, and the earth could not hold the atmosphere." (J. G. Albright, Physical Meterology, 1939, p. 30; cf. pp. 1–36.) At a height of about 50 miles the atmosphere is still dense enough to scatter sunlight; meteors have been rendered luminous at 200 miles, proving that sufficient atmosphere exists at that elevation to raise their temperature to incandescence by friction; auroras have been observed in the upper atmosphere at 375 miles.

The ordinary term for the mixture of gases comprising the atmosphere is Air, q. v., which also includes water vapor and solid and liquid particles. The following table (after F. A. Paneth, Quarterly Journal of the Royal Meteorological Society, vol. 63, 1937, p. 436) gives the various gases and their volume percentages for dry air, i. e., air without water vapor:

Nitrogen	78.09	100 percent
Oxygen	20.95	
Argon	0.93	
Carbon dioxide	0.03	
Neon	0.0018	
Krypton	0.0001	
Helium	0.00053	
Hydrogen	0.00005	
Xenon	0.000008	
Ozone	0.000001 (variable)	

2. A unit of pressure: (a) A normal atmosphere equal to the pressure exerted by a vertical column of mercury, 760 mm. in height, at 0° C., and with gravity taken at 980.665 cm sec^{-2}, equal to about 14.7 pounds per square inch. The British atmosphere is based on 30 inches of mercury. (b) The 45-degree atmosphere: same as above except the acceleration of gravity at sea level and latitude 45° is used instead of 980.665 cm sec^{-2}.

atmospheric acoustics, *n.*—A branch of the physics of the air which seeks to explain sounds having meteorological origins, and the many effects of the atmosphere on sounds in general. Sounds having meteorological origins are the humming of wires, the murmur of the forest, thunder, etc. Of the many effects of the atmosphere on sound may be mentioned the changes in velocity, reflection and refraction, the Doppler effect, echo, etc. *See:* W. J. Humphreys, Weather Rambles, pp. 26–45; and his Physics of the Air, 3d ed., 1940, pp. 415–450.

atmospheric electricity, *n.*—The sum of the electrical manifestations of the atmosphere, among which the most familiar are Lightning, the Aurora, and St. Elmo's Fire, q. v. Though these manifestations are all bound up with the existence of the Potential Gradient, q. v., the origin of atmospheric electricity and the earth's charge is still uncertain. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 395–413; J. G. Albright, Physical Meterology, 1939, pp. 297–314.

atmospheric optics, *n.*—A branch of optics concerned with all the optical qualities of, and their manifestations in, the atmosphere. It strives to explain, for instance, the colors of the sky, clouds, and hydrometeors; and the refraction, reflection, diffraction, and interference phenomena.

atmospheric pressure, *n.*—The force per unit area exerted by the atmosphere in any part of the atmospheric envelope. Since the atmosphere is a substance, it has mass and is acted upon by gravity. Since force is mass times acceleration, the pressure of the atmosphere at any point is due to the superincumbent mass of air times its accelerations, which are the acceleration of gravity combined with whatever other accelerations may be operating at the time, as, for instance, the acceleration of a rising or falling column of air. As weight is the force of attraction of the earth for any body, the atmospheric pressure may be measured in any units of weight, such as pounds per square inch, or in units of pressure such as centimeters of mercury, dynes per square centimeter, etc. Some of the expressions for the normal value of the atmospheric pressure are:

76. 0	centimeters of mercury
29. 92	inches of mercury
1033. 3	centimeters of water
33. 9	feet of water
1033. 3	grams per square centimeter
1, 013, 250. 0	dynes per square centimeter
14. 66	pounds per square inch
1. 01325	bars (1 bar=1,000,000 dynes/cm.^{2})
1013. 25	millibars

See: J. G. Albright, Physical Meteorology, 1939, pp. 35–36.

atmospheric radiation, *n.*—The RADIATION, q. v., emitted by the atmosphere in two directions: upward to space and downward to the earth, and consisting mainly of the long-wave terrestrial radiation plus the small amount of short-wave solar radiation absorbed in the atmosphere. Figuring on the basis of a year and using a heat unit of 10^{22} calories, it has been calculated that of the 201 heat units absorbed in the atmosphere, 134 are returned to the earth as the so-called "back radiation," and 67 are lost to space. In summer, this back radiation equals or exceeds one-half of the incoming solar radiation in all northern latitudes; in winter, it exceeds the total incoming solar radiation at all latitudes above 15° N. Hence, though atmospheric back radiation is not an ultimate heat source for the earth, it is obviously an important temporary one. *See:* V. Conrad, Fundamentals of Physical Climatology, 1942, pp. 9–11; H. Landsberg, Physical Climatology, 1941, pp. 91–92.

atmospherics, *n.*—Also called strays or static; electrical disturbances originating in the atmosphere in the same manner as lightning, i. e., by electrical discharges, or in some local piece of electric apparatus; manifested by crashing and grinding noises in radio receiving sets.

atmospheric tides, *n.*—Small fluctuations in the atmosphere, created by the gravitational action of the sun and moon in the same manner that these bodies produce the tides of the sea. They are so small that only by analysis of a long series of records can they be separated from the many other pressure changes in the atmosphere; as magnified by resonance, however, they may be a factor in some of the diurnal barometric variations. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 248–249.

atmospheric waves, *n.*—Wave motions in and of the atmosphere. They may be of several different kinds: (1) Pressure waves, which in turn are subdivided into diurnal, semidiurnal, terdiurnal, and quatrodiurnal fluctuations. The diurnal pressure wave has a a maximum at about 8 a. m. and a minimum at 8 p. m., and is believed to result from the alternate heating and cooling of the atmosphere by the sun during the earth's rotation. The other pressure waves are of lesser importance, and their exact causes are doubtful. (2) Seasonal waves, in which air flows across the equator into the colder hemisphere. Only about one-fifth of one percent of the atmosphere, however, is thus transported. (3) Waves due to the procession of highs and lows across a given region, causing a rise and fall of the barometer. (4) Waves originating from vibrating sources, from volcanic or man-made explosions, from avalanches, landslides, etc. (5) Waves which form anywhere in the atmosphere at a surface of discontinuity, and are due to gravitational, rotational, and inertial causes. Meteorologically speaking, the most important of these is the Cyclonic Wave, q. v. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 65–74; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 237–249.

attached thermometer, *n.*—A thermometer fastened about midway between the top and the cistern of a mercurial barometer, the bulb of which is entirely concealed within the metal tube, in order to show as nearly as possible the mean temperature of both the metal tube and the mercury. Its presence is necessary because the observed barometer readings must be reduced to the values they would have if the mercury and the scale were maintained at a constant standard temperature.

aureole, *n.*—1. The luminous area surrounding the sun or other bright light when seen through thin cloud, fog, or mist; a corona or glory. 2. The inner portion of a corona, or the whole of one which is only incompletely developed.

aurora, *n.*—1. A luminous glow sometimes seen at night in the northern and southern skies; in the northern sky it is called aurora borealis, and in the southern, aurora australis.

Many auroras are practically white; but red, yellow, and green also occur. They appear also in various forms; such as arcs, bands, rays, curtains or draperies, coronas, luminous patches, diffuse glows, and flaming or rapidly moving forms. Many auroras are quiescent; others flit and move about. They occur most frequently during years of sunspot maxima, but show no frequency relative to moon or season. In altitude they range from 100 to 1,000 kilometers above the earth. Auroras are caused by electrical discharges in the high atmosphere due to influences from the sun. 2. A term sometimes applied to the light of early dawn. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1941, pp. 409–413.

austausch, *n.*—A measure of the degree of turbulence that exists within a turbulent zone, in terms of the exchange of mass across unit horizontal surface, during unit time; so named from the German word meaning "interchange." A turbulent zone, which may range from a few feet to several hundred feet in width, is created in the atmosphere by friction between air currents and the surface of the earth, and also between adjacent layers of air. "Throughout this zone a constant interchange of properties between the earth's surface and the air above it, or between two adjacent bodies of air is constantly taking place. The properties which are commonly involved in this zone of turbulent interchange are heat, water vapor, momentum, and various solid impurities." (G. F. Taylor, Aeronautical Meteorology, 1938, pp. 77–78.) It is approximately the same as EDDY CONDUCTIVITY, q. v.

autobarotropy, *n.*—The state of the atmosphere in which an originally barotropic stratification is maintained, as, for instance, in an incompressible homogeneous atmosphere. *See:* BAROTROPY.

autoconvection, *n.*—Atmospheric CONVECTION, q. v., which is spontaneously initiated by a layer of air when the lapse rate of temperature is such that density increases with elevation at a sufficiently rapid rate. A mere increase of density with height does not lead to convection; other controlling factors are viscosity, turbulence, and insolation, besides the establishment of a lapse rate exceeding the AUTOCONVECTION GRADIENT, q. v.

autoconvection gradient, *n.*—Also known as the autoconvective lapse rate, and thus described: "When the lapse rate is equal to 3.42° C. per hundred meters, the decrease of temperature with height is such that the density of the air is constant with height. If the lapse rate exceeds 3.42° C. per hundred meters, the density of the air must increase with height. This is an exceedingly unstable condition, for the denser air from the higher levels must sink of itself (without external impulse) into the less dense air below. The specified lapse rate (3.42° C./100m.) therefore marks the theoretical lower limit of lapse rate for self-convection of air without an external impulse." (L. P. Harrison, Meteorology, 1942, pp. 101–102.) *See:* B. Haurwitz, Dynamic Meteorology, 1941, p. 353; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 153–155.

autumn, *n.*—The third SEASON, q. v., of the year, the period between summer and winter; commonly called "fall" in America. Astronomically speaking, autumn begins in the north temperate zone at the autumnal equinox, about September 22, and ends at the winter solstice, about December 21; but it is popularly considered in this country to comprise the months of September, October, and November; and in England, the months of August, September, and October. In the southern hemisphere, autumn occurs at the same time as the northern hemisphere's SPRING, q. v.

Autumnal weather is marked by copious dew, the coming of frosts, and the appearance of radiation fogs. "The storms of early autumn give us a boisterous foretaste of winter. As the general atmospheric circulation gains speed, so the storms, which mark the irregularities in the boundaries between the equatorial and polar winds, move faster. And they become stronger than the summer storms, developed as they are from weaker winds." (C. F. Brooks, Why the Weather?, 1935, p. 173.)

avalanche, *n.*—A mass of snow or ice detached from its position, and slipping down a mountain slope.

avalanche wind, *n.*—The rush of air produced in front of an avalanche or landslide, "It is the swift downrush of dry snow rather than the more deliberate advance of the ground avalanche that produces in front of the descending mass the most remarkable examples of the 'avalanche wind,' the force of which, at its worst, surpasses that of any tropical hurricane and is rivaled only by the violence of the tornado. The air displaced by the avalanche rushes not only straight forward but also on either side, uprooting trees and causing general destruction hundreds of yards beyond the area reached by the avalanche itself." (C. F. Talman, A Book About the Weather, 1931, pp. 95–96.) *See:* M. B. Summers, Avalanche Wind at Juneau, Monthly Weather Review, vol. 45, 1917, p. 114; FLURRY (2).

average, *n.*—An arithmetic mean; that is, the result obtained by adding a number of terms and dividing the sum by the number of terms. There is no essential mathematical difference, therefore, in deriving an average, mean, or normal, but their applications in meteorology and climatology are quite distinct.

In analyzing weather data, average and mean are often used interchangeably, and normal is sometimes used in the same sense, meaning no more than the average of a long record; but normal has a more specialized significance, distinct from mean or average. For instance, the mean temperature for a particular day, which is simply the average of the highest and lowest temperatures recorded on that day, is distinct from the normal mean temperature for the date, which is computed by averaging all the mean temperatures for that particular day on record. *See:* NORMAL.

Avogadro's hypothesis, *n.*—The principle that equal volumes of all gases under the same pressure and temperature contain the same number of molecules. In the case of an ideal gas, the number (called the Loschmidt number) per cubic centimeter at normal pressure and temperature is 2.705×10^{19}. *See:* W. J. Humphreys, Physics of the Air, 1940, p. 69; H. R. Byers, General Meteorology, 1944, p. 130.

azimuth, *n.*—The arc of the horizon intercepted between a given point and an adopted zero point. In pilot balloon observations in the U. S. Weather Bureau, north is the zero point, east is 90°, south is 180°, etc.; so that if the balloon were, at a given instant during its flight, due west of the observer, its horizontal angle or azimuth would be 270°.

B

b., *abbr.*—1. Abbreviation for blue sky in the BEAUFORT WEATHER NOTATION, q. v. 2. Abbreviation for BAR, q. v.

back, *v. i.*—To change direction counterclockwise; applied to the wind when it so changes, as, for example, from the north to northwest, east to northeast, etc., in the northern hemisphere; opposite in meaning to VEER, q. v., which signifies clockwise change, as from north to northeast in the northern hemisphere. In the southern hemisphere the meaning of these words in terms of the cardinal directions are exactly reversed.

It is said that the expression "to back" arose from the fact that most meteorological stations in Europe lie on the southern side of the average path of low pressure centers, around which the winds blow in a counterclockwise direction. A station thus located would record a veering of the wind as a low passed by. Occasionally, a low would travel south of the average path, and, as it passed a station, cause a change in wind direction opposite to the clockwise shift usually experienced, in which case the wind was said "to back."

backlash, *n.*—The "play" in an instrument. In self-recording instruments there is always a certain amount of clearance between the teeth of the gears and pinions. If this is not taken up when the instrument is started, a short interval might elapse before the clock begins to turn the cylinder which holds the recording sheet. This "play" or "backlash" may be eliminated, if, before the instrument is started, the recording cylinder is turned forward until the recording pen registers earlier, say 30 minutes, and is then turned backwards until the pen registers the exact time.

bad-i-sad-o-bistroz, *n.*—The "wind of 120 days"; a violent katabatic wind which blows from the northwest in the region around Afghanistan from May to September. *See:* SEISTAN.

baguio, *n.*—Also spelled bagio and bagyo; a term applied in the Philippine Islands to a TROPICAL CYCLONE, q. v. "The natives of the Philippines, who like all natives of Malay origin are good fishermen and daring seamen after their own fashion, perfectly distinguish between the typhoons or turning gales (cyclones) and the straight-lined monsoon gales. They call the first 'bagyo' and the latter 'signa'." (H. Piddington, Sailor's Horn-book, 6th ed., 1876, p. 70, footnote.)

bai, *n.*—A mist prevalent in China and Japan in spring and fall, when the loose surface is churned up by the wind and clouds of sand rise to a great height and are carried eastward, afterwards collecting moisture and falling as a colored mist which everywhere produces a thick coating of very fine yellow dust.

bai-u, *adj.*—The name of a season, during which copious rains occur, in southern Japan and in parts of China (where it is pronounced "meiyu"). The bai-u season (April and May in Japan, May to July in China) is the most important period for the cultivation and transplanting of rice. The bai-u rains are also called plum rains or mold rains, with reference to the season for ripening plums, and to the effects of continued dampness, respectively. *See:* T. Okada, On the Bai-u or Rainy Season in Japan, Bulletin of the Central Meteorological Observatory of Japan, No. 5, 1910; G. T. Trewartha, An Introduction to Weather and Climate, 1937, p. 175.

Bali wind, *n.*—Local name for a strong east wind at the eastern end of Java.

ball, *n.*—A term used to indicate wind speed. A one-ball wind is one having a speed of 10 miles per hour, a two-ball wind, 20 miles per hour, etc. The term occurs in the "Voyage of the Chelyuskin," translated from the Russian by Alec Brown (1935, New York). The phrase, "The wind was a five-ball norther" occurs on page 92, and similar uses of the word are also found elsewhere in the book.

ballistic, *adj.*—Pertaining to the factors which affect the trajectory of a projectile in flight. "To properly consider these factors, terms have been introduced known as ballistic meteorological conditions, namely, ballistic wind, ballistic density, and ballistic temperature. A ballistic meteorological condition is an imaginary one, which has the same effect on a trajectory as the true conditions that do exist within the limits of the trajectory." (W. Noll, Determination of Meteorological Corrections on the Ranges of Guns, Monthly Weather Review, vol. 47, 1914, p. 868.)

ballistic density, *n.*—An average or resultant ratio of observed density to normal density, determined by properly weighting the ratios of observed density to normal density, throughout the zone from the surface of the earth to the height of the maximum ordinate of the trajectory for which the ballistic density is being obtained.

"The resistance offered a projectile in its flight varies with the density of the air, other factors being constant. A decrease in density corresponds to an increase in range and vice versa. Consequently it is necessary to know the density of the air to the height to which the projectile rises, in order to properly determine the ranges. After the values of pressure aloft, vapor pressure aloft, and temperature aloft are obtained by use of airplanes or kites, the densities are computed and plotted against true height. From the density curve thus drawn the densities for every 250 meters altitude are read off." (W. Noll, Determination of Meteorological Corrections on the Ranges of Guns, Monthly Weather Review, vol. 47, 1914, p. 868.)

ballistic temperature, *n.*—A single computed temperature which is used to express for artillery purposes the temperature conditions between the level of the battery and a specified maximum altitude to which it is expected projectiles will ascend in traveling from the gun to the target. A separate ballistic temperature is determined for each maximum ordinate. When weighting factors are available, ballistic temperatures may be computed by the following procedure: For a particular maximum ordinate the mean temperatures for certain zones are determined. The differences between these temperatures and the standard temperatures for these particular zones are next determined. These temperature differences are then multiplied by weighting factors, and the sum of the products thus found gives the departure of the ballistic temperature from standard for the particular maximum ordinate in question. When the amount of this departure is added to 59°, the result is the ballistic temperature for the particular maximum ordinate, expressed in Fahrenheit degrees.

ballistic wind, *n.*—A calculated wind which would have the same effects upon the range and deflection of a projectile as would the actual winds through which the projectile passes.

ball lightning, *n.*—A form of Lightning, q. v., consisting of "luminous ball- or pear-shaped bodies that travel or float along freely in the air or over the surface of walls, roofs, floors, or the ground. No simple explanation of the phenomenon has been made, and a great many persons doubt its existence. . . . The persistence of the brilliant after-image of lightning for some time following the flash accounts for many of the reported instances." (J. G. Albright, Physical Meteorology, 1939, p. 335.) *See:* W. J. Humphreys, Ball Lightning, Proceedings of the American Philosophical Society, vol. 76, 1936, pp. 613–626.

ballonet ceiling, *n.*—"The altitude from which a pressure airship with empty ballonets can return to sea level without loss of operating pressure." (Nomenclature for Aeronautics, Report No. 474, National Advisory Committee for Aeronautics, 1937, p. 11.) *See:* CEILING; ABSOLUTE CEILING; SERVICE CEILING; STATIC CEILING.

ballon-sonde, *n.*—Synonym for SOUNDING BALLOON, q. v.

balloon, *n.*—A bag, more or less airtight, and filled with some gas lighter than air, for the purpose of ascent in the atmosphere.

Free manned balloons were used for observations of the atmosphere as early as 1784, when Dr. Jeffries took barometer, thermometer, and hygrometer observations, besides collecting samples of air. Since then free balloons and captive balloons, the latter sometimes manned, have been used to measure weather elements at various heights. Free manned balloons ascending to great heights have been used recently for atmospheric investigations, such as in the Picard and other stratosphere flights, and meteorological observations are usually made by those in charge of such flights. The three kinds of balloons most commonly used in weather observations are listed below and separately described. *See:* CEILING BALLOON; PILOT BALLOON; SOUNDING BALLOON.

balloon cover, *n.*—A large cover made to fit over 350- and 700-gram inflated balloons to facilitate their hauling in high or gusty winds.

balloon drag, *n.*—A small 10-gram balloon loaded with 300 to 400 grams of ballast attached below the radiosonde to retard ascent, thus insuring that the meteorological elements of the radiosonde will have ample time to react to their changing environment, and that a satisfactory record of the ascent will be secured. The drag balloon is usually so inflated as to burst at about 400 mb., or 7 km.

balloon, radiosonde, *n.*—A 350-gram balloon that is inflated to a diameter of about six feet and a free lift of about 400 grams to carry a radiosonde aloft. When made of natural rubber, the balloon attains an average bursting height of 18 km., but when made of synthetic rubber, only 15 km.

band lightning, *n.*—Same as RIBBON LIGHTNING, q. v.

bankfull stage, *n.*—The elevation, or stage, of the lowest bank of a stream within the reach in which the elevation is measured.

banner cloud, *n.*—A cloud which "resembles a great white flag floating from a high mountain peak. In strong winds the pressure to the immediate leeward of such a peak is, more or less, reduced, and the resulting low temperature, intensified by the mountain surface, appears to be the cause of this singular cloud that, though continuously evaporating, as constantly re-forms in the turbulent wake." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 303.)

bar, *n.*—1. A unit of pressure equal to 10^6 dynes/cm^2; equivalent to a mercurial barometer reading of 750.076 mm. at 0° C. (or 29.5306 inches at 32° F.), gravity being equal to 980.616 cm/sec^2. It is equal to the mean atmospheric pressure at about 100 meters above mean sea level. The standard atmospheric pressure of 760 mm. or 29.921 inches is equal to 1,013,250.144 dynes/cm^2.

The millibar is the thousandth part of a bar: it is equivalent to 1,000 dynes/cm^2. Hence the standard atmospheric pressure of 760 mm. is 1,013.3 mb.

A distinction must be made between the bar and the BARYE, q. v.: the latter is the c. g. s. unit of pressure, equal to 1 dyne/cm^2, while the bar is used in meteorology and is 1,000,000 times the barye. *See:* International Critical Tables, 1926, vol. 1, p. 34; Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. 21–22. 2. The heavy bank of thick black clouds, generally composed of stratocumulus and nimbostratus which is found near the center of a tropical cyclone. *See:* I. R. Tannehill, Hurricanes, 1938, p. 96. 3. A cloud formed at the crest of an air wave on the lee side of a mountain or other obstruction.

barat, *n.*—A heavy northwest squall in Menando Bay on the north coast of the island of Celebes; these squalls are prevalent from December to February.

barber, *n.*—1. "A gale of wind with damp snow or sleet and spray that freezes upon every object, especially the beard and hair. Said to be called barber by wharfmen of New York." (Century Supplement, Vol. XI, 1909, p. 111.) It is called barber (or berber) because the snow is so sharp that when driven by a gale, it nearly cuts the skin off the face. *See:* R. Abercromby, Weather, 1907, p. 224. 2. Vapor rising in streams from the water, well known in Nova Scotia, and the same as FROST SMOKE, q. v.

baric area, *n.*—The area enclosed within an ISOBAR, q. v.

barines, *n.*—Westerly winds in eastern Venezuela.

Barisal guns, *n.*—*See:* BRONTIDES.

baroclinic fluid, *n.*—A fluid in which the pressure is a function of other variables in addition to density; the isobaric surfaces, therefore, do not in general coincide with the isosteric surfaces, or surfaces of constant specific volume. *See:* BAROTROPIC FLUID.

barocyclonometer, *n.*—"One of the several instruments that have been devised for locating tropical hurricanes without the aid of a weather map." (Instructions to Marine Meteorological Observers, Circular M, U. S. Weather Bureau, 6th ed., 1938, p. 97.)

barogram, *n.*—A trace made by the pen of a BAROGRAPH, q. v.

barograph, *n.*—A barometer which makes a continuous record of barometric changes. Barographs may be of the mercurial or aneroid variety, but are generally of the latter type. An aneroid barograph consists of a single cell or of several evacuated cells in series. The lower cell is fastened to the frame of the barograph case, while the uppermost cell is free to move and is connected to a pen through a series of linkages to magnify the movement. The pen writes upon a record sheet wrapped around a cylinder which is caused to revolve by clockwork inside.

In most cases the changing temperature to which a barograph is subjected introduces small errors, such that the mechanism effecting continuous registration either obstructs the free action of the barometer proper or does not transmit to the record sheet a trace exactly representing the original fluctuations of pressure. The absolute value of the pressure indicated by the position of the tracing point is also subject to uncertainties, and while changes of pressure are shown by a barograph with more or less accuracy, it is impossible, even with the best instruments, to record the absolute pressure with a precision equal to that of an eye reading of a standard mercurial barometer. In general, therefore, the indications of automatic instruments are checked and corrected by reference to occasional eye readings of a standard barometer. *See:* Barometers and the Measurement of Atmospheric Pressure, Circular F, Instrument Division, U. S. Weather Bureau, 7th rev. ed., 1941, pp. 28–44.

barometer, *n.*—An instrument for measuring atmospheric pressure. There are two kinds of barometers, mercurial and aneroid.

The mercurial barometer was invented in 1643 by Evangelisto Torricelli (1608–1647), the first a pupil of Galileo and afterwards a master, himself. In describing the purpose of the experiment which resulted in the invention of the mercurial barometer, he makes a statement of interest to meterologists: i. e., that he aimed "not simply to produce a vacuum, but to make an instrument which shows the mutations of the air, now heavier and dense, and now light and thin." The mercurial barometer consists essentially of a tube filled with mercury, the mouth of which is immersed in a cup of the same liquid. Its construction is best understood by describing how it is made. Fill a 36-inch glass tube completely with pure mercury. With the thumb on the mouth of the tube, invert it, i. e., point the mouth-end down, and insert it into a cup of mercury, called the cistern. Upon removing the thumb and after supporting the tube vertically, it will be found that a portion of the mercury in the tube will pass into the cup, and, if the work is done at sea level, that the level of the mercury in the tube will be about 30 inches above the level in the cup. The mercury in the tube, called the barometric column, is supported by the air pressure on the mercury in the cistern. The space above the mercury in the tube is called Torricelli's vacuum. The difference between the level of the mercury in the tube and the level in the cistern will vary with elevation above the sea, and with the variations of atmospheric pressure. The instrument is fitted for observational use by incasing it in a metal tube which contains openings through which the levels of the mercury in the tube and cistern may be observed, and by providing the means by which accurate readings of the difference of the two levels may be readily obtained.

The Aneroid Barometer, q. v., is made, as its name implies, without liquid: sometimes it is called "holosteric," which means "wholly of solids." It was invented by Lucien Vidie in 1843, 200 years after the mercurial barometer.

barometer box (or **case**), *n.*—A box designed to house a mercurial barometer when in use. Its functions are (1) to provide protection for the instrument and (2) to shield it from sudden changes in temperature. A barometer box is usually equipped with accessories to hang the instrument, and to hold it steadily in a vertical position.

Enclosing a barometer in a tight box adds to the accuracy of a reading, because, as air can neither enter nor leave readily, the temperature of the mercury in the barometer tube becomes very close to that of the attached thermometer—and it is necessary to know the temperature of the barometer in order to reduce its readings to sea level, the standard reference plane.

barometric, *adj.*—1. Pertaining to a barometer, as in the phrase BAROMETRIC COLUMN, or to the results obtained by using the instrument, as in the expressions BAROMETRIC TENDENCY and BAROMETRIC HYPSOMETRY, q. v. 2. Often used in the same sense as pressure (atmospheric); e. g., BAROMETRIC GRADIENT, q. v., for pressure gradient.

barometric column, *n.*—*See:* BAROMETER.

barometric gradient, *n.*—Synonymous with pressure gradient, which is the rate of change of atmospheric pressure per unit horizontal distance, measured in a direction normal to the isobars.

barometric hypsometry (or **altimetry**), *n.*—The process of measuring height with a barometer. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 68; D. Brunt, Physical and Dynamical Meteorology, 1939, p. 35; Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. 133–166.

barometric pressure, *n.*—*See:* ATMOSPHERIC PRESSURE.

barometric rate, *n.*—The rapidity with which the atmospheric pressure rises or falls within a given period of time. *See:* BAROMETRIC TENDENCY.

barometric tendency, *n.*—The net change of barometric pressure within a specified time (usually 3 hours) before an observation, together with the proper sign, indicating not only the amount of change but whether the pressure is rising or falling, and also the characteristics of the rise or fall, such as "rising or falling," "unsteady," etc.

barometric wave, *n.*—Synonymous with SURGE, q. v.

barometry, *n.*—The study of the measurement of atmospheric pressure, with particular reference to ascertaining and correcting the errors of aneroid and mercurial barometers and improving their accuracy.

In a mercurial barometer, errors may be introduced (1) by defects in the instrument itself—imperfect vacuum above the mercury column, inexact graduations of the scale, etc.; (2) by improper exposure—in direct sunlight, too near a heat source, or in a place where it is subject to gusts of wind; and (3) by personal errors of the observer, such as failure to read the scale properly and misapplication of the corrections for temperature, altitude, gravity, etc.

An aneroid barometer is by nature less accurate than a mercurial barometer, and its errors are more difficult to ascertain, since they vary from time to time with the strains in the material. A barograph, of either the mercurial or aneroid type, has additional sources of error, due to the complexity of its mechanism. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 13–14, 33–37, 44–46.

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baromil, *n.*—The unit used in graduating a barometer in the c. g. s. system. If the barometer is read at 45° latitude at sea level and its temperature is at the freezing point of water, one baromil corresponds to a pressure of one millibar; under other conditions, corrections must be applied to reduce a baromil to a MILLIBAR, q. v.

barosphere, *n.*—A name sometimes given to the region of the atmosphere above 8 km.

baroswitch, *n.*—A switch in a radiosonde actuated by an aneroid element. It is used to switch the temperature and humidity elements, and certain fixed resistors, into a circuit. The pressure at the time is incidentally indicated by the switching operation.

barothermograph, *n.*—An instrument which automatically records temperature and pressure. It is a combination BAROGRAPH and THERMOGRAPH, q. v.

barotropic fluid, *n.*—A fluid in which the surfaces of equal pressure and of equal density coincide. *See:* BAROCLINIC FLUID.

barrier, *n.*—1. A thick, largely fresh-water ice formation with a nearly flat upper surface extending seaward from the land but attached thereto. 2. The clifted edge of SHELF ICE, q. v.

barrier berg, *n.*—*See:* TABULAR ICEBERG.

barrier theory, *n.*—A theory of cyclogenesis proposed by F. M. Exner, in which an outbreak of polar air into the region of the prevailing westerlies is considered to act as a barrier to the eastward motion of the warmer air and is said to cause the formation of a low pressure center just to the east of the barrier, around which a cyclonic vortex develops and travels eastward. "In a similar manner a continent, especially a mountainous continent, may act as a barrier. Exner refers in particular to Greenland and suggests that the Icelandic minimum to the east of the southern tip of Greenland may originate as a barrier effect." (B. Haurwitz, Dynamic Meteorology, 1941, p. 318.)

This hypothesis, developed by Exner from the work of the Austrian school of meteorologists, is also known as the DROP THEORY, q. v. It has not been generally accepted, because "it appears doubtful that the pressure deficit in the lee of the barrier is strong enough to lead to cyclogenesis except in very special cases." (Ibid., p. 318.) *See:* F. M. Exner, Dynamische Meteorologie, 2d ed., 1925, p. 339.

barye, *n.*—A c. g s. unit of pressure, equal to 1 dyne/cm^2. *See:* BAR.

base line, *n.*—A line with known true bearing, length, and elevations of extremities, used in two-theodolite observational work in the trigonometric calculation of the height or distance of balloons. In practice more than one base line is laid out, because when observing free balloons it is advantageous to use a base line which is as nearly as possible at right angles to the path of the balloon.

base-line check (raob), *n.*—A procedure in which the temperature-frequency-relationship of a radiosonde is determined. Once determined, the temperature corresponding to any other frequency may be found by means of a simple evaluation.

base map, *n.*—"A map, having essential outlines, used for indicating specialized data of various kinds." (Webster's New International Dictionary, 1939.)

Base maps are used extensively in meteorology and climatology for plotting observational data. In the former, they are used for preparing synoptic weather charts; these maps often have the barest outlines of states and countries, and only place-marks, with or without names for those places where meteorological data are available. Mountains and contour lines are omitted, and only the larger rivers and lakes indicated. In climatology, more complete base maps are used. Some data, as for instance snowfall, are shown on maps containing the mountain systems, because the distribution is then better understood. *See:* SYNOPTIC CHART.

bayamo, *n.*—A violent blast of wind, accompanied by vivid lightning, blowing from the land on the south coast of Cuba, especially near the Bight of Bayamo.

bay ice, *n.*—Young ice which first forms on the sea in autumn.

bc., *abbr.*—Abbreviation for sky partly clouded (¼ to ¾), in the BEAUFORT WEATHER NOTATION, q. v.

beaded lightning, *n.*—A type of LIGHTNING, q. v., seen when the observer happens to be end-on with respect to the line of discharge, so that several points, more brilliant than the rest of the path, appear as a string of incandescent beads. It is sometimes called "pearl" lightning. *See:* J. G. Albright, Physical Meteorology, 1939, p. 333.

Beaufort weather notation, *n.*—A code for describing the weather by means of letters and symbols, originally devised by Admiral Sir F. Beaufort (1774–1857), during the years 1805–1808; since altered and amplified by British and American meteorologists. *See:* Smithsonian Meteorological Tables, 5th rev. ed., 1939, p. 245; Admiralty Weather Manual, 1938, pp. 319–321; L. G. Garbett, Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather, Quarterly Journal of the Royal Meteorological Society, vol. 52, 1926, pp. 161–172.

Beaufort wind scale, *n.*—A system of estimating wind velocities, originally based (1805–1808) by its inventor, Admiral Beaufort of the British Navy, on the effects of various wind speeds on the amount of canvas which a full-rigged frigate of the early nineteenth century could carry; since modified and widely used in international meteorology.

As generally given in most meteorological texts, the Beaufort scale consists of thirteen degrees of wind speed, numbered from 0 (calm) to 12 (hurricane), with corresponding descriptions of the effects of the different winds on land and sea, and their limiting velocities in knots, miles per hour, meters per second, etc. Other wind scales have been devised for special uses, such as the NRM WIND SCALE, q. v. *See:* L. G. Garbett, Admiral Sir Francis Beaufort and the Beaufort Scales of Wind and Weather, Quarterly Journal of the Royal Meteorological Society, vol. 52, 1926, pp. 161–172.

Beer's law of absorption, *n.*—A law giving the absorption of radiation in passing through any medium; applied in meteorology to the atmosphere which absorbs radiation both from the sun and from the earth. The equation for atmospheric absorption according to Beer's law is:

$$I_\lambda = I_{\lambda 0} e^{-k_\lambda u}$$

where I_λ=radiation intensity of a monochromatic beam after transmission; I_{λ_0}=intensity of incident radiation; e=Napierian base; k_λ=absorption coefficient for radiation of wave length λ; and u=optical mass of the layer.

In determining the atmospheric absorption one must know the absorption coefficients of all the various gases present in the atmosphere. *See:* ABSORPTION; D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 113–114.

belat, *n.*—A strong land wind, from the north or northwest, which occasionally affects the southern coast of Arabia, and is accompanied by a hazy atmosphere due to sand blown from the interior desert.

Bemporad's formula, *n.*—A formula for the value of the optical AIR MASS, q. v., in the law of absorption of solar energy in passing through the earth's atmosphere:

$$m=\frac{\textit{atmospheric refraction}}{k \sin z}$$

where m=air mass in path of beam, k=constant, and z=sun's zenith distance.

For values of m computed by Bemporad, *see* Smithsonian Meteorological Tables, 1939, Table 100, p. 226.

Benard cell, *n.*—A type of eddy, also called a convection cell, having a horizontal axis and formed when the top surface of a fluid is cooled. This has been observed in a laboratory, but may exist in the atmosphere, it is thought, when instability is produced by the heating of the earth's surface by solar radiation.

See: D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 219–221; Proceedings of the Royal Society of London, 1928, Series A, p. 195.

bentu de soli, *n.*—An east wind on the coast of Sardinia.

berg, *n.*—Shortened form of ICEBERG, q. v.

Bergeron classification (of air masses), *n.*—*See:* AIR MASS; AIR MASS CLASSIFICATIONS.

Bergeron-Findeisen hypothesis, *n.*—*See:* RAINDROP.

berg wind, *n.*—A foehn wind in South Africa. "The Berg winds of the littoral of the Cape Province, South Africa . . . become heated simply in blowing down from the plateau; there is generally no liberation of latent heat by the condensation of water vapour. The plateau itself, in spite of its elevation, often enjoys temperatures in the daytime as high as are normal at sea-level, and if the wind blows down from the plateau to the coast, it is warmed by compression far above the coast temperature." (W. G. Kendrew, Climate, 1930, p. 301.)

Bermuda high, *n.*—The name often given to the high pressure cell usually found over the Atlantic Ocean near the Bermuda Islands, though it varies in position and intensity. When it moves westward so that its edges touch on the southeastern United States, hot weather may result throughout the whole eastern part of the country. *See:* BLOCKING (1).

bhoot, *n.*—In India, a dust WHIRLWIND, q. v.

billow clouds, *n.*—Clouds formed by wave motion on the surface of discontinuity between air layers of different density and temperature. They usually occur at elevations of 6 to 8 kilometers, in series of approximately regularly-spaced bands, where ascending motion at the wave crests reaches above the air's condensation level and causes cloud formation, and with intervening strips of clear sky where descending motion in the troughs occurs. *See:* C. F. Brooks, Why the Weather?, 1935, pp. 43–44; B. Haurwitz, Dynamic Meteorology, 1941, pp. 287–288; W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 301.

biochore, *n.*—In W. Köppen's classification of climate that part of the earth's surface having a life-sustaining climate. It is bounded on the one hand by the cryochore, or region of perpetual snow, and on the other by the xerochore, or waterless desert. Transition zones on either side are the bryochore, or tundra region, and the poëchore, or steppe region. The bulk of the biochore consists of the dendrochore, or tree region. *See:* Climatic Classification.

bioclimatic, *adj.*—Pertaining to the relations between climate and life. *See:* Bioclimatics.

bioclimatic law, *n.*—A law of Phenology, q. v., "according to which periodical events of plant and animal life advance over the United States at the rate of 1 degree of latitude, 5 degrees of longitude, and 400 feet of altitude every four days—northward, eastward, and upward in spring, and southward, westward, and downward in autumn." (C. F. Talman, Our Weather, pp. 367–368.)

bioclimatics, *n.*—The science which treats of the relations existing between life and climate. *See:* A. D. Hopkins, Bioclimatics, 1938.

bioclimatograph, *n.*—A form of climatograph, used to show the relation between climate and insect life. *See:* Climograph.

bioclimatology, *n.*—The science which treats of the effects of climate on human life and health. One of its aims is to discover the climatic regions most beneficial to persons suffering from certain types of disease.

birainy, *adj.*—A term applied to the climate of a place that has two periods of rainfall in a year. "As the belt of rains swings back and forth across the equator after the sun, there are two rainy seasons with the sun vertical, and two dry seasons when the sun is farthest from the zenith and while the trades blow. These conditions prevail on the equator, and as far north and south of the equator (about 10°–12°) as sufficient time elapses between the two zenithal positions of the sun for the two rainy seasons to be distinguished from one another. In this belt, under normal conditions, there is, therefore, no dry season of any considerable duration. The double rainy season is clearly seen in equatorial Africa and in parts of equatorial South America." (R. D. Ward, Climate, 2d ed., 1918, pp. 90–93.)

bise (or **bize**), *n.*—A cold, dry wind which blows from a northerly direction in the winter over the mountainous districts of southern Europe.

Bishop's ring, *n.*—A faint reddish-brown Corona, q. v., often seen under favorable circumstances around the sun, following volcanic eruptions, and named after the Reverend Sereno Bishop, of Honolulu, who first described the phenomenon. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 555.

Bjerknes cyclone model, *n.*—An idealized model, developed by Bjerknes and the Norwegian school of meteorologists, showing the normal distribution of air masses, fronts, cloud forms, precipitation, pressure, pressure tendencies, etc., about a wave cyclone during the various phases of its existence. It is of considerable assistance in the analysis of a synoptic weather map: often the cyclone actually present on the map bears little resemblance to the model, but almost invariably the essential features are there even though greatly distorted. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 303–308; J. Bjerknes, On the Structure of Moving Cyclones, Geofysiske Publikationer, vol. 1, 1918, pp. 1–8.

black blizzard, *n.*—A local term for dust storms in the Dust Bowl region of the United States. *See:* BLIZZARD; DUST BOWL.

black body, *n.*—An ideal body, the surface of which absorbs all the radiation that falls upon it; i. e., it neither reflects nor transmits any of the incident radiation. "It can be shown that such a body will radiate more energy for any and all wavelength intervals than any other body of the same temperature provided the radiation is due to the temperature alone, . . . that such a body will radiate any amount of energy that depends upon the temperature alone, and also that the radiated energy is distributed among different wavelength intervals according to a definite law." (W. E. Forsythe, ed., Measurement of Radiant Energy, 1937, p. 5.) The RADIATION LAWS, q. v., are mainly concerned with the behavior of a black body, the nearest approach to which among natural substances is soot, though the sun is often considered as a black body in meteorological studies of its radiation. *See:* BLACK-BODY RADIATION.

black-body radiation, *n.*—The maximum amount of radiation which can theoretically be emitted by unit surface of a body at a given temperature. In theory, it is the amount emitted by a BLACK BODY, q. v.; in nature, "the nearest approach to black-body radiation is the radiation which passes out through a small cavity in a solid body at a uniform temperature." (D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, p. 106.)

black bulb thermometer, *n.*—"A mercurial maximum thermometer, the bulb of which has been coated with lampblack or platinum black. The whole is inclosed in a glass jacket from which the air and moisture have been extracted. The transference of heat by conduction to or from surrounding objects is thus eliminated. The temperature of the bulb will rise to such a point that the energy given out in the form of radiation exactly balances the radiant energy absorbed. If such an instrument is surrounded by a case kept at a constant temperature, and if the insolation of the sun is allowed to fall upon it, the temperature recorded will give relative values of the insolation. The instrument is thus an actinometer rather than a thermometer. Without the use of the case, which is kept at a constant temperature, the instrument will give only rough relative values of the insolation received." (W. I. Milham, Meteorology, 1936, p. 75.)

black fog, *n.*—A type of Fog, q. v.
black frost, *n.*—A type of Frost, q. v.
black lightning, *n.*—Same as Dark Lightning, q. v.
black squall, *n.*—A squall attended by a mass of dark clouds; the opposite of a White Squall, q. v.
black storm, *n.*—*See:* Karaburan.
blizzard, *n.*—A violent, intensely cold wind, laden with snow mostly or entirely picked up from the ground.

"So far as is known, this term was first used in the middle western United States to describe a type of winter storm of rather frequent occurrence in that region, characterized by (1) high wind, (2) very low temperature, and (3) an abundance of fine snow in the air. The etymology of the word is still speculative . . . .

"There is a tendency, both in the United States and in other English speaking countries, to apply the word 'blizzard' indiscriminately to any heavy snowstorm accompanied by more or less wind . . . . This broad use of the term impairs its utility for purposes of exact description, and should be discouraged.

"It is doubtful whether true blizzards, characterized by intense cold, high wind, and blinding clouds of dry, powdery 'snowdrift', ever occur in the British Isles, and they are exceedingly rare in the eastern United States. They are not, however, peculiar to the interior of the American Continent, for the most intense storms of this character heretofore recorded are those of Adelie Land, Antarctica, so graphically described in Sir Douglas Mawson's 'Home of the Blizzard', London, 1915." (C. F. Talman, Note on the Meaning of 'Blizzard', Monthly Weather Review, vol. 48, 1920, p. 82.) Other storms similar to the blizzard are the Buran and Purga, q. v., of Russia and Siberia. *See:* C. F. Brooks, Why the Weather?, 1935, pp. 218–219; W. G. Kendrew, The Climates of the Continents, 3d ed., 1927, pp. 443–448.

blocking, *n.*—The retardation or deflection of eastward-moving pressure centers due to the stagnation of a high (less frequently a low) in their paths.

1. In the older school of forecasting, differentiation was made between complete and partial blocking. According to E. B. Garriott (Long-Range Weather Forecasts, Washington, 1904), a reversal or distortion of the normal pressure pattern over northern Europe retards the progression of highs and lows across the North Atlantic, then slows down the movement of systems in the Canadian Maritime Provinces, and several days later blocks the pressure centers in the St. Lawrence Valley and the Great Lakes region. Partial blocking, according to this viewpoint, occurs most notably in the United States when the Bermuda High, q. v., moves westward of its normal positions and spreads over the southeastern states, with the result that low centers coming from the west are deflected or shunted northward around the periphery of the high. As long as the high continues stationary in this area, the air circulation around its western side is from the south, and produces a Hot Spell, q. v., in the Mississippi Valley.

2. Recent extended forecasting work has given blocking a more general application. The term is used with reference to a slowing down of the west-east circulation in western Europe and the eastern North Atlantic, which is thought to be followed a week later by a similar retardation over North America, and possibly two weeks later by a stoppage of the eastward flow across the North Pacific. *See:* J. Namias, Methods of Extended Forecasting Practiced by the Five-day Forecast Section, U. S. Weather Bureau, Washington, 1943; R. A. Allen, P. Fletcher, J. Holmboe, J. Namias, H. C. Willett, Report on an Experiment in Five-day Weather Forecasting, Massachusetts Institute of Technology Meteorological Papers, vol. 8, No. 3, pp. 51–53.

blood rain, *n.*—*See:* RAIN.

blowing snow, *n.*—"Snow raised from the ground and carried by the wind so that the horizontal visibility becomes less than 5/8 mile (3,300 ft.), although no real precipitation is falling. The snow is carried up so high from the ground that the vertical visibility is reduced considerably." (U. S. Weather Bureau, Definitions of Hydrometeors and Other Atmospheric Phenomena, 1943, p. 16.) *See:* HYDROMETEOR; SNOW; BLOWING SNOW; U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 1941, p. 45.

bloxam, *v. t.*—To smooth mean values by a method invented independently by J. C. Bloxam in 1858, although it was used in the latter part of the eighteenth century by Peter Meerman. "The method is founded on the fact that, in meteorology, the mean of 10 or 11 consecutive days gives more accurately the normal constant value for the middle day of the series, than the middle day itself does; and then the value for every day in the year having been calculated upon this principle, this whole series of amended values can in turn be subjected to the same process; and the process may be reiterated until the daily values are brought to sufficiently regular ascending and descending lines." (Bloxam's Smoothing Process, Quarterly Journal of the Royal Meteorological Society, vol. 30, 1904, p. 95.) Essentially the same result would be obtained now by using modern statistical methods of curve fitting. *See:* SMOOTHING.

blue ice, *n.*—Pure ice in large masses, which is blue, owing to the scattering of light by its large molecules; the purer the ice, the deeper the blue. *See:* ICE; N. E. Dorsey, Properties of Ordinary Water Substance, 1940, pp. 398, 487.

blue flash, *n.*—*See:* GREEN FLASH.

blue-green flame, *n.*—*See:* GREEN FLASH.

blue sun (or **moon**), *n.*—*See:* GREEN SUN.

bm., *abbr.*—Abbreviation for BAROMIL(s), q. v.

bohorok, *n.*—A foehn-type wind which blows in parts of Sumatra during the months of May to September. *See:* FOEHN.

boiling point, *n.*—The temperature at which the saturation vapor pressure of a liquid is in equilibrium with the external pressure on the liquid. The boiling point therefore varies with the external pressure; this explains why "the higher you go, the lower is the temperature at which water boils. To use an approximate figure the boiling point is lowered 1.8 degrees F. for each 1,000 feet of altitude." (C. F. Brooks, Why the Weather?, 1935, p. 118.) The normal boiling point of water, referred to standard atmospheric pressure of 760 mm. of mercury, is 100° C., which is one of the fixed points of the centigrade temperature scale. A table of boiling points of water at various pressures is given in the Smithsonian Physical Tables, 8th rev. ed., 1934, p. 188.

bologram, *n.*—A curve, obtained with a spectrobolometer, which indicates the relative intensities of the radiations at various wave lengths in the solar spectrum.

bolometer, *n.*—An instrument used to measure thermal radiation. The name was coined by Professor Gildersleeve of Johns Hopkins University at the request of Langley, who devised the instrument. The bolometer consists of two blackened metallic strips, one of which is shaded and the other exposed. The difference in the electrical resistance between the strips is a measure of the intensity of radiation received.

bora, *n.*—A cold northerly wind of the Adriatic, caused by the passage of a cyclone over Italy, which draws the cold heavy air down from the Hungarian basin. It is similar to the MISTRAL, q. v., of the Gulf of Lion, and belongs to the FALLWIND, q. v., category. *See:* J. Hann, Handbook of Climatology, Part I, General Climatology, tr. R. D. Ward, 1903, pp. 363–365; W. J. Kendrew, The Climates of the Continents, 3d ed., 1937, pp. 276–277.

borasco, *n.*—A thunderstorm, or violent squall, especially on the Mediterranean.

Boreas, *n.*—1. Greek name of the north, north-northeast, or northeast wind, or its personification. 2. "Wind from the mountains. The god of the north wind." (Webster's New International Dictionary, 1939.)

bornan, *n.*—A breeze blowing from the valley of the Drance over the middle of Lake Geneva.

Bouguer's halo, *n.*—A faint white circular arc of light around the antisolar point, of about 39° radius; variously termed Bouguer's halo, white rainbow, false white rainbow, and fogbow. Its origin is controversial: some regard it as a rainbow formed by supercooled water droplets, others consider it a halo, although its explanation by refraction from ice crystals requires highly improbable crystal forms. B. B. Ray seems to have shown, on the basis of the electromagnetic theory of light, that it is a true rainbow produced by unusually small water drops and to have accounted for its size and faint white appearance. *See:* B. B. Ray, The Scattering of Liquid Droplets, and the Theory of Coronas, Glories and Iridescent Clouds, Proceedings of the Indian Association for the Cultivation of Science, vol. 8, 1923, pp. 23–46.

Bourdon tube, *n.*—A device which may be used to measure atmospheric pressure, and, in another form, to measure temperature.

"The Bourdon barometer, little used in meteorology, consists simply of a closed, curved tube of elliptical cross-section. Changes in the atmospheric pressure result in changes in the radius of curvature of the tube. One end being fixed, the motion of the other is magnified by a system of levers and indicates the pressure.

"The Bourdon thermometer consists of a curved tube of elliptical cross-section, completely filled with some organic liquid. It is therefore really a liquid-in-metal thermometer, but . . . it is the deformation of the element itself which indicates the changes in temperature." (W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 37, 72.)

Boyle's law, *n.*—A thermodynamic law which states that the volume of a gas varies inversely as its pressure, the temperature remaining constant. Expressed mathematically:

$$pV = c$$

where p=pressure; V=volume; c=a constant. This law holds exactly only for the behavior of an Ideal Gas, q. v., but is accurate enough for general purposes. Boyle discovered this law in 1662; it was rediscovered by Mariotte in 1676, and is sometimes known as Mariotte's law.

brave west winds, *n.*—A nautical term used to designate the strong, often stormy, winds from the west-northwest and northwest, which blow at all seasons of the year from 40° S. lat. and especially from 45° S. to about 60° S. Their strength and steadiness are due to the steep barometric gradient of those regions, and to the absence of extensive land areas. Sailing ships by their aid are able to compete with steamers in the trade between England and New Zealand via the Cape of Good Hope, the return journey being made around Cape Horn. *See:* Roaring Forties.

break, *n.*—A sudden change from abnormally high or low temperatures. Thus one may speak of the "break" of a hot or cold wave.

breather, *n.*—A tropical Squall, q. v.

Breese chart, *n.*—An index chart devised by Alexander Breese of the U. S. Weather Bureau for the purpose of showing the distribution of actinometric stations. The chart uses a Lambert equal-area projection map as a basis, but any projection will serve. Each 10-degree square is numbered so that if any area is named, its approximate position on the earth's surface may be visualized. The square just north of the equator and just east of Greenwich longitude is numbered $^{00}/_{00}$; the next one to the east is $^{00}/_{01}$; the next $^{00}/_{02}$; and so on around the globe, the final one in that row being $^{00}/_{35}$. Then directly above $^{00}/_{00}$, the square is named $^{01}/_{00}$; the next $^{01}/_{01}$, and so on.

Directly south of square $^{00}/_{00}$, in the southern hemisphere, is the square $^{10}/_{00}$, the next one east is $^{10}/_{01}$, the next $^{10}/_{02}$, and so on. The numbering is continued the same as in the northern hemisphere.

Taking any number at random, say $^{04}/_{10}$, one can visualize it as being just north of the 40th parallel, and east of 100th meridian east. Square number $^{04}/_{26}$ would be just north of the 40th parallel, but 260° east of Greenwich. For more exact locations, tenths may be added to the number scheme.

As to the notation: The first figure above the line gives the hemisphere, the northern being denoted by 0 and the southern by 1. The second figure above the line, multiplied by 10, gives the latitude.

The value below the line, multiplied by 10, gives the longitude, always measured east of Greenwich. But the longitude, when over 180°, and subtracted from 360° will give the value in "west longitude." For instance the square numbered $^{12}\!/_{26}$ is in the southern hemisphere: the latitude is 20° S., and the longitude is 260° E. of Greenwich or 100° W. long. (360°−260°). The number of the square always gives the latitude and longitude of the southeast corner of the square whether the square is north or south of the equator. *See:* MARSDEN CHART.

breeze, *n.*—1. In general, a light wind. 2. In the BEAUFORT WIND SCALE, q. v., a wind speed ranging from 4 to 31 miles per hour, and divided into the following Beaufort numbers:

2	Light breeze	4–7 miles per hour
3	Gentle breeze	8–12
4	Moderate breeze	13–18
5	Fresh breeze	19–24
6	Strong breeze	25–31

breva, *n.*—The day breeze on Lake Como, blowing up the valley toward the head of the lake.

brickfielder, *n.*—A hot, dry, dusty north wind from the interior deserts which sometimes visits the south coast of Australia. "Melbourne has recorded a maximum of over 100° (F.) on six consecutive days, when the pressure distribution was such as to cause a steady flow of air from the north." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 427.)

brisa, *n.*—1. A breeze (Spanish). 2. Brisas: A northeast wind which blows on the coast of South America during the trades. 3. The northeast monsoon in the Philippines. Also spelled BRIZA, q. v.

brisote, *n.*—In Cuba, the name for the northeast wind when it blows more strongly than usual. *See:* BRISA (1).

British thermal unit, *n.*—A unit of heat; it is $^1\!/_{180}$ of the quantity of heat required to raise the temperature of one pound of water from the melting point to the boiling point. The abbreviation of this term is, *B. t. u.*

briza, *n.*—Name for a local breeze in Puerto Rico. It is the regular northeast trade wind deflected to an east wind by the influence of the land surface. Also spelled BRISA, q. v.

Brocken bow, *n.*—Also known as glory; a set of rings of colored light around the shadow of an observer's head as cast upon a neighboring fog bank or cloud, "produced by the primary scattering of the incident light by the directly illuminated droplets of the cloud or fog bank." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 555.) *See:* B. B. Ray, The Scattering of Light by Liquid Droplets, and the Theory of Coronas, Glories, and Iridescent Clouds, Proceedings of the Indian Association for the Cultivation of Science, vol. 8, 1923, pp. 27–34.

Brocken spectre, *n.*—The illusory appearance of a gigantic figure, frequently observed on the Brocken, a famous peak of the Hartz mountains in Saxony (hence the name), but also visible on any mountaintop under suitable conditions. It is produced in a manner similar to the BROCKEN BOW, q. v.; if the cloud or fog bank upon which the shadow of the observer's head is cast by the sun is 150 feet or more away, the shadow and encircling rings of light are indistinct and give the resemblance of a spectral figure of superhuman size. *See:* J. G. Albright, Physical Meteorology, 1939, p. 371.

broeboe, *n.*—A strong, dry, east wind in the southwestern part of the island of Celebes.

broken sky (or **clouds**), *n.*—The condition of the sky when it is more than five-tenths, but not more than nine-tenths, covered by clouds. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 1941, p. 31, pars. 2–136.

brontides, *n.*—Low, thunder-like noises, of short duration, most frequent in actively seismic regions; they are the rumblings of very feeble earthquakes. "They are called mistpoeffers on the Belgian coast, Borisal guns in the Ganges delta, bull dog, desert sounds, or Hanley's guns in parts of Australia, gouffre in Haiti, Moondus noises at Moondus, Connecticut, Nebelzerteiler, Seedonner, Seeschiessen, etc., in Germany, baturlio, bouiti, bombiti, etc., in Italy." (C. F. Talman, Our Weather, p. 368.) *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 442.

brown snow, *n.*—Snow intermixed with dust particles; a not uncommon event in many parts of the world. Snow of other colors, such as RED SNOW and YELLOW SNOW, q. v., have also been reported. *See:* H. I. Baldwin, "The Fall of Brown Snow in New Hampshire, Science, 1936, p. 371; H. R. Byers, Meteorological History of the Brown Snowfall of February 1936, Monthly Weather Review, vol. 64, 1936, pp. 86–87; W. O. Robinson, Composition and Origin of Dust in the Fall of Brown Snow, New Hampshire and Vermont, February 24, 1936, Monthly Weather Review, vol. 64, 1936, p. 86.

brubu, *n.*—A SQUALL, q. v., in the East Indies.

Brückner cycle, *n.*—A supposed world-wide periodic variation in temperature, rainfall, and atmospheric pressure, small in amount and quite irregular in occurrence, with an average period of 34.8±0.7 years, though single periods vary from 20 to 50 years; announced in 1890 by Prof. Edward Brückner of Berne. It is based on the recurrence in Europe of "a variety of phenomena including the advance and retreat of the Alpine glaciers, variations in the dates of opening and closing of Russian rivers, the level of the Caspian Sea and the rivers emptying into it, the date of the grape harvest and the price of grain." (A. A. Miller, Climatology, 1931, p. 271.) *See:* J. Hann, Handbook of Climatology, Part I, tr. R. D. Ward, 1903, pp. 408–412; A. J. Henry, The Brückner Cycle of Climatic Oscillations in the United States, Annals of the Association of American Geographers, vol. 17, 1927, pp. 60–71; N. Shaw, Manual of Meteorology, vol. 2, 1928, pp. 314–316; R. D. Ward, Climate, 2d rev. ed., 1908, pp. 360–364.

bruma, *n.*—A HAZE, q. v., that appears in the afternoons on the coast of Chili when sea air is transported inland.

brüscha, *n.*—Local name for a northwest wind in the Bergell Valley, Switzerland.

brush discharge, *n.*—A discharge of electricity in the form of a brush (which is neither a spark discharge nor a glow discharge but somewhere between the two). In nature the best example is St. Elmo's Fire, q. v.; Byers mentions it as occurring from airplanes at the −10° C. isotherm level. *See:* H. R. Byers, General Meteorology, 1944, p. 561.

bull's eye, *n.*—1. The eye, or calm central portion of a storm. 2. A small dark cloud with a reddish center, supposed by sailors to portend a storm. 3. A kind of Squall, q. v., on the coast of Africa, "which the Portuguese describe as first appearing like a bright white spot at or near the zenith, in a perfectly clear sky and fine weather, and which, rapidly descending, brings with it a furious white squall or tornado." (H. Piddington, Sailor's Horn-book, 5th ed., 1869, p. 307.)

bumpiness, *n.*—An atmospheric condition which causes an airplane to experience a sudden upward or downward jolt, or succession of jolts.

If an airplane passes from a region of the atmosphere in which the vertical velocity has a certain value, to another region where the vertical velocity is distinctly different, the resulting change produces bumpiness. This is most marked in the updrafts and downdrafts associated with a thunderstorm. A second type of bumpiness occurs when an airplane encounters a shift in wind direction or variation in wind speed. For example, if it has been flying with the wind, it will undergo a downward jolt when the wind increases and an upward jolt when the wind lulls; or, if it has been flying with the wind, and the wind shifts so that it blows from a direction roughly that in which the plane is headed, an upward motion will result. A third kind of bumpiness, "generally in the form of one distinct bump, is encountered in flying through a strong (temperature) inversion. Here the lift on the airfoil changes suddenly and causes a bump, generally rather slight, as the inversion is penetrated." (G. F. Taylor, Aeronautical Meteorology, 1938, p. 308; cf. pp. 307–313.) *See:* Turbulence.

bumpy, *adj.*—A term applied to turbulent air. *See:* Turbulence; Bumpiness.

buoyancy, *n.*—*See:* Archimedes' Principle.

buran, *n.*—A violent northeast storm of south Russia and central Siberia, similar to the American Blizzard, q. v. "It is only when the wild Buran blows, the Purga of the tundras, that there is danger to man and beast. During these storms, the wind sweeps with extraordinary violence over the open plains. The air is thick with snow, descending from the sky and swept up from the ground, so that it is impossible to see. Though the temperature is not especially low, the cold is felt keenly, and anyone who is overtaken runs a serious risk of losing his way and being frozen to death. The Buran is known and dreaded in South Russia and through Siberia." (W. G. Kendrew, The Climates of the Continents, Oxford, 1937, p. 200.)

burga (or boorga), *n.*—A storm of wind and sleet in Alaska, similar to the Russian Purga, q. v.

burn, *v. i.*—In application to fog, to dissipate: the phrase, "the fog has burned off," means that a fog of the radiation or stratus type has been dissipated by the heating of the earth by the sun.
burster, *n.*—*See:* SOUTHERLY BURSTER.
Buys Ballot's law, *n.*—The principle governing the relation of wind direction to pressure distribution: "If one stands with his back to the wind, the pressure on his left hand is lower than on his right." Thus stated, the law applies in the Northern Hemisphere; but in the Southern Hemisphere, its reverse is true. The law was formulated about 1850 by C. H. D. Buys Ballot, who was chief of the Dutch Meteorological Service from 1854 to 1859.

C

c., *abbr.*—1. Abbreviation for CALM, q. v. 2. Former abbreviation for cirrus cloud, now abbreviated Ci.
C., *abbr.*—Abbreviation for CENTIGRADE (TEMPERATURE) SCALE, q. v.
cacimbo, *n.*—Portuguese name for the heavy mists, or SMOKES, q. v., of the Congo Basin in Africa.
cajú rains, *n.*—Name applied in northeast Brazil to light showers occurring in October. The rainy season (in Brazil) begins normally in December and lasts until April or May; then follows a dry season until the following rains at the end of the year. In most years there will be local showers in October known as "chuvas de cajú" (cajú rains), so called because they occur at the time of blossom of a popular fruit called cajú.
calf, *n.*—A small mass of ice that has separated by the process of CALVING, q. v., from a coastal glacier, iceberg, or floe.
calibration, *n.*—1. The process of evaluating the scale readings of an instrument in terms of the physical quantity to be measured, or of determining the corrections to be applied to scales of any measure (linear or circular) in order to obtain true values. *—adj.* Applied to the evaluation as corrections thus obtained. 2. *—n.* The result of the calibrating process.
California fogs, *n.*—Fogs peculiar to the California coast and its coastal valleys. The coast fogs are associated with cold ocean currents, the wind blowing away the warm surface water which is replaced by the deeper, colder water. The fogs of the coastal valleys are due to nighttime radiational cooling of the valleys which were filled in the afternoon by moist sea air. *See:* H. R. Byers, General Meteorology, 1944, pp. 519–523.
calina, *n.*—A local name given in Spain to the summer haze described by Kendrew (The Climate of the Continents, 1937, p. 286). He says: "In summer there is very active evaporation and almost complete drought, broken only by an occasional thunderstorm, and the fierce heat burns up the vegetation. Without irrigation the landscape is semi-desert, brown and grey are dominant colours, and dust is everywhere—the parched ground is thickly covered, and the air is hazy with minute dust particles which have been swept up by the strong winds. The haze is known as the calina, and is probably

due to irregular refraction of the light, as well as the dust. The view is frequently obscured by the dismal grey calina in all the south Mediterranean lands."

calm, *n.*—1. An entire or almost entire absence of wind. In the Beaufort Wind Scale, this condition is reported when smoke is observed to rise vertically and the wind speed is less than 1 mile per hour. In the U. S. Weather Bureau, it is reported when smoke rises vertically or the cups of an anemometer do not move. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 57. *—adj.* Applied to the condition of the atmosphere just described. 2. *—n.* The state of the sea in which the height from wave crest to wave trough is zero. *—adj.* Applied to the state of the sea just described. *See:* U. S. Weather Bureau, Instructions to Marine Meteorological Observers, Circular M, 6th ed., 1938, p. 54.

calm belt, *n.*—1. The region of low pressure and fitful winds near the equator, also called the Doldrums, q. v. 2. One or another of the zones of high pressure and light winds, known as the calms of Cancer and Capricorn, located near the poleward borders of the Tropics, q. v. *Note.*—These belts are so called from sailing-ship days when vessels were often becalmed in them for several days.

calm center, *n.*—*See:* Eye of the Storm.

calms of Cancer, of Capricorn, *n.*—*See:* Calm Belt.

calorie, *n.*—The amount of heat required to raise the temperature of one gram of water at 15° C. by one centigrade degree; also known as a gram calorie or small calorie.

calorimeter, *n.*—An instrument designed to measure quantities of heat; sometimes used in meteorology to measure solar radiation.

calving, *n.*—The breaking away of a mass of ice, called the Calf from a parent berg, glacier, floe, or barrier.

camanchaca, *n.*—A dense wet fog on the coasts of Chili and Peru, also known as the Garúa, q. v., which brings most of the moisture to these regions.

camsin, *n.*—*See:* Khamsin.

canal theory, *n.*—A theory of the general circulation of the atmosphere, proposed by William Ferrel in his "Popular Treatise on the Winds" (1889, ch. 3, pp. 89–162); so called because it is derived from a consideration of the behavior of a fluid in a trough or canal. "The theory assumes that the heated air of the tropics rises to high levels and flows poleward in the upper strata, that it gradually cools and settles down to the ground around the poles, and thence returns southward along the surface. Meanwhile the rotation of the earth disturbs these currents and sets up two great whirls in each hemisphere, one eastward in the middle latitudes and one westward in the tropics." (F. H. Bigelow, A Popular Account of the Countercurrent Theory of Storms, Proceedings of the Third Convention of Weather Bureau Officials, 1904, pp. 81–82.)

Candlemas Eve winds, *n.*—Heavy winds which often visit England during February and March.

canyon wind, *n.*—Same as Katabatic Wind, q. v.

capacity correction, *n.*—The correction applied to the reading of an ordinary mercurial barometer with a non-adjustable cistern, in order to compensate for a fluctuation in the level of the mercury in the cistern with respect to the zero of the scale. This correction is zero when the top of the mercury column stands at the "neutral point," which indicates that the height of the column is true to the scale; to all other readings a positive or negative correction must be made. *See:* Instrument Division, U. S. Weather Bureau, Circular F, Barometers and the Measurement of Atmospheric Pressure, 7th rev. ed., 1941, pp. 7–10.

capacity of the wind, *n.*—The total amount of detrital material of given character which can be sustained (per unit volume of air) by a wind of given velocity. In the aggregate, wind transports more material than water, although the latter, at the same speed of flow, is capable of carrying much larger particles. It has been estimated that the winds blowing across the Mississippi River Basin transport one thousand times as much material as does the river. During a dust storm the wind may carry from 160 up to 126,000 tons per cubic mile of air. *See:* E. E. Free, The Movement of Soil Material by the Wind, Bulletin No. 68, U. S. Department of Agriculture, 1911, pp. 44 and 80–81; COMPETENCE OF THE WIND.

cap cloud, *n.*—1. An apparently stationary cloud, resting on an isolated mountain peak, formed by the cooling and condensation of air forced up over the peak; sometimes called a standing cloud, which is a misnomer, for the cloud is constantly dissipating to leeward and as rapidly re-forming to the windward, so that it seems (but is not) permanent and fixed. 2. Name applied to FALSE CIRRUS, q. v., observed above the top of a swelling cumulus or cumulonimbus cloud in the form of a cap or hood. *See:* PILEUS.

cape doctor, *n.*—The strong southeast wind which blows on the South African coast.

capillarity correction, *n.*—The correction which must be made to the reading of a mercurial barometer to allow for the fact that the meniscus in the tube is convex upwards, thereby leading to the so-called capillary depression of the top of the mercury column because of which the column does not reach as high as it should in response to the atmospheric pressure. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 34–35.

capillary depression, *n.*—*See:* CAPILLARITY CORRECTION.

carbon dioxide, *n.*—A gas, CO_2, comprising about 0.03 percent of the atmosphere by volume; discovered in 1752 by Joseph Black. It is necessary for plant life.

cardinal winds, *n.*—Winds from the four cardinal, or principal, points of the compass, that is, north, east, south, and west.

cascade, *n.*—The mass of spray or dense vapor thrown outward from around the base of a WATERSPOUT, q. v.; also known as a "bush" or "bonfire."

case weather, *n.*—Term applied in the tobacco industry in Wisconsin (perhaps also elsewhere) to foggy weather which moistens the tobacco hanging in the sheds and makes it fit for handling and removal. The tobacco when thus moistened is said to be "in case."

castellate, *v. i.*—Of clouds, to assume castle-like forms.

castellatus, *adj.*—A variety of altocumulus clouds "with more or less vertical development, arranged in a line, and resting on a common horizontal base, which gives the cloud a crenellated (like a battlement) appearance." (International Cloud Atlas, 1932.) *See:* ALTOCUMULUS CASTELLATUS.

cat ice, *n.*—"Thin ice from under which the water has receded; shell ice." (Webster's New International Dictionary.)

cat's paw, *n.*—A light breeze affecting a small area, such as would cause patches of ripples on the surface of a stream; also known as a "puff of wind."

cavaliers, *n., pl.*—Local name about Montpellier in France for the days near the end of March or the beginning of April when the MISTRAL, q. v., is usually strongest.

caver, *n.*—A word used in the Hebrides for a gentle breeze; sometimes spelled kaver.

cavu, *n.*—A term used at airport weather stations to mean "ceiling and visibility unlimited"; it is formed from the initials of this phrase.

cb., *abbr.*—Abbreviation for CENTIBAR, q. v.

ceiling, *n.*—In U. S. Weather Bureau practice, "the height in feet of the lowest level below ten thousand feet above the station at which the total cloudiness (as projected against the entire dome of the sky) between the surface of the earth at the station and that level (10,000 feet) covers more than one-half of the entire area of the sky, except that in the presence of heavy precipitation, dense fog, or other conditions which prevent the observer from seeing any cloudiness that may be present, the ceiling will be at zero altitude; that is, at the surface." (U. S. Weather Bureau, Circular N, Instructions for Airway Meteorological Service, 5th ed., 1941, p. 28. A revised version of this definition states: "Ceiling is the lowest height above ground at which all clouds at and below that level cover more than one-half of the sky." (Amendment 5, second revision, effective 6–1–43.)

Besides the meteorological concept of ceiling, there are the following aeronautical usages of the term, each of which will be found under its separate heading: ABSOLUTE CEILING, BALLONET CEILING, SERVICE CEILING, and STATIC CEILING.

ceiling balloon, *n.*—A balloon used to calculate the height of the CEILING, q. v.; it is inflated with either hydrogen or helium and may be white, purple, or red. Knowing the rate of ascent of the balloon, the height above ground of a cloud layer may be ascertained by noting the interval of time from the release of the balloon to the instant when it disappears in the base of the cloud layer.

ceiling height indicator, *n.*—*See:* CLINOMETER; CEILING LIGHT.

ceiling light, *n.*—Also called a ceiling projector or cloud searchlight; a small searchlight which is used at night to project a narrow beam of light onto the base of a cloud in order to measure its height. The angular elevation of the illuminated spot thus produced is measured by an ALIDADE or CLINOMETER, q. v.; and if the ceiling light and the clinometer lie in the same horizontal plane, it follows that

$$Z = L \tan \beta$$

where Z is the ceiling height, L, the base line, is the distance between the two instruments, and β is the angular elevation of the illuminated spot. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 171–174.

ceiling of convection, *n.*—The height, usually referred to sea level, at which a stable thermal stratification of the atmosphere places an upper limit to the penetration of free thermal convective currents from the ground.

ceilometer, *n.*—An instrument for determining throughout the entire day and night the height of the cloud ceiling and the rate at which the ceiling is lifting and lowering. It consists of a photoelectric pickup unit (ceilometer detector), projector (ceilometer projector), and recorder (ceilometer recorder). The projector directs vertically an intense beam of modulated light to form a spot on the cloud base. The detector, situated a known distance (usually 1,000 feet) from the projector, contains an optical system which continually scans the projector beam and through a timed photoelectric amplifier and telemetering device causes to be registered on the recorder the angle at which light from the *spot* is reflected into the detector optical system. Cloud heights are determined from the information by triangulation. Manual operation of the detector is also possible, the observer noting the photoelectric amplifier output as the beam is scanned.

Cellini's halo, *n.*—*See:* HEILIGENSCHEIN.

cellular hypothesis, *n.*—A theory of the general circulation of the atmosphere, which seeks to explain the fact that the belt of high pressure around the earth of 30° latitude, the horse latitudes, and the belt of low pressure at 60° latitude are in fact not continuous, even on average annular charts of pressure distribution, and are especially irregular and uncertain over the continents and the western parts of the oceans.

"Bjerknes, Solberg, and Bergeron have recently announced a circulation scheme which takes these longitudinal differences into consideration. A picture has been formed that is theoretically possible and agrees fairly well with observations. It is the so-called cellular hypothesis of the general circulation. The circulation near the horse latitudes is considered to be taking place in four cells about 90 deg. in longitudinal width. These cells each contain an anticyclonic circulation which tilts upward from east to west, so that at high levels the anticyclones are farther west than at the surface. At about 60 deg. latitude, there are similar cells of the same number of degrees in width but containing cyclonic circulations that tilt in the opposite direction, i. e., from west upward to east." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 71; cf. pp. 71–74.) *See:* V. Bjerknes, J. Bjerknes, H. Solberg, T. Bergeron, Physikalische Hydrodynamik, 1933, p. 65.

Celsius scale, *n.*—A thermometric scale, proposed in 1742 by Andres Celsius, professor of astronomy at Upsala, with 0° as the boiling point of water and 100° as the melting point of ice, just the reverse of the centigrade scale, q. v.

center of action, *n.*—Name first applied by L. Teisserene de Bort in 1881 to each of certain semipermanent high and low pressure systems at the earth's surface. The principal centers of action in the northern hemisphere, are the Icelandic low, the Aleutian low, the Siberian high (winter), the North American high (winter), and the subtropical oceanic highs (strongest in summer). Fluctuations in the intensity, position, orientation, shape and size of these centers, are associated with widespread weather changes. It should be emphasized that the centers of action, as shown on weather maps giving mean conditions for a month, season, or year, do not exist as such day by day. *See:* Aleutian Low.

centibar, *n.*—One one-hundredth of a Bar, q. v.

centigrade degree, *n.*—"The variation in temperature which produces $\frac{1}{100}$ of the increase in pressure suffered by a mass of perfect gas at constant volume, when the temperature passes from 0° (temperature of melting ice, as officially defined) to 100° (temperature of the vapor of boiling water at 760 mm. pressure)." (W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 52.)

To convert centrigrade degrees (C.°) to Fahrenheit degrees (F.°):

$$F° = \frac{9}{5}\, C° + 32°$$

To convert Fahrenheit degrees to centigrade degrees:

$$C° = \frac{5}{9}\, (F° - 32°)$$

See: Centigrade Scale.

centigrade scale, *n.*—The thermometric scale in which the fundamental interval, between the temperature of melting ice, and the temperature of the vapor of boiling water at 760 mm. normal atmospheric pressure, is divided into 100 equal parts, each part being called a Centrigrade Degree, q. v. The boiling point is labeled 100°, the freezing point 0°.

The centigrade scale is probably derived from the Celsius Scale, q. v. "Linnaeus, the celebrated Swedish botanist, states that he first constructed mercurial thermometers, in which he placed zero at freezing water and 100 at the boiling-point, but whether this was consciously a modification of the numeration used by Celsius, or whether it was suggested by other considerations, is not stated. The fact remains, however, that the modern centigrade scale is due to Linnaeus rather than to Celsius." (C. Abbe, Treatise on Meteorological Apparatus and Methods, Report of the Chief Signal Officer, app. 46, Washington, 1888, p. 26.)

ceraunograph, *n.*—An instrument, also called a keraunograph, "for recording the occurrence of lightning discharges, whether close by, or as far away as to be invisible and their thunder unheard . . . . It is possible, with an instrument of this kind, to estimate the approximate distance, progress, and, to a large extent, even the direction and intensity of the storm." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 380.)

chain lightning, *n.*—1. Lightning in a long zigzag or broken line. 2. Same as BEADED LIGHTNING, q. v.

challiho, *n.*—Strong southerly winds, which blow in parts of India for some forty days around the month of April.

chamsin, *n.*—*See:* KHAMSIN.

chanduy, *n.*—"The dry-season breeze (at Guayaquil, Ecuador) which springs up every afternoon. When the rains begin late in December it disappears, not to return until after their cessation in June." (B. Niles, Casual Wanderings in Ecuador, 1923, p. 53.)

change of state, *n.*—The process by which a substance passes from one to another of the solid, the liquid, and the gaseous states, and in which marked changes in its physical properties and molecular structure occur. The change from the solid to the liquid state is called fusion or melting, the reverse change, freezing; the change from the liquid to the gaseous state is called vaporization, the reverse change, condensation; and the change from the solid directly to the vapor state is called sublimation, the reverse change, condensation.

In meteorology, the most important changes of state are those of water. Liquid water evaporates from the rivers, lakes, and seas and becomes water vapor, or freezes into ice; water vapor condenses into rain and other precipitation forms: ice, snow, sleet, etc., melt into liquid water. Thus, much of the weather is determined by the operation of these natural processes in the atmosphere.

characteristic curve, *n.*—The graph obtained by plotting the partial potential temperature against the mixing ratio on a ROSSBY DIAGRAM, q. v., of an upper-air sounding.

Charles' law, *n.*—The physical law which states that, for each rise of 1° C. in temperature, all the common gases expand by the same fraction (about 1/273) of their volume at 0° C., the pressure being kept constant; or

$$V_t = V_0\ (1 + at^\circ)$$

where V_t is the volume at temperature t in centigrade degrees, V_0 is the volume at 0° C., and a, the coefficient of expansion, is about 1/273 or 0.003660, since its precise value varies with the pressure, temperature, and nature of the gas considered.

This law is only approximately true. It is sometimes called "the law of Charles and Gay-Lussac" because, though discovered by Charles in 1787, Gay-Lussac independently derived it from experiments in 1802.

chemical hygrometer, *n.*—A form of absorption HYGROMETER, q. v.

chergui, *n.*—An east wind of Morocco.

chili, *n.*—A dry wind of Tunisia, similar to the SIROCCO, q. v.

chinook, *n.*—1. Name given in the western United States and Canada to a warm, dry, southwest wind along the eastern slopes of the Rocky Mountains, identical with the European FOEHN, q. v. It may occur at any season of the year, but its effects are most marked in winter, when it may cause a very rapid rise in temperature, as much as 20° to 30° F. in fifteen minutes, and cause ice and snow to disappear in a few hours, whence it is sometimes called the "snow eater." The chinook may begin at any hour, day or night. In velocity it varies from a gentle breeze to a gale. It may last three to four days. It may blow steadily for many hours, or come in shorter spells interrupted by colder and calmer intervals. The term chinook "was first used in western Oregon and Washington, and also in British Columbia, to designate a warm moist southwesterly wind coming from the general direction of the district formerly inhabited by the Chinook Indians on the lower Columbia River. It was—perhaps quite independently of this particular use of the term—applied by early settlers along the eastern base of the Rocky Mountains to the warm dry wind descending the eastern slopes of these mountains." (R. D. Ward, The Climates of the United States, 1925, pp. 413–414.) 2. Name given on the west coast of the United States to a moist southwesterly wind from the Pacific Ocean, warm in winter and cool in summer; commonly followed or attended by cloudy weather and rain, and thus sharply contrasted with the dry, warm weather of the true chinook, discussed above. *See:* R. D. Ward, The Climates of the United States, 1925, pp. 409–418.

chinook arch, *n.*—A bank of clouds over a range of the Rocky Mountains, heralding the approach of the CHINOOK (1), q. v. It is probably formed in the same manner as the MOAZAGOTL, q. v., i. e., by the formation of standing waves in the heated foehn air descending the leeward mountain slope, causing large-scale eddies which are sometimes capped by cumuliform or cirriform clouds. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 449–450; R. L. Ives, Colorado Front Range Crest Clouds and Related Phenomena, Geographical Review, vol. 31, 1941, pp. 23–45.

chocolatero, *n.*—1. Name applied in Mexico to the Gulf NORTHER, q. v., when it is not strong.

choroisotherm, *n.*—An isotherm used in representing the distribution of temperature in space, as distinguished from a CHRONOISOTHERM, q. v., which gives its distribution in time. The isotherms drawn on climatic maps and synoptic weather charts are all choroisotherms.

chota barsát, *n.*—Hindu name for a day of two of rainy weather that may precede the regular rains of the MONSOON, q. v., in India.

chronoanemoisothermal diagram, *n.*—A diagram which shows the normal temperature at a given place at all hours of the day for each wind direction. The ISOGRAM, q. v., employed on this diagram is called a chronoanemoisothermal line.

chronoisotherm, *n.*—*See:* CHOROISOTHERM.

chronothermometer, *n.*—A thermometer with an uncompensated (or anticompensated) balance wheel, used to show the mean temperature for a day. *See:* W. F. Stanley, Barometrical and Thermometrical Clocks for Registering Mean Atmospheric Pressure and Temperature, Quarterly Journal of the Royal Meteorological Society, vol. 3, 1877, pp. 352–354; On Three Years' Work with the "Chrono-Barometer and Chrono-Thermometer", 1882–84, Quarterly Journal of the Royal Meteorological Society, vol. 12, 1886, pp. 115–120.

chubasco, *n.*—A very violent wind and rain squall, attended with heavy thunder and vivid lightning, often encountered during the rainy season along the west coast of Central America.

churada, *n.*—A fierce rain squall in the Mariana Islands, occurring during the months of January, February, and March.

cierzo, *n.*—Spanish name for the MISTRAL, q. v. "and it is very suggestive of the continental conditions of Spain, as contrasted with the peninsular conditions of France, that at the mouth of the Ebro, as the cierzo, it (the mistral) is mainly confined to autumn and early winter, while at the mouth of the Rhone it is most violent in late winter and early spring." (L. W. Lyde, The Continent of Europe, 1913, pp. 59–60.)

circulation, *n.*—1. "The circulation, C, around a closed curve formed by fluid particles is the line integral of the velocity component tangential to the curve;

$$C = \oint V \cos \alpha \, ds$$

V is the velocity, ds the line element, and α the angle between V and ds." (B. Haurwitz, Dynamic Meteorology, 1941, p. 135.) 2. In a broad sense, the general, principal, or primary criculation of the atmosphere. It consists of the polar easterlies, the westerlies of middle latitudes, the trade winds of the subtropical regions; together with the high pressure cells at 30° north and south latitudes, separating the trades from the westerlies, and the low-pressure calm belt or doldrums, north of the equator, between the northeast and southeast trades. Many theories, none of them completely satisfactory, have been evolved to explain the physical processes governing the operations of these parts of the general circulation. For an exposition of Rossby's hypothesis of the three hemispheric circulation cells, consult C. G. Rossby, The Scientific Basis of Modern Meteorology, Climate and Man, Yearbook of Agriculture, U. S. Department of Agriculture, 1941, pp. 599–612. *See:* GENERAL CIRCULATION.

circulation principle, *n.*—"A physical law to the effect that differences in heat content along a surface such as the earth give rise to a corresponding condition of the temperature of the air that overlies it, and this difference in air temperature is compensated by a steady flow of vertical and horizontal convection currents which tend to equalize it." H. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 63.

circulation theorem, *n.*—*See:* CIRCULATION PRINCIPLE.

circumhorizontal arc, *n.*—A colored arc, red on the upper side, of about a quarter of a circle, which "is occasionally seen parallel to the horizon and about 46°, or a little more, below the sun. This arc is produced by light entering snow crystals through vertical sides and passing out through horizontal bases, and, therefore, the theory of its formation is identical with that of the circumzenithal arc." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 531–532.) *See:* CIRCUMZENITHAL ARC.

circumscribed halo, *n.*—An enclosing curve, with red inner border, around the HALO, q. v., of 22°; formed by the coalescence of the upper and lower tangent arcs of 22° which, with increase of elevation of the sun from the horizon, gradually bend their tips together. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 519–523.

circumzenithal arc, *n.*—An arc, usually strongly colored, of about one-quarter of a circle, having its center at the zenith, and about 46°, or a little more, above the sun; produced by the refraction and dispersion of the sun's light incident on the top of prismatic ice crystals present in the atmosphere. "It generally lasts only a few minutes, about five on the average, but during that time often is so brilliantly colored, especially along that portion nearest the sun—red on the outside, to violet, inclusive—as to be mistaken, by persons unfamiliar with it, for an exceptionally bright rainbow." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 530.) *See:* J. G. Albright, Physical Meteorology, 1939, pp. 362–363.

cirri, *n.*—Plural of CIRRUS, q. v.

cirriform, *adj.*—Relating to, or shaped like, CIRRUS, q. v.

cirro-.—A combining form of CIRRUS, q. v.

cirrocumulus, *n.*—A cloud layer or patch composed of small white flakes or of very small globular masses, usually without noticeable shadows, which are arranged in groups or lines, or more often in ripples resembling those of the sand on the seashore.

In general cirrocumulus represents a degraded state of cirrus and cirrostratus, both of which may change into it. In this case the changing patches often retain some fibrous structure in places.

Real cirrocumulus is uncommon. It must not be confused with small altocumulus on the edges of altocumulus sheets. There are, in fact, all states of transition between cirrocumulus and altocumulus proper; this is only to be expected as the process of formation is the same. In the absence of any other criterion the term cirrocumulus should only be used when—(1) There is evident connection with cirrus or cirrostratus. (2) The cloud observed results from a change in cirrus or cirrostratus. (3) The cloud observed shows some of the characteristics of ice crystal clouds which will be found enumerated under CIRRUS, q. v.

cirrostratus, *n.*—A thin whitish veil of cloud which does not blur the outlines of the sun or moon, but often gives rise to a HALO, q. v. Sometimes it is quite diffuse and merely gives the sky a milky look; sometimes it shows, more or less distinctly, a fibrous structure with disordered filaments. A sheet of cirrostratus is very extensive, and though in places it may be interrupted by rifts, it nearly always eventually covers the whole sky. The border of the sheet may be straight-edged and clear-cut but more often it is ragged or cut up. During the day, when the sun is sufficiently high above the horizon, the sheet is never thick enough to prevent shadows of objects on the ground.

A milky veil of fog (or thin stratus) is distinguished from a veil of cirrostratus of a similar appearance by the halo phenomena which the sun or the moon nearly always produces in a layer of cirrostratus. What is said under Cirrus, q. v., of the transparent character and colors of that cloud is true to a great extent of cirrostratus. The two principal species of cirrostratus are Cirrostratus Filosus and Cirrostratus Nebulosus, q. v.

cirrostratus filosus, *n.*—A white fibrous veil of cloud, in which the strands are more or less definite, often resembling a sheet of Cirrus Densus, q. v., from which indeed it may originate.

cirrostratus nebulosus, *n.*—A very uniform nebulous cloud veil, sometimes very thin and hardly visible, sometimes relatively dense, but always without definite details and usually with halo phenomena.

cirrus, *n.*—Detached high cloud of delicate and fibrous appearance, without shading, generally white in color, often of a silky appearance.

Cirrus appears in the most varied forms, such as isolated tufts, lines drawn across a blue sky, branching feather-like plumes, curved lines ending in tufts, etc.; and is often arranged in bands which cross the sky like meridian lines, and which, owing to the effect of perspective, seem to converge to a point on the horizon, or to two opposite points. (Cirrostratus and cirrocumulus often take part in the formation of these bands.) Being in general more or less inclined to the horizontal, it tends less than other clouds to become parallel to the horizon, under the effect of perspective, as the horizon is approached. Cirrus is always composed of ice crystals, and its transparent character depends upon the degree of separation of the crystals.

As a rule when cirrus crosses the sun's disk it hardly diminishes the sun's brightness. But when it is exceptionally thick, it may veil the sun's light and obliterate its contour. This is also the case with patches of altostratus, but cirrus is distinguished by the dazzling and silky whiteness of its edges. Halos are rather rare in cirrus. Sometimes isolated wisps of snow are seen against the blue sky, and resemble cirrus; they are of a less pure white and less silky than cirrus; wisps of rain are definitely gray, and a rainbow, should one be visible, shows their nature at once, for this cannot be produced in cirrus.

Before sunrise and after sunset, cirrus is often colored bright yellow or red. It is illuminated long before other clouds and fades out much later; some time after sunset it becomes gray. At all hours of the day cirrus, when near the horizon, is often of a yellowish color; this is due to the effects of distance and of the great thickness of air traversed by the rays of light from the cloud.

The four principal forms of cirrus are discussed in the following entries.

cirrus densus, *n.*—Cirrus of such thickness as to resemble a middle or even a low cloud.

cirrus filosus, *n.*—Cirrus in the form of more or less straight or irregularly curved filaments (neither tufts nor little hooks and without any of the parts being fused together).

cirrus nothus, *n.*—False Cirrus, q. v., proceeding from a cumulonimbus cloud and composed of the debris of its upper frozen parts.

cirrus uncinus, *n.*—Cirrus in the shape of a comma: the upper part either ends in a little tuft or is pointed.

cistern, *n.*—In a mercurial BAROMETER, q. v., the cylindrical vessel or container, open to the atmosphere, into which the mercury tube is dipped.

civil time, *n.*—Legally accepted time: it is based on mean solar time; and the civil day period is from one midnight to the next midnight, or 24 hours long.

civil twilight, *n.*—*See:* TWILIGHT.

classification of clouds, *n.*—*See:* CLOUD CLASSIFICATION.

Clausius-Clapeyron equation, *n.*—A thermodynamic equation which relates the latent heat of evaporation (L) to the rate of change of the saturation vapor pressure with temperature $\frac{de}{dT}$. It may be written:

$$\frac{L}{T}=A(v_2-v_1)\frac{de_s}{dT}$$

where T=the temperature in degrees absolute, A=a constant=2.392×10^{-8}, v_1=the specific volume of liquid water, v_2=the specific volume of water vapor, and e_s=the saturation vapor pressure. *See:* E. W. Hewson, and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 47–49.

Clayton-Egnell law, *n.*—*See:* EGNELL'S LAW.

clear, *adj.*—1. Applied, in general use, to a cloudless sky or to a day of negligible cloudiness and good visibility. 2. The state of the sky when it is cloudless or less than one-tenth covered by clouds. 3. The character of the day's weather from sunrise to sunset, when the average cloudiness, as determined by frequent observations, either has been zero, or the clouds have been so few that not more than one-tenth of the sky has been covered. *See:* U. S. Weather Bureau, Instructions for Preparing Meteorological Forms, 1938, p. 25. 4. The character of sunrise or sunset, when the sun is plainly visible at these times. *See:* Ibid., p. 17. —*v.i.* Of the weather, to change from a stormy or overcast condition to one of comparatively clear skies.

clear ice, *n.*—Ice with a glassy surface which varies from clearness to translucency: it is identical with the GLAZE, q. v., which forms on trees, etc., when freezing rain falls to earth, or on parts of airplanes. It is usually smooth or rippled, but when mixed with snow, sleet, small hail, etc., it may be rough, irregular, and whitish and have a different appearance than rime, due to its different mode of formation, structure, and shape. It is formed when relatively large supercooled water droplets, alone or mixed with solid precipitation, impinge on a surface either in rain which is at a temperature of or below 32° F., or in a cloud which has a concentration of large droplets at a temperature of or below 32° F.

clearing, *n.*—The act of the weather in changing from cloudy or stormy conditions to a condition characterized by a nearly cloudless sky and the cessation of precipitation.

clerk of the weather, *n.*—An imaginary individual once humorously supposed to control the weather.

climagram, *n.*—1. Any graphical representation of one or more climatic features of a place or region, regardless of the quantities used as abscissae and ordinates. 2. A diagram drawn in rectangular coordinates, of which the abscissa is temperature and the ordinate is relative humidity. *See:* W. Köppen and R. Geiger, Handbuch der Klimatologie, vol. 1, 1930, p. 393. 3. An abridged numerical statement of the principal climatic elements of a place. An example will serve to make this clear:

CLIMAGRAM OF BERLIN (32 M. S. L.)

Temperature, ° C.	Humidity	Cloudiness	Precipitation
$9.2\,\frac{18.9}{-0.4}\left(\frac{33.2}{-13.8}\right)\frac{37.0}{-25.0}$	$6.9\frac{10.8}{4.0}\ 76\frac{87}{64}$	$6.4\frac{7.6}{5.7}$	$582\frac{75}{38}\ 169\frac{16.2}{12.5}$

Interpretation of first group:

(all temperatures expressed in degrees centigrade)

9.2	annual mean temperature	$\frac{18.9}{-0.4}$	July mean / Jan. mean
$\frac{(33.2)}{(-13.8)}$	mean July highest / mean Jan. lowest	$\frac{37.0}{-25.0}$	July highest / Jan. lowest

Interpretation of second group:

6.9	annual mean absolute humidity, in millimeters	$\frac{10.8}{4.0}$	July mean absolute / Jan. mean absolute
76	annual average relative humidity, in percent	$\frac{87}{64}$	July average, relative / Jan. average, relative

Interpretation of third group:

6.4	average annual cloudiness, on the scale of 10	$\frac{7.6}{5.7}$	July average / Jan. average

Interpretation of fourth group:

582	average annual precipitation, in millimeters	$\frac{75}{38}$	July average / Jan. average
169	average annual rainy days	$\frac{16.2}{12.5}$	monthly average, July / monthly average, Jan.

See: G. Hellman, Kleinere Mitteilungen, Meteorologische Zeitschrift, vol. 41, September 1924, p. 278; CLIMOGRAPH; CLIMATIC DIAGRAM.

climate, *n.*—The sum total of the meteorological elements that characterize the average and extreme condition of the atmosphere over a long period of time at any one place or region of the earth's surface. These elements are "temperature (including radiation); moisture (including humidity, precipitation, and cloudiness); wind (including storms); pressure; evaporation; and also, but of less importance, the composition and the chemical, optical, and electrical phenomena of the atmosphere. The characteristics of each of these so-called CLIMATIC ELEMENTS are set forth in a standard series of numerical values, based on careful, systematic, and long-continued meteorological records, corrected and compared by well-known methods. Various forms of graphic presentation, by curves, or by wind roses, etc., are employed to emphasize and simplify the numerical results." (R. D. Ward, Climate, 2d ed., rev., 1918, p. 5.)

In meteorology, one measure of each of the above-mentioned elements is sufficient to describe the weather; in the study of climate, however, several measures are frequently necessary. For example, if 70° F. is the temperature of a certain place at a certain time, that is all that can be said about it, meteorologically speaking; but, in order to express one's experience of temperature as a climatic element, there are needed the normal daily and monthly temperatures, the mean annual and mean monthly temperatures, mean departure of the annual and monthly averages from their means, average highest and average lowest temperatures for each month, extreme highest and extreme lowest for each month (often more significant than the monthly normals), mean daily variability of temperature, etc. Moreover, it is necessary to consider each element in relation to the others. An average July temperature of 90° F. with 85 percent relative humidity, for instance, is very different, climatically, from 90° F. with only 45 percent relative humidity.

The two chief divisions of climate are PHYSICAL CLIMATE and SOLAR CLIMATE, q. v. Other subdivisions are CONTINENTAL CLIMATE, MARINE CLIMATE, MOUNTAIN CLIMATE, q. v.

climate divide, *n.*—A boundary between regions having separate types of climate. The only sharp climatic boundaries on the earth are produced by land relief. Mountain ranges produce sharp transitions in two ways: (a) by the rapid increase in elevation above the sea, hence a rapid decrease in surface temperature, upward along their flanks, and (b) by preventing the free interchange of air between the regions which they separate when these regions, because of difference in latitude or of surface, impart different properties to the air that moves over or rests on them. Mountain ranges often function as protection against severe weather. Hann used the Swiss Alps to illustrate this fact, for in crossing one of the passes the traveler in a few hours is transferred from the relatively cold climate of central Europe to the mild, sunny climate of Italy. The mountains in the western part of the United States, oriented north-south as they are, do not afford protection against cold northerly winds, but do confine the marine climate to the Pacific Coast, while, in the interior of the country, continental conditions prevail. *See:* J. Hann, Handbook of Climatology, tr. R. D. Ward, 1903, Ch. XX, pp. 366–374.

climatic classification, *n.*—Classification of the climates of the different regions of the earth's surface, based on one or more of the climatic elements such as (1) temperature, (2) rainfall, (3) humidity, (4) wind, (5) temperature and rainfall, (6) nearness to land

and sea, and many others. Classifications may also be based on the distribution of vegetation, on physiological effects, or may be on any basis suitable for the particular purpose or investigation.

The first classification of climate, made by the early Greeks, was based on temperature, or was thought to be, since parallels of latitude were made the boundaries of five zones, two polar, two temperate, and one torrid or tropical. The two temperate zones were the only ones supposed to be habitable. The exact latitudinal boundaries varied with the author and the geographic knowledge of the times. Strabo (born about 63 B. C.) taught that the tropics were not uninhabitable, that temperature varied with altitude as well as latitude; and that the climate of a place was affected by the distribution of land, water, and mountains.

Alexander Supan (born 1847) made some improvement over the old climatic zones by dividing the world into temperature zones; the hot belt was comprehended between the isotherms of 20° C. (68° F.), corresponding roughly to the torrid zone; the north temperate belt and south temperate belt lay between isotherms of 20° C. (68° F.) and 10° C. (50° F.), and the north cold and south cold caps comprised the region around the North and South Poles, extending from the 10° C. isotherm to either pole. Supan also made, in 1896, a classification of what he called climate provinces, thirty-five in all, based on the combined effects of temperature, precipitation, wind, and topography.

An improvement on Supan's climatic zones was made by Wladimir Köppen, who in 1918 and later, classified the world's climates into twenty-four climatic types according to annual monthly means of temperature and precipitation and also according to the distribution of the latter. Köppen also devised letter symbols corresponding to certain limits of the two elements, temperature and precipitation. Each type of climate is thus described by a letter formula which can be readily be translated. His system has become standard among climatologists and geographers.

Thornthwaite's classification, announced in 1931, differs from Köppen's in that, instead of employing simple temperature and precipitation values as limiting boundaries, two new concepts, TEMPERATURE EFFICIENCY and PRECIPITATION EFFECTIVENESS, q. v., are introduced by him. These cannot be expressed in ordinary climatic values, though they are derived from them, and consequently the boundaries of Thornthwaite's climate types are thought by some to be less easily comprehended than Köppen's. *See:* Bartholomew's Physical Atlas, vol. 3, Atlas of Meteorology, ed. A. Buchan, p. 7, and pl. 3; W. Köppen and R. Geiger, Handbuch der Klimatologie, vol. 1, Pt. C, Das Geographischen System der Klimat, 1936; A. Supan, Grundzüge der Physischen Erdkunke, vol. 1, 1927, p. 240 ff.; C. W. Thornthwaite, The Climates of North America According to a New Classification, Geographical Review, vol. 21, 1931, pp. 633–635; C. W. Thornthwaite, The Climates of the Earth, Ibid., vol. 23, 1933, pp. 433–440; G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 189–197; R. D. Ward, Climate, 2d ed., rev., pp. 35–75.

climatic controls, *n.*—1. The *terrestrial* and *atmospheric influences* which, acting upon the CLIMATIC ELEMENTS, q. v., with various degrees of intensity and in different combinations, "produce the changes in temperature and precipitation, which in turn give rise to varieties of weather and climate," (G. T. Trewartha, An Introduction to Weather and Climate, 1937, p. 7.) They are: (a) latitude; (b) distribution of land and water; (c) winds; (d) altitude; (e) mountain barriers (*see* CLIMATE DIVIDE); (f) semipermanent high and low pressure centers (*see* CENTER OF ACTION); (g) storms of various kinds; (h) miscellaneous influences, such as ocean currents, upwelling sea water, minor topographical features, etc. 2. "Factors of climatic control": Name given by Humphreys to a set of influences, including those just listed and several more, which, acting at various intervals of time, are collectively responsible for "the great and universal climatic changes that have left their records in abandoned beaches and forsaken moraines," (W. J. Humphreys, *Physics of the Air, 3d ed., 1940, p. 635; cf. pp. 577–635*). Some of the controlling factors are volcanic dust, land elevation, surface covering, and sunspots.

climatic cycles, *n.*—Actual or supposed recurrences of such weather phenomena as wet and dry years, hot and cold years, at more or less regular intervals, in response to long-range terrestrial and solar influences, such as volcanic dust and sunspots. The best known of these cycles, which have been discovered in great numbers, is the BRÜCKNER CYCLE, q. v. *See:* T. A. Blair, Climatology, 1942, pp. 90–101; H. H. Clayton, World Weather, 1923, pp. 284–322; J. Hann, Handbook of Climatology, Vol. I, tr. R. D. Ward, 1903, pp. 375–412; R. D. Ward, Climate, 2d ed., rev., 1918, pp. 339–371.

climatic data, *n.*—The basic facts of climate, as given in tables, maps, diagrams, and various statistical summaries derived from long-continued weather records as well as from records of the distribution of plants and animals, the seasonal progress of plants, the character of the soil, etc. *See:* T. A. Blair, Climatology, 1942, pp. 5–6, W. I. Milham, Meteorology, 1936, pp. 427–429.

climatic diagram, *n.*—A graph of two selected CLIMATIC ELEMENTS, q. v., designed to show the changes in their relationship throughout a year, by plotting their mean monthly values on a chart on which they are the co-ordinates, and connecting the points thus obtained with a continuous line. *See:* N. Shaw, Manual of Meteorology, Vol. I, 1932, p. 269; CLIMAGRAM.

climatic divide, *n.*—*See:* CLIMATE DIVIDE.

climatic elements, *n.*—*See:* CLIMATE.

climatic factors, *n.*—Certain physical conditions (other than the climatic elements) which currently control climate, or may by their changes over long periods cause climatic changes.

The current factors, which exercise immediate control and are responsible for one place having a climate different from that of another, are listed by all climatologists as: latitude, altitude, distribution of land and sea, and topography. In addition to the above, some climatologists include many other factors, such as ocean currents, the semipermanent high- and low-temperature areas, prevailing wind, etc.

Some of the long-range factors, which may change climate over long periods of time by their variations are: obliquity of the ecliptic, extent and composition of the atmosphere, land elevation, land and water distribution, ocean circulation, etc.

climatic province, *n.*—An area of the earth which has a definite climatological characteristic, according to a certain climatic classification. Thus, Köppen has in his classification eleven different kinds of climatic provinces, but due to the repetition of the same provinces in the various continents, there are, in the aggregate, many times eleven. Thornthwaite distinguishes thirty-two different kinds of provinces, in the climate of North America, but his classification has a somewhat different basis from that of Köppen. Supan divides the world into thirty-five climatic provinces. In each case, the purpose is to obtain a comprehensive system by which the climates of the various regions of the earth may be described, compared, and explained. *See:* CLIMATIC CLASSIFICATIONS.

climatic year, *n.*—The result obtained by substituting the values of the meteorological elements in a given year for the values of a type of climate given by one or another of the CLIMATIC CLASSIFICATIONS. For example, accepting Köppen's definition of a tropical climate, a particular place or region is said to have had a tropical year if, irrespective of location or the experience of its surroundings, it has experienced a humid year with all monthly mean temperatures in excess of 18° C. *See:* R. J. Russel, Climatic Years, Geographical Review, vol. 24, 1934, pp. 92–103; H. M. Kendall, Notes on Climatic Boundaries in the Eastern United States, Geographical Review, vol. 25, 1935, pp. 117–124; C. W. Thornthwaite, Atlas of Climatic Types in the United States, 1900–1939, U. S. Department of Agriculture, Miscellaneous Publication No. 421, 1941.

climatic zones, *n.*—1. In general, any divisions of the earth's surface, large or small, based on the climatic elements. 2. In particular, the five zonal divisions of the earth's climate known to the ancient Greeks and widely used down to the present time; their introduction is generally ascribed to Parmenides, who flourished about 450 B. C. "These five zones are the torrid zone, the two temperate zones, and the two frigid zones. The torrid zone is divided into two equal parts by the equator, and is bounded on the north and south by the tropics of Cancer and Capricorn. The width of the zone is thus 47°, and the sun reaches the zenith on at least one day during the year at every place within this zone. The two frigid zones lie wholly within the Arctic and Antarctic Circles and surround the two poles. The sun never rises at least one day in the year at all places within these zones. The two temperate zones lie between the frigid zones and the torrid zone and each is 43° wide. The torrid zone covers 40 percent, the two temperate zones 52 percent, and the two frigid zones 8 percent of the earth's surface. . . . The names of the zones are unfortunate, as they would seem to suggest a temperature basis for the subdivision, while in reality the subdivision is on the basis of latitude only." (W. I.

Milham, Meteorology, 1936, p. 430.) Hence they are really zones of Solar Climate, q. v. *See:* R. D. Ward, Climate, 2d ed., rev., 1918, pp. 19–23.

climatize, *v.*—To acclimate, or become acclimated.

climatography, *n.*—1. The study of descriptive, statistical, and cartographical climatology. 2. An account of the climate of a particular place or region.

climatology, *n.*—1. The science, closely related to meteorology and geography, which seeks (a) to determine and describe the various types of Climate, q. v., from analysis of Climatic Data, q. v., and (b) to explain the causes of these climates, their variation, geographical location, effects on plant and animal life, etc. It is thus possible to distinguish two main branches of climatology: statistical (or Descriptive Climatology) and Physical Climatology, each of which is discussed in a separate entry. In addition, various special branches have been developed, among them being Agricultural Climatology, Air-Mass Climatology, Anthropoclimatology, Bioclimatology, Medical Climatology, Palaeoclimatology, q. v. 2. An account of the climate of a particular region, e. g., A. J. Henry's Climatology of the United States, 1906.

climograph, *n.*—A Climatic Diagram, q. v., "for showing the mean monthly values of wet-bulb temperature and relative humidity at any place, and for comparing such data as recorded at different places throughout the world, especially with reference to the effects of climate on mankind. Other pairs of elements can be used in constructing climographs: e. g., the dry-bulb temperature and the relative humidity." (C. F. Talman, Our Weather, p. 369.) *See:* G. F. Taylor, The Control of Settlement by Humidity and Temperature, Australian Commonwealth Bureau of Meteorology, Bull. No. 14, 1916, pp. 7, 17; B. M. Varney, Some Further Uses of the Climograph, Monthly Weather Review, vol. 48, 1920, pp. 495–497.

climotherapy, *n.*—*See:* Medical Climatology.

clinometer, *n.*—A portable instrument used with a Ceiling Light, q. v., to measure cloud heights at night. *See:* U. S. Weather Bureau, Circular N, Instructions for Airway Meteorological Service, 5th ed., 1942, p. 160.

close, *adj.*—Descriptive of the weather, when the air is still, moist, and hot.

closed in, *adj.*—A phrase applied to an airport when the weather conditions make landings inadvisable, the implication being that the adverse weather conditions came about rather quickly. *See:* Socked In.

cloudage, *n.*—Cloudiness, a collective term for the clouds present in the sky.

cloud bank, *n.*—A mass of clouds stretching across the sky and usually of considerable vertical extent.

cloud banner, *n.*—*See:* Banner Cloud.

cloud bar, *n.*—*See:* Bar (3).

cloudburst, *n.*—"A sudden and extremely heavy downpour of rain; especially one in which the water falls in a continuous stream rather than in drops." (C. F. Talman, Our Weather, p. 369.) It is generally thought to occur when something interferes with the uprushing vertical currents which support the great mass of water (estimated at 300,000 tons) in a cumulonimbus cloud and so causes it to be suddenly and almost totally released. In mountainous regions, where a moderately heavy fall of rain may strike a small watershed, the entire fall often converges in a narrow gorge and causes great loss of life and property.

A quantitative definition of a cloudburst makes it a rainstorm in which the rate of fall is 100 mm. (3.94 inches) per hour. This is more than ten times the rate used by the U. S. Weather Bureau in defining a heavy rainfall. *See:* C. F. Brooks, Why the Weather?, 1935, pp. 59–60; W. Ferrel, A Popular Treatise on the Winds, 1889, pp. 429–434.

cloud camera, *n.*—1. An instrument for determining the speed and direction of movement of a cloud. *See:* C. Abbe, Treatise on Meteorological Apparatus and Methods, Report of the Chief Signal Officer, app. 46, 1888, pp. 335–336. 2. A photographic camera used in, or specially designed for, obtaining cloud pictures.

cloud cap, *n.*—*See:* CAP CLOUD.

cloud chart, *n.*—A map on which are plotted the CLOUD SYMBOLS, q. v. at each reporting station, together with different-colored arrows showing the direction of the wind and the movement of the lower and upper clouds; cloudiness is indicated by the amount of shading in the station circle. On this chart, green lines may be drawn to enclose areas reporting eight-tenths or more cloudiness, and yellow shading may be used to mark out areas where precipitation is occurring; but other methods may be followed, depending on the purpose to which the chart is to be put. *See:* NEPHANALYSIS.

cloud classification, *n.*—A scheme of distinguishing and grouping clouds according to their appearance, elevation, or method of formation. The one in general use, based on a classification introduced by Luke Howard in 1803, is that proposed in 1929 by the International Meteorological Commission for the study of clouds. It is the following:

Family A: High Clouds

(Mean lower level 20,000 feet)
1. Cirrus
2. Cirrocumulus
3. Cirrostratus

Family B: Middle Clouds

(Mean upper level 20,000 feet;
mean lower level 6,500 feet)
4. Altocumulus
5. Altostratus

Family C: Low Clouds

(Mean upper level 6,500 feet;
mean lower level close to surface)
6. Stratocumulus
7. Stratus
8. Nimbostratus

Family D: Clouds with Vertical Development

(Mean upper level that of **cirrus**;
mean lower level 1,600 feet)
9. Cumulus
10. Cumulonimbus

These ten main types, each of which is discussed under a separate heading, are further subdivided into several species and varieties. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 28–37; U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938.

cloud crest, *n.*—A cloud type similar to the CAP CLOUD (1), q. v. "When air is forced over a mountain ridge a crest cloud often forms, parallel to the ridge and apparently stationary, notwithstanding that the air at the same level is moving rapidly. In reality, the cloud is forming on the windward side owing to condensation resulting from the forced ascent and cooling of the air, and dissipating on the leeward side because of evaporation incident to the descent and consequent warming of the air." (W. R. Gregg, Aeronautical Meteorology, 2d ed., 1930, p. 165.) *See:* BANNER CLOUD; SANSAN.

cloud formation, *n.*—1. The process by which the various types of clouds are produced. "From a genetical point of view the tropospherical clouds may be divided into four categories, viz.: (1) clouds that form in unstable air masses, (2) clouds that form in stable air masses, (3) clouds that form in connection with quasi-horizontal inversions, and (4) frontal clouds." (S. Petterssen, Weather Analysis and Forecasting, 1940, p. 35; cf. pp. 35–37.) 2. A particular arrangement of clouds in the sky, or a striking development of a particular cloud.

cloudiness, *n.*—The amount of sky covered by clouds, irrespective of the thickness of the clouds; usually measured in tenths of the sky canopy.

cloudless, *adj.*—Same as CLEAR, q. v.

cloud mirror, *n.*—The mirror of a reflecting NEPHOSCOPE, q. v.; also, the reflecting nephoscope as a whole.

cloud symbols, *n.*—A set of ideograms used for a weather map to represent the various cloud types, such as cumulus humilis, altocumulus castellatus, cirrocumulus, et al. They are given in most texts on meteorology. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, p. 443; C. W. Barber, An Illustrated Outline of Weather Science, 1943, p. 240.

cloudy, *adj.*—1. In general, the state of the weather when clouds are present in the sky. 2. The state of the sky when from six- to nine-tenths of it is covered with clouds. 3. The character of the day's weather, from sunrise to sunset, when the average cloudiness, as determined by frequent observations, has been over eight-tenths. *See:* U. S. Weather Bureau, Instructions for Preparing Meteorological Forms, 1938, p. 25. 4. The character of sunrise and sunset, when the sun is observed, partially or completely, at these times. *See:* Ibid., p. 17.

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Cock-eyed Bob, *n.*—A local colloquial term in western Australia for a thundersquall frequent during the summer months on the northwest coast.

coefficient of absorption, *n.*—*See:* ABSORPTION COEFFICIENT.

coefficient of correlation, *n.*—A number, between the limiting values of +1 and −1, which expresses the degree of linear relationship between two variables, and which can be determined from any one of several formulas. A high positive value of the coefficient, i. e., one of +0.8 or greater, indicates a close relationship between the variables such that large values of the one are associated with large values of the other; conversely, a low negative value, −0.8 to −1, means that the two quantities vary closely in the opposite sense. A value of the coefficient of correlation near 0 shows that there is little relationship between the variables.

On the meteorological application of the coefficient, see CORRELATION and CORRELATIVE METEOROLOGY. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 177–179.

coefficient of viscosity, *n.*—*See:* VISCOSITY.

col, *n.*—A neck of relative low pressure between two anticyclones; also called a saddle or neutral point. S. Petterssen recognizes three types of cols: those without vorticity, those with anticyclonic vorticity, and those with cyclonic vorticity. *See:* Weather Analysis and Forecasting, 1940, p. 439.

cold air mass, *n.*—Broadly speaking, an air mass that is cold relative to neighboring air masses. The term implies that the air mass originated in higher latitudes than those in which it now finds itself, and that it is, therefore, colder than the surface over which it is moving. In the Bergeron classification, a cold air mass is denoted by the symbol *k*. *See:* AIR MASS (1).

cold front, *n.*—The line of discontinuity at the earth's surface (or at the intersection of the cold frontal surface with a horizontal plane in the atmosphere) along which a wedge of cold air is underrunning and displacing a warmer air mass. The term is also applied, inexactly, to the FRONTAL SURFACE, q. v., separating the cold from the warm air. *See:* FRONT.

cold-front thunderstorm, *n.*—A type of THUNDERSTORM, q. v., which occurs in series along a line usually 100 miles in advance of a cold front, is usually severe, and may come at any hour of the day or night. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, pp. 245–246.

cold-front type occlusion, *n.*—An occlusion formed generally on the east coasts of northern continents when the cold air in the rear of a cold front is colder than the air in advance of the front and hence will underrun the latter. *See:* OCCLUSION; WARM-FRONT TYPE OCCLUSION; S. Petterssen, Weather Analysis and Forecasting, 1940, p. 323.

cold period, *n.*—An interval of time, usually of extensive duration, during which unusually low temperatures prevail. *See:* COLD WAVE.

cold poles, *n.*—The places, in the northern and southern hemispheres, which have the lowest annual mean temperatures. The cold pole of the northern hemisphere is Verkhoyansk, Siberia (133°24′ E. long., 67°33′ N. lat.), with a mean annual temperature of 3° F. "The mean temperature in January at Verkhoyansk is −58° (F.), the mean minimum temperature −83° (F.), and −94° (F.), was once recorded, this being the lowest reading ever taken on the surface of the earth. The highest temperature ever recorded in January was −13° (F.)." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 197.) However, recent investigations of the river district, also in eastern Siberia, have shown that it "offers monthly January temperatures which are even 5 to 11 Fahrenheit degrees colder than those of Verkhoyansk. The absolute minima are probably 5 to 16 degrees colder." (V. Conrad, Fundamentals of Physical climatology, 1942, p. 55.) The cold pole of the southern hemisphere, insofar as scanty records can determine, is Framheim (163°39′ W. long., 78°41′ S. lat.), with a mean annual temperature of −14.4° F. and a mean August (midwinter) temperature of −48.6° F.

cold wave, *n.*—A rapid and marked fall of temperature during the cold season of the year. The United States Weather Bureau applies this term to a fall of temperature in twenty-four hours which equals or exceeds a specified number of degrees and reaches a specified minimum temperature or lower; the specifications vary for different parts of the country and for different periods of the year.

A cold wave occurs when a vigorous cold anticyclone pushes rapidly southward from polar or sub-polar regions with strong bitter northerly winds replacing milder southerly currents. *See:* W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, pp. 321–322; G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 144–146.

colla, *n.*—Name given in the Philippines to a period of stormy weather lasting for several days, with rain and winds mostly from the southwest and not exceeding Beaufort force eight, due to a stationary tropical cyclone, a cyclone moving very slowly northward, or a cyclone with an ill-defined center.

collada, *n.*—A strong wind (35 to 50 miles per hour and up) blowing from the north or northwest in the upper Gulf of California and from the northeast in the lower Gulf of California.

Colorado low, *n.*—A low pressure area which makes its first appearance as a definite center near the eastern slopes of the Rocky Mountains in eastern Colorado and deepens rapidly over the Great Plains Region.

comb nephoscope, *n.*—A variety of NEPHOSCOPE, q. v. "It consists of a brass rod about 9 feet long, bearing at its upper end a cross-piece 3½ feet long, to which a number of equidistant vertical spikes are attached. . . . When using the apparatus, the observer stations himself in such a position that the cloud selected for observation is seen in the same straight line as the central spike. He then turns the cross-piece until the cloud appears to travel along the line of spikes, while he himself remains motionless. The cross-piece will then be parallel to the line of motion of the cloud, and the direction in which it points can be read off on a graduated circle which is provided for the purpose. . . . The tangential velocity may be determined by noting the time taken for the cloud to pass from spike to spike." (Sir John Howe, Meteorology, 2d ed., 1914, pp. 214–215.)

comfort curve, *n.*—A line drawn on a chart, having temperature and humidity as co-ordinates, connecting values of those elements at which people will experience (indoors) the same degree of bodily comfort or discomfort. Such lines delimit a COMFORT ZONE, q. v., and are also known as equal comfort lines and as lines of EFFECTIVE TEMPERATURE, q. v. *See:* J. R. Allen and J. H. Walker, Heating and Air Conditioning, 5th ed., 1939, pp. 292–304; F. C. Houghton and C. P. Yagloglou, Determining Equal Comfort Lines, Journal of American Society of Heating and Ventilating Engineers, March 1923, pp. 1–12.

comfort zone, *n.*—The collective combinations of humidity, temperature, and air movement under which most people feel comfortable and which it is the object of AIR CONDITIONING, q. v., to achieve. *See:* J. R. Allen and J. H. Walker, Heating and Air Conditioning, 5th ed., 1939, pp. 300–304.

competence of the wind, *n.*—A term used by geologists to indicate the size of the particles of solid matter which can be carried by the wind. The size of a particle which can thus be transported depends on the shape and structure of the particle and on the wind speed. *See:* CAPACITY OF THE WIND.

composite map method, *n.*—A method of extended forecasting based on European weather types, developed by B. P. Multanovski and used in the Central Weather Bureau of the U. S. S. R. *See:* WEATHER TYPE; Irving Schell, A Preliminary Summary of the Multanovski School of Long Range Weather-Forecasting, Pt. I, Transactions of American Geophysical Union, 1936, National Research Council, Washington, D. C., pp. 141–151.

condensation, *n.*—The process by which a vapor becomes a liquid or a solid. In meteorology, condensation is considered exclusively with reference to water vapor, which changes to dew, frost, rime, fog, cloud, rain, snow, sleet, or hail, when the air temperature approaches the DEW POINT, q. v. In the open atmosphere, "water vapor is condensed: (1) by contact cooling; (2) by radiational cooling; (3) by the mixture of unequal masses of air of unequal temperatures; (4) by expansional or dynamic cooling due to vertical convection, or, occasionally, other causes, especially rotation, as in tornado and waterspout funnels." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 259; cf. pp. 259–283.) It is important to note that condensation occurs in the atmosphere only in the presence of a CONDENSATION NUCLEUS, q. v. *See:* D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 51–56; H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 17–18, 29–34, 176–185.

condensation adiabat, *n.*—*See:* ADIABAT.

condensation level, *n.*—Properly, the lifting condensation level, i. e., the level at which air becomes saturated when it is lifted adiabatically; to be distinguished from the CONVECTIVE CONDENSATION

Level, q. v. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 54–56.

condensation nucleus, *n.*—A particle upon which condensation of water vapor begins in the free atmosphere. Condensation in the free atmosphere invariably takes place on hygroscopic dust or hygroscopic gases present. The common sources of hygroscopic dust and gases are sea salt, products of combustion, and dust blown up from the earth's surface. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 41–44.

condensation pressure, *n.*—The pressure to which air must be expanded dry-adiabatically in order that it may be sufficiently cooled to become saturated. The temperature at which saturation is attained in this manner is lower than the original saturation temperature of the air, by reason of the fact that the vapor pressure is lowered in proportion to the amount of adiabatic expansion. *See:* Condensation Temperature.

condensation stages, *n.*—*See:* Adiabatic Process.

condensation temperature, *n.*—The temperature at which saturation would be reached at the existing vapor pressure of air. Condensation from the air should occur on any suitable surface which is colder than this temperature; or, in the presence of suitable condensation nuclei, condensation in the air will begin at this temperature (hygroscopic nuclei will initiate condensation at a somewhat higher temperature). *See:* Condensation Pressure.

condensation trails, *n.*—Small artificial clouds which are "observed frequently behind aircraft flying in air at a low temperature. The clouds are formed by the passage of the airplane, but their cause is not fully understood. Sometimes they develop through the adiabatic cooling arising from the decrease in pressure back of the wing tips. More frequently they are observed back of the engine exhaust and are caused by the additional moisture or condensation nuclei emitted by the exhaust. They always form in a layer of air of high relative humidity." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 355–356); H. R. Byers, General Meteorology, 1944, p. 449.

conditional equilibrium, *n.*—*See:* Stability.

conditional instability, *n.*—The state of moist unsaturated air in which the lapse rate is intermediate between the dry- and the moist-adiabatic; so called because the stability is conditional on the water vapor content and the occurrence of lift. *See:* B. Haurwitz, Dynamic Meteorology, 1940, p. 57; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 237–242; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 61–64.

conduction, *n.*—1. The transference of heat within and through a substance by means of internal molecular activity and without any obvious external motion. In the atmosphere, since air is a poor conductor, conduction is important only in heating layers of air in direct contact with the ground, and the two most important methods of atmospheric heat transfer are Convection (including eddy conduction) and Radiation, q. v. 2. "The flow of positive electricity in a body from a point of high potential to one of lower potential, or of negative electricity in the opposite direction, or a combination of both." (Webster's New International Dictionary.) The earth continuously discharges to the atmosphere a conduction current of roughly 1,000 amperes. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 404–405.

conductivity, *n.*—1. "The facility with which heat flows through a conductor, as measured by the quantity of heat transmitted per unit of time, per unit temperature gradient along the direction of flow, per unit cross-sectional area." 2. "The facility with which a substance conducts electricity, as measured by the current density per unit potential gradient in the direction of flow." (L. D. Weld, Glossary of Physics, 1937, p. 36.) On this electrical conductivity of the atmosphere, see W. J. Humphreys' Physics of the Air, 3d ed., 1940, pp. 401–402. *See:* CONDUCTION.

conformal map, *n.*—A map in which all angles between lines on the surface of the earth are preserved on the map, and consequently the shape of any small area on the map is the same as the shape of the corresponding area upon the earth; also known as an orthomorphic map, meaning "right shape." *See:* MAP PROJECTION; U. S. Coast and Geodetic Survey, Special Publication 68.

congestus, *adj.*—Descriptive of cumulus clouds which are in the form of a dome or tower; congestus implies a bringing together or a heaping up, and refers to the swollen appearance of the cloud. *See:* CUMULUS CONGESTUS.

coniology, *n.*—The scientific study of dust, its influence and effects on plant and animal life. Also spelled "koniology."

coniscope, *n.*—Same as KONISCOPE, q. v.

consecutive mean, *n.*—The mean of a small group of consecutive values, especially annual means, assigned to the middle time-term of the group, in the process of SMOOTHING, q. v.

For instance, in a thirty-year series of annual mean temperatures for the years 1900 to 1929, the arithmetic average for the first five years 1900–04 may be calculated and the value assigned to the middle year, 1902. Then the five-year mean for 1901–05 is taken and assigned to 1903, and so on to 1927. If a curve is drawn through the values calculated, it may be extrapolated both ways and values assigned to years 1900, 1901, 1928, and 1929. Consecutive means are also called moving averages. It is obvious that any number of odd years may be used for calculating the mean of the middle term. Moving averages are often used in climatological work.

conservation of angular momentum, *n.*—The principle of the constancy of moment of momentum in a system on which no external force acts. "The angular momentum of a body revolving about an axis is the product of its mass, its linear velocity, and the distance of its center of mass from the axis of rotation. As long as there is no unbalanced torque acting on the system, this product remains constant. Now if the radius of rotation is changed, the velocity must also change so that the angular momentum shall be as before. . . . Air blowing over the earth's surface partakes of the earth's west-to-east rotation, and is affected by this principle." (D. Piston, Meteorology, 1941, pp. 16–17.)

conservation of areas, *n.*—*See:* CONSERVATION OF ANGULAR MOMENTUM.

conservation of energy, *n.*—A principle in physics which states that energy is never created and never destroyed, so that the total amount of energy in the universe remains constant, though transformations from one form to an equivalent amount of some other form are continually occurring.

conservation of vorticity, *n.*—A physical principle which may be expressed by the equation:

$$\frac{(\zeta+\lambda)}{\Delta p}=\text{a constant}$$

where $(\zeta+\lambda)$ is the absolute vorticity of a parcel of air and Δp is its vertical thickness. This equation holds in the case of a DYNAMIC TROUGH, q. v., and also in the parallel case of air moving up a warm frontal surface. As the air ascends, it experiences vertical compression, i. e., Δp decreases; consequently, $(\zeta+\lambda)$ must decrease. Since, for a given latitude, λ (the CORIOLIS PARAMETER, q. v.) is a constant, ζ (the vorticity of the air relative to the earth) must decrease. A decrease in ζ means anticyclonic curvature; accordingly, the air is turned toward the right. Thus the ascending warm air spirals outward from the center of the depression. *See:* VORTICITY.

conservatism, *n.*—The relative constancy of an air mass property despite the activity of atmospheric processes which tend to change it. "If the magnitude of the property remains constant within the range of error of the observation for a period of 12 hours at the earth's surface; or from 24 to 48 hours in the free atmosphere, it is said to be conservative." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 221–222.)

conservative (air mass) property, *n.*—Any air mass property the nature or value of which is affected to a comparatively small degree by the various modifying influences, particularly adiabatic changes, to which a moving body of air is exposed. The following are some of the conservative properties of air: specific humidity, potential temperature, equivalent-potential temperature, vapor pressure, and dew point temperature. The first two are conservative for dry-adiabatic changes only. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 1–27.

constancy of angular momentum, *n.*—*See:* CONSERVATION OF ANGULAR MOMENTUM.

constant level chart, *n.*—Any chart which represents the synoptic distribution of one or more meteorological elements at any fixed geometric elevation (including zero) above sea level. The sea level or ten-thousand-foot pressure maps are examples of constant level charts.

constant pressure chart, *n.*—A chart which contains the synoptic contour lines of the height above sea level of any selected isobaric surface in the free atmosphere. In the selected isobaric surface the synoptic distribution of any other meteorological element may be represented on the constant pressure chart.

The height may be either true height or dynamic height. This chart is used for essentially the same purposes as the CONSTANT LEVEL CHART, q. v.

contact flight, *n.*—Flight of aircraft in which the altitude (orientation of aircraft in reference to the earth's surface) of the aircraft and its flight path can at all times be controlled by means of visual reference to the ground or water.

contact weather, *n.*—Weather in which all elements are such that the pilot of an airplane may operate without instruments, i. e., he can control his flight by means of visual reference to the ground or water. C weather is an abbreviation for contact weather.

contessa di vento, *n.*—The "wind countess"; a lenticular cloud often formed in the lee of Mount Etna, in Sicily, which "resembles a gigantic white turban with its crown merging into the clouds above it. . . . A long strip of cloud that at times hangs around the southern base of the same mountain and is said to foretoken rain is called 'La Serpe' (the snake)." (C. F. Talman, The Realm of the Air, 1931, p. 45.)

continental climate, *n.*—The climatic type characteristic of the interiors of the great land masses, the distinctive features of which are the large annual and daily range, of temperature and the cold winters and warm summers; which contrast strikingly with the small temperature variations, the mild winters and cool summers of its opposite, the MARINE CLIMATE, q. v. In a continental climate, furthermore, the air is less humid and cloudy than over the oceans. *See:* CONTINENTALITY; R. D. Ward, Climate, 2d ed., rev., 1918, pp. 38–42.

continentality, *n.*—A measure of the degree to which the climate of a particular region approaches the typical CONTINENTAL CLIMATE, q. v. It is the opposite of OCEANITY, q. v., and is expressed by an "index of continentality," generally based on a comparison of the mean annual ranges of temperature at various places, so that the station having the largest range would have the highest index of continentality. Several refinements of this rough procedure have been worked out. In addition, an index based on the relative frequency of continental and maritime air masses over an area has recently been proposed.

Ultimately, continentality integrates the various influences of land itself on climate. Considering only temperature, the most important element, the fact that soil absorbs and loses heat more readily than water explains, on the one hand, the relatively constant annual temperatures of regions exposed to oceanic influences, and, on the other hand, the warm summers (due to surface heating of the air) and cold winters (due to radiational cooling of the air) characteristic of the continental interiors. *See:* D. Brunt, Climatic Continentality and Oceanity, Geographical Journal vol. 64, 1924, pp. 43–56; V. Conrad, Fundamentals of Climatology, 1942, pp. 52–56; E. Dinies, Luftkörper-Klimatologie, Archiv Deutsch Seewarte, vol. 50, 1932; H. Landsberg, Physical Climatology, pp. 157–164, 194–199; J. Hann, Handbook of Climatology, Pt. I, tr. R. D. Ward, 1903, pp. 215–216.

continuity, *n.*—A term applied in the analysis of a series of synoptic charts to indicate that the analysis on each synoptic chart can be derived by a logical transition from that of the preceding chart, i. e., that the physical processes in the atmosphere as represented by the analysis of the successive synoptic charts progress continuously from the state represented by one chart to that of the following chart.

contour line, *n.*—A line on a map drawn through points having the same elevation above or below sea level. Contour lines, therefore, indicate the ground relief; lines close together signify steepness of slope, and far apart the reverse. The interval between the lines depends largely upon the scale of the map but sometimes upon the mean slope of the country represented.

contrastes, *n.*—Counterwinds frequent in the western part of the Mediterranean Basin, which often blow simultaneously from opposite quadrants at no great distance apart, while a cloudless sky prevails. They are most common in spring and autumn, in the vicinity of the Strait of Gibraltar, and are less violent on the African than on the Spanish coast.

control days, *n.*—Days whose weather is supposed by the superstitious to indicate the weather for a certain number of following days. Ground-hog Day (February 2d) and Saint Swithin's Day (July 15th) are well-known examples. *See:* W. J. Humphreys, Rain Making and Other Weather Vagaries, pp. 129–137.

convection, *n.*—1. In physics, the circulation resulting in a fluid of non-uniform temperature, owing to differences in density and the action of gravity. With Radiation and Conduction, q. v., it is one of the three methods for the transfer of energy. 2. In meteorology, the process whereby a circulation is created and maintained within a layer of the atmosphere, due either to surface heating of the bottom of the layer or to cooling at its top, and "consisting in the sinking of relatively heavy air and the consequent forcing up of air which, volume for volume and under the same pressure, is relatively light." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 104.) Convection occurs in the atmosphere on a large scale, as in the case of air rising in the Doldrums, q. v., or on a small scale, as in the case of a local Convection Current, q. v. In addition to this process, often called "thermal convection," some meteorologists recognize "mechanical convection," in which air is forced to rise on the windward side of an obstacle and to descend on the leeward side. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 162–163; D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 219–222; W. I. Milham, Meteorology, 1936, pp. 44–47; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 102–104, 107–108, 264–272.

convection current, *n.*—Same as a Thermal, q. v.

convection theory, *n.*—An hypothesis of the formation of a cyclone, according to which strong local heating causes humid air to rise to great heights, and air flows into the region over which the ascent takes place, acquires a cyclonic vorticity, and consequently leads to cyclogenesis. This theory seems to explain the formation of a tropical cyclone better than it does the origin of an extratropical one. "It seems unlikely that an appreciable number of extratropical cyclones are caused by convection and convergence. It is difficult to visualize a sufficiently strong heating in temperate latitudes, especially during the winter when the cyclones are most frequent. Furthermore, most extratropical cyclones are associated with frontal systems even in their earliest stages." (B. Haurwitz, Dynamic Meteorology, 1941, p. 320.) For other theories of cyclogenesis, *see:* BARRIER THEORY, COUNTERCURRENT THEORY OF STORMS, DROP THEORY.

convective condensation level, *n.*—The level to which air, if heated sufficiently from below, will adiabatically rise before it will become saturated; accordingly, the height at which the base of cumuliform clouds may form by thermal convection from the surface. *See:* CONDENSATION LEVEL.

convective equilibrium, *n.*—The state of the atmosphere in which its vertical temperature distribution is governed entirely by TURBULENT MIXING, q. v. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 85.

convective instability, *n.*—Also called potential instability; the condition of an unsaturated layer of air having a stratification of humidity such that, upon being lifted, the lower part of the layer becomes saturated first, and hence cools thereafter at a slower rate than does the upper, drier portion, until the lapse rate of the whole layer becomes equal to the saturation adiabatic and any further lifting results in instability. The EQUIVALENT-POTENTIAL TEMPERATURE, q. v., decreases with elevation through a convectively unstable layer. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 76–78; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 86–88.

convective rain, *n.*—Rain that is caused by the adiabatic cooling of moist air which rises by reason of the vertical thermal or convective instability of the atmosphere.

convective region, *n.*—A term sometimes applied to that part of the atmosphere below the stratosphere, i. e., the troposphere, so called because the vertical interchange of air there is by convection.

convective showers, *n.*—Intermittent convective rain.

convective thunderstorm, *n.*—Convective showers which develop to thunderstorm intensity, i. e., that build up electrical space charges of sufficient potential to produce lightning discharges.

convergence, *n.*—The increase of mass within a given layer of the atmosphere when the winds are such that there is a net horizontal inflow of air into the layer. The accumulation of mass leads to vertical motion that limits the amount of the excess. Hence, if there is convergent flow at the surface, there must be upward vertical motion; if there is horizontal convergence at any level aloft, there must be upward or downward motion. In general, convergence is associated with low pressure centers, DIVERGENCE, q. v., the opposite phenomenon, with anticyclones; but divergence also occurs above the warm frontal surface of an extratropical cyclone. There exist, furthermore, several more or less permanent belts of convergence on the earth, such as the INTERTROPIC CONVERGENCE ZONE, q. v., and the zones across the Atlantic and Pacific oceans where air of polar and air of tropical origin come together. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 156–157.

conversion factor, *n.*—A number by which a quantity expressed in one system of units may be converted to another system. For example, to convert: miles per hour to meters per second, multiply by 0.4470409; meters per second to miles per hour, multiply by 2.36932.

cooling power, *n.*—The net rate at which heat can be taken up from any body by its environment. In climatology, the human body is considered, because man's comfort largely depends on the ability of the air to receive the heat which the body must throw off in order to maintain the proper balance of metabolism. "If the environment does not permit this heat loss, the individuals feel uncomfortable and finally may die from heat stroke. If, on the contrary, the environment is too cold and gives rise to heat losses from the body beyond the amount produced, chilling and, eventually, freezing will take place." (H. Landsberg, Physical Climatology, 1941, p. 165; cf. pp. 164–168.) Cooling power is usually measured by the KATA-THERMOMETER or by the COOLOMETER, q. v. *See:* A. G. Price, A Note on the Cooling Power, American Geographical Society, Special Publications, No. 23, App. III, 1939.

coolometer, *n.*—An instrument devised by W. S. Weeks for measuring the COOLING POWER, q. v., of the air. It is made of a copper cylinder, which is heated electrically to a constant temperature, the current required for the purpose being a measure of the rate of cooling. *See:* W. S. Weeks, A New Instrument for Measuring Cooling Power, Journal of Industrial Hygiene, vol. 13, No. 7, September 1931.

cooperative observer, *n.*—An unpaid observer of the U. S. Weather Bureau; formerly called a voluntary observer. His station, which is usually equipped by the Weather Bureau with the necessary meteorological instruments, is called a cooperative station.

cordonazo, *n.*—A violent southerly gale on the west coast of Mexico, generally occurring between June and November, and probably due to the passage of a tropical cyclone offshore.

Coriolis effect, *n.*—The deflection of winds due to the influence of the rotation of the earth. Owing to this effect, winds in the northern hemisphere are deflected to the right, and in the southern, to the left. *See:* FERREL'S LAW; CORIOLIS FORCE.

Coriolis force, *n.*—In modern meteorology, the name usually applied to the deflecting influence of the earth's rotation on winds, first completely explained by Ferrel. It is defined as:

$$C.F. = \lambda v$$

where $\lambda = 2\omega \sin \phi$ is called the CORIOLIS PARAMETER, q. v., v is the velocity of the wind, and $C.F.$ is the Coriolis force.

Because a stream of air or any moving body is deflected to the right in the Northern Hemisphere, to the left in the Southern, it is natural to think of this influence as a real force impelling the body in either direction. It is only an apparent force, however, whose nature is best understood from the following simple case.

Consider a body of air at the north pole, *P*, which starts freely moving southward along a meridian toward a point *A*. In the time necessary for it to reach *A*, this latter point will have revolved around with the rotating earth, and will now be located at *B*, a point on the same latitude circle farther to the east. Hence, with reference to an observer on and moving with the earth, the air will seem to have blown towards the west of south in a curved path, and to have been constantly deflected to the right. Actually, as an observer in space would recognize, its course throughout was along the straight line (in space *PA*). At the south pole, air moving in like manner northward will seem to undergo deflection to the left. East and west motions in either hemisphere are similarly affected. There is no deflecting force at the equator.

For complete explanation, *see:* W. J. Humphreys, Weather Proverbs and Paradoxes (the paradox, "air pushed north blows east"), and Physics of the Air; B. Haurwitz, Dynamic Meterology, 1941, pp. 124–126; D. Brunt, Physical and Dynamical Meterology, 1939, pp. 166–167.

Coriolis parameter, *n.*—*See:* Coriolis Force.

coromell, *n.*—A night land breeze, prevailing from November to May at La Paz, at the southwest extremity of the Gulf of California.

corona, *n.*—1. A set of one or more rainbow-colored rings of small radii concentrically surrounding the sun, moon, or other source of light when covered by a thin cloud veil. "Around the source and bounded by a brownish-red ring is a luminous area called the Aureole, q. v. Often the corona consists of this aureole alone; sometimes two or three other concentric rings appear outside the aureole, ranging from a whitish blue on the inside to a red on the outside, the colors being very faint in the outer rings.

"The corona can be distinguished from the halo by the fact that the color sequence is opposite in the two, the red of the corona being on the outside, while that of the halo is on the inside. The corona is due to the diffraction of the light by the tiny drops of water (in the cloud), instead of refraction through ice spicules as in the case of the halo." (J. G. Albright, Physical Meteorology, 1939, pp. 370–371.) The radius of a corona is inversely proportional to the size of the water drops: a small corona indicates large drops, and vice versa. Hence, "when a corona is observed to be rapidly becoming smaller it may, in conjunction with other signs, be taken as an indication that a storm is imminent, because the more humid the air the larger the droplets." (C. F. Talman, The Realm of the Air, 1931, p. 193.) *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 547–554. 2. A circle of light occasionally formed by the apparent convergence of the beams of the Aurora, q. v. 3. The brilliant aureole of light which surrounds the sun at the instant of total eclipse, and in total brightness is approximately equal to one-half the brightness of the full moon.

corposant, *n.*—Same as St. Elmo's Fire, q. v.; the name is derived from corpo santo, or ghost, and was given because of the supposed supernatural nature of the phenomenon.

correlation, *n.*—1. "The amount of similarity in direction and degree, of variations in corresponding pairs of observations in two series of variables." (A. K. Kurtz and H. A. Edgerton, Statistical Dictionary, 1939, p. 39.) In meteorology, there are many instances in which an increase in one variable is associated with an increase in a second, without the necessary existence of a known physical relationship between the two; or, conversely, large values of the first tend to be associated with small values of the second, which is called "inverse correlation." For instance, according to studies by W. H. Dines, above-normal pressure at 9 km. is always associated with an above-normal mean temperature in the column of air below 9 km.; and above-normal temperature at the tropopause is usually accompanied with below-normal height of the tropopause. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 320–327. 2. The study of the relationship between a pair of variables or more. *See:* Correlative Meteorology. 3. Same as the Coefficient of Correlation, q. v.

correlation coefficient, *n.*—*See:* Coefficient of Correlation.

correlation ratio, *n.*—A measure of relation between two variables; it is the square root of the quantity one minus the ratio of the sum of squares, over all arrays, of the departures of the observations from their respective array means to the sum of squares of the departures of the observations from the general mean. If y_{ix} is the *ith* observation corresponding to the value x of the independent variable, if $\bar{y}_x$ is the mean value of the observations corresponding to x, and if $\bar{y}$ is the mean of all observations, the correlation ratio η_{yx} is given by

$$\eta_{yx}=\sqrt{1-\frac{\sum_{x}\sum_{i}(y_{ix}-\bar{y}_x)^2}{\sum_{x}\sum_{i}(y_{ix}-\bar{y})^2}}$$

It is a generalization of the correlation coefficient, and is the correlation between the y's and any function of x which passes through the mean values of the y's for each value of x. If there are n values of x for which values of y have been observed, a polynomial of the *nth* degree, or any other curves with n adjustable parameters, may be made to pass through the n values of $\bar{y}_x$.

correlative meteorology, *n.*—The branch of meteorology which treats by the methods of Correlation, q. v., the relations existing among large-scale weather phenomena. For example, studies seem to have shown "the tendency of pressure at stations in the Pacific (San Francisco, Tokio, Honolulu, Samoa, and South America), and of rainfall in India and Java (presumably also in Australia and Abyssinia to increase, while pressure in the region of the Indian Ocean . . . decreases." (G. T. Walker, Correlation in Seasonal Variations of Weather, IX, Memoirs of the Indian Meteorological Department, vol. 24, 1924, p. 323.) *See:* R. A. Allen, Statistical

Studies of Certain Characteristics of the General Circulation of the Northern Hemisphere, Quarterly Journal of the Royal Meteorological Society, vol. 66, 1940, Supplement, pp. 88–101; H. H. Clayton, World Weather, 1923, pp. 363–371; N. Shaw, Manual of Meteorology, vol. 2, 1928, pp. 329–340.

cosmic radiation, *n.*—Corpuscular radiation of enormous energy, great penetrating power, and very high speed, which apparently travels through space equally in all directions. Its source or sources are unknown. *See:* F. K. Richtmyer and E. H. Kennard, Introduction to Modern Physics, 3d ed., 1942, pp. 643–697.

cosmic rays, *n.*—*See:* COSMIC RADIATION.

cotton-ball clouds, *n.*—Clouds of the form indicated by the name; generally cumulus or altocumulus.

countercurrent theory of storms, *n.*—An hypothesis developed by F. H. Bigelow about 1902 to explain the formation of cyclones and anticyclones by the interaction in middle latitudes of polar and equatorial currents of air. "For example, if, when two such currents meet, the equatorial one is on the east, they will tend to go away from each other on account of deflection, and a low will be formed between them. On the contrary when the equatorial current is west of the polar current they are deflected toward each other and result in the formation of a high pressure area." (C. F. Brooks and F. V. Tripp, Some Early History of the Development of our Knowledge Concerning Extratropical Cyclones, Bulletin of the American Meteorological Society, vol. 6, 1925, p. 58.) *See:* F. H. Bigelow, A Popular Account of the Countercurrent Theory of Storms, Proceedings of the Third Convention of Weather Bureau Officials, 1904, pp. 79–89; W. I. Milham, Meteorology, 1936, pp. 311–313.

counterglow, *n.*—Same as gegenschein; a round or elongated spot of light at a point on the zodiacal band opposite the sun, explained in one theory as "caused by light reflected from particles describing orbits about the sun and earth jointly, a particularly large number of which are visible at any time in the part of the sky directly opposite the sun." (H. Jeffreys, The Earth, 2d ed., 1929, p. 54.) *See:* ZODIACAL LIGHT.

counter sun, *n.*—*See:* ANTHELION.

countertrade, *n.*—1. Term formerly applied to the prevailing westerly winds of the middle latitudes. 2. Same as the ANTITRADE, q. v., the wind blowing above and counter to the trade wind.

creeping, *n.*—A defect in the action of an aneroid barometer when subjected to a large and rapid change of pressure; it consists of a sluggish adjustment of the index to or toward the correct reading, and is caused by molecular changes, as yet not clearly understood, which occur within the materials of the aneroid box and steel springs.

crepuscular rays, *n.*—Beams of light apparently diverging from the sun, seen both before and after sunrise and sunset, especially in a hazy or humid atmosphere. The beams are rendered luminous by the dust or water vapor, and are especially striking when they shine through rifts in the clouds. They are actually parallel: their apparent divergence is surely the result of perspective.

This phenomenon is known as "the sun drawing water." Sailors once called it "the backstays of the sun"; the natives of Polynesia call it "the ropes of Maui"; in parts of England it is known as "Jacob's ladder." It is believed that the Homeric phrase, "rosy-fingered morn" refers to these crepuscular rays.

crepuscule, *n.*—The same as TWILIGHT, q. v.

crest cloud, *n.*—Same as CLOUD CREST, q. v.

crest stage, *n.*—The highest elevation, or stage, reached during a rise by flood waters flowing in a channel.

criador, *n.*—Name applied in northern Spain to the rain-bringing west wind.

critical state, *n.*—"A condition of a substance such that the liquid and the vapor states are identical. For a pure substance, this occurs only at a particular temperature (*the critical temperature*) and pressure (*the critical pressure*). A substance above its critical temperature will not separate into two fluid phases, however great the pressure applied." (L. D. Weld, Glossary of Physics, 1937, p. 42.) Since the critical temperature of air is approximately −141° C., that of water 374°, it is obvious that air cannot naturally occur as a liquid on the earth, and that water may exist in all three states, solid, liquid, and vapor. *See:* TRIPLE POINT.

crivetz, *n.*—A term applied in Rumania and parts of southern Russia to a wind coming from the northeast quadrant; but especially to a cold, bora-like wind from the north-northeast, characteristic of the climate of Rumania. It has been estimated that over one-fifth of the winds at Bucharest belong to this latter type.

cross, *n.*—A rare halo phenomenon, in which strips of white light intersect over the sun at right angles; presumably due "merely to the simultaneous occurrence of a parhelic circle, or segment of it next the sun, and a light pillar. Possibly, it might also be produced by the intersection of the secondary halos of 22°, or even by some combination of 'pillar,' parhelic circle, and secondary halos." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 544.)

cross cirrus, *n.*—A variety of CIRRUS, q. v.

cross section, *n.*—As used in meteorology, the representation of conditions prevailing in the atmosphere in a vertical plane from the surface up to any desired height, along a line from one weather station to another. Cross sections are of two general types. The first, which may be called the analytic cross section, is based on synoptic data, and shows the location of frontal surfaces, of the tropopause, of clouds and precipitation; the distribution of temperature and specific humidity; the names of the various air masses, the direction and speed of the upper winds, etc.,—all as they exist simultaneously in the atmosphere. The second type, the pilot's picture cross section, differs in that it is based on a time scale, so that it represents the weather conditions it is expected the pilot will encounter along his route. In addition to showing most of the above elements, as they are forecasted, special attention is paid to the indication of layers of turbulence, subsidence inversions, and icing levels. A recommended flight plan is also given to take advantage of the most favorable weather conditions. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 404–405; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 66–67; H. C. Willett, Discussion and Illustration of Problems Suggested by the Analysis of Atmospheric Cross-Sections, Massachusetts Institute of Technology, Papers in Physical Oceanography and Meteorology, vol. 4, No. 2, 1935.

cross wind, *n.*—The component of the wind which is directed perpendicular to the line of flight of an airplane or projectile.

cross wind force, *n.*—The component of the wind perpendicular to the lift and to the drag of the total air force on an aircraft or airfoil.

cryoconite holes, *n.*—Holes, found in vast numbers near the edges of the Greenland Glacier, and also found in the pack ice off the east coast of Greenland, which are believed to be caused by the sinking into the ice of dust blown from the coast.

Cs., *abbr.*—Abbreviation for CIRROSTRATUS, q. v.

Cu., *abbr.*—Abbreviation for CUMULUS, q. v.

cumulative temperature, *n.*—Same as ACCUMULATED TEMPERATURE, q. v.

cumuli, *n.*—Plural of CUMULUS, q. v.

cumuliform (or **cumuliformis**), *adj.*—1. A general term applied to all clouds having dome-shaped upper surfaces which exhibit protuberances, the bases of such clouds being generally all on the same horizontal plane. Cumuliform clouds are characteristically distinct and separated from one another by clear spaces. 2. Applied to a type of fine weather sky characterized by the presence of cumulus with horizontal bases, more or less dome-shaped but without excessive vertical development. 3. Applied to a disturbed sky without cumulonimbus, i. e., to an intense convection sky, characterized by thick and jagged cumulus, but with no cirriform structure at their summits. 4. Applied to a disturbed sky, with intense convection and characterized by the presence of cumulonimbus.

cumulo-.—Combining form of CUMULUS, q. v.

cumulo-cirrus, *n.*—A former name for ALTOCUMULUS, q. v.

cumulonimbus, *n.*—A cumulus cloud of very great vertical development (often 4 miles or more deep from base to summit) and comparable horizontal extent, the top of which is composed of ice crystal clouds, its distinguishing characteristic. Although these upper cirriform parts may assume many varied shapes, yet in numerous cases they spread out into the semblance of an anvil, called the INCUS. In general, the ice crystal clouds are known as ANVIL CIRRUS, FALSE CIRRUS, or CIRRUS NOTHUS, q. v.

"Like the heavy and swelling cumulus, cumulonimbus is formed either in calms, especially on hot thundery days, or in a strong wind in the rear of disturbances.

"Cumulonimbus is a regular factory of clouds. By extension at various levels it often produces either cirrus masses by an extension of the ice crystal parts, or masses of altocumulus or stratocumulus by an extension of the cumuliform parts, and these may end by becoming detached from the parent cloud." (U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938, p. 23; cf. pp. 12–13.)

Cumulonimbus is the familiar thunder cloud, and its precipitation is of a violent, intermittent, showery character. Hail often falls from exceptionally powerful cumulonimbus. Its principal species are Cumulonimbus Calvus, Cumulonimbus Capillatus, and Cumulonimbus Mammatus, q. v. *See:* Thunderstorm.

cumulonimbus calvus, *n.*—A species of cumulonimbus having bulging tops, in which, however, no cirriform parts are evident. "Nevertheless the freezing of the upper parts has already begun; the tops are beginning to lose their cumulus structure, that is to say, their rounded outlines and clear-cut contour; the hard and 'cauliflower' swellings soon become confused and melt away so that nothing can be seen in the white mass but more or less vertical fibres. The freezing, accompanied by the change into a fibrous structure, often goes on very rapidly." (U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938, p. 13.)

cumulonimbus capillatus, *n.*—A species of cumulonimbus "which displays distinct cirriform parts, having sometimes, but not always, the shape of an anvil." (U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938, p. 13.)

cumulonimbus mammatus, *n.*—A variety of cumulonimbus in which the base exhibits indistinctly a formation of rolls, resembling pouches or breasts.

cumulus, *n.*—Member of Family D of the international Cloud Classification, i. e., a cloud with vertical development, the mean lower level of which is 1,600 feet. The summit of the cloud, in general dome-shaped, shows rounded bulges, while the base is usually horizontal. It appears variously white, shaded, or dark, according to its position with reference to the sun. Its base is generally of a gray color.

"Typical cumulus, over land areas, develops on days of clear skies, and is due to the currents of diurnal convection; it appears in the morning, grows, and then more or less dissolves again toward the evening.

"Cumulus . . . has a uniform structure, that is to say, it is composed of rounded parts right up to its summit, with no fibrous structure. Even when highly developed, cumulus can only produce light precipitation." (U. S. Weather Bureau, Code for Cloud Forms and States of the Sky, Circular S, 1938, p. 11.)

The principal species are Cumulus Congestus and Cumulus Humilis, q. v. *See:* Fractocumulus.

cumulus congestus, *n.*—A very distended and sprouting cumulus cloud, whose domes have a cauliflower appearance. It is of two types: (1) that formed in calm air and especially on hot days when there is a tendency for thunderstorm activity; (2) that formed in strong winds in the rear of disturbances. Both types have great vertical development, but the second is more tossed about and broken up. Neither shows ice crystal clouds at the top: this sign would mean that they had passed into the stage of Cumulonimbus, q. v.

curl, *n.*—The curl of any vector is the vector product of the operator ∇ and the vector. In meteorology, the curl of vector quantities such as pressure gradient, velocity, and velocity acceleration are considered.

The curl of the fluid velocity is also called the vorticity, and is given by the equation

$$\nabla\times\vec{\nabla}=curl\ \vec{V}=$$

$$\vec{i}\left(\frac{\partial w}{\partial y}-\frac{\partial v}{\partial z}\right)+\vec{j}\left(\frac{\partial u}{\partial z}-\frac{\partial w}{\partial x}\right)+\vec{k}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)$$

where V is the velocity vector; i, j, k are the unit vectors, and u, v, w are the velocity components in the x, y, z directions, respectively, of an orthozonal cartesian co-ordinate system.

For a velocity in the horizontal (x, y) plane, the curl is a vertical vector and is given by the equation:

$$curl_2\ \vec{V}=\vec{k}\left(\frac{\partial v}{\partial x}-\frac{\partial u}{\partial y}\right)$$

See: S. Petterssen, Weather Analysis and Forecasting, 1940, p. 232.

current, *n.*—1. The vertical component of air motion; an air current is thus distinguished from the wind, which is the horizontal component. 2. A large-scale horizontal motion of air. Thus, references to the equatorial and polar currents are sometimes encountered. 3. A large stream of ocean water moving continuously in about the same path, and distinguished from the water through which it flows mainly by temperature and salinity differences. Three classes of ocean currents have been distinguished: "(1) currents that are related to the distribution of density in the sea, (2) currents that are caused directly by the stress which the wind exerts on the sea surface, and (3) tidal currents and currents associated with internal waves." (H. U. Sverdrup, Oceanography for Meteorologists, 1942, p. 92.)

Ocean currents often exercise a profound influence on the climate of coastal regions. *See:* T. A. Blair, Climatology, 1942, pp. 71–76; H. Landsberg, Physical Climatology, 1941, pp. 200–204; G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 90–99.

curve of saturation, *n.*—*See:* Saturation Curve.

C weather, *n.*—An abbrevation of "contact weather," which means that an airport is open to all types of airplanes. The term is defined by current Civil Aeronautics Administration regulations with respect to the minimum requirements of ceiling and visibility for contact flight, which means flight by visual reference to ground or water.

cyanometry, *n.*—The study of the blueness of the sky. *See:* Hans and Meta Neuberger, Color Memory in Cyanometry, Bulletin of the American Meteorological Society, vol. 24, 1943, pp. 47–53.

cycle, *n.*—1. A regularly recurring succession of events, such as the cycle of the seasons. 2. In thermodynamics, a process in which the working substance ordinarily undergoes changes of heat into work, or vice versa, and which is termed a closed cycle if the working substance periodically returns to its initial state. *See:* Carnot Cycle. 3. In climatology, a period of years, the weather of which is supposed to recur in the same order at more or less regular intervals. The most noted of these cycles is the Brückner Cycle, q. v.

cyclogenesis, *n.*—The process which creates a new cyclone or which intensifies the circulation around a pre-existing one. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 159–160; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 435–437.

cyclolysis, *n.*—The decrease and eventual extinction of the circulation around a low pressure center. This final stage in the life history of a cyclone comes when its energy supply is exhausted, and it becomes a steadily weakening whirl which eventually melts into the general circulation.

cyclone, *n.*—A circular or nearly circular area of low atmospheric pressure around which the winds blow counterclockwise in the northern hemisphere, clockwise in the southern.

The word "cyclone" was first used in 1855 by Henry Piddington as the generic name for all circular or highly curved wind systems, but it has since undergone modifications in two directions. In the first sense, the term Tropical Cyclone, q. v., is used to designate the relatively small, very violent storm of tropical latitudes also known as a hurricane and a typhoon. The diameter of a tropical cyclone is sometimes less than 50 miles and seldom as great as 300. The winds revolving about its calm center frequently exceed a velocity of 100 miles an hour. It has no fronts associated with it, at least initially.

In the second usage of the word, an Extratropical Cyclone, q. v., also called a low or a depression, is the name given to a low pressure system of much greater size and (usually) less violence, frequent in middle latitudes. Its average diameter is of the order of 1,500 miles. Its winds usually range from light (at the outskirts) to strong or gale force (near but not at the center). Unlike the tropical cyclone, which affects only a small area, it may cause precipitation and cloudiness over many thousands of square miles. Finally, it has a frontal structure, with which its origin, development, and dissolution are integrally associated.

cyclone cellar, *n.*—Also called tornado cave; a place of shelter built in localities frequented by tornadoes, for safe retreat from these violent storms. Such cellars or caves are often constructed of concrete, are ventilated, and are used as storage places for fruits and vegetables.

cyclone family, *n.*—A series of extratropical cyclones, usually four, which occurs in the interval between two successive outbreaks of polar air, and which travels along the polar front toward the east or northeast. The time interval may vary from three to seven days, and the number of cyclone waves from three to six. "The first of these, which usually is occluded, travels farthest to the north, and each of the following waves is younger and less developed than its predecessor. With the steady accumulation of polar air north of the front, the front is forced farther and farther to the south, so that the last wave tends somewhat farther to the south than the first one." (S. Petterssen, Weather Analysis and Forecasting, 1940, p. 350.) *See:* J. Bjerknes and H. Solberg, The Life Cycle of

Cyclones and the Polar Front Theory of Atmospheric Circulation, Geofysiske Publikationer, Vol. III, 1922, pp. 13–14.

cyclone model, *n.*—*See:* Bjerknes Cyclone Model.

cyclone wave, *n.*—The first stage in the development of an extratropical cyclone, according to the Norwegian wave theory.

A perturbation of the state of equilibrium at a surface of discontinuity (such as the polar front) assumes the form of a wave due to the interaction of the forces of gravitation, shear, and the earth's rotation. Gravity waves (such as waves on a water surface) tend to remain stable, i. e., their magnitude remains approximately constant during propagation. Shearing waves (such as those which produce the Billow Cloud, q. v.) are always unstable, i. e., their magnitude increases with time. The atmospheric waves of the order of 1,000 km. wave length required by the theory, if they consisted solely of a combination of gravity and shearing waves, would be essentially vertical, stable, and would never develop into mature extratropical cyclones. Consequently, the effect of the earth's rotation is important. Though the inertia waves which it produces are stable, its action produces predominantly horizontal motion. Hence, at wave lengths of approximately 1,000–3,000 km., the shearing instability is greater than the gravitational stability, owing to the almost horizontal motion; and the stabilizing effect of the earth's rotation is not yet strong enough to overcome shearing instability. Thus a cyclone wave can develop and occlude. *See:* B. Haurwitz, The Norwegian Wave Theory of Cyclones, Bulletin of the American Meteorological Society, vol. 18, 1937, pp. 193–201 (reprinted in Air Mass and Isentropic Analysis, 5th ed., 1940, pp. 37–45); B. Haurwitz, Dynamic Meteorology, 1941, pp. 271–312; S. Petterssen, Weather Analysis and Forecasting, Bulletin of the American Meteorological Society, 1940, pp. 303–319.

cyclonic rain, *n.*—Any rainfall connected with and caused by the passage of a barometric depression: the immediate causes of the rain are rising air currents, i. e., vertical currents or warm air masses overrunning colder air masses.

cyclostrophic wind, *n.*—1. A term used by Sir Napier Shaw to describe that component of the wind due to the curvature of the path, the other component being the geostrophic. 2. Also applied in the classification of winds to those having a high velocity in a curved path, such as tornadoes and tropical cyclones, which are also called Eulerian Winds, q. v. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 149; N. Shaw, Manual of Meteorology, Vol. IV, 1931, p. 80; D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 189–190.

D

d., *abbr.*—Abbreviation for Drizzle, q. v., in the Beaufort Weather Notation, q. v.

daily extremes, *n.*—*See:* Extreme.

daily mean, *n.*—1. The average value of any meteorological element, such as temperature, pressure, humidity, etc., over a period of 24 hours. It is the mean ordinate of the curve that represents the daily march of the element, and may be found by measuring the area under the curve and dividing this area by the length of the base. The mean thus obtained is rarely distinguishable from the mean of twenty-four hourly ordinates; and in practice merely half the sum of the maximum and minimum values is often used as a sufficient approximation. 2. The average values of any meteorological element for each day of the year obtained from a record of many years, in which case they are sometimes called normal daily values.

daily range, *n.*—*See:* RANGE.

Dalton's law, *n.*—A physical law which states that in a mixture of two or more gases, the total pressure is equal to the sum of the pressures which would be exerted by each gas if it alone were present. According to this principle, the several constituents of the atmosphere, acted upon by the force of gravity, would each form a separate atmosphere, entirely independent of the others if no disturbing influences acted. (William Ferrel, Recent Advances in Meteorology, Annual Report of the Chief Signal Officer, 1885, app. 71, Washington, 1886, p. 34.)

damp air, *n.*—Air having high relative humidity, say over 85 percent: this term is in contradistinction to DRY AIR, q. v., whose relative humidity is less than 60 percent.

damp haze, *n.*—Obstruction to vision due to the presence in the air of small water droplets or very hygroscopic particles, which do not, however, reduce the horizontal visibility to less than 1¼ miles. Damp haze is "similar to a very thin fog, but the droplets or particles are more scattered than in light fog and presumably also smaller. This phenomenon is usually distinguished from dry haze by its grayish color, the 'greasy' appearance of clouds seen through it as viewed through a dirty windowpane, and the generally high relative humidity. Commonly observed on seacoasts and in Southern States, most frequently with onshore winds and in the vicinity of tropical disturbances. A common mode of formation is the carrying up to high levels of particles from salt-water spray in windy weather." (U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 46.)

danger line, *n.*—1. A term used in predicting river stages; it denotes the height of the water above which damage to the adjoining countryside may be expected to result when the river is rising. It is now officially known as the flood stage in the United States. 2. The mark on the river gage corresponding to the flood stage.

dark, *adj.*—Used as a modifying term in describing the appearance of the sky. For example, "dark overcast" is reported when the sky is covered with clouds of an unusually gloomy or threatening appearance. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 33.

dark lightning, *n.*—A photographic effect, in which lightning flashes register dark instead of bright; first observed by Clayden, an English meteorologist, in night photographs of lightning flashes, and hence also called the "Clayden effect." There is, of course, no such thing as black or dark lightning in nature. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 371.

dawn, *n.*—The first appearance of light in the East before sunrise, or the time of that appearance. It is synonymous with daybreak and morning twilight. *See:* TWILIGHT.

day, *n.*—1. Sidereal day: the interval between two successive meridian transits of the vernal equinox. 2. Apparent solar day: the interval between two successive passages of the sun across the meridian. 3. Mean solar day: the interval between two successive upper or two successive lower meridian transits of the mean sun, a fictitious sun which moves with uniform velocity along the celestial equator at such a rate that its right ascension is as nearly as possible equal to the mean longitude of the real sun. 4. Civil day: a mean solar day reckoned from midnight to midnight, usually divided into two 12-hour divisions. Astronomers and military personnel reckon their hours from 0 midnight to 24 midnight; thus 4 p. m. civil time would be 16 hours astronomical time. 5. The period of daylight, as distinguished from night. *See:* RAIN DAY, RAINY DAY, WINTER DAY.

day degree, *n.*—A unit of one degree of temperature per day, used in computing the accumulated temperature, i. e., the aggregate of the daily excesses of temperature over some adopted standard reference value.

The number of day degrees for one month (or other period of time) is computed by considering only those days whose average temperatures are above the reference temperature. Adding up the excesses on those days will give the number of day degrees for the month. For example: if the daily mean temperatures for a certain March were below 42°, except for three days which had daily means of 44°, 48°, and 47°, the number of day degrees in that month referred to 42°, as standard, would be 13. *See:* ACCUMULATED TEMPERATURE.

debacle, *n.*—The breaking up of ice in a stream, and the rush of water, broken ice, and debris which follows.

decade, *n.*—Usually a group of 10 years; but often used in meteorology to mean a group of 10 days.

declination, *n.*—1. Astronomy: the angular distance of a celestial body north or south of the celestial equator, measured along an hour circle. 2. Terrestrial magnetism: the angle between the astronomic meridian and the magnetic meridian, considered east or west according as the magnetic meridian is east or west of true north. Magnetic declination is often called variation of the compass, or simply variation.

deepening, *n.*—The process by which the central pressure system, usually a low, decreases with time. The rate of deepening is equal to the barometric tendency in the center of the system. *See:* J. Bjerknes, The Deepening of Extra-Tropical Cyclone, Quarterly Journal of the Royal Meteorological Society, vol. 66, 1940, Supplement, pp. 57–59; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 426–440.

deflation, *n.*—A term used in physical geography to mean the removal of loose material by the wind, leaving the rocks bare to the continuous attack of the weather. Deflation is responsible for the uniformly sandy or stony surfaces of deserts.

deflecting (or **deflective**) **force,** *n.*—*See:* Coriolis Force; Ferrel's Law.

deflection of the wind, *n.*—The deviation of wind to the right of its original direction in the Northern Hemisphere, to the left in the Southern, due to Coriolis Force, q. v. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940. pp. 114–117.

degree, *n.*—1. On the centigrade thermometer scale, $\frac{1}{100}$th of the interval from the freezing point to the boiling point of water under standard conditions; on the Fahrenheit scale, $\frac{1}{180}$th of this interval. The length of a degree depends on the expansion of the thermometric substance used, which varies slightly over the scale. Therefore a degree is not absolutely the same along the whole length of the scale on liquid-in-glass thermometers (even apart from errors due to the unevenness of the thermometer bore). The degrees on a gas thermometer are more nearly alike, since it is known that gases expand nearly equally for equal rises of temperature when kept at constant pressure, and since it is also known that if their volume is kept constant, their pressure increases nearly equally. The degree of the gas thermometer is $\frac{1}{100}$th of the increase of pressure between freezing and boiling. The degree of the hydrogen thermometer, the most common form of the gas thermometer, is almost exactly the same as the degree of the Thermodynamic Scale, q. v. 2. A unit of angular measure; the angle subtended by $\frac{1}{360}$th part of the circumference of a circle.

degree day, *n.*—A departure of one degree per day in the mean daily temperature, from an adopted standard reference temperature, usually 65° F. The number of degree days for an individual day is the actual departure of the mean temperature from the standard; and the number of degree days in a month, or other interval, is the sum of all the daily values. When the mean temperature on a given day is 65° F., or higher, that day is not considered in making the monthly total. For example, for mean temperatures of 75°, 65°, 60°, 52°, 48°, 57°, the daily degree days for summation would be 0, 0, 5, 13, 17, 8. 65° F. was chosen the standard because, according to heating engineers, the minimum temperature of bodily comfort in the home is reached when the mean daily temperature falls below that value. A knowledge of the degree days to be expected for a given month in a given locality is useful for residential and industrial heating purposes. *See:* T. A. Blair, Climatology, 1942, pp. 20–22.

degrees of frost, *n.*—A phrase used in England; it means the number of degrees that the temperature falls below the freezing point: thus, a day with a temperature of 27° F. may be designated as a day of 5 degrees of frost.

deice, *v. t.*—To remove ice deposited on aircraft.

deicer, *n.*—Any device which eliminates ice after formation, or prevents its formation, on an airplane wing, control surface, carburetor, windshield, propeller, etc.

density, *n.*—The ratio of the mass to the volume of a substance. If the masses of all equal volumes of a substance are identical, the density is uniform and is equal to the mass in any unit of volume.

If the masses of equal volumes are not the same, the density is not uniform.

In the c. g. s. system, density is expressed in grams per cubic centimeter; the density of water at 4° C. is approximately unity. The density of dry air at a pressure of 760 mm. and a temperature of 0° C. is 1.293×10^{-3} grams per cubic centimeter, and this is the value ordinarily used in meteorology except in special investigations where more accurate determinations, depending on pressure and temperature, are employed.

density correction, *n.*—The correction to the length of the mercurial column of a barometer which must be made when atmospheric pressure observations are taken, because the pressures reported at two stations cannot be compared unless the densities of the mercury in the two barometers are the same or are reduced to the same standard temperature, which is that of melting ice, i. e. 32° F. or 0° C. *See:* BAROMETRY.

density-of-snow gage, *n.*—*See:* SNOW GAGE.

densus, *adj.*—Applied to a species of cirrus clouds with such thickness that, without care, an observer might mistake them for middle or lower clouds.

depegram, *n.*—A curve on a diagram with entropy and temperature as co-ordinates, representing the distribution of the dew point in relation to changes of pressure for a given sounding of the atmosphere.

depression, *n.*—A common term for an extensive area of relatively low barometric pressure. Other terms having roughly the same meaning are: cyclone, tropical cyclone, extratropical cyclone, hurricane, low, etc.

depression of the dew point, *n.*—The difference in degrees between the prevailing temperature and the current temperature of the DEW POINT, q. v.

depression of the wet-bulb, *n.*—The difference in degrees between the current temperatures of the dry- and the wet-bulb thermometers of a PSYCHROMETER, q. v.

descriptive climatology, *n.*—That branch of climatology which treats of the component elements of weather and climate as revealed by climatological statistics and discusses the interaction of these elements at any place upon the life and health of man and upon his various activities. *See:* PHYSICAL CLIMATOLOGY.

desert, *n.*—A region so devoid of vegetation as to be incapable of supporting any considerable population. Three kinds of deserts may be distinguished: (1) the polar ice and snow deserts, marked by perpetual snow cover and intense cold; (2) the middle latitude deserts, in the basin-like interiors of the continents, such as the Gobi, characterized by scant rainfall and high summer temperatures; and (3) the trade wind deserts, notably the Sahara, the distinguishing features of which are negligible precipitation and large daily temperature range. *See:* T. A. Blair, Climatology, 1942, pp. 172–179, 293, 298, 336–343, 435–439, 443–445, 461–462; G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 231–240, 249–250; R. D. Ward, Climate, 2d ed., rev., 1918, pp. 253–260, 298–303, 335–337.

desert devil, *n.*—*See:* DEVIL.

desert wind, *n.*—A wind coming from a desert; such winds obviously must be dry, and are usually hot, but may be cold. In southern California, where they are very destructive, certain winds coming from Nevada have temperatures considerably below freezing and very low relative humidity. *See:* F. D. Young, Desert Winds in Southern California, Monthly Weather Review, vol. 59, 1931, pp. 380–383.

desiccation, *n.*—The process by which a region suffers a complete loss of its water, due to decrease of rainfall, increase of evaporation, or to changes in other climatic controls. Desiccation is manifested by the drying up of streams and lakes, the destruction of vegetation, the loss of surface soil, etc.

deviation, *n.*—1. The algebraic difference between the mean of a series of data and an individual member of the series. *See:* STANDARD DEVIATION. 2. The angle between the DIRECTION OF THE WIND, q. v., and the BAROMETRIC GRADIENT, q. v.; to be distinguished from the INCLINATION OF THE WIND, which is the angle between the wind direction and the isobars themselves. 3. The difference in degrees between true north and the magnetic north indicated by a compass, which varies with geographical location. *See:* DECLINATION (2).

devil, *n.*—A name applied in India to a dust devil or DUST WHIRL, q. v. The "desert devil" of South Africa and the "dancing devil" of southwestern United States are the same phenomenon.

dew, *n.*—Water condensed onto objects near the ground whose temperatures have fallen below the dew point of the adjacent air due to radiational cooling during the night, but are still above freezing; frost occurs when the temperatures are below freezing. The necessary conditions for the formation of dew are: (a) a well insulated radiating surface on which it can be deposited; (b) a clear, still atmosphere with a low relative humidity; and (c) warm, moist ground or other source of moisture nearby. Dew does not fall from the sky, as older theories taught and as is still popularly believed.

The correct explanation of dew was first given in 1814 by W. C. Wells (1757–1817), in his "Essay on Dew." *See:* J. G. Albright, Physical Meteorology, 1939, pp. 228–229.

dew point, *n.*—The temperature to which air must be cooled, at constant pressure and constant water vapor content, in order for SATURATION, q. v., to occur. Since the pressure of the water vapor content of the air then becomes the saturation pressure, the dew point may also be defined as the temperature at which the saturation pressure is the same as the existing vapor pressure. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 133–134; B. Haurwitz, Dynamic Meteorology, 1941, pp. 39–41; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 226–227, 329–332.

dew-point apparatus, *n.*—A laboratory device used to determine the dew point directly. It is based on the principle that the dew point is the temperature at which dew is first observed to form on any cooling surface. It usually consists of a polished silver vessel containing a suitable liquid which is cooled by any desired method. At the moment when drops of moisture are first seen on the silver, a thermometer, dipped in the liquid, is read and the dew point thus determined. This instrument is also known as the dew-point hygrometer. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 99–100.

diathermancy of the atmosphere, *n.*—The ability of the atmosphere to transmit heat rays; the degree to which the atmosphere has this property depends, at any point on the earth's surface, upon latitude, season, pressure; and on certain properties of the atmosphere such as humidity, dust content, etc.

diffraction, *n.*—A phenomenon met with in wave motion in which only approximate rectilinear propagation results when the wave lengths are very small in comparison with ordinary obstacles and openings. Sound waves, X-rays, electrical rays, and other forms of wave motion undergo diffraction, but its principal manifestations are in light. In meteorological optics, the important diffraction phenomena are the AUREOLE, BISHOP'S RING, CORONA, and GLORY, q. v. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 547–556; R. W. Wood, Physical Optics, 3d ed., 1934, pp. 218–291.

diffuse front, *n.*—A FRONT, q. v., in which the frontal zone is of such wide horizontal extent that the normal discontinuity is replaced by a broad region of nearly continuous change in temperature, wind, etc.

diffuse reflection, *n.*—The reflection of light by large particles in the atmosphere such as dust, water droplets, and ice crystals, is of this type, and the depletion of the beam does not conform to Rayleigh's law of SCATTERING, q. v., by air molecules.

diffuse sky radiation, *n.*—The scattered solar radiation received by the earth from the atmosphere as distinguished from the radiation incident in direct sunlight. It has been estimated that, for a whole year and in terms of a unit equal to 10^{22} calories, the earth's surface gains 36 units of radiant energy from the sun directly, and 26 by scattered radiation. *See:* H. Landsberg, Physical Climatology, 1941, pp. 91–92.

diffusion, *n.*—The process by which a fluid permeates its environment. In MOLECULAR DIFFUSION, q. v., the permeation takes place by the thermal agitation of the molecules. This agitation varies directly with temperature and inversely with pressure. It causes spontaneous mixing within a single gas, or among several gases when in contact. In EDDY DIFFUSION, q. v., which occurs in a turbulent atmosphere, the mixing involves large masses of air, with important effects on the atmospheric equilibrium.

direction of the wind, *n.*—The point of the compass from which the wind blows, not that toward which it is moving. Wind direction is also expressed in degrees measured clockwise from north: thus an east wind has a direction of 90°, a northwest wind, of 315°, etc.

discharge, *n.*—The rate of volume flow of water in a given stream at a given time and place. The rate of flow is usually expressed in terms of cubic feet per second (abbreviated to "second feet"), liters per second, gallons per minute, or million gallons per day.

discomfort, *n.*—A feeling of bodily ill being, induced by improper conditions of temperature, humidity, and air movement within a building. Air-conditioning engineers have determined the COM-

FORT ZONE, q. v., within which the majority of people feel comfortable.

discontinuity, *n.*—A zone or layer in the atmosphere within which there is a comparatively rapid transition of any of the meteorological elements from one value to another. A FRONTAL ZONE, q. v., is a discontinuity between two air masses, and is involved by changes in temperature, density, humidity, wind speed and direction, etc. *See:* D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 203–211; B. Haurwitz, Dynamic Meteorology, 1941, pp. 167–179.

disturbance, *n.*—1. Any local departure from the normal wind pattern, such as described under SECONDARY CIRCULATION, q. v. 2. Synonymous with cyclone, both tropical and extratropical, as in the phrase "a tropical disturbance."

diurnal, *adj.*—Daily; applied to many meteorological phenomena having a distinctive daily behavior. For instance, the diurnal march of temperature, in middle-latitude continents, shows a rise from a minimum shortly after sunrise to a maximum in midafternoon; and the diurnal temperature range is the difference in degrees between the highest and lowest temperatures. Similarly, there exist two types of well-defined diurnal pressure changes. "One obtains at places of considerable elevation and is marked by a barometric maximum during the warmest hours and minimum during the coldest. The other applies to low, especially sea level, stations and is the reverse of the above, the maximum occurring during the coldest hours and the minimum during the warmest." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 243.) There is also a DIURNAL VARIATION OF THE WIND, q. v.

diurnal variation of the wind, *n.*—The daily change in both wind direction and speed, due to the heating of the earth's surface by the sun, which may be summarized in the rule that the wind at the surface veers and increases by day and backs and decreases by night (on land and in the Northern Hemisphere). The change in direction is explained under HELIOTROPIC WIND, q. v.; the change in velocity is the result of surface heating, which sets up during the day a vertical convectional interchange between the faster-moving wind of the free air and the slower-moving surface wind. This interchange is greatest generally in midafternoon, when the heating and the surface wind velocity are both at a maximum. It is negligible during the night and when the wind speed is at its lowest. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 302–306.

divective, *adj.*—One of the two complementary unitary elements of the dynamics of the weather (the other being the advective); the divective influence is the influence which causes air to cross the line of a closed curve drawn on the surface, from within to without; a divective region, where such an influence is at work, is marked by scanty rainfall and cloudiness; and a divective wind is one which blows outward from a divective region. *See:* N. Shaw, Manual of Meteorology, Vol. III, 1930, pp. 398, 410, 414–422.

divergence, *n.*—In fluid motion, a net outflow of mass across a closed surface bounding a limited volume of the fluid. This condition exists in the atmosphere, e. g., when the distribution of winds within a given layer of air is such that there is a net horizontal outflow of air from the region. The resulting deficit is compensated by a downward movement of the air from aloft when the layer is at the surface, and a movement which may be both upward and downward when the layer is at a higher level. Areas of divergent winds at the surface are regions unfavorable to the occurrence of precipitation, for the descending motion prevents the convective activity associated with the opposite condition, CONVERGENCE, q. v. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 126–128, 289–293; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 227–237, 326–336.

D layer, *n.*—An ionized region or layer of the atmosphere approximately 70 kilometers above the earth's surface, which partly absorbs radio waves and also reflects long radio waves; usually waves of medium to short wave lengths can pass upward through it without serious absorption. *See:* E LAYER; F LAYER; Chapman and Bartels, Geomagnetism, 1940, Vol. I, pp. 498–499.

doctor, *n.*—1. Colloquial name for a sea breeze in tropical climates, because of the invigorating qualities of sea air. 2. Name given to the HARMATTAN, q. v., on the Guinea coast of Africa, which, even though it is dry and dusty, affords relief from the steamy heat of the equatorial rainy season. *See:* W. G. Kendrew, The Climates of the Continents, 3d ed., 1947, p. 41.

dog days, *n.*—A period of hot weather, supposedly extending from late July to early September. It derives its name from Sirius, the Dog Star, the rising of which with the sun was formerly associated with the coming of dry, hot, and sultry weather, because Sirius was supposed to have an evil influence on human affairs in general. This superstition arose in the days of the Romans and like all superstitions, persists in spite of scientific teachings. The ancients assigned various dates to the beginning and duration of dog days. In current almanacs for the latitude of Greenwich they begin July 3 and end August 11.

departure, *n.*—The amount by which the value of a meteorological element (either the instantaneous value or the mean over a brief period) differs from the value taken as normal for the given time. Departures may be positive or negative. For example, if the normal temperature for July 1st and July 2d is 73° F., and if the mean temperature for July 1st in a certain year happens to be 75° F. and for July 2d, 70° F., then the departures are +2° F. and −3° F., respectively. The accumulated departure for a month is the algebraic sum of the daily departures.

doldrums, *n.*—The equatorial belt of calms or light fitful winds, lying between the northeast trade winds of the Northern Hemisphere and the southeast trades of the Southern. The doldrums are variable in position, and tend to move north and south with the sun, with a lag of about six weeks, though they are more often north than south of the equator. In addition to the absence of sustained wind, which made them the bane of sailing ship masters, the doldrums are subject to heavy downpours, thunderstorms, and squalls. *See:* GENERAL CIRCULATION; INTERTROPIC CONVERGENCE ZONE.

dosimeter, *n.*—In meteorology, an instrument for measuring the total ultraviolet, solar, and sky radiation. *See:* H. Landsberg, The Ultra-Violet Dosimeter, Bulletin of the American Meteorological Society, vol. 18, 1937, pp. 161–167.

Dove's law, *n.*—General name for the rules governing the systematic rotation of storm winds, and the regular progression of storms, developed by Heinrich Wilhelm Dove (1803–1879). *See:* H. W. Dove, The Law of Storms, tr. R. H. Scott, 1862; N. Shaw, Manual of Meteorology, Vol. I, 1932, pp. 142, 290–291, 296.

downdraft, *n.*—A downward-moving air current; generally encountered in thunderstorm conditions, when it is associated with an UPDRAFT, q. v.; both may attain enormous vertical velocities and are most hazardous to aircraft.

drainage area, *n.*—The region drained by a river and by its tributaries above a given point on the river.

drift, *n.*—1. Wind-driven snow in motion along the surface, sometimes rising to heights of 100 feet or more. 2. Snow lodged in the lee of surface irregularities under the influence of the wind. 3. The motion, of sea ice or of vessels, resulting from ocean currents.

drifting snow, *n.*—Snow raised from the ground and carried by the wind, so that the horizontal visibility becomes less than 5/8 mile (3,300 feet), although no precipitation need be falling. The snow drifts so low above the ground that the vertical visibility is not appreciably diminished. There are three degrees reported: "light drifting snow," "moderate drifting snow," and "thick drifting snow." (U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 45.) *See:* HYDROMETEOR; SNOW; BLOWING SNOW.

drip, *n.*—Moisture from fog or cloud condensed on leaves, twigs, etc., and falling therefrom. *See:* FOG-DRIP.

drizzle, *n.*—Precipitation from stratiform clouds, in the form of very small and very numerous drops of water, which apparently float in the air and bring poor visibility. The amount of precipitation from drizzle may be considerable, about 0.04 inches in an hour. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 39.

drizzling, *n.*—The falling of DRIZZLE, q. v. —*adj.* Applied to weather when drizzle is falling.

drop theory, *n.*—Another name for the BARRIER THEORY, q. v., of the genesis of cyclones and anticyclones, developed in modern times by Exner on the basis of the work of Helmholtz and Margules. *See:* E. W. Woolard, Theories of the Extratropical Traveling Cyclone, Bulletin of the American Meteorological Society, vol. 6, 1925, pp. 49–57.

drosometer, *n.*—An infrequently used instrument for measuring the amount of dew formed on a given surface. In one type a hemispherical glass vacuum cup is used. The glass cools to the DEW POINT, q. v., by radiative loss of heat; dew is deposited on its surface, is collected at the bottom of the cup, and is weighed so that the amount may be expressed in grams per unit area.

drought, *n.*—In general, an extended period of dry weather; or, a period of deficient rainfall that may extend over an indefinite number of days, without any set quantitative standard by which to determine the degree of deficiency needed to constitute a drought. Qualitatively, it may be defined by its effects, as a dry period sufficient in length and severity to cause at least partial crop failure. It has been pointed out that it is difficult to define the term exactly, "for the reason that the effects depend so largely upon other factors than the deficiency of rainfall; for example, the accompanying temperatures, the amount of wind movement, the character and condition of the soil, evaporation and cloudiness, the stage of the crop, and other varying controls enter into the problem." (R. D. Ward, The Climates of the United States, 1925, p. 226.) Furthermore, drought is a relative term; a period of scanty rainfall that would be fatal to crops in one region might be sufficient for growth in another.

For discussions of the problem of defining this term, *see:* T. A. Blair, Climatology, 1942, p. 37; A. J. Henry, The Great Drought of 1930 in the United States, Monthly Weather Review, vol. 58, 1930, pp. 351–353; W. G. Hoyt, Droughts, Hydrology, ed. O. E. Meinzer, 1942, pp. 579–591; H. Landsberg, Physical Climatology, 1941, pp. 171–174. *See:* DRY SPELL.

dry adiabatic rate, *n.*—The rate at which dry air warms or cools during adiabatic descent and ascent, respectively; for absolutely dry air, it is 1° C. per 102.39 meters of vertical distance when the lapse rate is neutral. *See:* ADIABATIC GRADIENT; ADIABATIC PROCESS.

dry adiabatic lapse rate, *n.*—The LAPSE RATE, q. v.; in neutral equilibrium, it is equal to 1° C./102.39 m.

dry air, *n.*—In meteorology air that has relative humidity so low that evaporation takes place actively. In the BEAUFORT WEATHER NOTATION, q. v., dry air is defined as air whose relative humidity is less than 60 percent.

dry-bulb thermometer, *n.*—*See:* PSYCHROMETER.

dry fog, *n.*—A haze due to the presence of dust or smoke particles in the air; it is not a true fog, since it does not consist of water droplets, and, unlike fog, it may occur when the air temperature is several degrees above the dew point.

dry haze, *n.*—Dust or salt particles which are dry and so extremely small that they cannot be felt or discerned individually by the unaided eye. *See:* Instructions for Airways Meteorological Service, U. S. Weather Bureau, Circular N, 5th ed., 1941, p. 44.

dry season, *n.*—The season of the year characterized by scanty rainfall. In the Tropics the seasons are not controlled primarily by temperature as they are in the Temperate Zones, but by precipitation; and there are two seasons, called the wet (or rainy) and the dry. The dry season is, however, seldom wholly rainless.

dry spell, *n.*—1. A period, usually of not less than two weeks duration, during which no measurable rainfall occurs at a certain place or region. When extended into a month or more, a dry spell is considered a DROUGHT, q. v. 2. A period, of not less than four days, during which the daily maximum temperature remains at least 3° to 4° C. above the normal maximum and the relative humidity continues below 50 percent. *See:* H. Landsberg, Physical Climatology, 1941, pp. 171–172.

dry stage, *n.*—*See:* ADIABATIC PROCESS.

dusk, *n.*—That part of morning twilight from complete darkness to the beginning of civil twilight, and that part of evening twilight from the ending of civil twilight to the beginning of complete darkness. *See:* TWILIGHT.

dust, *n.*—Solid material suspended in the atmosphere in the form of small particles, many of them microscopic. It has been estimated that the average total volume of atmospheric dust is roughly equal to that of a cube of about 587 feet on the side. Dust is due to several natural and human sources: volcanic eruptions, salt sea spray, blowing soil, sandstorms, plant pollen and bacteria, smoke and ashes of forest fires; as well as domestic and industrial combustion, exhaust from motors, traffic dust, etc. Dust supplies the condensation nuclei for precipitation, causes haziness and diminution of sunlight, and constitutes a grave health hazard in many industrial localities. *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 197–199; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 587–600; H. Landsberg, Physical Climatology, 1941, pp. 81–84; C. F. Talman, A Book About the Weather, 1931, pp. 19–23.

Dust Bowl, *n.*—A name given early in 1935 to the region in the south-central United States then afflicted with droughts and dust storms. It included parts of five states: Colorado, Kansas, New Mexico, Texas, and Oklahoma. *See:* Public Health Report, No. 50, October 4, 1935, Washington, D. C., p. 1370.

dust counter, *n.*—An instrument for determining the dust content of the air; also called a nucleus counter, because the original form of the instrument, the Aitken dust counter, utilized the principle that dust particles serve as condensation nuclei for water droplets. Hence, when dust-laden air has been cooled to the dew point and the droplets settle on a ruled plate in the instrument, a count of these by the aid of a microscope is an index to the number of dust particles in the sample of air under investigation. Other forms of the dust counter have been devised: those by Owens and by Hill are the two most notable. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 21–23; L. Greenburg, Studies on the Industrial Dust Problem, II, A Review of the Methods used for Sampling Aerial Dust, Reprint No. 1004, Public Health Reports, 1925.

dust devil, *n.*—*See:* DUST WHIRL.

dust storm, *n.*—A strong wind carrying large clouds of dust or sand, common in desert and plain regions; its influence may be felt thousands of miles from the source. "For the development of a widespread dust storm, three factors must contribute: (1) an ample supply of dust and loose soil on the ground, (2) strong enough winds to stir up the dust (in excess of 30 m. p. h. to produce a thick dust) and (3) a steep lapse rate in the dust-carrying air." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 264.) China, the United States, Egypt, the Sahara, the Gobi, and numerous other parts of the world are subject to dust storms. The amounts of material transported by them are enormous: it has been estimated that the dust storms of March 1901, originating in the Sahara, deposited not less than 1,800,000 tons of dust over the continent of Europe and as much more over the Mediterranean. The dust storms and accompanying droughts in the middle United States during the years 1933–1937 approached the character of a national catastrophe. *See:* H. R. Byers, op. cit.; pp. 264–271; C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 24–25; H. Landsberg, Physical Climatology, 1941, pp. 185–188; G. R. Parkinson, Dust Storms over the Great Plains, Bulletin of the American Meteorological Society, vol. 17, 1936, pp. 127–135; C. F. Talman, A Book about the Weather, 1931, pp. 21–22.

dust whirl, *n.*—A rotating column of air, about 100 to 300 feet in height, carrying dust, straw, leaves, and other light material. It has no real relationship to the DUST STORM, q. v. It is best developed on a calm, hot afternoon with clear skies, and in desert regions. Intense surface heating builds up a very steep lapse rate in the lower layers of the air, so that "overturning takes place almost with explosive speed; a small circulation is formed as the surrounding air rushes in toward the first column of rising air that forms, and a more or less violent whirl is created." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 271.) *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 151–155.

dynamic climatology, *n.*—Same as AIR-MASS CLIMATOLOGY, q. v.

dynamic cooling, *n.*—The adiabatic loss of heat by ascending air which, in rising to a region of lower pressure, undergoes expansion, requiring the expenditure of energy and consequently leading to a depletion of internal heat. In the atmosphere, this process is the most effective means of producing precipitation, since air is readily cooled by it to the DEW POINT, q. v., where condensation and eventual precipitation can result.

The reverse process, *dynamic heating*, is the adiabatic addition of heat, by the work done upon air undergoing compression in descending to a level of higher pressure. It is best exemplified by the FOEHN WIND, q. v.

dynamic height, *n.*—The potential energy of a unit mass at a given point above sea level; usually expressed in terms of the DYNAMIC METER, q. v. *See:* GEOPOTENTIAL.

dynamic meter, *n.*—A unit of geopotential, numerically about 2 percent less than the geometric height above sea level in meters, often used instead of linear measure to express the DYNAMIC HEIGHT, q. v., of an equipotential surface. *See:* GEOPOTENTIAL.

dynamic meteorology, *n.*—A branch of meteorology, also known as theoretical meteorology, which seeks to explain, by the application of mathematical physics and the laboratory data of classical physics, "the forces that create and maintain atmospheric motions and the heat transformations associated therewith. Within the field of dynamic meteorology, distinction is often made between *hydrodynamics* which deals with forces and motion and *thermodynamics* which deals with heat. The word *aerodynamics* is reserved for the study of the interaction between air currents and objects, such as airfoils." (S. Petterssen, Introduction to Meteorology, 1941, p. 1.) *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 1.

dynamic trough, *n.*—A barometric trough formed on the lee side of a north-south mountain range when a west wind is blowing; often seen on U. S. weather maps east of the Rocky *Mountains.*

Owing to the principle of the CONSERVATION OF VORTICITY, q. v., the air flowing up the western slope of the range undergoes vertical compression, and acquires anticyclonic curvature. It is thereby turned toward the right, i. e., toward the southeast. Upon passing over the crest of the range, the subsequent downslope motion straightens out its path, but the flow continues toward the southeast for a considerable distance. Then, when the air blows over the level plain on the lee of the mountain, it gradually acquires cyclonic curvature and is turned toward the left, i. e., toward the northeast. A dynamic trough is thus created.

dyne, *n.*—"The absolute, c. g. s. unit of force, defined as that force which, acting upon a free mass of 1 gram, would impart to it an acceleration of 1 cm/sec^2." (L. D. Weld, Glossary of Physics, 1937, p. 59.) *See:* BARYE.

E

e., *abbr.*—1. Abbreviation for WET AIR without rain in the BEAUFORT WEATHER NOTATION, q. v. 2. Symbol for the partial pressure of water vapor. 3. Symbol for the base of the natural or Napierian logarithms.

earth-air current, *n.*—The steady electrical current that flows between the earth and the atmosphere on account of their difference in potential. Its average value for fair weather over the earth is about 2×10^{-16} amperes per square centimeter; a figure which, multiplied by the area of the earth, gives an enormous current. Other forms of earth-air currents occur sporadically. "Lightning occurs over the entire earth at a rate not far from 100 flashes per second, each flash transferring some 10 or 20 coulombs of electricity. Precipitation in all its forms usually carries some electricity with it, often in considerable amounts. Convection currents of air also carry the ions of the atmosphere up or down, producing, in effect, currents." (J. G. Albright, Physical Meteorology, 1939, p. 311.) *See:* ATMOSPHERIC ELECTRICITY.

earth currents, *n.*—Electrical currents circulating within the earth's crust, "differing markedly from place to place and subject both to irregular and spasmodic, and to regular and periodic, variations in intensity and direction. Both the regular variations and the disturbances show a consistent relationship to the changes noted in other cosmic phenomena, notably the earth's magnetic field, the aurora, and solar activity." (W. J. Rooney, Earth-Currents, in Terrestrial Magnetism and Electricity, ed. J. A. Fleming, 1939, p. 270; cf. pp. 270–307.)

earthlight, *n.*—The faint illumination of the dark part of the moon's disk caused by sunlight reflected from the earth's surface and atmosphere; also known as earth shine.

"Spectroscopic observations and photographs in different colors show that earthlight contains a greater percentage of blue light than there is in direct sunlight. This result is not surprising, for a considerable part of the light is selectively reflected by the earth's atmosphere, and in this light the blue of the sky predominates." (R. H. Baker, Astronomy, 3d ed., 1938, p. 109.)

earth shadow, *n.*—1. Shadowy beams projecting upward into an apparently clear atmosphere. This is a familiar Antarctic phenomenon when minute particles of ice are present in the air: the shadows of mountain peaks appear as long tapering dark bars, sometimes curved, in the air. 2. The shadow of the earth in space, which has the form of a cone with its apex pointed away from the sun. An eclipse of the moon occurs when the moon passes into this earth shadow.

earth radiation, *n.*—*See:* NOCTURNAL RADIATION.

earth temperature, *n.*—The temperature of the surface of the earth. Heat is received by direct radiation from the sun, by radiation and conduction from the atmosphere, and by conduction from below; heat is lost by radiation and conduction; the net balance between gain and loss determines the temperature.

The surface soils exhibit diurnal and seasonal changes in temperature. The diurnal changes are not usually noticeable below about 12 inches, but the seasonal changes extend to about 50 feet. Waters from deep springs are perennially cool and reflect the temperature of their sources of invariable temperatures. Their depths are too great to be affected by the atmospheric variations, and also too far from the heated interior to be influenced by it.

earth thermometer, *n.*—*See:* SOIL THERMOMETER.

ebullition, *n.*—The boiling of a liquid; there is a rapid formation of bubbles of saturated vapor in the interior of the liquid, which rise to the surface and escape. *See:* EVAPORATION.

echelon clouds, *n.*—A cloud effect resembling an inverted flight of stairs. The bases of the clouds (which are aligned in a row) are all at the same elevation, but since the clouds are higher than the observer, each successive cloud, as the distance increases, is seen at a lower angle than its predecessor. Thus the whole line of cloud seems to descend away from the observer. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 451.

eclipse wind, *n.*—"A light wind moving from the space traversed by the passing shadow of the moon during a solar eclipse, as if the air under the shadow became somewhat cooled by radiation, and thus developed a faint convectional descent and outflow." (W. M. Davis, Elementary Meteorology, 1894, p. 113.) *See:* W. I. Milham, Meteorology, 1936, p. 180.

ecliptic, *n.*—The great circle of the celestial sphere in which the apparent annual motion of the sun among the fixed stars takes place; it is the intersection of the plane of the earth's orbit with the celestial sphere. The ecliptic is inclined to the celestial equator by approximately 23½°. The zodiac extends 8° on each side of the ecliptic.

ecology, *n.*—The science which deals with the interrelations between climate and plant, animal and human life. Some of the subjects it investigates are: the distribution of flora and fauna, the migrations of birds and certain species of fish, human civilizations in relation to their climatic environments, the onset and spread of disease. *See:* H. Landsberg, Physical Climatology, 1941, pp. 243–248; PHENOLOGY.

eddy, *n.*—The more or less circular motion produced by an obstruction in the path of a moving fluid, such as the wind. Friction at the earth's surface, obstacles such as trees, hills, mountains, buildings—all create innumerable irregular eddies in the atmosphere. They consist of a rotary movement of part of the stream of air about an axis which may be in any direction; and they are highly variable in structure, size, and velocity. The meteorological importance of eddies lies in the fact that they travel with the wind and vertical currents into other layers of the atmosphere, and thus result in a diffusion of various atmospheric properties. *See:* EDDY DIFFUSION, EDDY VISCOSITY.

eddy conductivity, *n.*—The transfer of a physical property, such as heat, by eddies, from one layer to another of a fluid in turbulent motion. Also called eddy convectivity, it is practically the same as AUSTAUSCH, q. v., but differs from EDDY VISCOSITY, q. v., in that the latter concerns the transfer of momentum only, and is based on an analysis of the wind structure. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 248–255.

eddy diffusion, *n.*—Atmospheric mixing brought about by eddy or turbulent motion, in which heat, water vapor, and the momentum of the wind are transported from one layer to another. *See:* G. I. Taylor, Eddy Motion in the Atmosphere, Philosophical Transactions, London, vol. 215, 1915; Phenomena Connected with Turbulence in the Lower Atmosphere, Proceedings of the Royal Society of London, A94, 1918, pp. 137–155; The Transport of Vorticity and Heat Through Fluids in Turbulent Motion, Proceedings of the Royal Society of London, A135, 1932, pp. 685–702.

eddy viscosity, *n.*—In meteorology, the virtual viscosity resulting from eddies within a stream of air, which operate to effect an exchange of mass between the surface layers and the layers of air above, similar to but on a far larger scale than the exchange of molecules in molecular or internal viscosity. The measure of this process, the coefficient of eddy viscosity, is of the order of 10^5 times larger than the coefficient of molecular viscosity. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 196–199, 206–207, 210–212; N. Shaw, Manual of Meteorology, Vol. II, 1928, p. xxv.

effective radiation, *n.*—The difference between the radiant energy received from the sky by any surface and that emitted by the surface due to its own thermal energy. In meteorology, it expresses the net rate at which a body at the surface of the earth loses heat by radiation alone. Although this radiation takes place during the entire 24 hours, it is also called NOCTURNAL RADIATION q. v., as the latter is the radiation from a surface toward space less the radiations from the atmosphere and from celestial bodies. *See:* A. Angstrom, Effective Radiation during the Second International Polar Year, and Radiation of the Atmosphere, Smithsonian Miscellaneous Collection, vol. 65, No. 3.

effective rainfall, *n.*—The portion of the total rainfall which finally reaches streams and rivers. *See:* C. Salter, Rainfall of the British Isles, 1921, pp. 282–288.

effective temperature, *n.*—1. An arbitrary, empirically determined index which unites into a single value the effects of temperature, humidity, and air movement on the degree of warmth or cold felt by the human body, subjected to various combinations of these elements. The value of the effective temperature, which is much used in AIR CONDITIONING, q. v., is numerically equivalent to that of the temperature of still, saturated air which would induce the same feeling of heat or cold. *See:* COMFORT ZONE; J. R. Allen and J. H. Walker, Heating and Air Conditioning, 5th ed., 1939, pp. 296–300. 2. In PHENOLOGY, q. v., the difference in degrees between the prevailing temperature and a certain definite temperature below which a plant will not grow. This latter temperature, "which may be called the 'zero of vital temperature,' varies with different species and may vary with varieties of the same species. It varies also with different functions of the same plant. . . . If the zero temperature is 46°, and the prevailing is 48°, the effective temperature is 2°." (J. W. Smith, Agricultural Meteorology, 1920, p. 67.) 3. The temperature, taken as 5° C., at which plants, especially cereals, begin to develop or vegetate. *See:* U. S. Weather Bureau, Bulletin No. 36, p. 170. 4. In radiation theory, the temperature at which a perfect radiator would emit energy at the same rate as a given radiating body; calculated by STEFAN'S LAW, q. v. The effective temperature of the surface of the sun is about 5760° absolute.

Egnell's law, *n.*—The approximately correct principle that "above any fixed place the velocity of straight or nearly straight winds in the upper half of the troposphere increases with height at roughly the same rate that the density of the air decreases." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 143.) This law, sometimes called Clayton-Egnell's law because it was determined independently by these men, may be mathematically expressed in the form

$$vp = \text{constant}$$

where v is the wind velocity and p is the density of the air.

Ekman spiral, *n.*—A diagrammatic representation of the theoretical change of vector wind velocity with height, from the surface of the earth to the gradient level, about 1,500 feet, where the wind blows parallel to the isobars in the absence of the deviating effect of surface friction. It is a logarithmic curve, formed by plotting the theoretical wind directions and speeds as vectors from a common origin, for regular intervals from the surface to the gradient level, and connecting the end points of the vectors with a smooth curve. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 128–134.

E layer, *n.*—A rarefied and highly ionized stratum of the atmosphere some thirty kilometers thick, its base at about eighty kilometers above the earth's surface, commonly called the Kennelly-Heaviside layer after the men who first proved its existence. "This layer is very highly conductive electrically and is of great importance in radio broadcasting, as it serves to reflect the radio waves back to earth and confine them within the layer, thus making long distance reception possible." (J. G. Albright, Physical Meteorology, 1939, p. 310.) *See:* B. Haurwitz, The Physical State of the Upper Atmosphere, 1941, pp. 20–28.

electric currents, *n.*—For discussions of electric currents in the atmosphere, see ATMOSPHERIC ELECTRICITY and EARTH-AIR CURRENT; for electric currents in the earth's crust, see EARTH CURRENTS

electricity, *n.*—*See:* ATMOSPHERIC ELECTRICITY.

electric storm, *n.*—1. Name sometimes given to a THUNDERSTORM, q. v., on account of its accompanying electrical phenomena. 2. Name applied to an electrical condition which often occurs on the Great Plains of the United States and also on other regions of the earth, in fine weather, without clouds or precipitation, and often with dry, dusty winds. "The air is highly electrified. Light electrical discharges may be seen in the air or may take place through the body. Wire fences and other metallic objects give shocks when touched. Mountain tops, trees, the horns of cattle, and other objects are sometimes tipped with 'balls of fire'." (R. D. Ward, The Climates of the United States, 1925, p. 327.) 3. A sudden and severe change in the normal pattern of the EARTH CURRENTS, q. v., with oscillations of potential, interfering with the magnetic compass, the telephone, and the radio, and usually accompanied by unusual activity of the earth's AURORA, q. v.

electrometer, *n.*—An instrument used to measure electrical potential differences. One form, the Thomson quadrant, is used to study the electrification of the atmosphere; other types are used on shipboard and in balloons. Another common form is the ELECTROSCOPE, q. v.

electroscope, *n.*—An instrument for detecting the presence of an electric charge. A simple form consists of a glass globe or case containing a metal rod at the end of which are attached two pith balls or two leaves of thin gold foil, by the divergence of which the charge and the potential difference may be judged.

element, *n.*—1. Any one of the properties or conditions of the atmosphere which specify its physical state at a given place for any particular period of time. *See:* CLIMATIC ELEMENTS; METEOROLOGICAL ELEMENTS. 2. "The elements": the weather, especially when stormy, as in the expression "The elements are raging." 3. Any chemical constituent of the atmosphere, such as nitrogen, oxygen, water vapor, argon, carbon dioxide, etc. 4. Chemical element: a substance which cannot be separated into constituents other than itself by chemical means, such as iron, mercury, oxygen, etc.

elephanta, *n.*—"A strong southerly or southeasterly wind which blows on the Malabar coast of India during the months of September and October and marks the end of the southwest monsoon." (Admiralty Weather Manual, 1938, p. 214.)

elevation, *n.*—1. The height of any point above mean sea level; distinguished from ALTITUDE, q. v., which usually means height above ground. 2. Station elevation: a definite height above mean sea level adopted for a meteorological station, to which barometric observations are correlated for purposes of record and publication. 3. Actual elevation: the height above mean sea level of the zero point of the barometer of a weather station. *See:* U. S. Weather Bureau, Instrument Division, Barometers and the Measurement of Atmospheric Pressure, Circular F, 7th ed., 1941, pp. 66–68.

Elmo's fire, *n.*—*See:* ST. ELMO'S FIRE.

emagram, *n.*—A THERMODYNAMIC DIAGRAM, q. v., devised by Refsdal, with temperature on a linear scale as abscissa and pressure on a logarithmic scale as ordinate; dry and saturation adiabats and mixing ratio lines are plotted. Equal areas on this chart represent equal amounts of work. The energy available for vertical convection may be determined by measuring the area between a given atmospheric sounding and the path an air parcel will follow in adiabatic ascent. Areas on the diagram where the rising air is warmer than its surroundings are called positive areas, since they represent energy which will assist its ascent; areas where the air is colder are called negative areas, since they represent energy which will retard it. The net energy for producing instability in the process of convection is the algebraic sum of these areas. If the positive areas predominate, the air is likely to become unstable; if the negative are larger, instability and convective activity are unlikely. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, pp. 64–66.

emissary sky, *n.*—A sky of cirrus clouds, either isolated or forming little groups at some distance from each other; one of the first signs of the presence at a distance of a storm, from which the cirrus emanates.

energy diagram, *n.*—*See:* THERMODYNAMIC DIAGRAM.

entropy, *n.*—The name designating the mathematical quantity

$$\phi=\int_{T_0}^{T}\frac{dQ}{T}$$

which, like energy, is a uniquely determined function of the state of a thermodynamic system, and is most helpful in understanding the thermal changes experienced by a substance in a thermodynamic process.

The above expression defines entropy as the integral of the quantity of heat (dQ) involved in a change of state, divided by T, the absolute temperature of the isotherm along which the change takes place. In meteorology, a more useful formula,

$$\phi=c_p \log \theta+\text{constant}$$

states that it is equal to the specific heat of dry air at constant pressure times the logarithm of θ, the POTENTIAL TEMPERATURE, q. v. In other words, the entropy of dry air is proportional to its potential temperature, and a surface of constant potential temperature is also a surface of constant entropy. On such an isentropic surface, so called because the change of entropy is zero, the gain or loss of heat (dQ) is also zero, and a change of state is both isentropic and adiabatic. Hence, by the aid of a conservative air mass property, such as the mixing ratio, which does not change during an adiabatic process as long as the air is unsaturated, an air parcel may be identified and its motion followed on an isentropic surface. These considerations form the background of Isentropic Analysis, q. v. *See:* D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 69–75; Karl K. Darrow, Entropy, Bell Telephone System, Technical Publications, Monograph B–1347, 1942; H. A. Everett, Thermodynamics, 2d ed., 1943, pp. 36–37, 126–133; B. Haurwitz, Dynamic Meteorology, 1941, pp. 62–65; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 43–46; J. Namias, An Introduction to the Study of Air Mass and Isentropic Analysis, 5th ed., rev., 1940, pp. 136–137; N. Shaw, Manual of Meteorology, Vol. II, 1928, pp. xxv–xxvii, 114–122.

eolation, *n.*—A term used in physical geography, meaning the wearing away of land surfaces by wind-driven dust or sand.

eolian, *adj.*—*See:* Aeolian.

equal area map, *n.*—A map drawn so that every square mile in one portion of the map is equal to a square mile in any other portion; however, the shapes of parts of the country represented may be distorted beyond recognition. Equal area maps have been devised by various cartographers. They are useful in climatological studies. *See:* Map Projections; Charles H. Deetz and Oscar S. Adams, Elements of Map Projection, Special Publication No. 38, Coast and Geodetic Survey, 4th ed., 1934, p. 54, 161–163, et al.; W. R. Gregg and I. R. Tannehill, International Standard Projections for Meteorological Charts, Monthly Weather Review, 1937, pp. 411–415.

equation of state, *n.*—*See:* Gas Equation of State.

equation of time, *n.*—The difference between mean solar time and apparent solar time; it is zero, four times a year, about April 15, June 15, August 31, and December 24. Between April 15 and June 15 and between August 31 and December 24, mean time is ahead of apparent time; and between June 15 and August 31 and between December 24 and April 15, mean time is behind apparent time. The equation of time is now usually considered to be the correction, which when added algebraically to mean time, gives apparent time; but in some tabulations, it is given with the opposite sign.

equator, *n.*—1. The terrestrial equator: the great circle on the earth midway between the poles. It is the zero of all measurements of latitude. 2. The celestial equator: the great circle in which the plane of the earth's equator, extended, intersects the celestial sphere.

equatorial air, *n.*—Warm and moist air, originating in equatorial regions. Designated E in the Bergeron classification (*see* Air Mass); its origin over steaming jungles and warm seas gives it high relative humidities even above the surface layers, a tendency toward unstable equilibrium, and convective instability, properties which change little with the seasons or with space. It differs from tropical maritime (*mT*) air in that it lacks the stability aloft characteristic of the latter. "The belt that is occupied by equatorial air coincides with the doldrums, and it moves northward and southward in an annual rhythm as do the subtropical anticyclones." (S. Petterssen, Weather Analysis and Forecasting, 1940, p. 194.)

equatorial calms, *n.*—Same as the DOLDRUMS, q. v.

equatorial front, *n.*—1. The zone of most rapid transition of temperature in the substratosphere. *See:* H. C. Willett, on Dynamic Meterology, in Physics of the Earth, Pt. III, Meteorology, Bulletin of the National Research Council, 1931, p. 229. 2. Name loosely applied to the zone of convergence in the region of the DOLDRUMS, q. v. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 270–271; INTERTROPIC CONVERGENCE.

equideparture, *n.*—Equality of departure from a normal value. Lines or curves of equideparture are called isametrals; they may be drawn on a map, for example, to show areas where the atmospheric pressure is above or below normal by the same amount.

equinoctial, *adj.* and *n.*—Pertaining to the EQUINOX, q. v.; cf. EQUINOCTIAL STORM.

equinoctial rains, *n.*—Rains regularly occurring in the equatorial regions about the time of the equinoxes.

equinoctial storm, *n.*—A rainstorm which, according to long-standing popular belief, is likely to occur in the latter half of September and also of March, the times of the EQUINOXES, q. v. Equinoctial storms or gales, in their early usage, "appear to have referred, mainly if not exclusively, to the autumnal equinox, in point of time, and the North Atlantic and adjacent lands, especially England and New England, in respect to place"; and to have been "extended to include also the vernal equinox, and spread by the emigrant and the traveller to the ends of the earth." (W. J. Humphreys, Rain Making and Other Weather Vagaries, 1926, pp. 138 and 139; cf. pp. 138–140.)

Analysis of weather records, however, fails to substantiate this belief. Rainy weather occurs at the equinoxes, just as it does at any time of the year, depending on the atmospheric conditions; but no physical reason exists why the sun's crossing the equator should be associated with storms. "The reason for a belief in an equinoctial storm is probably the fact that about this time of year the first storms of the winter type, with steadily falling precipitation, make their appearance. They stand in sharp contrast to the summer type with the sultry weather and thundershowers. Storms of the winter type can occur, however, during any month of the summer." (W. I. Milham, Meteorology, 1936, p. 416.) *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 173–174.

equinox, *n.*—1. The moment, occurring twice each year, when the sun, in its apparent annual motion among the fixed stars, crosses the celestial equator; so called because then the night is equal to the day, each being twelve hours long over the whole earth. The autumnal equinox occurs on or about September 22d, when the sun is traveling southward; the vernal equinox on or about March 21st, when it is moving northward. 2. Either of the two points on the ecliptic at which the ecliptic intersects the celestial equator; sometimes called the equinoctial points, they are, more specifically, the autumnal and the vernal equinoxes.

equipluve, *n.*—A line on a rainfall map connecting places having the same value of the pluviometric coefficient, the latter being the ratio, expressed in percent, of the actual mean rainfall in a particular month to a calculated mean rainfall, based on the assumption that *the annual rainfall is evenly distributed throughout the* year. *See:* B. A. Wallis, The Rainfall of the Northeastern United States, Monthly Weather Review, vol. 43, 1915, pp. 11–14.

equipotential surface, *n.*—A surface in any field of force (electrical, magnetic, gravitational, etc.), every point on which has the same potential.

equisubstantial surface, *n.*—An atmospheric surface in which any particular variable quantity has a constant value. *See:* V. Bjerknes, On the Dynamics of the Circular Vortex, Geofysiske Publikationer, vol. 2, 1921, p. 2.

equivalent-potential temperature, *n.*—1. The temperature to which air would come if it were brought adiabatically to the top of the atmosphere (i. e., to zero pressure), so that all its moisture content were condensed and precipitated and the latent heat of condensation given to the air, and then lowered and compressed to a level having the standard pressure of 1,000 mbs. It is the most conservative air mass property: "The equivalent-potential temperature combines the processes involved in the definition of the potential and the equivalent temperature; hence it is independent of any effects due to expansion or compression as well as condensation." (J. Namias, An Introduction to the Study of Air Mass and Isentropic Analysis, 5th ed., 1940, p. 8.)

The equation for the equivalent-potential temperature is

$$\Theta_E = \Theta_d e^{\frac{Lw}{c_p T}}$$

where θ_E is the equivalent-potential temperature, θ_d the partial potential temperature, e the base of the natural logarithms, L the latent heat of condensation, w the mixing ratio, c_p the specific heat of dry air at constant pressure, and T the temperature of the condensation level. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 42–44; B. Haurwitz, Dynamic Meteorology, 1941, pp. 67–69. 2. Name also given to the temperature that air would have if all its water vapor content were condensed out at a constant pressure of 1,000 mbs., which is not exactly the same as the preceding. *See:* J. Namias, op. cit., p. 8, footnote (by R. G. Stone); E. W. Hewson and R. W. Longley, Meteorology, Theoretical and Applied, 1944, pp. 232–234.

equivalent temperature, *n.*—1. Defined by Rossby and most modern authors as the temperature to which air would come if subjected to a pseudoadiabatic process until all its water vapor content had been condensed, and then returned dry-adiabatically to its initial pressure i. e.,

$$T_E = T e^{\frac{Lw}{c_p T}}$$

Where T_E is the equivalent temperature, T the temperature at the condensation level, e the base of natural logarithms, L the latent heat of condensation, w the mixing ratio, and c_p the specific heat of dry air at constant pressure. 2. Used by some writers as the name of a somewhat different quantity, the temperature attained by air if all the water vapor is condensed and the latent heat of condensation so released is given to the air, the whole process taking place at constant pressure, that is,

$$T_e = T_w + \frac{Lx'}{c_p}$$

where T_e is the equivalent temperature, which is usually very nearly the same in value as that defined above, (but may differ appreciably), T_w is the wet-bulb temperature, x' the mixing ratio of saturated air at T_w and L and c_p having the meanings previously given. T_E and T_e differ because in the first, pressure and temperature vary greatly during the process in which the water vapor is condensed, whereas in the latter the process takes place at constant pressure. They would be equal if, in a pseudoadiabatic process, the condensed water all dropped out at T_w. 3. Independently applied, before its introduction in the previous senses, to an index of human comfort defined as the temperature air would have if all the latent heat represented by its water vapor content were used to raise its temperature. It is essentially equivalent to (2) above, but it differs from the EFFECTIVE TEMPERATURE, q. v., the other common quantity used in estimating the degree of human comfort. *See:* Great Britain, Department of Scientific and Industrial Research, Building Research Board, Technical Paper No. 13, The Equivalent Temperature of a Room and its Measurement, London, 1932.

erg, *n.*—"The absolute c. g. s. unit of energy and work, whose length and force factors are the centimeter and the dyne; i. e., the *centimeter dyne.*" (L. D. Weld, Glossary of Physics, 1937, p. 74.)

error, *n.*—In the "theory of measurements," the difference between the true value of a quantity and the observed value. An error may be due to several causes, such as an error of scale, a defect in the instrument, or personal equation. It is, therefore, different from a mistake which is due to the inexperience or carelessness of the observer.

estival, *adj.*—*See:* AESTIVAL.

Espy-Köppen theory, *n.*—An explanation of the diurnal variation of the velocity of the wind, announced, as applied to surface winds, by Espy in 1840, and, as applied to upper winds, by Köppen in 1875. *See:* DIURNAL VARIATION OF THE WIND; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 145–146.

Espy's theory of storms, *n.*—An hypothesis of the origin, development, and movement of the general, or cyclonic storm, proposed by the American meteorologist, James Pollard Espy (1785–1860) in his "Philosophy of Storms," Boston, 1841. Espy believed that a storm's low pressure center is due "to the removal of air from that region by thermal convection, the heat coming in part, at least, from that set free by condensation of water vapor; that this low pressure induces a spiral inflow of air; and that the whole storm is carried forward by the general circulation of the atmosphere." (W. J. Humphreys, Ways of the Weather, 1942, p. 380.) His theory fails to account satisfactorily for the extratropical cyclone, but reasonably well explains the genesis, structure, and progress of the tropical cyclone. *See:* N. Shaw, Manual of Meteorology, Vol. I, 1932, pp. 136, 300–301; Armand N. Spitz, Meteorology in the Franklin Institute, Journal of the Franklin Institute, vol. 237, 1944, pp. 274–287.

etesian, *n., adj.*—The northerly summer wind of the Mediterranean, especially over the Aegean Sea. The etesian winds were well known to the ancient Greeks, who observed their periodic nature, and said that they blew for 40 days beginning with the rising of the Dog Star, Sirius.

Now, records show that they blow intermittently from mid-May to mid-October, having their greatest frequency during July and August. They are dry but refreshing over the southern European countries. In crossing the Mediterranean Sea, they pick up moisture and bring mist and fog to Algeria and Tunis, but moderate the temperatures on the North African Coast.

They are also called by the Turkish name Meltemi. *See:* J. S. Paraskevopoulos, The Etesians, Monthly Weather Review, vol. 50, 1922, pp. 417–422.

Eulerian wind, *n.*—A class of winds, such as tornadoes and tropical cyclones, in which the chief controlling influence to balance the pressure gradient is acceleration (terrestrial rotation and friction being relatively negligible). This type of wind, ordinarily known as the cyclostrophic, was so named by H. Jeffreys in honor of Euler (1707–1785), a Swiss mathematician, who was one of the first to give the equations of fluid motion. *See:* Cyclostrophic Wind; Wind Velocity Equations; also H. Jeffreys, On the Dynamics of Wind, Quarterly Journal of the Royal Meteorological Society, vol. 48, 1922, pp. 29–46; N. Shaw, Manual of Meteorology, Vol. IV, 1931, p. 80.

evaporation, *n.*—1. The process by which a liquid changes to the gaseous state; in meteorology, ordinarily understood to refer to the change of liquid water into water vapor, which process continues, under the proper conditions, until Saturation, q. v., is reached. In the atmosphere, the opposite process, condensation, simultaneously occurs whenever a water surface is exposed to unsaturated air; so that meteorologists really refer to, and measure, the *net* evaporation, that is, the difference between the amount of water that leaves a surface as vapor and the amount that is condensed onto it as water may obviously be positive, zero, or negative. Almost 75 percent of the earth's surface is a water surface, and oceans, lakes, rivers, etc. supply by evaporation the greatest portion of the water vapor in the atmosphere. The rate of evaporation from a free-water surface depends on many factors, but is greatest, in general, with high temperature and low vapor pressure just above the surface. Hence, water evaporates most quickly in hot dry climates. The total yearly amount of evaporation may be greater or smaller than the annual rainfall to widely varying degrees, a fact which is recognized and utilized in studying climates. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 124–128; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 250–259; W. J. Humphreys, Ways of the Weather, 1942, pp. 41, 113–117; H. Landsberg, Physical Climatology, 1941, pp. 136–139; Physics of the Earth, Vol. IX, ed. O. E. Meinzer, 1942, pp. 56–82, 259–330. 2. The quantity of water which is evaporated. *See:* EVAPORATION POWER (2).

evaporation gage, *n.*—Any of the various types of instruments for measuring evaporation; also known as an ATMOMETER or EVAPORIMETER, q. v.

Meteorological observatories usually employ either evaporation tanks, about 6 feet square by 2 feet deep, or evaporation pans. The latter, in the standard form used by the U. S. Weather Bureau, is a galvanized iron pan, cylindrical in shape, 10 inches deep, 4 feet in diameter, kept filled with water to within 2 or 3 inches of the top. With the pan there are (1) the still-well, to provide an unruffled water surface, (2) the level, to keep the top of the still-well horizontal, and (3) the hook gage, to measure the changes in the level of the water in the still-well and thus the amount of water evaporated. Near the pan are provided maximum and minimum thermometers, an anemometer, and a rain gage, to determine the weather conditions that affect evaporation. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 129–131; B. C. Kadel, Instructions for the Installation and Operation of Class "A" Evaporation Stations, U. S. Weather Bureau, Instrument Division, Circular L, 1919, pp. 1–8; S. T. Harding, Evaporation from Free Water Surfaces, in Physics of the Earth, Vol. IX, ed. O. E. Meinzer, 1942, pp. 72–77; W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 114–116.

evaporation hook gage, *n.*—*See:* EVAPORATION GAGE.

evaporation opportunity, *n.*—The ratio of the actual rate of evaporation from a land or water surface in contact with the atmosphere to the EVAPORATIVITY, q. v., under existing atmospheric conditions. This ratio is generally stated as a percentage, and is given by the formula

$$E.\ O. = 100\frac{e}{E}$$

where $E.\ O.$ is the evaporation opportunity, e is the actual evaporation, and E is the evaporativity. This ratio is also known as the relative evaporation. *See:* O. E. Meinzer, Atmospheric Water, Monthly Weather Review, vol. 47, 1919, pp. 809–810.

evaporation pan, *n.*—*See:* EVAPORATION GAGE.

evaporation power, *n.*—1. An index to the degree to which a region is favorable or unfavorable to evaporation. For instance, the evaporation power is greater in the deserts of California than elsewhere in the United States; in general, it is greatest at the Equator and decreases toward either Pole. This term, if referred to unit area exposed parallel to the wind and expressed in the same terms, is equivalent to EVAPORATIVITY or EVAPORATIVE CAPACITY, q. v. 2. Same as EVAPORATION (2), as generally understood. "The actual evaporation from a given water or soil surface is seldom measured, because there does not exist any adequate technique. . . . Therefore, in climatology, instead of actual evaporation the evaporation power is measured. That means the determination of the amount of water that evaporates from an artificially filled reservoir. In other words, this amount of water would evaporate in nature if it were available in the soil or natural water surfaces." (H. Landsberg, Physical Climatology, 1941, p. 31.)

evaporative capacity, *n.*—"The maximum rate of evaporation which can be produced by a given atmospheric environment from a unit area of wet surface exposed parallel with the wind, the surface having at all times a temperature exactly equal to that of the surrounding air." (R. E. Horton, Evaporative Capacity, Monthly Weather Review, vol. 47, 1919, p. 856.) This is essentially the same as EVAPORATIVITY, q. v.

evaporativity, *n.*—The potential rate of evaporation as distinguished from the actual rate; defined as "the rate of evaporation under the existing atmospheric conditions from a surface of water which is chemically pure and has the temperature of the atmosphere. . . . The evaporativity of a given part of the atmosphere depends on several conditions, the most important of which are temperature, *relative humidity*, and barometric pressure." (O. E. Meinzer, Outline and Glossary of Ground Water Hydrology, U. S. Geological Survey, 1919, p. 5.) *See:* EVAPORATION OPPORTUNITY; EVAPORATIVE CAPACITY.

evaporimeter, *n.*—An instrument for measuring the rate of evaporation of water into the atmosphere; also called an ATMOMETER, q. v.

The Piche evaporimeter consists of a glass tube about 9 inches long and ¼ inch internal diameter. The top is hermetically sealed; the lower end is closed by a disk of metal and a spring which holds a disk of porous paper in place. The tube, being filled with water, keeps the paper disk wet with a continuous supply of water to replace whatever is evaporated. The amount of evaporation is measured by the fall of the water in the tube. The supply should be so generous that the small disk of paper is kept wet even in the driest winds. The evaporating surface of the wet paper averages 1.182 square inches.

evaporometer, *n.*—*See:* ATMOMETER.

excessive precipitation, *n.*—Rainfall in which the rate of fall is greater than certain adopted limits, chosen with regard to the normal precipitation (excluding snow) of a given place or area. In the U. S. Weather Bureau, it is defined, for states along the southern Atlantic coast and the Gulf coast, as rainfall in which the depth of precipitation is 0.90 inches at the end of thirty minutes, 1.50 inches at the end of an hour; and, for the rest of the country, as rainfall in which the depth of precipitation at the end of each of the same periods is 0.50 inches and 0.80 inches, respectively. *See:* U. S. Weather Bureau, Division of Climate and Crop Weather, Instructions for Preparing Meteorological Forms, 1940, p. 22.

Exner's barrier theory, *n.*—*See:* Barrier Theory.
exposure, *n.*—1. The location of meteorological instruments with respect to the sun, altitude, and natural and artificial surroundings. Instruments must have a proper exposure so that they will measure the intended element of the weather in a satisfactory and adequate manner. Instructions are given in the U. S. Weather Bureau publications as to the proper exposure of each instrument used. 2. The position or lay of the land with respect to sunlight or winds. In some countries with deep valleys this factor is very important. In Alpine and other mountain valleys there are sunny and shady slopes which present striking contracts in distribution of frosts and fitness for agricultural pursuits. *See:* Adret; Ubac.
exsiccation, *n.*—In climatology, the drying up of an area due to some change which decreases the amount of moisture without reducing the rainfall. Draining a marsh is an example of exsiccation, which should be carefully distinguished from Desiccation, q. v.
extinction, *n.*—The decrease in intensity of radiation from the sun (or any other source) in passing through a medium such as the atmosphere; it is due to scattering, selective absorption, and reflection, not only by suspended particles of any nature in the atmosphere, but also by the molecules of the gases composing the atmosphere.
extinction coefficient, *n.*—A measure of the diminution in intensity of radiation traversing a medium. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 562–563; W. E. K. Middleton, Visibility in Meteorology, 2d ed., rev., 1941, pp. 10–11.
extratropical cyclone, *n.*—A barometric formation of middle and higher latitudes, characterized by an extensive low pressure area around which the winds blow in a counterclockwise direction in the Northern Hemisphere, clockwise in the Southern; it is in general circular or oval in shape, approximately 500–1,000 miles in diameter, causing precipitation, cloudiness, and moderate to strong winds over hundreds of thousands of square miles. It is so named because these formations are a characteristic feature of the weather over most of the earth poleward from 30° north or south latitude, where they occur with an average frequency of about twelve a month.

The extratropical cyclone is born of the conflict in the middle latitudes between southward flowing Polar air and northward moving air from the Tropics. Hence it consists in its mature stage essentially of two parts, the warm sector of tropic air, usually in its southeastern or eastern quadrant, where the weather is relatively warm, humid, and is usually less cloudy and rainy than the remaining part, the cold air on either side of the wedge-shaped warm sector. The rear of the warm sector is separated at the surface from the advancing cold air by the cold front, where the wind shifts, say, from southwest to northwest, the temperature drops abruptly, the pressure rises, and thunderstorms and squalls, or at least convective clouds and turbulence occur. The forward edge of the warm air, from which the cold air is retreating, is the warm frontal surface, sloping up over the cold air, up which the warm air glides, causing considerable cloudiness and precipitation hundreds of miles ahead of the actual low pressure center. As the cyclone develops, the warm sector gradually disappears from the surface, due to the process of occlusion; then its life span is doomed to be short, unless external factors regenerate it.

The following references pertaining to this subject should be consulted for fuller information: Bjerknes Cyclone Model, Cold Front, Cyclone, Cyclone Family, Cyclone Wave, Front, Frontal Surface, Occlusion, Polar Front, Warm Front. *See:* W. J. Humphreys, Ways of the Weather, 1942, pp. 164–166; J. G. Albright, Physical Meteorology, 1939, pp. 279–296; H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 84–99; J. Bjerknes, On the Structure of Moving Cyclones, Geofysiske Publikationer, Vol. I, No. 2, 1919; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 220–235.

extreme, *adj.*—1. Term applied to the highest and the lowest temperatures (or other meteorological element) which had occurred over a very long record for each month and for the year. 2. —*adj., n.* Sometimes applied to the extremes of temperatures in individual months; and again to the average of the highest and the lowest temperatures, as the so-called "mean monthly extremes and mean annual extremes." *See:* J. Hann, Handbook of Climatology, Pt. I, tr. R. D. Ward, 1903, pp. 21, 284.

eye of the storm, *n.*—An area in the center of a tropical cyclone (hurricane), averaging 14 miles in diameter, with no precipitation, very light winds, and sometimes a complete calm and a clear sky.

At sea, however, this area of calm does not mean safety for such ships as may have reached it, for there is a fearful cross sea which breaks over the ships with crushing force.

Another outstanding feature of the eye of the storm is the rise of temperature and fall of humidity; the former may rise 10° or more and the latter may fall as much as 50 percent. The temperature may rise even after nightfall, and is due, it is believed, to descending air, which explains also the lower humidity.

eye of the wind, *n.*—A nautical term meaning the direction from which the wind is blowing. To sail into the wind's eye means to sail to windward.

F

f., *abbr.*—Abbreviation for fog in the Beaufort Weather Notation, q. v.

F., *abbr.*—Abbreviation for Fahrenheit (temperature). Another abbreviation is Fahr. *See:* Fahrenheit; Temperature Scales.

factors of climate, *n.*—*See:* Climatic Factors.

Fah. or **Fahr.,** *abbr.*—Abbreviation for Fahrenheit, q. v.

Fahrenheit, *n.*—The name of one of the most widely used Temperature Scales, q. v. Named after Daniel Gabriel Fahrenheit (1686–1736), a physicist and maker of scientific instruments, who introduced this scale of temperature through his interest in meteorology and was the first to use mercury in a thermometer. Fahrenheit adopted the principles of Roemer's scale, which was based on the boiling point of water for the highest reference point and zero for the lowest point of the scale, the latter being taken as the temperature of a mixture of salt and ice. Roemer divided his scale, between these upper and lower limits, into 60 parts or degrees according to the sexagesimal numeration inherited from Babylonian astronomy; being an astronomer, he naturally adopted 60 divisions for his scale, on which 7½° or 8° was the freezing point and 22½° the body temperature.

Fahrenheit chose the same minimum point as did Roemer, but took body temperature as his highest point. Finding the Roemer degree too large, he subdivided it into four parts, and thus made 90° the body temperature and 32° the freezing point. Later he changed the body temperature to 96° and found the boiling point to be 212°.

The Fahrenheit degree is a convenient size for meteorological observations, since reading to the nearest whole degree is accurate enough for current observations used in forecasting and most climatic studies. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 54–55; C. Abbe, 1888, App. 46 of Annual Report of the Chief Signal Officer for 1887, pp. 24–25; and Carl B. Boyer, A Vestige of Babylonian Influence in Thermometry, Science, May 29, 1942, p. 553.

fair, *adj.*—Used in a general sense to signify fine weather. In a circular letter, dated August 15, 1941, the U. S. Weather Bureau issued the following as a definition of fair as used in weather forecasts: "Hereafter, the word fair as used by the Weather Bureau will mean fine with skies clear or mostly clear in the sense accepted by the public. Fair will mean sunshine by day and moon or stars visible at night. However, if clear skies are indicated, the forecast may also contain mention of sunshine, or use the words 'bright,' 'clear,' 'sunny,' or other language to indicate that there will be sunshine or clear skies."

fair, *v. i.*—Meaning "to clear," when applied to the weather.

fair weather, *adj.*—*See:* FAIR, *adj.*

fall, *n.*—1. When applied to an instrument, a decrease in the reading, as in the expression "the fall of the barometer." 2. A season of the year, also called autumn; in the popular mind it usually includes September, October, and November in the North Temperate Zone; but astronomical autumn is the period from the autumnal equinox about September 22d to the winter solstice about December 21st. *See:* SEASON. 3. Often applied to a snowfall, as in the phrase a "fall of snow," or other form of precipitation. *See:* RAINFALL.

fallwind, *n.*—A cold wind blowing down a mountain slope; warmed adiabatically during its descent, as in the FOEHN, q. v., but still cold relative to the surrounding air. Some well-known examples are the BORA and MISTRAL, q. v., which blow from very cold interior plateaus to comparatively warm, sheltered lowlands. *See:* J. Hann, Handbook of Climatology, Pt. I, General Climatology, tr. R. D. Ward, 1903, pp. 363–365; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 167–169.

false cirrus, *n.*—Cirrus proceeding from a cumulonimbus cloud, and composed of the debris of the upper frozen parts of the cloud; also known as CIRRUS NOTHUS, q. v.

"The name false cirrus is usually given to the fibrous cloud that often spreads out from the summit of thunderheads or forms a flossy scarf around them. Because it occurs below the ordinary level of cirrus this kind of cloud was once thought to consist of water rather than ice, hence the epithet 'false' applied to it. Aviators have, however, inspected it at close range and found it to be true ice cloud." (C. F. Talman, The Realm of the Air, 1931, pp. 40–41.)

Fata Morgana, *n.*—A complex mirage, characterized by marked distortion of images, generally in the vertical, so that such objects as cliffs and cottages are distorted and magnified into castles, and at times even multiplied. Fata Morgana, or Morgan the fairy, was, according to British legends, a half sister of King Arthur, who used the mirage to demonstrate her powers. These mirages have been seen in the Strait of Messina and elsewhere. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 474–475.

fe., *abbr.*—Abbreviation for wet fog in the BEAUFORT WEATHER NOTATION.

Ferrel's law, *n.*—The principle which relates to the deflection of winds by the earth's rotation, an effect of what is now generally known as the CORIOLIS FORCE, q. v.

William Ferrel (1817–1891) was the first to derive a complete quantitative formulation of this effect, from the mathematical theory of fluid motion on the rotating earth. He stated his law in these words: "If a body moves in any direction upon the earth's surface, there is a deflecting force arising from the earth's rotation, which deflects it to the right in the northern hemisphere, but to the left in the southern hemisphere." (A Popular Treatise on the Winds, 1889, p. 78; cf. pp. 77–88.) *See:* E. W. Woolard, Historical Note on the Deflecting Influence of the Rotation of the Earth, Journal of the Franklin Institute, vol. 233, 1942, pp. 465–470.

few, *adj.*—A measure of the amount of cloudiness; it means that less than one-tenth of the sky is covered with clouds.

fg., *abbr.*—Abbreviation for fog over low ground, at an inland station, in the BEAUFORT WEATHER NOTATION, q. v.

fiducial points, *n.*—Points (or lines) of any kind of scale used for reference or comparison. In meteorological thermometry the fiducial points are: 100° C. (or 212° F.), which is the temperature of steam under standard pressure (760 mm.); and 0° C. (or 32° F.), which is the temperature of melting ice.

fiducial temperature, *n.*—The temperature at which, in a specified latitude, the reading of a particular barometer requires no correction (for temperature and latitude).

field, *n.*—A region of space at each point of which a given physical or mathematical quantity has some definite value. Thus, one may speak of a *gravitational* or *magnetic field.* Specifically, in meteorology, the surface distribution of atmospheric pressure constitutes a pressure field over a two-dimensional region of space.

field ice, *n.*—Large floating tracts of ice, encountered in the polar seas.

filling, *n.*—The process, opposite to DEEPENING, q. v., in which the central pressure of a cyclone increases. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, p. 426.

fire hazards, *n.*—Elements of weather, such as lightning, high and dry winds, high temperature, low relative humidity, and spells of dry weather, which contribute to the starting of a fire in nature. Of these, lightning is the only one that can initiate a fire; the other elements are responsible both for ease of starting fires and for spreading them. These hazards apply to cities and farming country as well as to forests and grasslands.

Fire hazards in a forest, other than the weather elements mentioned above, are the quantity of dead material there heaped up (called duff, litter, or forest fuels) and the condition of this material, whether moist or dry. The condition of the living trees and underbrush is also important in this regard. *See:* FIRE WEATHER.

fire weather, *n.*—Weather conditions which are favorable for the starting of fires, particularly in forests. The elements which are given in a report on fire weather include weather, temperature, relative humidity, wind direction and velocity, and visibility, to which are added statements regarding the degree of danger and special advices. *See:* C. F. Talman, A Book About the Weather, 1931, pp. 220–228.

firn (or **firn snow**), *n.*—1. Snow that has become granular and compacted. New firn snow lies with its grains fairly loose, but as it grows old the grains become more and more firmly held together by a cement of ice originating from a film of thaw water surrounding them. Advanced firn snow is the more solid structure. Firn and névé are synonymous. 2. Old snow on top of glaciers, but not yet converted into ice. *See:* G. Seligman, Snow Structure and Ski Fields, 1936, pp. 126, 149–153.

firnification, *n.*—The process by which newly fallen snow is converted into FIRN, q. v.

first law of thermodynamics, *n.*—*See:* THERMODYNAMICS.

flash flood, *n.*—A local flood which rises and subsides rapidly.

flat, *adj.*—Applied to weather maps having very weak pressure gradients and an indifferent, or neutral, pressure distribution.

F layer, *n.*—An ionized region of the atmosphere, some 100 kilometers thick, the base of which is at about 200 kilometers above the earth's surface. It is divided into the lower layer, the F_1, or Appleton layer, and the F_2 layer, at about 300 kilometers elevation. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 310–311; B. Haurwitz, The Physical State of the Upper Atmosphere, 1941, pp. 20–28.

floe, *n.*—A sheet of floating ice; a detached portion of an ice field.

floe berg, *n.*—A mass of floating ice, more or less cohesive in structure, presenting the appearance of a miniature iceberg.

flood, *n.*—A rise of the sea above its normal tidal height, due to storm or volcanic action; a rise of a river or stream above its banks, generally on account of a heavy snowfall or excessive rainfall in the watershed through which it passes, and most frequently in spring. In localities subject to river floods, such as the Mississippi and Ohio Valleys of the United States, an important function of the meteorological service is to forecast the height of the flood waters and the times at which the crest of the flood will pass various points along the river. *See:* C. F. Brooks, Why the Weather?, 1935, pp. 17–18, 60–62; C. F. Talman, A Book About the Weather, 1931, pp. 210–219.

flood stage, *n.*—The elevation, or stage, at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

flurry, *n.*—1. A shower of snow, brief, and accompanied by a gust of wind. One speaks of a "flurry of snow," or "snow flurries." 2. A sudden and brief wind squall. 3. Applied in Canada to an AVALANCHE WIND, q. v., which is called a "wind flurry."

"Remarkable effects are produced by the local cyclone or hurricane induced by the swift avalanches. This sometimes extends for 100 yards outside the course of the solid avalanche and is called the 'flurry' because it is clouded with particles of snow." (From a speech by T. C. Keefer, printed in American Meteorological Journal, vol. 9, 1892, pp. 95–96.)

foehn, *n.*—1. A dry wind with a strong downward component, warm for the season, characteristic of many mountainous regions, notably the Alps, and also the Rockies, where it is known as the CHINOOK, q. v.

When the pressure distribution is such that air flows up over a mountain barrier, it undergoes expansion and cools at the dry adiabatic lapse rate (1° C. per 100 meters) until its temperature has dropped to the dew point. Then condensation occurs, leading to the formation of a cloud (the foehn cloud) above the mountain, and possible precipitation on its windward slope. During the rest of its rise to the top of the range, the rate of cooling is reduced by the latent heat of condensation given to the air, so that its temperature decreases, on the average, 0.6° C. per 100 meters. On the other hand, throughout the whole course of descent on the leeward side of the range, warming (caused by compression) takes place at the dry adiabatic lapse rate. Thus during ascent the air gains heat and loses moisture, and then after descent it arrives on the plain beyond the mountain as a dry, warm wind. For example, if a wind starts up over a mountain 3 kilometers (3,000 meters) high, at an initial temperature of 20° C. and a relative humidity of 60 percent, it will arrive at the base on the other side as a dry air mass with a temperature of approximately 30° C. Thus, especially in winter, the foehn greatly moderates the cold weather, and has an almost magical power to melt snow and ice. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 220–221; V. Conrad, Fundamentals of Physical Climatology, 1942, pp. 82–83; J. Hann, Handbook of Climatology, Pt. I, General Climatology, tr. R. D. Ward, 1903, pp. 344–365; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 93–94. 2. Name sometimes given to all descending air currents, or fallwinds which are warmed by compression; but since fallwinds are still relatively cold and the true foehn is warm, this usage is misleading. *See:* FALLWIND.

foehn cloud, *n.*—A cloud formation on the leeward side of a mountain range over which a foehn wind is passing; also called "foehn wall," and, in parts of North America, a CHINOOK ARCH, q. v.

foehn cyclone, *n.*—A cyclone formed on the east side of a mountain range over which a foehn is blowing, due to the strong temperature contrast, sometimes as much as 50° F., existing between the warm foehn air and the cold air it is displacing. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, pp. 94–95.

foehn wall, *n.*—*See:* FOEHN CLOUD.

fog, *n.*—A cloud formed at the surface of the earth by the condensation of atmospheric water vapor into a multitude of minute water droplets (average diameter about 40 microns) or, less frequently, tiny ice crystals, and interfering to varying degrees with the horizontal visibility at the surface. With the exception of FROST SMOKE, q. v., the different types of fog originate when the temperature and dew point of air having a high moisture content and a supply of hygroscopic condensation nuclei become identical, mainly as the result of surface cooling. The types of fog may be classified as follows:

(a) Air-mass fogs, in which the principal factor of formation is the cooling of the air to its dew point. They consist of three main types, advection fog, radiation fog, and upslope fog. In the first, warm air is transported over cold water: the best example is sea fog, such as occurs off Newfoundland when air from the south blows over the cold waters of the Laborador current. Ground fog, the most common type on the continents, and the high-inversion fog of California, the Arctic, and central or eastern Europe, are both radiation fogs. They occur when moist surface air undergoes strong nocturnal cooling due to the radiative loss of heat by the earth and by the air in the immediate surface layers, where a temperature inversion is formed, especially on clear, calm nights. Upslope fog is formed by the adiabatic cooling of air flowing along a surface of gradually increasing elevation; for example, when a moist easterly wind blows up from the Great Plains of North America to the Rocky Mountains.

(b) Frontal fogs, in which the evaporation of water vapor into the air from falling precipitation, acts to raise the dew point while other factors lower the temperature so that condensation results. For instance, the convergence associated with fronts tends to cause vertical motion and adiabatic cooling of the air. Frontal fogs are subdivided into the prefrontal, front passage, and postfrontal types. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 186–212; B. C. Haynes, Meteorology for Pilots, 1943, pp. 139–149; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 110–135; C. F. Talman, A Book About the Weather, 1931, pp. 47–53; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 269–302; G. I. Taylor, The Formation of Fog and Mist, Quarterly Journal of the Royal Meteorological Society, vol. 43, 1917, pp. 241–268; H. D. Willett, Fog and Haze, Their Causes, Distribution, and Forecasting, Monthly Weather Review, vol. 56, 1928, pp. 435–468.

fog bow, *n.*—Same as BOUGUER'S HALO, q. v.

fog-drip, *n.*—Water dripping to the ground from trees or other objects which have collected moisture from wind-blown fog. The dripping is in some instances as heavy as light rain, as in the case of the redwood trees along the coast of northern California. There are several regions in the world noted for this phenomenon: England, Table Mountain in South Africa, and Ascension Island.

During the almost rainless summers of southern California, fog-drip prevents an excessive aridity that would ruin vegetation. As much as 0.05 inch of water—equivalent to a moderate shower—has been deposited from a California fog in a single night.

It is related of the famous Carol or Holy Tree, on the Island of Ferro in the Canaries, that it supplied the inhabitants with drinking water until it was blown down! *See:* CAMANCHACA; RAIN TREES; GARÚA; C. F. Talman, A Book About the Weather, 1931, pp. 47–49.

fog scale, *n.*—Any of the various classifications of fog intensity, usually in terms of effectiveness in decreasing horizontal visibility. For some of these, *see* Admiralty Weather Manual, 1938, p. 47; Meteorological Glossary, Great Britain Air Ministry Meteorological Office, 3d ed., 1941, p. 86; U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 46.

föhn, *n.*—*See:* FOEHN.

force coefficient, *n.*—In engineering applications of WIND PRESSURE, q. v., "the average force per unit projected area divided by velocity pressure; that is, the ratio of the effective resultant pressure on the total projected area to the velocity pressure." (U. S. Bureau of Standards, Research Paper No. 545, 1933, p. 499.) *See:* VELOCITY PRESSURE.

forecast, *n.*—A prediction of coming weather for a definite period and area. The United States Weather Bureau issues forecasts for the general public four times daily, at 4 a. m. and 10 a. m., and at 4 p. m. and 10 p. m., E. S. T., for periods varying from 36 to 48 hours in advance. The usual elements included in a forecast are (a) weather (that is, FAIR, RAIN, or SNOW, etc.), (b) the temperature (whether warmer or cooler and occasionally, when conditions warrant, the degree of heat or cold expected), and (c) the wind (its character: strong, moderate, variable, etc.). The forecast may be enlarged to warn against any unusual phenomena such as severe winds, heavy snowfall, and cold waves, etc. Special forecasts are also issued for the operation of aircraft at 6-hour intervals for 8-hour periods. The elements forecasted are ceiling, visibility, icing, turbulence, wind direction and velocity at various elevations, amount and elevation of clouds, and unusual phenomena, such as severe local storms. —*v. t.* To predict the weather for a given period and area, usually by extending into the future the weather situation, with anticipated developments, as it is given by the current synoptic weather maps, upper level charts, pressure change charts, and other forecasting tools.

Fortin barometer, *n.*—A portable mercurial barometer, the principal feature of which is the means provided to raise or lower the level of the mercury in the cistern. This is accomplished by a screw operating against the leather bottom of the mercury cistern.

fracto-.—A prefix added to the name of a basic cloud form to indicate a torn, ragged, and scattered appearance caused by strong winds.

fractocumulus, *n.*—A variety of CUMULUS, q. v.; a low, small, scudding, ragged cloud, lacking the clear-cut outlines of ordinary cumulus, generally seen in bad weather under a sheet of altostratus or nimbostratus.

fractostratus, *n.*—A remnant of a broken-up layer of STRATUS, q. v., or a shred-like wispy cloud of independent formation, which may develop into a thin, low layer below a sheet of altostratus or nimbostratus, which may be visible through the interstices of the fractostratus.

"A layer of fractostratus may be distinguished from nimbostratus by its darker appearance, and by being broken up into cloud elements. If these elements have a cumuliform appearance in places the cloud layer is called fractocumulus and not fractostratus." (U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938, p. 10.)

frazil ice, *n.*—Fine spicules of ice found in swiftly flowing streams too turbulent for the formation of sheet ice. The same phenomenon, when found in salt water, is called lolly ice.

Frazil (derived from a French word for cinders, which it resembles) forms in supercooled water when the air temperature is far below freezing. In some cases the number of spicules per cubic foot is very large, and it resembles a mass of snow. Frazil ice may extend to the bottom of the stream and dam its flow, thus causing property damage or stopping water wheels. *See:* H. T. Barnes, Ice Engineering, 1928, pp. 108–138.

free air, *n.*—That portion of the atmosphere not influenced by disturbances due to the presence of terrestrial objects, and out of the range of surface recording instruments. The expression, therefore, ordinarily applies to all levels above 20 meters. The meteorology of the free air is generally called AEROLOGY, q. v.

free lift, *n.*—The actual lifting force of an inflated pilot balloon, expressed in grams. The free lift plus the weight of the balloon is the total lift. *See:* ARCHIMEDES' PRINCIPLE.

freeze, *n.*—The condition which exists when over a widespread area the surface temperature of a whole air mass remains below 0° C. or 32° F. for a sufficient time to constitute the characteristic feature of the weather. It differs from the "dry freeze" or "black frost," purely local freezing due to chilling of the surface air by rapid radiation from a restricted portion of the earth.

freezing point, *n.*—In meteorology, the temperature at which pure water freezes or pure ice melts, i. e., 0° C. or 32° F. In other words, it is the temperature of a mixture of pure water and pure ice, and serves as one of the fiducial points of THERMOMETRY, q. v.

The freezing point of any solvent (such as water) is lowered below its normal value by an amount proportional to the quantity of dissolved substances. Therefore, since bodies of most natural water contain more or less dissolved matter, their freezing points are less than 0° C. or 32° F. For instance, the freezing point of sea water is about −2.0° C. or 28.4° F.

The freezing point of water also varies with pressure. The effect is such that, with an increase of external pressure, the freezing point is lowered, while, with a decrease of external pressure, it is elevated. This effect is, however, small; a decrease of 0.0072° C. occurs for each additional atmosphere of pressure. *See:* FUSION; BOILING POINT.

freezing rain, *n.*—Precipitation in the form of rain, a portion of which freezes and forms a smooth coating of ice (or glaze) upon striking exposed objects. *See:* GLAZE.

frequency, *n.*—1. The time rate of vibration or the number of complete cycles per unit time: in music, it is called the pitch, for example, 16 cycles per second is the note of lowest pitch which can be heard by most people. 2. A term used in climatology to denote the number of times a certain phenomenon of the weather occurs in a given time. Thus, one may speak of the mean frequency of days with precipitation of a certain amount, or the frequency of winds from the different directions.

fresh, *adj.*—1. Applied to air, either indoors or out (usually the latter), which is stimulating and refreshing, and is free from contamination, in contrast to the stale air of poorly ventilated buildings. 2. Applied to a wind which is rather strong for the class to which it belongs. Thus, in the BEAUFORT WIND SCALE, q. v., a fresh breeze has a velocity of 19 to 24 miles per hour, the limiting values for a breeze in general being 4 to 31 miles per hour. In the U. S. Weather Bureau, however, the term is applied to a wind, the velocity of which is between 19 and 31 miles per hour. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1940, p. 57.

freshet, *n.*—1. A flood or overflowing of a stream or river caused by heavy or long-continued rains or melted snow. 2. A stream of fresh water.

friagem, *n.*—An occasional period of cool weather on the middle Amazon in Brazil, lasting 5 or 6 days in May or June, and brought about by the penetration of a relatively cold south wind to this usually uniform equatorial climate. "The temperature may fall about 8° (F.), and the natives shiver and are liable to catch colds owing to even this slight drop from the normal." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 381.)

frigid zone, *n.*—One of the climatic divisions of the earth based on astronomical considerations, rather than on actual climatic conditions. The North Frigid Zone comprises the portion of the earth's surface that lies north of the Arctic Circle; and the south frigid zone, the portion south of the Antarctic Circle. *See:* CLIMATIC CLASSIFICATION.

front, *n.*—1. The line of intersection of a FRONTAL SURFACE, q. v., with a horizontal plane (e. g., the earth's surface); or the line on the earth's surface, or at higher levels, where two different air masses meet. Fronts above the earth's surface are called upper-air cold or warm fronts. *See:* UPPER FRONT. 2. Also taken by some as the boundary surface, or layer, of discontinuity separating two different air masses, which is more properly the FRONTAL SURFACE, q. v.; this use of the term has the merit of convenience but is inexact. When a stream of warm, light tropical air, for example, meets a stream of cold, dense polar air, the two air masses do not simply mix, but are separated by a definite sloping layer of discontinuity, the FRONTAL ZONE, q. v., beneath which the cold air underlies the warm air in the form of a flat wedge. The tropical air is lifted over the polar air, is cooled by expansion, and develops clouds. In this case, the line on the ground, next to the warm air, which marks the boundary is called the front and that side of the sloping layer of discontinuity which faces the warm air is termed the frontal surface.

A warm front is the line of discontinuity at the front of an air mass which is replacing a retreating colder air mass. The slope of a warm frontal surface varies from 1-in-100 to 1-in-300. Its characteristics are cirrus, cirrostratus, altostratus, and altocumulus clouds, and rain. After the passage of the warm front there is an abrupt rise in temperature, a wind shift, and clearing weather.

A cold frontal surface has a steeper slope, ranging from 1-in-25 to 1-in-100. It actively displaces the warm air by underrunning it and forcing it upward and is thus marked by convective type clouds and thunderstorms. The cold front, when the cold frontal surface intersects the surface, is also the well-known WIND-SHIFT LINE, q. v.; and, as it passes, the weather phenomena are an abrupt fall in temperature, a wind shift, and a marked improvement in weather conditions.

An occluded front (or OCCLUSION, q. v.) is formed when the cold front overtakes the warm front of a cyclone; the warm air lying between them is forced upward. Occlusions may be of the warm-front type, in which the air in advance of the front is colder than that behind; the cold-front type, in which the air in advance is the warmer; or of the neutral type, in which the air in advance and the air behind are both approximately the same temperature. *See:* FRONTOGENESIS; FRONTOLYSIS.

frontal, *adj.*—Pertaining to a front, as FRONTAL SURFACE, q. v.

frontal surface, *n.*—The surface of separation between two different and adjacent air masses. Frontal surfaces are not mathematical surfaces, but rather layers or zones of transition; though their thicknesses are so small compared with the size of the adjacent air masses that they may be considered surfaces for all practical purposes. By convention, to provide for unusually broad or diffuse transition zones, the frontal surface has been taken as that side of the frontal zone next to the warmer air. *See:* FRONT; FRONTAL ZONE.

frontal zone, *n.*—The region of transition between two air masses; a sloping layer of the atmosphere, separating air of different temperature, density, or wind velocity, wherein there is a gradual change in the values of such elements.

frontogenesis, *n.*—The creation of a new FRONT, q. v., or regeneration of an old one, which occurs, generally speaking, in a region where there is a large temperature gradient and a converging wind system, combining to bring into close proximity air particles of different temperature, density, and speed and direction of movement. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 147–155; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 238–273.

frontolysis, *n.*—The process by which a front weakens or dissolves, owing to the fact that the air masses it separates have become one homogeneous whole. It is the opposite of FRONTOGENESIS, q. v., and is usually brought about by mixing between the air masses or by horizontal divergence of the wind at the frontal zone, which causes the temperature gradient between the two air masses to become so small that the sharp discontinuity needed to sustain the front disappears. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 265–271.

frost, *n.*—1. A light, feathery deposit of ice caused by the condensation of water vapor, directly in the crystalline form, on terrestrial objects whose temperatures are below freezing, the process being the same as that by which dew is formed, except that the latter occurs only when the temperature of the bedewed object is above freezing. *See:* DEW.

Frost is designated as "light," "heavy," or "killing" by the U. S. Weather Bureau: "light" signifies one which has no destructive effect except to tender plants and vines; "heavy," a copious deposit, but one which does not kill the staple products of the locality; and "killing," one which is destructive to vegetation and staple products. 2. The occurrence of temperatures below freezing; however, in the case of light frost, white frost, or hoarfrost, it is the befrosted objects whose temperature is below freezing while the surrounding air is above freezing. Black frost or hard frost refers to a condition prevailing in late autumn when both air and terrestrial objects have temperatures below freezing. Vegetation is blackened, but hoarfrost does not form. This term is seldom used in the higher latitudes after winter has set in. *See:* DEGREE OF FROST; GLAZED FROST; RIME; GROUND FROST; SILVER FROST; SILVER STORM; SILVER THAW; FROST LINE.

frost heaving, *n.*—The lifting of a surface by the internal action of frost. It generally occurs after a thaw, when the soil is filled with water droplets and when a sudden drop of the temperature below freezing changes the droplets into ice crystals, which involves expansion, and, consequently, causes an upward movement of the soil. Because the moisture is not evenly distributed in the ground, the bulges are irregularly distributed. The same phenomenon may affect a roadway and produce considerable bumpiness.

Frost heaving is identical with frost lifting, which refers to the raising up of plants which, due to the alternate action of frost and thaw, lose their root hold and topple over. Fence posts are similarly uprooted.

frostless zone, *n.*—Same as THERMAL BELT, q. v.

frost line, *n.*—The maximum depth to which the ground becomes frozen; it may be given for a particular winter, for the average of several winters, or for the extreme depth ever reached. In the United States frost penetrates on the average to about an inch in the south up to over 60 inches in Minnesota and Maine; but in very long and cold winters the extreme measurements have been 100 inches in Minnesota and 108 inches in Maine. The frost line reaches deeper and deeper as latitude increases, and finally a northern point is reached where the ground is "everlastingly frozen," which means that it never thaws out completely, but only the surface may melt each spring and summer. In spite of this, however, agriculture is carried on in the thawed-out upper layer of ground. At Yakutsk, Siberia, a boring showed 380 feet of frost penetration, and even then the frost line was not reached. There does exist, however, a point, or zone, below which frost cannot penetrate as the internal heat of the earth prevents it.

frost smoke, *n.*—A thick fog or mist most common in high latitudes, rising from the surface of the sea when the relatively warm water is exposed to an air temperature much below freezing; also called by several other names, sea smoke and frost mist among them.

"In the Arctic regions the rising of clouds of vapor, or steaming, over the open sea has often been observed in the presence of very cold air. The phenomenon is seen best when the sudden opening of a rift in a solidly frozen sea surface exposes water to an atmosphere which has been cooled to an extremely low temperature by radiation over the continuous snow surface. Then the steam may rise in such clouds as to resemble the smoke clouds of a conflagration. This phenomenon is simply due to the fact that the vapor pressure over the relatively warm sea water is so much greater than the saturation pressure in the extremely cold surface air that evaporation takes place at a rate which immediately produces supersaturation, and condensation as steam, or sea smoke fog, exactly as occurs over hot water in an ordinary atmosphere. The fact that this process renders the cold air mass unstable wherever it occurs is shown by the rapidity with which such vapor rises and dissipates. Therefore sea smoke can develop into a dense and persistent fog only under exceptional circumstances." (H. C. Willett, Fog and Haze, Their Causes, Distribution, and Forecasting, Monthly Weather Review, vol. 56, 1928, p. 444.) *See:* Arctic Sea Smoke; Frost Mist; Sea Smoke; Steam Fog.

fumulus, *n.*—A cloud form common to the different types given under Cloud Classification, q. v.

"At all levels, from cirrus to stratus, a very thin veil may form, so delicate that it may be almost invisible. These veils seem to be most frequent on hot days, and in low latitudes. Occasionally they may be observed to thicken rapidly, forming clouds easily visible, especially cirrus and cumulus. The clouds thus produced seem unstable however, and usually melt away soon after their formation." (U. S. Weather Bureau, Codes for Cloud Forms and States of the Sky, Circular S, 1938, p. 13.)

funnel cloud, *n.*—The characteristic tornado cloud which is often shaped like a funnel. This cloud develops in a low cumulonimbus cloud mass, and the small end reaches down towards the earth. *See:* Tornado.

fusion, *n.*—In general, the transition of a substance from the solid to the liquid state, or the melting together of two substances. In meteorology, however, the term is used with reference to the melting of ice, which takes place at the temperature of 0° C. or 32° F. under standard pressure, 760 mm.

If heat is supplied to a mass of ice or snow, the temperature of the mass will rise to the melting point and remain at that point until the entire mass is reduced to a liquid. This indicates that a certain amount of heat is required to change ice to water; it is called the heat of fusion, and the unit is the amount of heat in calories required to melt 1 gram of ice. The latent heat of fusion of ice is about 80 calories per gram. *See:* LATENT HEAT.

G

g., *abbr.*—1. Abbreviation for the acceleration of GRAVITY, q. v. 2. Abbreviation for gloom (=gloomy weather) in the BEAUFORT WEATHER NOTATION, q. v. *See:* GLOOM.

gage (or **gauge**), *n.*—General name for any measuring instrument; often used in combination with a specific term, such as rain gage or snow gage. A barometer is sometimes called a weather gage.

gale, *n.*—In general, a wind with a velocity exceeding 30 miles an hour; the precise limiting velocities vary among the different meteorological services. In both British and American practice, however, it is a wind of force 8 or 9 in the original BEAUFORT WEATHER NOTATION (q. v.), i. e., the velocity is from 39 to 54 miles an hour. The U. S. Weather Bureau calls a wind between 55 and 75 miles an hour a "whole gale"; the British Meteorological Office applies the term "strong gale" to the same range.

garúa, *n.*—A thick, damp fog on the coasts of Ecuador, Peru, and Chile, which, while not amounting to rain, creates a raw, cold atmosphere that may last for weeks in winter along the coast and supplies most of the moisture in the area around Lima. *See:* W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 366; CAMANCHACA.

gas, *n.*—A substance that is in a state "in which the cohesion is so negligibly small that it will diffuse throughout any enclosure in which it is placed; specifically, when the substance is at a temperature above its critical temperature." (L. D. Weld, Glossary of Physics, 1937, p. 89.) A gas, then, has no definite volume of its own, and no free surface. It has many of the properties of a liquid; it exercises pressure, is elastic, viscous, compressible, and expansible.

The physical condition of a gas is completely specified by its pressure, temperature, and density. These three quantities are connected by the GAS EQUATION OF STATE, q. v. Since the atmosphere, composed of several gases and water vapor, may itself be treated as a gas, this equation is of great service in solving many problems of dynamic meteorology. *See:* ATMOSPHERE; CRITICAL STATE; IDEAL GAS; VAPOR.

gas constant, *n.*—The constant in the equation of state for a perfect GAS, q. v.; the characteristic gas constant and the universal gas constant must be distinguished, though both are often denoted by the same symbol, R. The universal gas constant is properly mR, where m, the molecular weight, is always taken to be 1 gram mole; hence the product mR is the same in any given system of units for all gases, and is about 8.315×10^7 ergs per degree per mole. The characteristic gas constant is the quotient of the universal constant by the molecular weight of the given gas. It may be evaluated from measurements of corresponding values of pressure, volume, and temperature of a gas, and (apart from units) depends only on the kind of gas. For dry air, the characteristic gas constant may be taken in c. g. s. units as 2.87×10^6 cm²/sec² per degree. *See:* International Critical Tables, 1926, p. 18.

gas equation of state, *n.*—A relation between the variables that specify the physical state of a gas, which results from combining Boyle's law and Charles' law (*see* GAS LAWS). It may be written

$$p V = R T$$

where p is the pressure, V the volume, and T the absolute temperature of the gas, and R is the universal GAS CONSTANT, q. v. Experiment has shown that the "permanent" gases (excepting water vapor) which compose the earth's atmosphere, over ordinary ranges of pressure and temperature, obey this equation very closely.

gas laws, *n.*—Laws governing, strictly, the behavior of an IDEAL GAS, q. v., but sufficiently valid for the purposes of meteorology when applied to the gases of the atmosphere, with the exception of water vapor, to which, when it is near its liquefying temperature, the gas laws cease to apply. These laws are: (1) Boyle's law (named after its discoverer, Robert Boyle) which states that at a constant temperature the volume of a given mass of gas varies inversely as the pressure; or, that at a constant temperature the product of the volume and pressure of a given mass of gas is constant. This law was discovered independently by Ediné Mariotte, fourteen years after Boyle published it in 1662; hence it is sometimes called Mariotte's law. (2) Charles' law, determined by experiment in 1787, which states that the thermal coefficient of expansion at constant pressure is constant and the same for all gases: that is,

$$V_t = V_o(1 + \alpha_t)$$

where t is the temperature on, say, the centigrade scale, V_t is the volume of the gas at the temperature t, V_o is its volume at 0° C., and α is $1/273$, very closely. Gay-Lussac arrived at the same law in 1802, and so it is often referred to the "law of Charles and Gay-Lussac." *See:* VAN DER WAAL'S EQUATION.

gas thermometer, *n.*—An instrument which uses either the increase in pressure or the increase in volume of a gas when heated to indicate temperature changes. Hence it may be of either of two types, the constant-volume gas thermometer, in which the changing pressure of a fixed mass of vapor in a container of invariable volume is related to the different temperatures; or the constant-pressure gas thermometer, in which the varying volume occupied by a fixed mass of vapor kept at the same pressure is measured at the different levels of temperature. The former is more widely used, and, if hydrogen is the gas used, is considered the most satisfactory of all temperature-measuring devices. *See:* A. W. Duff (ed.), Physics, 8th rev. ed., 1937, pp. 196–201; J. H. Keenan, Thermodynamics, 1941, p. 376; R. B. Lindsay, General Physics, 1940, pp. 166–167.

gegenschein, *n.*—*See:* COUNTERGLOW.

general circulation, *n.*—The average or prevailing large-scale movements of the atmosphere as represented by the yearly means of all available records of surface and upper-air wind velocities, which fit into the average annual pressure patterns. Thus, in general, circulation is the mean condition and, to some extent, an idealized picture of the atmospheric circulation. The actual circulation on individual days includes the modifications and variations due to the migratory cyclones and anticyclones of middle latitudes; on the whole, the general circulation is most apparent in the prevailing westerlies and the trade winds.

Various theories to explain the general circulation have been proposed. Some are given in the literature cited below; the hypothesis proposed by C. G. Rossby is outlined under PRIMARY CIRCULATION, q. v. *See:* V. Bjerknes, On the Dynamics of the Circular Vortex, Geofysicke Publikasjoner, vol. 2, No. 4, 1921; D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 387–417; H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 63–75; A. E. M. Geddes, Meteorology, 2d ed., 1939, pp. 135–144; B. Hauritz, Dynamic Meteorology, 1941, pp. 254–270.

gentle, *adj.*—1. Loosely applied to any light wind without any quantitative significance as to velocity. 2. In the BEAUFORT WIND SCALE, applied to a BREEZE, q. v., 8 to 12 miles per hour in velocity, and denominated by Beaufort number 3. 3. In the U. S. Weather Bureau, a descriptive word for a wind of the same velocity, 8 to 12 miles per hour.

geoid, *n.*—The equipotential surface of gravity which coincides with the mean surface of the oceans of the earth. Under the continents it is the surface to which the waters of the ocean would tend to conform if allowed to flow into very narrow and shallow canals cut through the land. (G. L. Hosmer, Geodesy, 1930, p. 242.) The geoid may be regarded as the true mathematical surface of the earth, as distinguished from the actual physical surface and from the ideal reference ellipsoid.

geopotential, *n.*—The potential energy of unit mass relative to sea level, numerically equal to the work that would be done in lifting the unit mass from sea level to the height at which the mass is located; commonly expressed in terms of the DYNAMIC METER, q. v. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 1–3; Smithsonian Meteorological Tables, 8th rev. ed., 1939, pp. ciii–civ.

geosphere, *n.*—The solid portion of the earth, synonymous with the lithosphere. The liquid portion is called the hydrosphere; and the gaseous, the atmosphere.

geostrophic dividers, *n.*—An instrument, based on the same principles as the GEOSTROPHIC WIND SCALE, q. v., for determining the velocity of the geostrophic wind from the data on a weather map.

geostrophic wind, *n.*—A steady horizontal air motion along straight, parallel isobars in an unchanging pressure field, with gravity the only external force, and in a direction perpendicular to that in which the Coriolis force (due to the earth's rotation) and the pressure gradient force are acting equally and oppositely. The wind velocity resulting from this balance of forces is given by the equation

$$\lambda v = \frac{1}{\rho} \frac{\delta p}{\delta x}$$

where λ is the Coriolis Parameter, q. v., ρ is the density, $\frac{\delta p}{\delta x}$ is the pressure gradient force, and v is the geostrophic wind velocity. The Gradient Wind, q. v., results from identical equilibrium conditions, except that the pressure field is composed of curved isobars; the geostrophic wind is obviously a special case of this more general type of air motion, since it occurs when the radius of curvature of the isobars is infinite, i. e., the isobars are straight lines. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 145–155; H. Jeffreys, On the Dynamics of Wind, Quarterly Journal of the Royal Meteorological Society, vol. 48, 1922, pp. 29–47; On the Dynamics of Geostrophic Winds, Quarterly Journal of the Royal Meteorological Society, vol. 52, 1926, pp. 85–103.

geostrophic wind scale, *n.*—A graphical device by means of which the Geostrophic Wind velocity, q. v., may be conveniently determined from a weather chart. It is usually made of some transparent material, with multiple scales suitable for use at different latitudes. The designer of geostrophic wind scale takes into account (a) the map projection on which the scale is to be used; (b) the isobaric interval to be employed; (c) the density of the air; and (d) the units of velocity desired. *See:* B. C. Haynes, Upper Wind Forecasting, Monthly Weather Review, vol. 66, 1938, pp. 4–6; C. V. Brown, A Design for Geostrophic Wind Scale, Bulletin of the American Meteorological Society, vol. 21, 1940, pp. 178–181; S. Lichtblau, A Design for a Geostrophic Wind Scale, Monthly Weather Review, vol. 65, pp. 109–110.

glacial, *adj.*—Pertaining to a Glacier, q. v.; applied, e. g., to the periods of widespread glacier activity, parts of the so-called ice ages; also to the climatic conditions prevailing in these times. *See:* C. E. P. Brooks, The Evolution of Climate, 2d ed., 1925; Climate Through the Ages, 1926.

glacial anticyclone, *n.*—The semipermanent high pressure area capping either pole of the earth. *See:* W. H. Hobbs, The Glacial Anticyclones, 1926; N. Shaw, Manual of Meteorology, Vol. II, 1928, pp. 255–256.

glacier, *n.*—An extensive, slowly flowing body of ice, formed on land in a cold region where more snow falls than is melted; the snow is transformed into ice by pressure and, together with frozen liquid water, constitutes the body of the glacier. Greenland is covered by a glacier, moving slowly down to the seacoast, where its edges drop off as icebergs; numerous mountain valleys throughout the world, such as the Alps, the Alaskan range, the Himalayas, contain great glaciers. *See:* C. F. Talman, A Book About the Weather, 1931, pp. 101–109.

glacier wind, *n.*—A draft of cold air blowing out from a cave-like opening in the front of a glacier, caused by the density difference between the cold air inside and the relatively warm air without. "Similar winds, blowing out during summer and in during winter, occasionally are found at the mouth of caves, called blowing caverns, on the sides of hills or mountains." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 165.)

glare, *n.*—1. An optical state in the atmosphere in which it is difficult to see because of "the reflection and scattering of light by particles in the line of sight. This glare commonly is reduced by a passing cloud. Also it can be reduced by looking through yellow to reddish glasses since light of this color is not nearly so much scattered by dust as is the blue, for instance." (W. J. Humphreys, Ways of the Weather, 1942, p. 46.) 2. Same as AIR LIGHT, q. v.

glare ice, *n.*—A smooth, bright sheet of ice.

glass, *n.*—A contraction of the nautical term "weather glass" for a mercurial barometer. Sailors use the expression, "The glass is falling," meaning that the atmospheric pressure is decreasing.

glaze, *n.*—A transparent or translucent coating of ice having a smooth glossy appearance. It is formed by the freezing of rain on terrestrial objects. *See:* FREEZING RAIN.

glazed frost, *n.*—In the classification of hydrometeors adopted by the International Meteorological Organization and used by the British Meteorological Office, the name given to GLAZE, q. v. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, p. 40.

globe lightning, *n.*—Same as BALL LIGHTNING, q. v.

gloom, *n.*—In the BEAUFORT WEATHER NOTATION, q. v., the state of the weather "when, owing to dense cloud or smoke accumulation above the surface, daylight is very much reduced without the visibility at the surface being much impaired." (Admiralty Weather Manual, 1938, p. 42.)

glory, *n.*—*See:* BROCKEN BOW.

Gold slide, *n.*—"A special slide rule attached to the barometer and incorporating the attached thermometer, and having scales of temperature, index correction, latitude, and height above sea level. It gives the complete correction and reduction to sea level with sufficient accuracy." (W. E. K. Middleton, Meteorological Instruments, p. 32.) This device, used on many British ships, is named after its inventor. *See:* BAROMETRY.

gradient, *n.*—1. The rate of change in the value of any quantity with distance in any given direction; in practice usually the rate of change in a horizontal or vertical plane, in the direction of the maximum rate of change. The temperature gradient, for example, may be given for a horizontal plane, or for the vertical direction, along a line normal to the isothermal lines or surfaces. The vertical temperature gradient varies greatly and may be positive or negative. When the temperature decreases with elevation, the convention is to call the gradient positive.

Horizontal pressure gradients are usually measured along a direction normal to the isobars, positive toward lower pressures, the reverse of the practices in abstract mathematics. When the isobars are close together, the gradient is said to be steep, and when far apart, the field of pressure is said to be "flat," or the gradient, "weak." 2. In mathematics, the vector ΔF, where F is any function of position.

gradient wind, *n.*—Steady, horizontal, functionless, atmospheric motion in which the wind blows parallel to curved isobars in an unchanging pressure field, and the centrifugal, Coriolis, and pressure-gradient forces balance. The gradient wind velocity is the wind speed attained under these conditions. It does not occur at the earth's surface, due to friction, but is closely realized at a height of, roughly, 1,500 feet. This does not mean that the wind has the same value at all levels above, "but only that above this height the velocity of an approximately steady wind is very nearly the gradient velocity appropriate to the atmospheric density, horizontal pressure gradient, and latitude at the place in question." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 121.)

The GEOSTROPHIC WIND, q. v., is a special case of the gradient wind. *See:* WIND VELOCITY EQUATIONS; D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 187–202; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 101–104; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 205–220.

gram, *n.*—A c. g. s. unit of mass; originally defined as the mass of 1 cubic centimeter of water at 4° C.; but now taken as the one-thousandth part of the standard kilogram, a mass preserved by the International Bureau of Weights and Measures at Sèvres, France. The United States Government possesses two copies which are preserved at the U. S. Bureau of Standards.

gramcalorie, *n.*—*See:* CALORIE.

granular snow, *n.*—In the description of hydrometeors proposed by International Meteorological Organization, "precipitation of white, opaque, snowlike grains, similar to soft hail, but more or less flattened or oblong in shape and generally less than 1 mm. in diameter, at least in one direction. They do not noticeably rebound or disintegrate when falling on hard ground." (S. Petterssen, Weather Analysis and Forecasting, 1940, p. 37.)

graphing board, *n.*—A clipboard holding a number of sheets of graph paper. "It consists of an ordinary clipboard, 14 inches square, on one side of which a metal strip is mounted. The metal strip aids in holding the form in place and acts as a guide for a celluloid triangle, on which wind directions in degrees are graduated. An altitude scale, indicating the assumed height of the balloon at the end of each minute, is also graduated on the metal strip." (Instructions for Making Pilot Balloon Observations, U. S. Weather Bureau, Circular O, 1940, par. 122.)

graupel, *n.*—German name for the hydrometeor called "grésil" in French and "soft hail" in English, and formed by the freezing of water droplets onto a snow crystal falling through a cloud. Graupel looks like little crumbly pellets of snow—miniature snowballs—and ranges in size from that of coarse shot to that of small peas. *See:* C. F. Brooks, Why the Weather?, 2d ed., rev., 1935, pp. 228–229.

gravitation, *n.*—The force with which, according to Newton's hypothesis, any two particles of matter in the universe attract each other; it is directed along the straight line joining the particles, and its magnitude is given by the equation

$$F=K\frac{m_1m_2}{d^2}$$

where m_1 and m_2 are the respective masses of the particles, d^2 is the square of the distance between them, and K is the gravitation constant, approximately equal to $6.67\times10^{-8}\times cm^3g^{-1}sec^{-2}$. *See:* P. R. Heyl and P. Chrzonowski, A New Determination of the Constant of Gravitation, U. S. Bureau of Standards, Research Paper Report 1480, 1942.

gravity, *n.*—The apparent force per unit mass with which the earth attracts bodies near its surface, as measured by the acceleration of a freely falling body relative to the surface of the earth. The direction of this acceleration defines the astronomical vertical. Gravity is the resultant of the gravitational attraction of the earth and the centripetal acceleration of the earth's surface in space due to its axial rotation.

Gravity may be expressed either as an acceleration, e. g., in cm/sec^2, or as the equivalent force, expressed, say, in dynes, that would produce this acceleration. The apparent force W acting on a body of mass m at a point where the acceleration of gravity is g is given by the equation

$$W=mg$$

and is called the weight of the body.

The earth, because of its spheroidal form, does not attract bodies according to the simple law which holds for a sphere; furthermore, the rotational acceleration of the surface of the earth varies with latitude. Accordingly, the acceleration of gravity and the weight of a given mass both vary with latitude at the earth's surface; other small variations also occur because of topographical irregularities and the heterogenous composition of the earth's crust.

Gravity also varies slightly, in both magnitude and direction, with height above sea level. The concept of GEOPOTENTIAL, q. v., has been introduced to take care of this variation when necessary in exact work in dynamic meteorology.

The mathematical form of the relation of gravity to latitude may be derived from physical theory, but the numerical values of the constants must be determined by geodetic gravity surveys. Standard gravity, adopted by the International Committee on Weights and Measures as the "accepted" value to which all measurements involving gravity are to be referred, is 980.665 cm/sec^2. In meteorological work involving the reduction of barometric readings to a common basis for comparison, the value of gravity at sea level and 45° latitude, 980.621 cm/sec^2, is used by the U. S. Weather Bureau. *See:* International Critical Tables, Vol. I, 1926, pp. 37, 395, 401;

Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. xxxviii–xliii.

gravity correction, *n.*—A quantity which must be applied to the readings of all mercurial barometers not located at sea level at 45° north or south latitude where the value of GRAVITY, q. v., is taken as a standard of reference. The correction is made in order to obtain comparable pressure values all over the world, since the height of the mercury column varies with gravity, and gravity in turn varies with elevation and latitude.

gravity wind, *n.*—Same as KATABATIC WIND, q. v.

gray body, *n.*—*See:* GREY BODY.

greasy, *adj.*—Applied to the sky when the weather is threatening, and the sky appears oily and dirty. It is one of the characteristic marks of DAMP HAZE, q. v.

Great Basin high, *n.*—An area of high barometric pressure, centered over the Great Basin region of Nevada, formed by the piling up and stagnation of air owing to the stability of the surface layers and the natural barriers afforded by the topography of the Basin.

green flash, *n.*—A brilliant green coloring of the upper edge of the sun as it is about to disappear at sunset below a distant clear horizon. The green is so vivid that the phenomenon is called the "green flash." It is due to refraction by the atmosphere, which disperses the last spot of light into a spectrum and causes the colors to disappear in the order of refrangibility. The blue and green in the solar light are bent a little farther downward than the orange and yellow, and hence disappear last. The same phenomenon may also be discerned at sunrise, in reverse order—blue, green, orange, and yellow—for the blue and green, being most refrangible, then appear first. *See:* J. G. Albright, Physical Meteorology, 1939, p. 355; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 466–467; N. Shaw, Manual of Meteorology, Vol. III, 1930, pp. 67–68; C. F. Talman, A Book About the Weather, 1931, pp. 137–138.

greenhouse effect, *n.*—The thermal result of the fact that the comparatively short wave length solar radiation penetrates the atmosphere rather freely, only to be largely absorbed near and at the earth's surface, whereas the long wave length terrestrial radiation passes upward with great difficulty. This effect is due to the fact that the absorption bands of water vapor, ozone, and carbon dioxide are more prominent in the wave lengths occupied by terrestrial radiation than in the short wave lengths of solar radiation. Hence the lower atmosphere is almost perfectly transparent to incoming radiation, but partially opaque to outgoing long-wave radiation. *See:* V. Conrad, Fundamentals of Physical Climatology, 1942, p. 11.

green sky, *n.*—A greenish tinge to part of the sky, supposed by seamen to herald wind or rain, and, in some cases, a tropical cyclone. *See:* W. H. Pick, The Significance of a Green Sky, Quarterly Journal of the Royal Meteorological Society, vol. 56, 1930, pp. 350–352; cf. p. 364; and vol. 57, 1931, p. 30.

green sun, *n.*—A phenomenon due to atmospheric conditions such that most of the solar spectrum is absorbed, while the green rays are unaffected. The color of the sun at any time depends on the selective depletion of its rays in traversing the atmosphere. Normally, the sun appears orange, yellow, or red, but a sun of another color, say a blue sun, is possible.

Similarly, a green moon and even a blue moon may be observed at sunset. The necessary conditions are a moon of one-quarter size in the western sky, and atmospheric conditions which cast green or blue colored rays of sunlight up over clouds and mountaintops, illuminating the atmosphere in front of the moon, while the sun sinks below the horizon. *See:* C. M. Smith, Proceedings of the Royal Society of Edinburgh, Vol. XIII, p. 116; Monthly Weather Review, 1906, p. 408.

gregale, *n.*—A strong northeast wind of the central Mediterranean.

grey body, *n.*—A radiating surface which is such that "while its radiation has the same spectral energy distribution, its emissive power is less at any temperature than that of a black body; and such that, while not black, its absorptivity is nonselective." (L. D. Weld, Glossary of Physics, 1937, p. 93.) Like a Black Body, q. v., a grey body does not exist in nature; but both are helpful concepts in studying the problems of radiation.

ground fog, *n.*—A shallow but often dense Fog, q. v. of the radiation type, through which the stars may be observed at night and the sun in daytime. It appears first at the ground and remains there even after it thickens. It is characterized by a temperature inversion whose base is at the ground and whose upper edge is at the top of or above the fog. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 192–194; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 326–332; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 281–286.

ground frost, *n.*—1. A freezing condition injurious to vegetation, which is considered to have occurred when a minimum thermometer exposed to the sky and just above a grass surface records a temperature of 30.4° F. or below. 2. Frozen ground; the depth of frost refers to the depth of permanently frozen ground. *See:* Frost Line.

ground ice, *n.*—1. Ice formed on the bed of a river, lake, or shallow sea where there is a strong current, while the water as a whole remains unfrozen; also known as anchor ice. 2. Bodies of clear ice in more or less permanently frozen ground, such as the ice formed beneath tundra surfaces, or the permanently frozen soil known also as ground frost. Other synonymous terms are: subsoil ice, underground ice, subterranean ice, fossil ice, stone ice. *See:* E. Laffingwell, U. S. Geological Survey, Professional Paper No. 109, 1919, p. 180.

ground inversion, *n.*—An increase of temperature with height in the layer of air just above the earth's surface, which is especially frequent in winter in continental interiors, and which often prevails in the morning after a cold, clear, still night when the earth and the air in contact with it have lost heat by radiation to space, whereas the atmosphere at roughly 1,500 meters has not correspondingly cooled and is hence warmer than the ground.

ground water, *n.*—All water below the land surface, having its origin in the downward seepage of surface water and extending to a layer of impervious material. It is believed impossible for water to percolate farther than six miles below the surface because the pressure at that depth is so great that no pores or crevices can exist. The top of ground water is called the water table, which may vary from the land surface to a certain depth called the permanent water table; it is not level but slopes generally with the impervious layer.

growing season, *n.*—The season which, in general, is warm enough for the growth of plants, the extreme average limits of duration being from the average date of the last killing frost in spring to that of the first killing frost in autumn. On the whole, however, the growing season is confined to that period of the year when the daily means are above 42° F. The length of this season varies, even in the same place, for different plants, for some plants can stand severe frost while others are killed by low temperatures above the frost limit. It may also vary in different places for the same plant; for instance, spring wheat requires 130 to 180 days to mature in the Pacific States and takes only 100 days at Fairbanks, Alaska. *See:* ACCUMULATED TEMPERATURES; DAY DEGREE.

growler, *n.*—An irregular piece of ice detached from an iceberg or floe ice, and very dangerous to ocean vessels; so called because of the sound it makes when rolling in the waves.

Guilbert's rules, *n.*—A system of precepts for weather forecasting, announced in 1905 by Gabriel Guilbert, and based on three fundamental rules, all of which relate to the winds associated with a low. *See:* A. E. M. Geddes, Meteorology, 2d ed., 1939, pp. 365–366; G. Guilbert, Nouvelle Methode de Prévision du Temps, 1909; W. I. Milham, Meteorology, 1936, pp. 386–387.

gust, *n.*—1. A sudden brief increase in the force of the wind of more transient character than a SQUALL, q.v., and followed by a lull or slackening of the wind. All winds near the earth's surface display alternate gusts and lulls. The winds at about 1,000 feet above its surface are comparatively smooth; but at the surface, owing to eddy motions caused by surface objects and to thermal instability from convectional currents, the wind fluctuates greatly in speed: the intensity of gusts increases as these eddy motions and thermal instability increase. All winds, then, at the surface are more or less gusty; the speeds of the gusts may vary from 25 percent to 100 percent of the average velocity, with a frequency of 30 to 40 gusts per hour. Winds are least gusty over water and most gusty over rough country. In all cases gustiness decreases with elevation. 2. The violent wind or squall that accompanies a thunderstorm. 3. A burst or gush of rain.

gustiness, *n.*—The irregularity in the velocity of the wind, caused either by the mechanical effect of surface irregularities, which create eddy currents that disrupt the smooth air flow, or by convection currents due to surface heating. *See:* THERMAL; TURBULENCE; BUMPINESS; GUST.

gustiness factor, *n.*—A measure of the gustiness of the wind. "The small scale variations in wind . . . are indicated very clearly on the records from a pressure tube anemometer. The velocity and direction pens both record a ribbon-like trace caused by continuous and rapid variations following no obvious regularity . . . the width of the trace is an indication of the degree of gustiness, and a 'gustiness factor' may be defined:

$$\text{gustiness factor} = \frac{\text{range of fluctuation in gusts and lulls}}{\text{mean wind}}$$

The range is determined from the highest gusts and lowest lulls over a period, such as an hour, ignoring any very exceptional variation. The factor is conveniently given as a percentage; for example, if the mean wind is 30 miles per hour with gust up to 45 miles per hour and lulls down to 15 per miles per hour, the range is 30 miles per hour, and the factor is 100 percent." (R. C. Sutcliffe, Meteorology for Aviators, 1st American ed., 1940, p. 95.)

H

h., *abbr.*—Abbreviation for hail in the Beaufort Weather Notation, q. v.

haar, *n.*—"A local name in eastern Scotland and parts of eastern England for a kind of wet sea fog which at times invades coastal districts. Haars occur most frequently in summer months." (The Meteorological Glossary, Meteorological Office, London, 3d ed., 1939, p. 103.)

haboob, *n.*—A dense dust or sand storm on the deserts of Egypt and Arabia, or on the plains of India. The dust cloud may rise to 5,000 feet, and the wind may be violent enough to unroof verandas and overturn light streetcars in the towns. This type of storm lasts about 2 hours, and is sometimes followed by heavy rain. In Egypt, it apparently results from a current of relatively cold air undercutting the warm desert air, causing intense convection and the picking up of surface dust and sand, which is hurled about by the turbulent air. Other spellings are haboub, habub, hubbub. *See:* T. J. Sutton, Haboobs, Quarterly Journal of the Royal Meteorological Society, vol. 57, 1931, pp. 143–161.

Hadley's principle, *n.*—An explanation of the trade winds given by George Hadley in 1735, on the basis of the effect of the latitudinal variation in the linear speed of the earth's rotation on air movement. As an explanation of the trade winds, his principle was dynamically incomplete. *See*: N. Shaw, Manual of Meteorology, Vol. I, 1932, pp. 123, 289–290.

hail, *n.*—Precipitation in the form of balls or irregular lumps of ice, snow, and sometimes rime; to be distinguished from Small Hail, q. v.

Hailstones are rarely spherical in shape, usually only roughly so; they are often conical or pyramidal. In size, they vary from very small pellets to large lumps: one which penetrated a tile roof measured 9.8 inches by 5.5 inches by 4.7 inches. It is said that the largest hailstone observed in the United States fell at Potter, Nebr., on July 6, 1928; it measured 17 inches in circumference and weighed 1½ pounds, while many more hailstones occurring in the same storm were as large as grapefruit. "At Cazorla, Spain, on June

15, 1829, houses were crushed under blocks of ice which are said to have weighed four and a half pounds." (C. F. Talman, A Book About the Weather, 1931, p. 79.)

Hail, therefore, is sometimes destructive of human and animal life, because of its excessive size and weight. Ordinary hail is always the scourge of growing plants, especially grapes, olives, tobacco, and hops. It is extremely dangerous to aircraft.

Hail occurs almost exclusively in the front portion of a violent or prolonged thunderstorm, and never occurs when the surface temperature is below freezing. Hence it is a summer rather than a winter phenomenon. Its mode of formation is described under HAILSTONE, q. v. *See*: C. F. Talman, A Book About the Weather, 1931, pp. 75–82.

hail stage, *n.*—The part of the ADIABATIC PROCESS, q. v., which theoretically begins when the ascending air has cooled to 0° C. and its liquid water content has begun to freeze. The temperature is supposed to remain constant at the freezing point, even while the air continues to rise, until all the water has turned into ice. The phenomenon of supercooling, however, shows that the hail stage frequently does not actually take place in nature; and, furthermore, it cannot occur in a pseudo-adiabatic process—one in which the condensed water falls out of the ascending air. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, p. 32; B. Haurwitz, Dynamic Meteorology, 1941, p. 48.

hailstone, *n.*—A single unit of HAIL, q. v., varying in size from that of a pea to that of a grapefruit, and sometimes even larger.

"The process by which the nucleus of the hailstone is formed, and its layer upon layer of snow and ice built up, seems to be as follows: Such drops of rain as the strong updraft within the (thunder) cloud blows into the region of freezing temperatures quickly congeal and also gather coatings of snow and frost. After a time, each incipient hailstone gets into a weaker updraft, for this is always irregular and puffy, or else tumbles to the edge of the ascending column. In either case, it then falls back into the region of liquid drops, where it gathers a layer of water, a portion of which, at once, is frozen by the low temperature of the kernel. But again it meets an upward gust, or falls back where the ascending draft is stronger, and again the cyclic journey from realm of rain to region of snow is begun; and each time—there may be several—the journey is completed, a new layer of ice and a fresh layer of snow are added." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 360–361.) Thus, by the time the hailstone reaches the earth, it has acquired an onion-like structure; though some hailstones fall to the surface as lumps of clear ice, having grown without undergoing a number of vertical excursions. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 251–253; D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 55–56; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1941, pp. 319–320.

hailstorm, *n.*—A storm, generally a severe or prolonged thunderstorm, in which hail occurs. *See:* H. Landsberg, Physical Climatology, 1941, pp. 183–185.

hair hygrograph, *n.*—An instrument for measuring and recording humidity by means of the variations in length of a strand of human hair; when freed from natural oils, hair has the property of increasing in length about 2½ percent of its original length when the relative humidity changes from 0 to 100 percent. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 94–99.

hair hygrometer, *n.*—A device for measuring relative humidity, less frequently used in meteorology than the HAIR HYGROGRAPH, q. v. It generally consists of a frame in which a strand of hair is kept at approximately constant tension, one end being attached to the arm of a pivoted bell crank, the other arm of which is a balanced pointer for indicating the changes in humidity corresponding to changes in the length of the hair.

halo, *n.*—General name of a class of optical meteors, which appear as colored or whitish rings and arcs about the sun or moon, when seen through an ice crystal cloud or in a sky filled with ice crystals; they are due to the refraction of the light which passes through the crystals, and, in the case of the whitish halos, to reflection from their surfaces. A colored halo may be distinguished from a corona by the fact that it has the red nearest the sun or moon, whereas the corona has the red in the outer rings.

Numerous varieties of halos are theoretically possible and many have been observed. By far the most common, however, is the 22° halo or a fragment of it, "a circle of 22° radius, around the sun or moon, red on the inside, followed by yellow and green, to blue on the outside. It is produced by the refraction, by minute six-sided columns of ice, of light that enters one side-face and comes out at the second face beyond, after passing through the crystal in the shortest direction parallel to the face skipped. In this case the direction of the light is changed on passing through the snow crystal by about 22°, the red least and the blue most. When there are myriads of such crystals in the air, pointing in every direction and turning over and over, the sky, whitish from scattered light, is illuminated also with this 22° circle of refracted light." (W. J. Humphreys, Ways of the Weather, 1942, p. 289.)

For some other halo phenomena, refer to PARHELIC CIRCLE, PARHELION, CIRCUMSCRIBED HALO, SUN DOG, SUN CROSS, SUN PILLAR, CIRCUMZENITHAL ARC, ANTHELION, PARANTHELION; HEVELIAN HALO. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 359–363; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 501–536; C. F. Talman, A Book About the Weather, 1931, pp. 110–114; R. W. Wood, Physical Optics, 3d ed., 1934, pp. 394–396; E. W. Woolard; The Geometrical Theory of Halos, Monthly Weather Review, vol. 64, 1936, pp. 321–325; vol. 65, 1937, pp. 4–6, 55–57, 190–192, 301–302; vol. 69, 1941, pp. 260–262.

halcyon days, *n.*—The name given by the ancients to the seven days preceding, and the seven days following, the winter SOLSTICE, q. v. "This phrase, so familiar as expressive of a period of tranquility and happiness, is derived from a fable that, during the period just indicated, while the halcyon bird or kingfisher was breeding, the sea was always calm, and might be navigated in perfect security by the mariner." (R. Chambers, The Book of Days, Vol. I, p. 726.)

harmattan, *n.*—Name given, on the coast of Africa in the region of the Cape Verde Islands and the Gulf of Guinea, to the northeast trade wind, which blows during the dry season (November to March) directly from the Sahara Desert and is exceedingly dry and dusty. It affords comparative comfort, however, when contrasted with the steamy heat of the rainy season, and hence is called the DOCTOR, q. v., for its supposedly healthful properties. *See:* W. G. Kendrew, Climates of the Continents, 3d ed., 1937, p. 41.

haul, *v.*—1. In nautical parlance, to change the course of a ship, especially so as to sail closer to the wind. 2. To change direction: applied to the wind in a sense usually identical with "to BACK," q. v. "A distinction is often made between haul and veer, as said of the wind. Perhaps the more general usage is to say that the wind hauls from north to west (counterclockwise) and veers from north to east (clockwise), but some authorities support the contrary use." (Webster's New International Dictionary, 2d ed., Unabridged, 1939.)

haze, *n.*—Fine dust or salt particles dispersed through the atmosphere, so small that they cannot be felt or distinguished individually by the unaided eye, but which diminish horizontal visibility and give the atmosphere a characteristic hazy and opalescent appearance, casting a uniform bluish or yellowish veil over the landscape and subduing its colors. These colorations serve to distinguish haze from the grayish MIST, q. v., the thickness of which it may sometimes attain.

The U. S. Weather Bureau distinguishes between this kind of obstruction (which it calls DRY HAZE) and DAMP HAZE, q. v. *See:* OPTICAL HAZE; HAZE LINE; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 38–39; U. S. Weather Bureau, Instructions for Airways Meteorological Service, Circular N, 5th ed., 1941, pp. 44, 46.

In international meteorological practice, a condition of atmospheric obscurity, caused by dust and smoke, in which the visibility is more than 1 but less than 2 kilometers.

haze line, *n.*—The boundary in the lower atmosphere between relatively clean and bright air above a temperature inversion caused by surface TURBULENCE, q. v., and dust and smoke-filled air beneath; "smoke, haze, and the lighter dust particles will be carried by turbulence up to the inversion where they will spread laterally under the inversion to form a well-marked haze and smoke line, in the absence of clouds at that level." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 58–59.)

hazy, *adj.*—Term descriptive of a condition of atmospheric obscurity due to haze or some other cause of poor transparency, such as OPTICAL HAZE, q. v.

heat, *n.*—A form of energy, most commonly manifested to the senses by a rise in the temperature of a material body to which heat is being transferred.

For a long time previous to the middle of the 19th century heat was believed to be a kind of elastic fluid penetrating the molecules of matter. This fluid was called "caloric," and was supposed to be indestructible and uncreatable and even imponderable. But this theory could not stand up against the objections proposed by experimental physicists. From the beginning of the 19th century many experiments seemed to show that heat was caused by work done upon a substance, whether solid, liquid, or gas. Boring a hole in iron, stirring a liquid, or compressing a gas; all these processes generate heat. The theory thus arose that such operations caused the ultimate molecules of matter to vibrate faster; and it was eventually established that heat is a form of motion.

Heat is simply the kinetic energy of random motion of the molecules; a mass whose molecules vibrate faster than those of another is the hotter. As a substance grows cooler, the molecular vibration grows less; until finally, with no vibration at all, absolute zero of temperature is reached, and the body has no heat.

Units of heat:—It has been found that it takes the same amount of heat to raise equal masses of a given substance the same number of degrees, to a given point on the temperature scale. The heat required is very nearly the same at all parts of the scale, but there is a small variation; for instance, it takes almost 2 percent more heat to raise the temperature of mercury 1 degree at 0° C. than it does at 80° C.

The amount of heat required to raise a given substance 1 degree is called its SPECIFIC HEAT, q. v. The amount of heat required to raise 1 gram of pure water from 14½° to 15½° C. is called a GRAM CALORIE, or simply a CALORIE, q. v. The specific heat of any other substance is the ratio of its specific heat to that of water. The large calorie, or the kilogram calorie, is 1,000 times the gram calorie. The British thermal unit is the amount of heat required to raise one pound of water 1° F.; it is abbreviated to B. t. u.

Since heat is produced by work, and since heat again may be converted back into work, the gram calorie may be expressed in work units, or vice versa. The mechanical equivalent of heat is the number of ergs in 1 calorie.

One 15° calorie $=4.1852\pm0.0006$ Abs. joules.
One 15° calorie $=4185\times10^4$ ergs.
One joule $=0.2391$ calories $=10^7$ ergs.
One 15° calorie $=0.003965$ B. t. u.

heat balance, *n.*—The equilibrium which exists on the average between the radiation received from the sun and that emitted by the earth. That equilibrium exists is proven by the fact that the earth's temperature is constant; for if it were emitting less radiation than was received, its temperature would rise, and vice versa.

On the average, regions of the earth nearer the Equator than 35° latitude receive more energy from the sun than they are able to reradiate, while latitudes higher than 35° receive less. The excess of heat is carried from the low latitudes to the higher ones by atmospheric and oceanic circulations, and is re-radiated there; thus there exists, in general, a meridional transport of warm air poleward, chiefly at high levels in the atmosphere; and a similar flow of cold air at the surface toward the Equator. The heat balance forms the basis of the general circulation of the atmosphere. *See:* CIRCULATION; GENERAL CIRCULATION; RADIATION; Smithsonian Miscellaneous Collection, vol. 82, No. 3; N. Shaw, Manual of Meteorology, Vol. III, pp. 105–108; D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 126, 154.

heat capacity, *n.*—The quantity of heat, in calories, required to raise the temperature of a body 1 degree. If the body has unit mass, then the heat capacity is the same as its SPECIFIC HEAT, q. v. *See:* THERMAL CAPACITY.

heat equator, *n.*—1. The line connecting places on the earth's surface having the highest mean annual temperatures. This line is generally north of the geographical Equator except over the Atlantic and Pacific Oceans, where for the most part it lies south of equator. The highest mean temperatures determining the heat equator are not uniform around the circuit, but are 5 or more degrees higher on the lands than on the oceans. It is believed that "the true cause of the varying temperature along the heat equator is to be found in the interchange of polar and equatorial waters by the ocean currents, whereby the equatorial ocean is somewhat cooled and the polar oceans are much warmed; while on the lands there is no such interchanging process. The torrid lands are therefore hotter than the ocean of the same latitude; and the lands of high altitudes are colder than seas alongside them. The lands take a temperature proper to their latitude, while the oceans attempt to equalize the temperatures between equator and poles." (W. M. Davis, Elementary Meteorology, 1894, pp. 64–65.) 2. The 10-degree north parallel of latitude which has the highest mean temperature of all the latitude circles, including even the Equator. This parallel is therefore called the thermal or heat equator. *See:* J. Hann, Handbook on Climatology, tr. R. D. Ward, 1903, pp. 200–201.

heat exhaustion, *n.*—A condition of low body temperature and low internal heat production, caused by failure of the body to respond normally to excessively warm weather. It is not the same as HEATSTROKE or SUNSTROKE, q. v. *See:* C. A. Mills, Medical Climatology, 1939, pp. 196–198.

heat laws, *n.*—*See:* THERMODYNAMICS; FUSION.

heat lightning, *n.*—Illumination from distant lightning flashes, generally seen near the horizon, toward or during the evening, often with a clear sky overhead; "usually explained as the reflection from the hazy air of the lightning flashes of storms below the horizon and too distant to be audible. It is called heat lightning because it is characteristic of hot weather when local thunderstorms occur." (C. F. Brooks, Why the Weather?, rev. ed., 1935, p. 127.)

heat of condensation (or **vaporization**), *n.*—The amount of heat given up by a unit mass of a substance when passing from the vapor to the liquid state; or, the amount of heat absorbed by a unit mass of a substance when passing from the liquid to the vapor state, both at constant temperature. The amount is the same in both cases for the same substance at the same temperature.

If water with a free surface at standard pressure is brought to the boiling point, 100° C., it will bubble and gradually pass away as steam; the temperature, however, will remain at 100° C. until all the water is boiled away no matter how much heat is applied. The heat absorbed after the water has attained 100° C. is used in two ways: first, in giving additional energy to the molecules; and secondly, in performing the work of expansion needed to transform the liquid into a gas.

The heat of vaporization of water at 100° C. is about 540 calories per gram. It is greater at lower temperatures. *See:* HEAT OF FUSION; HEAT of SUBLIMATION; LATENT HEAT.

heat of fusion (or **freezing**), *n.*—The amount of heat required to convert unit mass of a solid to its liquid state, at constant temperature; or, the amount of heat given up by 1 gram of a substance in passing from the liquid to the solid state, while the temperature remains constant. For one and the same substance, the two amounts are the same. The heat of fusion of ice (or latent heat) is 79.7 calories per gram. *See:* LATENT HEAT; HEAT OF CONDENSATION.

heat of sublimation, *n.*—The amount of heat used when a solid changes directly to its gaseous state in doing external work (that of expansion) and internal work (that required to increase the molecular velocity). It is customarily measured in calories per gram, and would equal the sum of the heats of fusion and of vaporization if all these processes took place at the same temperature.

heatstroke, *n.*—*See:* SUNSTROKE.

heat units, *n.*—*See:* HEAT.

heat wave, *n.*—A period of abnormally high temperatures, lasting more than a day or so; also known as a hot, or warm wave. The intensity of heat necessary for it to be regarded as a heat wave varies, of course, with the locality, for a spell of weather which would be considered unusually hot in one place might be normal for another in a more equatorward latitude. Furthermore, the relative moisture content plays an important part in determining the intensity of a heat wave; in many instances, it is the excessively high humidity rather than the temperature which makes the weather so uncomfortable. *See:* HEAT EXHAUSTION; COLD WAVE; R. D. Ward, The Climates of the United States, 1925, pp. 383–395.

heaving, *n.*—*See:* FROST HEAVING.

Heaviside layer, *n.*—Same as the Kennelly-Heaviside or the E LAYER, q. v.

height, *n.*—1. Commonly, vertical distance, expressed as so many linear units (e. g., feet or meters) above sea level or above some other specified reference basis. 2. Any measure or index of vertical distance, e. g., DYNAMIC HEIGHT, q. v., expressed in dynamic meters; or the height of an isobaric level expressed in pressure units such as the MILLIBAR, q. v. *See:* N. Shaw, Manual of Meteorology, Vol. II, 1932, pp. xx–xxi. 3. The moment of greatest intensity of a given phenomenon, as in the phrase, "the height of the storm."

heiligenschein, *n.*—A luminous, white corona surrounding and glorifying the shadow of an observer's head cast upon a lawn, meadow, stubble field, or other uneven surface, when the sun is low in the heavens; especially brilliant when the grass or other vegetation is thickly covered with dew. It is caused by the diffraction of sunlight externally reflected from the dewdrops. This phenomenon is sometimes called "Cellini's halo," since it is said to have been first noticed and described by Benvenuto Cellini, who regarded this halo around the shadow of his head as a special mark of divine favor. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 556.

heliograph, *n.*—1. An instrument, used for signaling, which reflects the sun's rays from one station to another by a system of mirrors. 2. A name given in 1840 by Thomas B. Jordan, an instrument maker of Falmouth, England, to an instrument for registering the intensity of solar light. 3. A French sunshine recorder, devised by Dr. J. Dupaigne, which records the duration of sunshine by the action of sunlight on ferro prussiate paper. *See:* J. Dupaigne, A New Heliograph, Scientific American Supplement, vol. 84, Dec. 20, 1917, p. 412.

heliotropic wind, *n.*—The diurnal component of the wind velocity, leading to a diurnal shift of the wind or turning of the wind with the sun.

"The average direction of the wind changes slightly during the day, both over plains and on mountaintops, the tendency being for it always to follow the sun, or, rather, the most heated section of the earth. That is, the wind tends to be east during the forenoon, south (in the northern hemisphere) during the early afternoon, and west during the late afternoon and early evening. This does not mean that at each instant the wind really blows directly from the then warmest region, but that the actual changes through the day in the average hourly wind directions can be accounted for by a velocity component away from that region. The whole sequence results from the thermal expansion of the atmosphere (progressive from east to west), which causes an increase of pressure and consequently an outward flow at all levels above the surface. The area covered is so vast that the time involved, only a few hours, is insufficient for the completion of the convection circuit, so that even the surface winds are away from the most heated regions, as stated, and not toward them, as in sea and land breezes, for instance. The compensating or return current occurs at night, when the component, outside the tropics at least, is from the higher latitudes. In reality the entire phenomenon is only a diurnal surge, a flux and reflux, of the atmosphere due to diurnal heating and cooling." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 146.)

helm, *n.*—1. A local name for a violent wind in Cumberland and Westmoreland, England. 2. A local name for the cloud which forms over a mountaintop before or during a storm in the districts just mentioned.

Hevelian halo, *n.*—A faint white Halo, q. v., also called "the halo of Hevelius," occasionally seen 90° from the sun, and probably caused by the refraction and internal reflection of the sun's light by bipyramidal ice crystals floating in the air. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 528–530.

Hertz's diagram, *n.*—A graph for following the thermodynamic changes taking place in adiabatically ascending moist air, introduced by H. Hertz in 1844. This first adiabatic chart took into account the HAIL STAGE, q. v., omitted on most diagrams. Its abscissa was absolute temperature, the ordinate was pressure, both on a logarithmic scale; a set of lines gave the moisture content in grams per kilogram; three adiabatic stages—dry, rain, and snow—were represented by three diagonals; and the hail stage coincided with the 273° isotherm.

In 1900, Neuhoff modified Hertz's diagram; he retained absolute temperature as the abscissa, but made height the ordinate, and showed pressures as slanting cross lines. He drew the dry and the saturation adiabats as straight and slightly curving lines, respectively. This Hertz-Neuhoff or Neuhoff's diagram has since been modified, but remains the basis of the ADIABATIC CHART and PSEUDO-ADIABATIC CHART, q. v., in common use today. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 34–37; A. E. M. Geddes, Meteorology, 2d ed., 1939, pp. 160–162.

hibernal, *adj.*—Pertaining to winter. Its contrasting term is AESTIVAL, which pertains to summer.

hibernation, *n.*—A state of dormancy, or winter sleep, of many animals; with some, it is very deep, and they can hardly be aroused, while with others it is less deep and even intermittent. This state is induced, it is believed, by the lack of food. Birds do not hibernate. *See:* AESTIVATION.

high, *adj.*—1. A descriptive term in the International System of Cloud Classification. "High clouds" is the name for Family A, comprising cirrus, cirrocumulus, and cirrostratus clouds. *See:* CLOUD CLASSIFICATION. 2. Used as a modifying term in connection with wind, temperature, humidity, and pressure, generally with no exact quantitative significance. —*n.* Synonymous with ANTICYCLONE, q. v.

high pressure area, *n.*—Synonymous with high barometric area, HIGH or ANTICYCLONE, q. v.

hoarfrost, *n.*—Atmospheric moisture deposited through SUBLIMATION, q. v., upon terrestrial objects in the form of ice crystals by the same process which causes dew but at a time when the temperature of the objects is at or below freezing. *See:* DEW; S. Petterssen, Weather Analysis and Forecasting, 1944, p. 40; C. F. Talman, A Book About the Weather, 1931, p. 72.

hodograph, *n.*—In meteorology, a line connecting the end points of the vectors that represent upper wind velocities, derived by computation from a pilot balloon observation, when these vectors are plotted on polar co-ordinate paper.

hole in the air, *n.*—An atmospheric condition, also called an AIR POCKET, q. v., which causes an aircraft to lose altitude, often very suddenly. It is brought about by various conditions: (a) by flying into an area of descending air; (b) by flying into a region where the component of air flow is more nearly in the direction of the flight than it was formerly, or where the wind speed is less. This term, while at one time in common use, does not, of course, describe the real condition of the air where the "hole" appears to be, which was popularly but erroneously supposed to be a more or less vacuous condition.

holosteric barometer, *n.*—Another term for an aneroid barometer. The word aneroid means "containing no liquid"; while the word holosteric means "wholly of solids." *See:* ANEROID.

homobront, *n.*—*See:* ISOBRONT.

homogeneous atmosphere, *n.*—A hypothetical atmosphere in which the density is the same throughout, and the pressure at the surface is the same as that of the actual atmosphere. Such an atmosphere would have an approximate altitude of 8,000 meters. *See:* H. R. Byers, General Meteorology, 1st ed., 1944, pp. 148–150.

horizon, *n.*—1. Astronomical: the great circle on the celestial sphere halfway between zenith and nadir. 2. Geographical: the line where earth and sky appear to meet. 3. Sea horizon: where sky and water appear to meet. The distance to the sea horizon is given by the formula

$$s \text{ (in miles)} = 1.317\sqrt{h \text{ in feet}}$$
$$s \text{ (in kilometers)} = 3.839\sqrt{h \text{ in meters}}$$

where s = distance of horizon from observer, and h = height of eye above sea level.

See: Smithsonian Geographical Tables, 1929, p. lxiii.

horn card, *n.*—A transparent disk, used by sailors, with a diagram representing the average wind directions and barometer falls in tropical cyclones, with the data for northern latitudes on one side and for southern latitudes on the other. It makes clear why the wind remains nearly constant from the same direction, increases, veers, or backs in the storm field. *See:* A Handbook of Weather for Seamen, Meteorological Office 379, London, 1935.

horse latitudes, *n.*—Belts or, more properly, cells of prevailing high pressure, located in the mean at 35° north and south latitude, which migrate north and south with the sun, and are characterized by light variable winds (sometimes gales), and by clear fine weather, due to the descending air. On either side the pressure diminishes, resulting in the prevailing westerlies on the poleward sides, and the trade winds on the equatorial sides.

The explanation usually given for the origin of the name is that vessels in former years, employed in carrying horses to the West Indies, were frequently obliged to throw some of these animals overboard during the periods of distress caused by the continued weather changes, sudden gusts and calms, rains, thunder and lightning, which are characteristic of horse latitude weather. A more reasonable explanation, however, seems to be that the vessels, being so often delayed by the calms, ran short of fresh water and thus the crew had to jettison all or some of the animals.

hot wave, *n.*—*See:* HEAT WAVE.

hot winds, *n.*—Winds characterized by intense heat and extreme dryness. In the United States they are especially frequent in the Great Plains region west of the Mississippi River and to the desert regions of the Southwest. They come during a general hot spell; in narrow bands, ranging from perhaps 100 feet to a half mile or so in width, with intermediate belts, varying from a few yards to a few miles in width, of somewhat less terrific heat between them. They usually last for only a few hours, but may recur in rapid succession in the same general locality. Similar winds occur in other parts of the world also, as in Australia and northern India. *See:* R. D. Ward, The Climates of the United States, 1925, pp. 404–409.

humidity, *n.*—The state of the atmosphere with respect to water vapor content; it may be measured in many different ways. *See:* Absolute Humidity; Dew Point; Mixing Ratio; Relative Humidity; Saturation Deficit; Specific Humidity; Vapor Pressure; Water Vapor.

hurricane, *n.*—1. A tropical cyclone, especially one in the West Indian Region. A cyclone originating in this region and passing northward into the Temperate Zone is often called a "West India hurricane," even after it has assumed the character of an extratropical cyclone. If it is sufficiently severe, it justifies the display of "hurricane warnings" at ports on the east coast of the United States. *See:* Tropical Cyclone; Typhoon. 2. The designation of the highest wind force on the Beaufort Wind Scale, q. v., applied to any wind exceeding 75 miles an hour (or 35 meters per second) in speed.

hydraulics, *n.*—A branch of engineering which comprises the study of the flow of fluids, especially the flow of water in rivers, canals, etc., and which is, therefore, a branch of applied Hydrodynamics, q. v.

hydrodynamics, *n.*—The branch of mechanics which treats of the motions of fluids, and has, therefore, many applications in Dynamic Meteorology, q. v.

hydrogenesis, *n.*—A process of natural condensation of moisture in the air spaces in the surface soil or rock.

"This process is said to be in operation in the desert of Sahara and other places around the Mediterranean Sea, and is supposed to explain the underground water levels for which the rainfall supply seems insufficient." (J. Gottmann, New Facts and Some Reflections on the Sahara, Geographical Review, vol. 32, 1942, p. 658.)

hydrologic cycle, *n.*—This refers to a series of water phenomena or phases, namely: (a) precipitation from clouds falling on sea and land; (b) flow of water from the land to sea as run-off or seepage; (c) evaporation from falling moisture (in all forms) and from all moist surfaces, forming the water vapor of the atmosphere; and (d) condensation of water vapor producing clouds, thus completing the cycle.

hydrology, *n.*—"The science which treats of the phenomena of water in all its states; of the distribution and occurrence of water in the earth's atmosphere, on the earth's surface, and in the soil and rock strata; and of the relation of these phenomena to the life and activities of man." (A. F. Meyer, Elements of Hydrology, 1917.)

hydrometeor, *n.*—Any product from condensation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface.

The following three-fold classification of hydrometeors follows that adopted by the U. S. Weather Bureau in 1938:

I. Liquid water droplets or ice crystals suspended in the air, i. e., not falling from aloft out of clouds:
  1. Damp Haze
  2. Fog—Light, Moderate, Heavy
  3. Ice Fog (Pogonip)
  4. Drifting Snow
  5. Blowing Snow

II. Precipitation: products of condensation which
  (a) Fall more or less continuously or in showers:
  1. Rain
  2. Snow
  3. Rain and Snow, Mixed
  4. Sleet
  (b) Fall almost exclusively in showers:
  5. Snow Pellets
  6. Small Hail
  7. Hail
  (c) Never fall in showers:
  8. Drizzle
  9. Snow Grains
  10. Ice Crystals

III. Water (liquid or solid) deposits on ground objects, formed by condensation, freezing, or sublimation:
  1. Frost
  2. Rime—Hard and Soft
  3. Glaze

These hydrometeors are discussed under the appropriate entries. Differences exist between this classification and that prepared by Tor Bergeron for the International Meteorological Organization in 1937. *See:* T. Bergeron, Hydrometeor-Beschreibungen, International Meteorological Organization, Publication No. 38, Sept. 1937, pp. 45–73; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 37–42; U. S. Weather Bureau, Definitions of Hydrometeors and Other Atmospheric Phenomena, 1943; G. Hellmann, Classification of the Hydrometeors, Monthly Weather Review, vol. 44, 1916, pp. 385–392; vol. 45, 1917, pp. 13–16; C. F. Marvin, Notes and Comments on Classification of Hydrometeors, vol. 45, 1917, pp. 17–18.

hydrometeorology, *n.*—A branch of meteorology treating of the water in the atmosphere, and of precipitation and its after effects such as run-off, floods, etc.

hydrometer, *n.*—1. An instrument used to determine the specific gravity of liquids. 2. The term applied by French scientists, both to instruments which determine specific gravity, and also to instruments which measure rainfall, although pluviomètre is the more common term for this latter class.

hydrosphere, *n.*—1. The water portion of the earth; as distinguished from the solid part which is called the LITHOSPHERE, q. v. 2. In a more inclusive sense, the water vapor in the atmosphere, the sea, the rivers and the ground waters.

hydrostatic equation, *n.*—The equation which describes the dynamical state of the atmosphere when completely at rest relative to the surface of the earth:

$$\frac{1}{\rho}\frac{\partial p}{\partial Z}=-g$$

where ρ=the density; $\frac{\partial p}{\partial Z}$=the rate of change of pressure with height; and g=the acceleration of gravity.

hyetal, *adj.*—Of or pertaining to Rain, q. v.

hyetal coefficient, *n.*—*See:* Pluviometric Coefficient.

hyetal equator, *n.*—A line separating areas whose rainfall follows the seasons of the Northern Hemisphere from those whose rainfall follows the seasons of the Southern Hemisphere. This line lies south of the geographical equator to the east of the continents, and north of it to the west of the continents. *See:* Bartholomew's Physical Atlas, Vol. III, Atlas of Meteorology, ed. A. Buchan, 1899, p. 18.

hyetal regions, *n.*—Areas in terms of which the rainfall of the world may be classified in accordance with some property or measurement of rainfall. For example, a world has been drawn showing hyetal regions based on the seasonal distribution of rainfall. There are five classifications: (1) Constant drought, i. e., no month with six days on which rain falls; (2) Periodic rain, i. e., rainy season in summer, dry season in winter and spring; (3) Rainy season in winter, dry season in summer; (4) Rain at all seasons, with either a summer or a winter and autumn maximum; (5) Constant rain, i. e., no month with less than fifteen days of rain. *See:* Bartholomew's Physical Atlas, Vol. III, Atlas of Meteorology, ed. A. Bucha, 1899, Chart 19.

hyetograph, *n.*—1. A rainfall chart. 2. A form of self-registering Rain Gage, q. v. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 105.

hyetography, *n.*—The science which studies the geographic distribution of rainfall.

hyetology, *n.*—The science which deals with Precipitation, q. v.

hygrodeik, *n.*—A form of hygrometer so arranged that the relative humidity, the dew point, and the absolute humidity may be directly and quickly ascertained. It consists of wet and dry bulb thermometers mounted on opposite edges of a specially designed chart which has intersecting curves; at the top is a swinging index fitted with a sliding pointer, by means of which the values of the above elements may be read from the curves.

hygrogram, *n.*—The record made by a Hygrograph, q. v.

hygrograph, *n.*—An instrument which makes a continuous record of the relative humidity; the almost universal form is the Hair Hygrograph, q. v.

hygrology, *n.*—The science which deals with Humidity, q. v.

hygrometer, *n.*—An instrument which indicates either the relative humidity or, in the case of the dew point hygrometer, the dew point of the air. The various types of hygrometers may be divided into: 1. Those using hygroscopic substances, which respond to the changes in the relative humidity; e. g., the HAIR HYGROMETER, q. v. 2. The dew point hygrometer; see DEW POINT APPARATUS. 3. Absorption hygrometers, chemical (little used in meteorology) and electrical (used in the RADIOSONDE, q. v.). This latter type, based on the variation of the electrical resistance of a film of hygroscopic chemical, is much more responsive to variations in relative humidity at low temperatures than the hair hygrometer. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 88, 94–100–199.

hygrometry, *n.*—The branch of physics which treats of the measurement of the humidity of the atmosphere and other gases.

hygrothermograph, *n.*—A self-recording instrument, combining the registration of both relative humidity and temperature on one record sheet. Different colored inks are used to prevent confusion. The instrument operates in every particular similar to the HYGROGRAPH and the THERMOGRAPH, q. v.

hypsometer, *n.*—"An instrument for measuring the boiling points of liquids, especially for the purpose of estimating elevations above sea level." (L. D. Weld, Glossary of Physics, 1937, p. 106.)

hypsometric formula, *n.*—A formula for either reducing barometric readings to sea level (or other given height) or determining heights by the barometer. *See:* Smithsonian Meteorological Tables, 5th ed., rev., 1939, p. xliv; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 68–75.

hypsometry, *n.*—The science of measuring heights, either above sea level or above any other fixed plane. When a barometer is used as the means of measurement, the term BAROMETRIC HYPSOMETRY, q. v., is applied.

I

ice, *n.*—The solid state of WATER, q. v., which may be attained in the atmosphere either by the freezing of liquid water or by condensation directly from water vapor. Many forms of ice exist in nature: among them are snow, ice spicules, clear ice, frazil ice, anchor ice, glacier and iceberg ice, glaze, and icing on aircraft. As far as known, ice appears in nature only in the crystalline form.

Ice has interesting mechanical properties. Though brittle as rock salt, it may also be bent into a permanent set. On the other hand, it seems perfectly elastic under small stresses. At very low temperatures it loses its usual slippery quality and becomes sticky; under pressure, however, it melts and becomes very slippery, due to the formation of a thin film of water on the surface.

Descriptions of the various kinds of ice are given under the proper headings.

ice age, *n.*—A period of geologic history during which considerable portions of the earth were covered with glacial ice. There have been many ice ages in the geological history of the earth; during some, the ice sheets were situated in the polar regions, but in others they were in equatorial regions. In the last ice age, the Pleistocene, about one-fifth of the earth's surface was glaciated at one time or another, but not all at one time, and the ice sheets did not radiate from the poles in a regular manner. It is believed that at the present time, we are living in the later period of the Pleistocene Ice Age; i. e., the glaciers are still retreating.

iceberg, *n.*—A mass of Land Ice, q. v., which has broken away from its parent formation on the coast, and either floats in the sea or is stranded in the shallows; commonly referred to as berg.

The giant icebergs of the Antarctic may be tens of kilometers wide and up to 100 kilometers long; they may rise 90 meters out of the water, corresponding to a thickness of about 800 meters. They have been mistaken for islands. In the Arctic, icebergs generally lesser in size, originate from glaciers, particularly on Northern Land, Franz Josef's Land, Spitzbergen, and Greenland; the last named produces from ten to fifteen thousand a year, while the glaciers on the first three islands are small and produce only small icebergs. The bergs drift south with the Labrador Current; they "reach farthest south off the Grand Banks of Newfoundland in the months March to June or July, where they represent a serious menace to shipping." (H. U. Sverdrup, Oceanography for Meteorologists, 1942, p. 222; cf. pp. 217–222.)

ice blink, *n.*—The white or yellowish-white glare on the sky produced by the reflection from considerable areas of sea ice.

ice cap, *n.*—A perennial cover of ice and snow over an extensive area of land or sea. There are several ice caps in the world, the most important being those on the Antarctic Continent, on Greenland, and in the Polar Sea which lies to the north of North America and eastern Siberia and extends beyond the Pole. The precipitation on the ice caps is light, but steadily accumulates except for the losses by evaporation and by movement of glaciers out to sea. *See:* Glacial Anticyclones.

ice-cap climate, *n.*—The climate peculiar to an ice-cap region. The data on this climatic type are meager, but in general the mean annual temperatures vary from about −10° F. at the North Pole to about −30° F. in the Antarctic, and freezing weather prevails all the time. The precipitation is light, especially in the interior of the ice caps, where there are practically no storms. Gales occur locally at their margins. *See:* G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 339–341.

ice cave, *n.*—A cave in which ice lasts through the whole or the greater part of the year. The explanation of this phenomenon lies in the fact that in winter the cold (and hence heavy) air flows downward into the cave and displaces the warmer air which rises and flows away. Water enters the cave either by percolation or by flowing in at the top and freezes there. In summer, the warm surface air cannot flow downwards into the caves; hence any slight warming within the cave takes place by the slow process of conduction of heat through the overhead column of air or through the ground, and this process is not in general sufficient to melt the ice.

ice crystals, *n.*—1. The form in which Ice, q. v., always (as far as known) occurs in nature. Five types have been distinguished: hexagonal columns, hexagonal pyramids, hexagonal plates, triangular plates, and twelve-sided plates. Their genesis is the same as that of a raindrop, i. e., condensation upon some sort of a nucleus; and the hexagonal is the usual form, but it is varied by countless patterns of interesting and intricate design. These designs depend, it is believed, on the life history of the crystal, the temperatures and moisture conditions it has experienced. The union of several ice crystals produces a SNOWFLAKE, q. v. 2. A HYDROMETEOR, q. v., which never falls in showers, consisting as it does of tiny unbranched spicules of ice which seem to float in the air. It is distinguished from ICE FOG, q. v., by the greater visibility it permits. Ice crystals often give rise to a SUN PILLAR, q. v., or to other optical phenomena. *See:* U. S. Weather Bureau, Definitions of Hydrometeors and Other Atmospheric Phenomena, 1943, p. 28.

ice flowers, *n.*—1. Formations of ice crystals within a sheet of ice, or on the surface of quiet, slowly freezing water, which assume beautiful, flower-like designs. *See:* E. W. Dorsey, Properties of Ordinary Water Substance, 1940, p. 405. 2. Delicate tufts of hoarfrost or rime that occasionally form in great abundance on surface ice. *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 258–259. 3. Foliated or wire-like forms taken by ice in certain soils, when, upon freezing, it emerges bodily from small cracks in the soil surface. *See:* E. W. Hilgard, Soil, 1907, p. 119.

ice fog, *n.*—A HYDROMETEOR, q. v., which consists of a fog formed of ice spicules, usually under conditions of clear, cold, windless weather. Most frequent in the higher latitudes, it also is known as frost in the air, frozen fog, pogonip, etc.

ice fringe, *n.*—A deposit on objects, not of frost from the water vapor of the atmosphere, but of moisture exuded from the stems of plants and appearing as frosted fringes or ribbons; it is also called an ice ribbon.

"The ice ribbon is produced by the freezing of water that rises, by capillary action, in one or more sap tubes, and comes to the surface mainly, if not wholly, through a row of minute openings. This water comes from the soil directly and not by way of the line roots." (W. J. Humphreys, Ice Ribbons, Scientific Monthly, Nov. 1925, pp. 511–514.)

Icelandic low, *n.*—The semipermanent low pressure area centered over the northern part of the Atlantic Ocean, generally in the vicinity of Iceland. Like the ALEUTIAN LOW, q. v., it is an important CENTER OF ACTION, q. v., for the weather of the middle and high northern latitudes, especially in the winter.

ice needle, *n.*—A thin shaft of ice, also called an ice spicule, which seems to float in the air when rendered visible by sunshine. Cirrus clouds are mostly composed of ice needles. *See:* ICE CRYSTALS.

ice point, *n.*—The temperature, 32° F., 0° C., 273.1° K., at which WATER, q. v., freezes under normal atmospheric pressure, 1,013 millibars.

Ice Pole, *n.*—The center around which ice in the northern latitudes is distributed in a series of concentric belts. "The Ice Pole, or pole of inaccessibility as it is sometimes called, lies in the vicinity of latitude 83° to 85° N. and longitude 170° to 180° W." (E. H. Smith, National Research Council, Physics of the Earth, Vol. V, Oceanography, p. 395.)

ice ribbon, *n.*—*See:* ICE FRINGE.

ice storm, *n.*—A storm characterized by the falling of rain from a relatively warm layer of air aloft to the surface of the earth when the latter is at subfreezing temperatures, and the consequent freezing of the rain as a film of ice on terrestrial objects; also called freezing rain, silver thaw, glaze, and, mistakenly, sleet storm. "Such storms often do great damage by breaking down trees and wires, especially when accompanied by wind; sidewalks, streets, and highways become coated with ice, to the great inconvenience of and serious hazard to pedestrians and motorists. Air traffic, also, may be considerably hindered." (J. G. Albright, Physical Meteorology, 1939, p. 256.) *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 178–180; C. F. Talman, A Book About the Weather, 1931, pp. 83–91.

icicle, *n.*—Ice in the shape of a spearhead, hanging point downward from a roof, rail fence, cliffside, etc., and formed, in sizes ranging from those of finger length to some 3 feet in diameter and 25 feet long, when liquid water from a sheltered source comes into contact with subfreezing air and freezes more or less rapidly as it flows. *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, pp. 268–269.

icing (of aircraft), *n.*—The formation of ice on an aircraft in flight, often to the extreme peril of its occupants; it is caused by the freezing of liquid water droplets which strike the leading edges and exposed surfaces. "There are only two fundamental conditions for ice formation: first, the plane must be flying through visible water in the form of rain or cloud; and second, the temperature of the liquid droplets must be 32° F. or below when they strike the aircraft.

"Ice can form at any temperature below 32° F. and has been observed at temperatures as low as −40° F. The heaviest icing usually occurs in the range from 15° to 32° F." (B. C. Haynes, Meterology for Pilots, 2d ed., 1943, p. 167.) The ice may be any one of three kinds: clear ice or GLAZE, RIME, and FROST, q. v. It weighs down the aircraft, decreases its lift by deforming the airfoil, lowers propeller efficiency, freezes controls, and may even render a motor inoperative by accumulating in the carburetor. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 227–237; B. C. Haynes, op. cit., pp. 167–183; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 361–368; E. J. Minser, Icing of Aircraft, Air Commerce Bulletin, vol. 6, 1934, pp. 144–149, Studies of Synoptic Free-Air Conditions for Icing on Aircraft, Bulletin of the American Meteorological Society, vol. 19, 1938, pp. 111–112; G. C. Simpson, Ice Accretion on Aircraft, Professional Notes, No. 82, London, Meteorological Office, 1937; R. C. Sutcliffe, Meteorology for Aviators, 1940, pp. 138–143; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 313–318.

ideal gas, *n.*—A GAS, q. v., which obeys the general GAS EQUATION OF STATE, q. v., which has constant specific heats, and the internal energy of which is a function of temperature only. No gas existing in nature is an ideal or perfect gas, but many real gases satisfy these three conditions very closely, especially at high temperatures and low pressures, and always satisfy them approximately except when near the liquefying temperature. Air may be considered an ideal gas when the humidity is not too near the saturation value.

illumination climate, *n.*—The climatic element of natural illumination, supplied either directly from the sun or from the sky; also called light climate. The amount of illumination varies from day to day and from season to season, and it is different in the various parts of the world. These changes depend, primarily, on the degrees of absorption of solar radiation by an atmosphere of fluctuating water vapor content, on the quantity of dust and other impurities in the air, on changes in the character of the solar radiation itself, and on the varying distance of a place from the sun according to the time of year.

illuminometer, *n.*—An instrument for measuring the intensity of illumination at any point, i. e., the radiant energy capable of producing visual sensation; synonymous with photometer. *See:* W. E. Forsythe, ed., Measurement of Radiant Energy, 1937, Chap. XII, pp. 389–407.

inclination of the wind, *n.*—The angle that the direction in which the wind is blowing makes with the isobar at the place of observation. On the ocean this angle is usually between 20° and 30°; over land it is somewhat more, as the angle increases with friction, and friction is much more pronounced over land than over water.

incus, *n.*—The anvil-shaped top of a cumulonimbus cloud.

index, *n.*—1. An indicator, usually numerically expressed, of the relation of one phenomenon to another. For an example, see the ZONAL INDEX. 2. A quantity or system of quantities sometimes used in climatology to indicate the character of the weather of a month. "A weather index is a statistical table which shall correctly gauge by a numerical value the weather of the months relative to each other, that is, making allowance for the degree of clemency or inclemency appropriate to each month." (E. M. Nelson, A Numerical Index of the Weather of Each Month, 1910, p. 3.) C. W. Thornthwaite uses numerical indices to indicate PRECIPITATION EFFECTIVENESS, q. v. 3. An indicating part of an instrument. For instance, the IVORY POINT, q. v., of the Fortin barometer is also called the "fixed index point," and the small dumbbell-shaped glass object which marks the point of lowest temperature in a MINIMUM THERMOMETER, q. v., is known as its "index."

Indian summer, *n.*—Any spell of warm, quiet, hazy weather that may occur in October or even in early November; in some years there may be only a few days of such weather or none at all, while in other years there may be one or more extended periods. The term dates back to the 18th century in the United States; there are equivalents of Indian summer in the countries of Europe, but they are there known by other names. *See:* C. F. Brooks, Why the Weather? rev. ed., 1935, pp. 189–191; R. D. Ward, The Climates of the United States, 1925, pp. 395–403.

infiltration, *n.*—In hydrology, the movement of water from the surface into the soil. Infiltration is equal to the total precipitation less the losses due to interception by vegetation, retention in the depressions upon the land surfaces, evaporation from all moist surfaces, and surface run-off.

insolation, *n.*—The rate at which radiant energy is incident directly from the sun per unit horizontal area at any place on or above the surface of the earth. Its value depends upon: (a) the solar constant, (b) the distance of the point from sun, (c) the inclination of the suns' rays to the horizontal plane at the point under consideration, and (d) the transparency of the atmosphere. *See:* W. J. Humphreys, Physics of the Air, 1940, pp. 83–101; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 7–11.

instability, *n.*—A state in which the vertical distribution of temperature is such that an air particle, if given either an upward or a downward impulse, will tend to move away with increasing speed from its original level. (In the case of unsaturated air, the lapse rate for instability will be greater than the dry adiabatic lapse rate; in that of saturated air, greater than the saturated adiabatic lapse rate.) The principal kinds of instability—absolute, conditional, convective, and latent—are each discussed under an individual entry. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 25, 30, 41–42; B. Haurwitz, Dynamic Meteorology, 1941, pp. 20–26; 56–57; 76–78; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 236–247; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 50–110.

instability shower, *n.*—Rainfall, brief and intermittent, "caused by steepening of the lapse rate in any way, such as the rapid warming of the lower layers of a cold current as it moves over a relatively warm surface. In most cases there is an appreciable addition of moisture to the lower layers, as, for example, when a polar continental current moves over a body of warm water." (R. G. Stone, ed., An Introduction to the Study of Air Mass and Isentropic Analysis, 5th ed., 1940, p. 229.)

instrumental (or **scale**) **error,** *n.*—In general, an error in the reading of an instrument that is due to one or more imperfections of the instrument, including those of the graduations on its scale. In the U. S. Weather Bureau, it is the practice to combine all these errors into one correction in the case of the barometer and its scale. *See:* U. S. Weather Bureau, Instrument Division, Barometers and the Measurement of Atmospheric Pressure, Circular F, 7th ed., rev., 1941, pp. 16–17.

instrument shelter, *n.*—In the United States, a structure with louvered sides and a double roof for ventilation, in which thermometers and other instruments may be exposed. It is called a thermometer screen in England. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, pp. 144–145, and 176.

interception, *n.*—The process by which trees, underbrush, standing crops, and other objects prevent a certain amount of rainfall from reaching the soil. The amount varies from 40 to close to 100 percent, the latter in the case of a gentle shower. Interception is a factor in lessening danger from floods. *See:* R. E. Horton, Rainfall Interception, Monthly Weather Review, vol. 47, 1919, pp. 603–623.

interceptometer, *n.*—A rain-collecting device placed under a tree or amid brush and crops, the catch of which is compared with that of a rain gage set in the open, in order to determine the amount of rainfall loss by INTERCEPTION, q. v.

interglacial period, *n.*—Any one of the intervals between successive advances of the ice sheets during a given ice age, as e. g., the Pleistocene; also known as an interglacial stage. *See:* C. E. P. Brooks, The Evolution of Climate, 1925, pp. 32, 41, 48; A. P. Coleman, Ice Ages, Recent and Ancient, 1926, pp. 23, 38, 70, 71; W. B. Wright, The Quaternary Ice Age, 1937, pp. 180, 181.

international index numbers, *n.*—The numbers agreed upon by an international committee to designate meteorological stations. They were originally intended to indicate the names of stations in telegraphic and radio reports and messages, but are now also used on maps. In North America, numbers from 0 to 999 have been assigned according to an agreed-upon system.

international temperature scale, *n.*—A thermometric scale conforming very closely with the thermodynamic scale, "designed to be definite, conveniently and accurately reproducible, and to provide means for uniquely determining any temperature within the range of the scale, thus promoting uniformity in numerical statements of temperature." (Smithsonian Physical Tables, 8th rev. ed., 1934, p. 239.) See this work for a table listing the basic fixed points of the scale and the values assigned to them.

intertropic convergence zone, *n.*—The region of the frontal discontinuity which develops when an outbreak of cold air penetrates the DOLDRUMS, q. v., and replaces this calm belt by a relatively narrow zone of violent interaction with the equatorial air, along which the most severe weather of the tropics is to be found: overcast skies, strong squalls, heavy rains, and severe local thunderstorms. It is not as well-developed on land as over the oceans; in the Northern Hemisphere in summer it lies at about 10° N. lat., while in winter it is found at roughly 5° N. lat. in the Atlantic and Pacific Oceans, at approximately 10° S. lat. in the Indian Ocean, and close to 20° S. lat. eastward of Australia. It is strongest in late summer and late winter, when the two hemispheres have the maximum difference in temperature. The equatorial front and the intertropical front are other names for this zone. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 254–255; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 270–271.

inversion, *n.*—1. The condition which exists in the atmosphere when the temperature increases rather than decreases with height through a layer of air. An inversion at the earth's surface is due most commonly to radiational cooling of the lower levels, which does not affect the air above. In the free air, an inversion exists obviously when a warmer air mass overlies a colder one: this is called a frontal inversion. A Subsidence Inversion, q. v., is frequently found in anticyclones. Turbulence, q. v., produces an inversion by establishing dry adiabatic lapse rate in the turbulent layer, the top of which becomes colder than the calmer air above. The term "upper inversion" is sometimes applied to the change in lapse rate encountered at the base of the Stratosphere, q. v. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 56–60; W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 50; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 100–101. 2. A decrease in the moisture content with height through a layer of the atmosphere; called a dry or a minimum inversion. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 38–39; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 405.

inversion of rainfall, *n.*—The phenomenon observed in mountainous regions, where the amount of rainfall increases up to a certain level and then decreases. Since rain evaporates while falling, it is most abundant just below the cloud base. Therefore, in hilly country, the rainfall is usually more abundant on the slopes than in the valleys. However, in the case of mountains which reach above the level where rain clouds mostly form, their summits will have less precipitation. *See:* W. G. Kendrew, Climate, 1930, pp. 235–236.

ion, *n.*—An atom or molecule which has a smaller or greater number of electrons than in its normal electrically neutral state.

In the air there are always some molecules which have either gained or lost one or more electrons. When a layer of air contains ions, it is said to be ionized. In this state it becomes a conductor of electricity. *See:* International Critical Tables, Vol. VI, 1929, p. 110; W. J. Humphreys, Physics of the Air, 1940, pp. 402–3; Ionosphere.

ionosphere, *n.*—The region of the high upper atmosphere where a relatively great degree of ionization exists and causes reflection of radio waves. This region contains several distinct ionized layers, of which the Kennelly-Heaviside Layer, q. v., also known as the E Layer, is the most noted. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 309–310; B. Haurwitz, The Physical State of the Upper Atmosphere, 1941, pp. 19–28.

iridescent clouds, *n.*—Cirrostratus or cirrocumulus clouds which exhibit brilliant spots or borders of colors, usually red and green: observed up to 30° or more from the sun. This phenomenon has been explained as a diffraction phenomenon, the colored parts of the clouds being segments of large coronas, though the colored portions are so small compared with the complete corona that no curvature or concentricity is noticed. The cloud particles causing this phenomenon are very small, and all of nearly the same size. *See:* G. C. Simpson, Coronae and Iridescent Clouds, Quarterly Journal of the Royal Meteorological Society, vol. 38, 1912, pp. 291–299.

irisation, *n.*—The phenomonen exhibited by Iridescent Clouds, q. v.

isabnormal line, *n.*—A line drawn through places having the same Anomaly, q. v., usually of temperature; also called an isanomalous line.

isallobar, *n.*—A line connecting points on a weather map having the same Barometric Tendency, q. v., both with regard to magnitude and direction (positive or negative) of change.

isallobaric wind, *n.*—The component of the wind which blows at right angles to the isallobars, in the direction of the largest pressure falls. For example, in a rapidly deepening low center, the winds tend to "head in" or "toe in" toward the place where the pressure is decreasing most rapidly.

isallotherm, *n.*—A line connecting points at which the same change of temperature has occurred within a given period.

isanakatabar, *n.*—A line indicating equal pressure amplitudes, or a line of equal variation of pressure. *See:* N. Shaw, Manual of Meteorology, Vol. II, 1936, p. 371.

isanomalous line, *n.*—*See:* Isabnormal Line.

isanthesic line, *n.*—A line drawn on a map to connect places at which the blossoming of any plant occurs simultaneously.

isentrope, *n.*—A line connecting points of equal Entropy, q. v. *See:* Isentropic Analysis.

isentropic, *adj.*—"Taking place without change of entropy." —*n.* "The graph representing the variables in a transformation during which the entropy remains constant." (L. D. Weld, Glossary of Physics, 1937, p. 116.)

An adiabatic line or an adiabat is also an isentropic line. This term is also applied to a surface of constant potential temperature, as an Isentropic Surface, q. v. *See:* E. W. Woolard, et al., Graphical Thermodynamics of the Free Air, Monthly Weather Review, vol. 54, 1926, p. 454.

isentropic analysis, *n.*—An analysis, by means of data obtained from aerological soundings, of the physical and dynamic processes taking place in the free atmosphere on the basis of the location and configuration of the various isentropic surfaces and the distribution of air properties and air movement on these surfaces. Isentropic Charts, q. v., and vertical Cross Sections, q. v., are used principally in this analysis.

From the mathematical definition of Entropy, q. v., and from thermodynamic considerations, it can be shown that the entropy of an air parcel is proportional to its potential temperature. Now, potential temperature and mixing ratio (or relative humidity) are two of the most conservative of the properties of an air mass. It is therefore possible to select in the atmosphere a certain surface of constant potential temperature and to follow the movement of an air parcel along it, for its mixing ratio will generally be invariant. Since entropy is proportional to potential temperature, a surface of constant potential temperature is also an isentropic surface, a surface of constant entropy. Hence, parcels of adiabatically moving air having the chosen potential temperature may be traced along the appropriate isentropic surface from day to day, using mixing ratio as the identifying property. Furthermore, lateral mixing between air parcels in the atmosphere takes place along isentropic surfaces, and such mixing causes shearing stresses between the various air currents in the atmosphere. Therefore, "isentropic analysis suggests itself as a practical tool in synoptic meteorology for the following two reasons: (1) It provides a method of identifying and following large-scale moist and dry currents and of anticipating their subsequent thermodynamic modifications. (2) It provides a method for taking into consideration lateral shearing stresses and their hydrodynamical effects on the prevailing flow pattern." J. Namias, An Introduction to the Study of Air Mass and Isentropic Analysis, 5th ed., 1940, p. 139, cf. pp. 136–171.

isentropic surface, *n.*—A surface in the atmosphere on which potential temperature is a constant. It is not a level surface, but has domes and troughs, since it is higher in a cold air mass than in a warm one. It tends to coincide with a frontal surface, especially when there is no cloud system connected with the latter; a well-marked cold front shows, just to the rear, a steep slope in the isentropic surface, which slope runs parallel to the line of the front. If, however, one or more isentropic surfaces intersect the frontal surface, lateral mixing between the two air masses is indicated, and the front may dissipate. *See*: E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 406–407; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 356–357.

iso-.—A combining form from the Greek, meaning "equal"; a familiar word with this prefix is ISOTHERM. Before a vowel iso- becomes is-; an example is ISALLOTHERM. The second element is properly and usually of Greek origin, rarely of Latin, the proper prefix in the latter case being equi-, of which a common example is EQUINOCTIAL. Properly the prefix iso- should be restricted to terms denoting equal quantity or intensity, for simultaneity of occurrence is better denoted by hama-.

isobar, *n.*—A line connecting places having the same barometric pressure. Usually the barometric pressures at all points are reduced to mean sea level, but they may, of course, be reduced to any other surface. Isobars are drawn on daily weather charts to indicate the instantaneous pressures over a certain area for the same time of day. Isobaric charts, in meteorological atlases, show the average pressure over the whole globe for the year, and for each month, or other chosen period.

Isobars were formerly drawn in the Forecast Division of the U. S. Weather Bureau, for every tenth of an inch of mercury; but on July 1, 1939, the millibar was adopted as the pressure unit. The isobars are now drawn for each interval of 3 millibars of pressure variation, which closely corresponds to the interval of $\frac{1}{10}$ inch heretofore used, since 1 millibar equals approximately $\frac{1}{30}$ inch.

isobaric, *adj.*—Indicating equal barometric pressure; relating to an ISOBAR, q. v. Some examples are: (a) Isobaric line: an isobar; (b) Isobaric surface: a surface in the atmosphere, every point of which has the same barometric pressure.

isobront, *n.*—A line connecting points at which some specified phase of a passing thunderstorm simultaneously occurs. Isobronts may be drawn for points at which the first thunder is heard simultaneously, for points of heaviest thunder, etc.

isoceraunic, *adj.*—Indicating or having equal frequency or intensity of thunderstorm phenomena.

isodef, *n.*—A line of equal percentage deficiency from the mean. *See*: W. R. Baldwin-Wiseman, The Cartographic Study of Drought, Quarterly Journal of the Royal Meteorological Society, vol. 60, 1934, p. 525.

isodrosotherm, *n.*—An ISOGRAM, q. v., of dew point temperature.

isodynamic surface, *n.*—A surface in which a force of any nature, whether magnetic, gravitational, or other type, is constant.

isogonal, *adj.*—*See*: AGONIC LINE.

isogradient, *n.*—A line connecting points on a chart having the same horizontal gradient of barometric pressure, temperature, or other element.

isogram, *n.*—A line drawn on a map or chart connecting points of equal value of some meteorological or climatological element. *See:* ISOPLETH.

isohel, *n.*—A line drawn through points having the same amount of sunshine during any specified period.

isohyet, *n.*—A line drawn on a map through points having the same amount of precipitation for any specified period.

isokeraunic, *adj.*—*See:* ISOCERAUNIC.

isoline, *n.*—A term used by the Germans and synonymous with ISOGRAM and ISOPLETH, q. v.

isomer, *n.*—"A line on a map indicating an equal proportion; e. g., maps showing the proportion of a year's rainfall which falls in any specified period, such as a month, are termed Isomeric Rainfall Maps." (C. Salter, Rainfall of the British Isles, 1921, Glossary, p. 289.) The isomeric lines on such maps are also called rainfall isomers. *See:* EQUIPLUVE; PLUVIOMETRIC COEFFICIENT.

isoneph, *n.*—A line drawn through points on a map having the same degree of cloudiness.

isopleth, *n.*—1. A special form of ISOGRAM, q. v., which "shows the variation of an element in relation to two co-ordinates; one of the co-ordinates representing the time of the year (month), and the other usually the time of the day (hour), but sometimes space (especially altitude)." (B. C. Haynes, Meteorology for Pilots, 2d ed., 1943, p. 229.) 2. In a less restricted sense, a synonym for isogram: isobars, isotherms, etc. are often called isopleths. 3. The chart on which an isogram is drawn.

isopluvial, *adj.*—Pertaining to a line connecting points on rainfall charts having the same PLUVIAL INDEX, q. v. Such a line is not the same as an ISOHYET, q. v., for the charts on which they appear are made not for the purpose of studying amounts of rainfall for a single period, but for the purpose of analyzing the high rates of precipitation for 1-day to 6-day periods which are likely to occur in a given number of years, e. g., 15, 25, 50, and 100 years. *See:* Miami Conservancy District Technical Report, pt. 5, pp. 80–106.

isopycnic, *adj.*—Having equality in density. Thus, an isopycnic line is one passing through points at which the air density is equal; and an isopycnic surface is a surface of equal air density. *See:* D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, p. 171.

isosters, *n.*—A line of equal specific volume; since the latter is the volume per unit mass, it is the reciprocal of the DENSITY, q. v., and an isosteric line or surface is identical with an ISOPYCNIC line or surface, q. v.

isotherm, *n.*—A line connecting points having the same temperature. An isotherm may be drawn to represent the temperature at any particular time, or the average temperature for any specified period. Thus, there are, for instance, isotherms on daily weather charts indicating instantaneous temperatures, and on climatological charts, indicating the mean temperatures for the months of the year.

In some cases isotherms are drawn to indicate the actual temperatures; but these are in many cases very complicated due to the differences in elevations among the stations reporting, and for climatic study, isotherms representing temperature observations reduced to sea level are much simpler.

The reduction of temperature to sea level is a matter of great difficulty, however. The rate of decrease of temperature with lowered elevation varies with the season and the region, being different, for instance, on the interior of a great plateau than on an isolated mountain. The Smithsonian Meteorological Tables contain tables for reducing temperatures to sea level. These tables are computed for rates of temperature change ranging from 1° F. in 200 feet, to 1° F. in 900 feet, and from 1° C. in 100 meters, to 1° C. in 500 meters. The rates to be used must be selected by those using the tables. *See:* Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. xxxiii, 76, 77.

isothermal layer, *n.*—1. Synonymous with STRATOSPHERE, q. v. 2. Any layer in the atmosphere through which the temperature does not change appreciably with height.

isotropic radiation, *n.*—A diffuse RADIATION, q. v., which has the same intensity in all directions.

ivory point, *n.*—A small marker, projecting downwards from the top of the cistern in the Fortin type of mercurial BAROMETER, q. v., which forms a fixed and definite point to which the level of the mercury in the cistern can be adjusted in taking readings of the barometer. It is the zero of the barometer scale.

J

January thaw, *n.*—A period of mild weather, popularly supposed to recur each January in the United States, especially in New England and the Middle Atlantic States. According to one investigator, "An examination of the Weather Bureau records of daily mean temperature for the last 50 or 54 years discloses a marked crest in the graphs of the average daily mean temperatures for the three-day period, January 21–23, at Baltimore, Philadelphia, New York, Boston, Pittsburg, Raleigh, and Atlanta." (R. Nunn, The January Thaw, Monthly Weather Review, vol. 55, 1927, p. 20.) *See:* C. F. Brooks, Why the Weather?, rev. ed., 1935, p. 233; C. F. Marvin, Are Irregularities in the Annual March of Temperature Persistent?, Monthly Weather Review, vol. 47, 1919, pp. 544–555; R. D. Ward, The Climates of the United States, 1925, pp. 126–127.

Jevon's effect, *n.*—The disturbance in the distribution and amount of rainfall caused by the rain gage itself. W. S. Jevons pointed out in 1861 that the rain gage produces a disturbance of the air flow past it, and thereby an irregularity in the distribution of precipitation of such a kind that part of the rain is carried past the gage. The loss of rainfall by the gage, he showed, was proportional to the wind speed. Several devices have been invented to overcome the Jevons effect, of which the best known is the NIPHER SHIELD, q. v. *See:* H. Koschmieder, Methods and Results of Definite Rain Measurements, Monthly Weather Review, vol. 62, 1934, pp. 5–7; W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 111–112.

joule, *n.*—A practical unit of work; equal to 10^7 ergs, the ERG, q. v., being the c.g.s. unit but inconveniently small for practical purposes.

Joule's law, *n.*—A thermodynamic law which states that all the work done in compressing a gas at constant temperature is converted into heat, and conversely, that when the gas expands, at constant temperature, the quantity of heat absorbed is equal to the quantity of work done. This law is only approximately valid in nature, but is true for a perfect or ideal gas.

jp., *abbr.*—Abbreviation for precipitation in sight of a station, in the BEAUFORT WEATHER NOTATION, q. v.

K

K., *abbr.*—Abbreviation for the Kelvin scale of temperature, which is the same as ABSOLUTE TEMPERATURE, q. v. The relation between the Kelvin and centigrade scales is expressed accurately enough for most purposes by the following equation: $K° = C° + 273$.

Kaikias, *n.*—Greek name of the northeast or north-northeast wind, or its personification.

kaléma, *n.*—A very heavy surf breaking on the Guinea coast during the winter, even when there is no wind.

karaburan, *n.*—A "black storm" in central Asia, in which violent east-northeast winds begin early in spring, and "continue by day till the end of summer. Blowing with gale force, they carry with them clouds of dust swept up from the desert, which darken the air and make life miserable." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, pp. 185–186.)

katabatic wind, *n.*—Air flowing down an incline; caused by the cooling of surface air, which then, impelled by gravity, flows downward. Also called mountain wind, canyon wind, and gravity wind. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 159–160.

katallobar, *n.*—An area over which the barometer pressure has fallen within some specified time. *See:* ANALLOBAR; ALLOBAR.

kataphalanx, *n.*—Synonymous with COLD FRONT, q. v., or squall surface; the discontinuity in front of a wedge of cold air which is displacing warmer air in its path, and which cuts the earth's surface at the squall line and slopes upward toward the rear of the cyclone. *See:* J. Bjerknes, On the Structure of Moving Cyclones, Monthly Weather Review, vol. 47, 1919, p. 95.

katathermometer, *n.*—An apparatus developed by L. Hill early in the twentieth centry for measuring the cooling effect of the air in relation to human comfort and health. One form of this instrument consists of two large-bulbed spirit thermometers; the bulb of one is covered with muslin, and both bulbs are immersed in warm water until 110° F. is reached, when they are withdrawn. The water is then wiped from them, they are allowed to cool, and the time of cooling is noted. Another type consists of a large-bulbed spirit thermometer with only two graduation marks at 35° and 38° C. The thermometer is warmed to 40° C., and the time required for the spirit column to fall from 38° to 35° C. is noted. *See:* C. E. A. Winslow, The Katathermometer as a Measure of the Effect of the Atmospheric Conditions upon Bodily Comfort, Science, May 19, 1916, pp. 716–719; W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 143.

Kelvin scale of temperature, *n.*—A temperature scale, synonymous with the absolute thermodynamic scale, independent of the properties of any particular substance, and defined as follows in L. D. Weld's Glossary of Physics, 1937, p. 120: "An ideal, absolute temperature scale, proposed by Kelvin (1848), the equal intervals on which correspond to equal quantities of work derived from a working substance performing in perfect Carnot cycles between the respective isothermals. It closely approximates the ordinary hydrogen-pressure absolute scale." On this scale, the freezing point of water is 273.13° K., and the boiling point, 373.13° K., under one atmosphere of pressure, as nearly as it has yet been possible to determine.

Kelvin temperature, *n.*—*See*: ABSOLUTE TEMPERATURE.

Kennelly-Heaviside layer, *n.*—*See*: E LAYER.

key day, *n.*—A day, the weather of which is popularly supposed to be a sign of the weather to come, although the idea is without basis in fact or reason; sometimes called a control day. Examples are: January 1st; ground hog day (February 2nd); and St. Swithin's Day (July 15th). *See:* W. J. Humphreys, Rain Making and Other Weather Vagaries, 1926, pp. 129–137.

khamsin, *n.*—The name of a class of winds in Egypt. They are "hot dry winds blowing from the south quadrants, and are most common in the spring months when the air is thick with drifting dust and sand. These hot southerly winds are often described in exaggerated terms, and though they cause considerable discomfort, they cannot be said to be dangerous as a rule. The controlling factor of the 'khamsin' winds is a depression moving along the Mediterranean not far from the Egyptian coast, combined with the high-pressure area lying in upper Egypt usually to the coast of the Nile. Under these conditions a hot dry wind blows, strongly at first from the southeast, veering gradually to the southwest and west; then, as the low pressure passes away to the eastward the wind shifts rapidly into the north with much diminished force, bringing cool weather.

The first indications of these winds are a falling barometer as the depression approaches from the west, a rapid decrease in humidity at night as dry air begins to arrive from the south, and the appearance of high, light, cirrus clouds in advance of the depressions. As these conditions develop the wind increases in force, the air is filled with dust and sand, which raise its temperature and at times render objects invisible at a short distance." (H. G. Lyons, Climatic Influences in Egypt, Quarterly Journal of the Royal Meteorological Society, vol. 36, 1910, p. 224.)

Kirchoff's law, *n.*—A radiation law which states that at a given temperature the ratio between the absorptive and emissive power for a given wave length is the same for all bodies. *See:* D. Brunt, Physical and Dynamical Meteorology, 2d ed., 1939, pp. 105–106; N. Shaw, Manual of Meteorology, Vol. III, 1930, p. 111.

Its mathematical statement is:

$$\frac{e_\lambda}{a_\lambda} = C_{\lambda t}$$

where e_λ is the emissive power; a_λ, the absorptive power; and C is a contant depending upon wave length λ and temperature t. *See:* Radiation Laws; Black Body.

kite observation, *n.*—A Sounding, q. v., of the upper air by means of instruments carried aloft by a kite.

The use of kites in meteorology began probably in 1749 when Alexander Wilson of Glasgow raised thermometers with them. Three years later Franklin made his lightning experiment. In 1894 Professor A. Lawrence Rotch began systematic observations at Blue Hill Observatory, Massachusetts, with kites, and was the first to lift self-recording meteorological instruments into the free air. This use of kites at Blue Hill antedates that of the U. S. Weather Bureau which, however, used kites as early as May 6, 1885, for observations of atmospheric electricity. On August 4, 1894, a modified Richard thermograph was raised to 1,430 feet. Later Marvin redesigned the Hargrave box kite for use by the Bureau and used his meteorograph in connection with it, to record temperature, humidity, pressure, and wind velocity. *See:* Meteorograph; F. O. Stetson, Kite Work etc., Monthly Weather Review, vol. 32, 1904, p. 567; C. F. Marvin, Mechanics and Equilibrium of Kites, Monthly Weather Review, vol. 27, 1897, pp. 136–162; U. S. Weather Bureau, Aerological Division, Kites and Kite Making, 1930; W. R. Blair, Exploration of the Upper Air by Means of Kites and Balloons, American Philosophical Society, Vol. XLVIII No. 191, 1909; S. P. Fergusson, Kites and Instruments Employed in the Exploration of the Air, Annals of the Astronomical Observatory, Harvard College, Vol. XLIII, Pt. III, App. D.

The use of kites was gradually discontinued after the advent of the airplane, both because of the hazard to aviation that the kite wires presented and also because the airplane itself became available for soundings.

kite station, *n.*—A meteorological station at which upper air observations were made with the aid of kites. Stations of this type are no longer in operation.

knik wind, *n.*—Local name for a strong southeast wind in the vicinity of Palmer (Matanuska Valley), Alaska, most frequent in the winter though it may occur at any time of the year.

kona storm, *n.*—A storm over the Hawaiian Islands, characterized by strong southerly or southwesterly winds and heavy rains. The term is of Polynesian origin and means leeward. The Hawaiian Islands, lying within the northeast trade wind zone, receive most of their precipitation from these winds, which are lifted by the land barriers, causing orographic rainfall. The kona rains occur over the normally leeward sides of the mountain slopes, i. e., the southerly, and are occasioned by cyclonic storms whose centers pass north of Hawaii.

The kona storms occur, on an average, about five times a year; they are accompanied by heavy rains amounting to an inch or more, and the wind force is often destructive, but on the whole they are beneficial. *See:* L. H. Daingerfield, Kona Storms, Monthly Weather Review, vol. 49, 1921, pp. 327–329.

konimeter, *n.*—An instrument for determining the dust content of a sample of air. A measured volume of air is brought into contact with a sticky plate, and the particles of dust thus caught are counted under a microscope.

koniscope, *n.*—An instrument invented by John Aitken for roughly ascertaining the quantity of dust in the air, and based on his observation "that certain color phenomena took place in cloudy condensation produced by expansion," and "that the colors so produced varied according to the number of dust particles present in the air," so that "the amount of dust in the air might be tested by observing the tests produced in it." (J. W. Moore, Meteorology Practical and Applied, 2d ed., 1910, p. 198.)

konisphere, *n.*—Same as the STAUBOSPHERE, q. v.

kq., *abbr.*—Abbreviation for line squall in the BEAUFORT WEATHER NOTATION, q. v.

Krakatoa, *n.* and *adj.*—1. An island in the Strait of Sunda. In 1883, an explosive volcanic eruption occurred there, one of the greatest on record; the volcanic dust produced observable color effects in the sky for more than 3 years. 2. Krakatoa wind, a name sometimes applied to a wind from an easterly quadrant blowing at an altitude of 25 kilometers and upwards above the equatorial regions, so called because it carried the ashes from Krakatoa around the globe.

ks., *abbr.*—Abbreviation for storm of drifting snow in the BEAUFORT WEATHER NOTATION, q. v.

kz., *abbr.*—Abbreviation for sandstorm or dust storm in the BEAUFORT WEATHER NOTATION, q. v.

L

l., *abbr.*—Abbreviation for lightning in the BEAUFORT WEATHER NOTATION, q. v.

lag, *n.*—1. A difference between the indicated reading of an instrument and the actual current value of the quantity it is designed to measure, due to a failure of the instrument to respond instantaneously to variations of this quantity. For example, when the temperature of the air is rising, a thermometer will always indicate slightly too low a temperature; and when falling, slightly too high a temperature. The lag coefficient of a thermometer depends on the materials composing it, on whether the air is moving or not, and on whether the temperature is rising or falling. The lag of a thermometer is different (generally greater) for rising than for falling temperatures. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 56–60. 2. The difference in phase between an electromotive force and the current which it produces. The current always lags behind the electromotive force in phase.

lake breeze, *n.*—A wind, generally light, produced by the differential heating of the waters of a lake and the surrounding land, in much the same manner as the SEA BREEZE, q. v. *See:* W. M. Davis, Elementary Meteorology, 1894, pp. 98, 135; J. Hann, Handbook of Climatology, Pt. I, Physical Climatology, tr. R. D. Ward, 1903, pp. 160–161.

Lambert's formula, *n.*—An equation for calculating the mean direction of the wind from a series of observations; it may be written

$$\tan \alpha = \frac{E-W(NE+SE-NW-SW)\cos 45^\circ}{N-S(NE+NW-SE-SW)\cos 45^\circ}$$

where α is the angle between the meridian and the mean wind direction, and the symbols for the eight specified directions each denote the number of times the wind has blown from that direction.

land breeze, *n.*—*See*: SEA BREEZE.

landspout, *n.*—Former name of a TORNADO, q. v., by analogy with its marine counterpart, the WATERSPOUT, q. v.

Laplace's formula, *n.*—An equation expressing the relation between atmospheric pressure and height above sea level, used to reduce barometric readings to sea level or to any other desired level. *See:* Smithsonian Meteorological Tables, 5th rev. ed., 1939, p. xliv.

lapse, *n.*—The decrease of a meteorological element, such as temperature or pressure, with height in the free atmosphere.

lapse limit, *n.*—Same as TROPOPAUSE, q. v.

lapse rate, *n.*—1. In general, the rate of change in the value of any meteorological element with elevation. 2. Usually restricted to rate of decrease of temperature with elevation; thus the lapse rate of temperature is synonymous with the vertical temperature gradient. The temperature lapse rate is usually positive, i. e., the temperature falls off with elevation: it is negative when the temperature increases with height as in the case of an INVERSION, q. v. This general temperature decrease through a given layer of air should not be confused with the rate of cooling of an air parcel ascending through this layer. *See:* ADIABATIC LAPSE RATE; TROPOSPHERE; STRATOSPHERE.

latent heat, *n.*—The heat absorbed by a substance, without change in temperature, while passing from a liquid to a vapor state, or from a solid to a liquid, and released in the reverse change of state.

The term was coined by Dr. Joseph Black (1728–1799), who first noted the slowness of ice to melt and of water to vaporize when heat was applied to them, and realized that only part of the heat acted to raise the temperature, a sensible effect, while the remainder acted "latently" to impart potential energy to the molecules and effect the changes of state. The latent heat of evaporation of water varies with temperature, but may be determined accurately up to 40° C. by the formula

$$L=594.9-0.51\,t$$

where L is the latent heat and t is the temperature in degrees centigrade. The latent heat of fusion of ice is 79.7 calories per gram. *See:* HEAT OF CONDENSATION; HEAT OF FUSION.

latent instability, *n.*—A type of CONDITIONAL INSTABILITY, q. v., which can be released by vertical displacement of air. *See:* B. Haurwitz, Dynamic Meteorology, 1940, pp. 75–76.

laurence, *n.*—A shimmering seen over a hot surface (such as a stubble field) on a calm, cloudless, summer day, caused by the unequal refractions of light by innumerable convective air columns of different temperatures and densities. *See:* W. J. Humphreys, Laurence, Bulletin of the American Meteorological Society, Vol. 19, 1938, p. 46.

law of the conservation of energy, *n.*—A physical law, based on experimental evidence, which states that energy can neither be created nor destroyed, or, in other words, that the total amount of energy in the universe is a constant.

Energy may, however, be transferred from one system to another, and transformed from one kind into another. For example, to consider first the transference of mechanical energy, the potential energy of water in a dam is transferred to the water wheel, in the form of kinetic energy. Again, the chemical energy of a battery is transformed into electrical energy when current is taken from it.

The first law of thermodynamics expresses the principle of the conservation of energy in such a way as to include heat energy. It states that the heat taken in by a working substance is always equal to the work done by it plus the increase in its internal energy. In meteorology, there are numerous applications of this law. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 28.

law of storms, *n.*—A statement of the two more obvious characteristics of a CYCLONE, q. v.; namely, the systematic rotation of the storm winds around the center, and the regular progression of the whole disturbance. The formulation of this law was largely due to the investigations of Brandes (1826) and Dove (1828), both of Germany, and of Redfield (1831) in the United States. Knowledge of the law led to the issuance of rules for seamen, enabling them so to navigate their vessels as to escape the storm entirely or to avoid its most dangerous portion.

leader stroke, *n.*—The first of the component strokes of a lightning discharge, also called the "stepped leader" because it stops or hesitates many times in its downward course from cloud to ground. *See:* LIGHTNING.

Lenard effect, *n.*—1. The separation of electric charges in falling rain, caused by breaking up of the water droplets, the drops becoming positively electrified and the air negatively. *See:* N. Shaw, Manual of Meteorology, Vol. III, 1930, p. 380. 2. Ionization of the air by ultraviolet radiations. *See:* Le Radium, avril, 1912, p. 169.

lenticular cloud, *n.*—A stationary cloud, resembling a huge lens, being broad in its middle and base, tapering at the ends, and having a smooth appearance; formed above a hill or mountain by the condensation of an ascending current of moist air, and sometimes over plains or rolling surfaces by the same process. The cloud continually evaporates on its leeward side, and the air current passes through it, but condensation of the constant supply of ascending moist air from windward sustains it and makes it seem unmoving. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 238–239; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 301–302; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 355.

lenticularis, *adj.*—A descriptive term given by Clement Ley (1894) to a patch of cloud approaching the shape of a double-convex lens.

The International Cloud Atlas, 1932, p. 24, thus describes this type: "Clouds of an ovoid shape with clean-cut edges, and sometimes irisations, especially common on days of föhn, sirocco, and mistral winds."

leste, *n.*—A hot, dry, easterly wind of the Madeira and Canary Islands. It is of the sirocco type, blowing from the African desert, and is most frequent during July, August, and September. It usually lasts 3 days, but may vary in duration from 1 to 7 days. The temperature is rarely much above 90° F., but the relative humidity is very low, 20 to 25 percent. The wind often attains a speed of 15 to 30 miles per hour. This wind, like the SIROCCO, q. v., is due to passing cyclonic storms.

levante, *n.*—Spanish name for the east wind.

levanter, *n.*—An east wind in the Strait of Gibraltar, accompanied by cloudy, foggy weather much feared by mariners in sailing-ship days, and also by rain, especially in the winter. Its coming is indicated 24 hours in advance by such local weather signs as dampness in the air or clouds accumulating over the mountaintops along the shore.

levantera, *n.*—A persistent east wind of the Adriatic, usually accompanied by cloudy weather.

levanto, *n.*—A hot southeasterly wind which blows over the Canary Islands.

leveche, *n.*—In Spain, a local name for the SIROCCO, q. v., which is chiefly experienced along the southeast coast from Valencia to Malaga, and generally blows from a direction between southeast and southwest.

life zone, *n.*—A climatic belt corresponding to the region of a distinctive type of plant and animal life. The main life zones are the boreal, austral, and tropical; these are subdivided further. *See:* C. H. Merriam, Life Zones and Crop Zones of the United States, U. S. Department of Agriculture, Bulletin No. 10, 1898.

lift, *n.*—1. "The component, perpendicular to the relative wind and in the plane of symmetry, of the total air force on an aircraft or airfoil. It must be specified whether this applies to a complete aircraft or the parts thereof. (In the case of an airship this is often called 'dynamic lift.') Its symbol is L.

"The 'absolute lift coefficient' is C_L as defined by the equation

$C_L=\frac{L}{qS}$ in which L is the lift, q is the impact pressure $(=\frac{1}{2}\rho V^2)$,

and S is the effective area of the surface upon which the air force acts." (U. S. National Advisory Committee for Aeronautics, Nomenclature for Aeronautics, Report 157, 1923, p. 167.) In the formula given for the impact pressure, ρ is the density of the air and V is the velocity of the wind. 2. The distance that a particle of air at any level must be lifted in order to saturate it, assuming dry adiabatic cooling. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, p. 119.

lifting condensation level, *n.*—*See*: CONDENSATION LEVEL.

light, *adj.*—1. Applied to the wind to indicate, in general, a relatively low velocity. For example, in the BEAUFORT WIND SCALE, q. v., a light air is a wind of 1 to 3 miles per hour, and a light breeze is a wind of 4 to 7 miles per hour. 2. One of the degrees of intensity of various hydrometeors and lithometeors, which are usually reported as "light," "moderate," or "heavy" according to certain arbitrary standards of rate of fall, visibility, etc. *See:* U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th rev. ed., 1941.

light climate, *n.*—Same as ILLUMINATION CLIMATE, q. v.

lightning, *n.*—A discharge of electricity from one part of a thundercloud to another part, from cloud to another cloud, or between cloud and earth.

Enormous electrical stresses are commonly set up within thunderstorm clouds simultaneously, by induction; similar stresses are produced between the cloud and the earth's surface. The initial discharge occurs when the resistance of the intervening air is overcome; it probably starts as a brush discharge within the cloud, which grows by ionization so that the conducting path gradually lengthens. In the case of a discharge from cloud to earth, the "leader stroke" thus builds downward to the earth in an irregular path, as successive discharges increase the line of conduction. One hundred or more discharges may be necessary to complete this stroke. Branching may occur as the discharges seek out other paths through the electrical field and expend their energy before reaching the earth. When the "leader stroke" reaches the surface, a heavy stroke, called the "main stroke," follows immediately in the opposite direction. Intense illumination, due to the high degree of ionization which causes many of the atoms in the air to be in excited states and emit radiation, builds upward from the earth toward the cloud along the path of the "leader stroke." The color of this illumination may be white, red, yellow, indeed any color of the spectrum, the particular color depending on the nature of the gas through which the stroke travels. *See:* K. B. McEachron, The Thunderstorm, General Electric Review, Sept. 1936; The Lightning Stroke, General Electric Review, Oct. 1936; K. B. McEachron, and K. G. Patrick, Playing with Lightning, 1940.

The various forms of lightning are treated in separate entries.

lightning recorder, *n.*—An instrument used to detect the occurrence of lightning. Its method of operation is similar to that of a radio receiver. The same instrument in principle goes by many other names, for example, CERAUNOGRAPH, q. v.

lightning storm, *n.*—A thunderstorm with or without rain reaching the ground; and used synonymously with the terms, ELECTRIC STORM and THUNDERSTORM, particularly in the western portions of the United States in connection with the causes of forest fires. *See:* W. G. Morris, Occurrence and Behavior of Lightning Storms on the National Forests, Bulletin of the American Meteorological Society, 1932, p. 173; S. B. Show, Lightning and Forest Fires in California, Monthly Weather Review, 1923, p. 566; THUNDERSTORM.

line blow, *n.*—A wind of strong, or even gale, force on the southern side of an anticyclone, probably so called because there is little shifting of wind direction during the blow, as contrasted with the marked shifting which occurs with a cyclonic windstorm.

line squall, *n.*—A SQUALL, q. v., or series of squalls occurring along a SQUALL LINE, q. v.; usually marked by a sudden change of wind direction, generally from the southeast or south to west, northwest, and north; and frequently accompanied by heavy rain, snow, or hail, thunder and lightning, a sudden fall of temperature, and a rise of pressure and relative humidity.

The term line squall, according to Sir Napier Shaw, is adopted from the seamen's name for a squall that comes up with a line of cloud extending across the sky and athwart the wind. *See:* Admiralty Weather Manual, 1938, pp. 285–287.

liquid-in-glass thermometer, *n.*—A thermometer whose thermic element is a liquid contained in glass. The liquids used most frequently are mercury and alcohol. The indications of these instruments depend upon the differential expansion of the liquid used and the glass container or tube. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 61–68.

liquid-in-metal thermometer, *n.*—A thermometer in which the expanding liquid is encased in metal. The mercury-in-steel thermometer is the most common type; it is really a special form of the BOURDON TUBE, q. v. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, pp. 72–74.

lithometeor, *n.*—Generic term for a class of atmospheric phenomena, among which dry haze and smoke are the most common examples. In contrast to a HYDROMETEOR, q. v., which consists largely of water, a lithometeor is composed of solid dust or sand particles, or the ashy products of combustion. Dry haze is made up of "dust or salt particles which are dry and so extremely small that they cannot be felt nor discovered individually by the unaided eye; however, they diminish the visibility and give a characteristic smoky (hazy and opalescent) appearance to the sky." (U. S. Weather Bureau, Definitions of Hydrometeors, Lithometeors, and other Atmospheric Phenomena, 1938.)

lizard-balloon, *n.*—A balloon with a detachable tail which is automatically dropped when the balloon has undergone a certain amount of expansion. It serves to measure the ratio of pressure to temperature, and to determine the approximate density of the air, at the level where the tail is released.

lolly ice, *n.*—*See*: FRAZIL ICE.

long range forecast, *n.*—A forecast of the weather made for periods longer than 36 or 48 hours, i. e., a forecast of the weather for a period longer than can be made by methods used for making the 36- or 48-hour forecast. For a discussion of the methods used, *see* Hewson and Longley, Meteorology Theoretical and Applied, 1944, p. 427–429.

long-wave radiation, *n.*—*See*: TERRESTRIAL RADIATION.

looming, *n.*—An optical phenomenon in which objects below and beyond the horizon appear to the view of the observer, and even the horizon itself is extended. This is caused by a more-than-normal decrease of density with elevation, which occurs when the temperature of the surface layers of air is extremely low, causing abnormal refraction of light coming from distant objects to the eye of the observer. This phenomenon is the reverse of SINKING, q. v. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 357–358; W. J. Humphreys, Physics of the Air, 3d ed. 1940, p. 469.

low, *n.*—A region of the atmosphere where the barometric pressure is below normal, usually surrounded by closed isobars with the point of minimum pressure in the center. "Low" is not strictly synonymous with CYCLONE, q. v., since lows often appear on the weather map without a well-defined cyclonic wind circulation. Moreover, an EXTRATROPICAL CYCLONE, q. v., always has a frontal structure; a low need not have. *See:* ANTICYCLONE; ALEUTIAN LOW, HIGH, ICELANDIC LOW.

Lowitz, Arcs of, *n.*—*See*: ARCS OF LOWITZ.

lull, *n.*—1. Same as CALM (q. v.), i. e., an absence of wind. 2. Often used to denote merely a temporary lessening of the wind speed below the current average. Thus, one may speak of the wind stream as being composed of gusts and lulls. *See:* GUST.

luminous cloud, *n.*—1. A cloud illuminated by an interior electrical discharge, a phenomenon described under SHEET LIGHTNING, q. v. 2. Name sometimes given to NACREOUS CLOUDS and NOCTILUCENT CLOUDS, q. v.

lux, *n.*—"A practical metric unit of illumination, equal to one lumen per square meter; or, the illumination of a surface at a uniform distance of one meter from a symmetrical point source of one candle." (L. D. Weld, Glossary of Physics, 1937, p. 134.)

M

m., *abbr.*—Abbreviation for mist in the BEAUFORT WEATHER NOTATION, q. v.

mackerel sky, *n.*—A formation of rounded and isolated cirrocumulus clouds resembling the pattern of scales on the back of a mackerel; when the clouds are a trifle angular in shape, they are called "mackerel scales." *See:* R. Abercromby, Weather, 1887, p. 107; Mares' Tails.

macroclimate, *n.*—The general climate over a comparatively large area considered as a whole, as distinguished from the detailed variations within very small areas (which constitute the Microclimate, q. v.). The data of macroclimate are those obtained by observations at ordinary official weather stations.

macrometeorology, *n.*—1. The study of the weather over an extended period of time, weeks or months, for the purpose of examining general large-scale weather changes, as, for instance, those pertaining to the general circulation. 2. The study of meteorological phenomena as they occur over the whole or a considerable area of the earth; in this usage, macrometeorology is closely allied to World Meteorology, q. v., and is the opposite of Micrometeorology, q. v.

magnetic elements, *n.*—The three following quantities characterizing the magnetic field of the earth: (1) The magnetic declination, which is the angle between the astronomic meridian (the true north-south direction) and the Magnetic Meridian, q. v.; the declination is considered east or west according as the magnetic meridian lies east or west of true north. (2) The dip or inclination, which is the angle that the magnetic lines of force make with the horizontal. (3) The magnetic intensity, of which the horizontal component alone is usually measured; defined as "a vector quantity pertaining to the magnetic field, the measure of which, at any point in a vacuum, is the force per unit pole experienced by a free magnetic pole placed at that point." (L. D. Weld, Glossary of Physics, 1937, p. 136.)

magnetic equator, *n.*—The line on the surface of the earth where the magnetic needle remains horizontal, or does not dip: that is, where the magnetic lines of force are horizontal. Also called the Aclinic Line.

magnetic field, *n.*—A region of space at each point of which a definite magnetic force exists.

magnetic lines of force, *n.*—Lines in a magnetic field that are everywhere in the direction of the magnetic force; i. e., the magnetic force at any point is tangent to the line through that point. The lines may be drawn at arbitrary intervals of the force, but it is usual to indicate the strength of the magnetic field by the number of lines per square centimeter at right angles to the direction of the field, each line being equal to one oersted, the practical, c.g.s. electromagnetic unit of magnetic intensity.

magnetic meridian, *n.*—A line on the surface of the earth everywhere coinciding with the direction of the lines of horizontal magnetic force.

mammatus, *adj.*—Any cloud whose lower surface is in the form of pouches or breasts. This form is found especially in stratocumulus and cumulonimbus clouds, either at the base, or even more frequently on the lower surface of the anvil projection. It is also found occasionally in cirrus clouds, probably when they have originated in the anvil of a dispersing cumulonimbus.

manometer, *n.*—An instrument for measuring the pressure of gases. There are various forms, but a common one is a U-shaped tube open at both ends, one being open to the atmosphere and the other connected to the vessel containing the gases whose pressure is to be measured; mercury, or other liquid, is in the bend of the tube. The pressure is represented by the difference in height between the two columns of liquid. Several forms of the manometer are described in the Glazebrook "Dictionary of Applied Physics," 1922, vol. 1, p. 623–642. The mercurial barometer is a form of manometer.

map projection, *n.*—A systematic representation of the latitude and longitude lines of the earth on a plane surface, by means of any geometrical construction that sets up a correspondence between the points of the earth's surface and the points of a region in a plane. Once the grid of latitude and longitude lines has been constructed, it is relatively easy to fill in the outlines of the continents, their natural features, political boundaries, etc., and thus complete the map.

In meteorology, the Lambert conformal conic projection is almost universally used for weather analysis in the middle latitudes; the standard parallels (the latitude lines along which the scale is taken as standard) are 30° N. and 60° N., or 30° S. and 60° S., by international agreement. The Bonne projection and the American polyconic are other widely used conic projections. The Mercator is widely used for navigational purposes and is, by international agreement, the accepted projection for weather analysis in low latitudes. The azimuthal equidistant projection is frequently used for maps of the northern or southern hemisphere; the stereographic is commonly employed for weather analysis over a whole hemisphere; the gnomonic and the azimuthal equal-area are also often used. *See:* O. S. Adams, A Study of Map Projections in General, U. S. Coast and Geodetic Survey, Special Publication No. 60, 1919; O. S. Adams and C. H. Deetz, Elements of Map Projection, U. S. Coast and Geodetic Survey, Special Publication No. 68, 1938.

march, *n.*—The progression of any of the METEOROLOGICAL ELEMENTS, q. v., throughout the day, month, or year. For instance, the daily march of temperature refers to the increase of temperature to a maximum in midafternoon and its decrease through the night hours to a minimum about sunrise. *See:* T. A. Blair, Climatology, 1942, pp. 19–21.

mares' tails, *n.*—A popular name given to well-defined cirrus clouds thickening into cirrostratus, and then gradually lowering into watery altostratus. The clouds resemble a mare's tail, and may prove the precurser of a storm, as indicated in the old rhyme:

> "Mackerel sky and mares' tails
> Make tall ships carry low sails."

marine barometer, *n.*—A type of mercurial barometer adapted for use on shipboard. It has a fixed cistern (unlike the well-known Fortin type, in which the level of the mercury in the cistern can be raised or lowered); and the tube containing the mercury column "is provided with a fine capillary section in order to damp out the oscillations of the mercury caused by the motion of the ship." (W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 17.)

marine climate, *n.*—The climatic type controlled by an oceanic environment, found on the windward shores of continents and on islands, and characterized, in sharp contrast to a CONTINENTAL CLIMATE, q. v., by small diurnal and annual temperature ranges and high relative humidity. *See:* OCEANITY; T. A. Blair, Climatology, 1942, pp. 47–52.

marine meteorology, *n.*—The branch of METEOROLOGY, q. v., concerned with weather over the oceans, especially in relation to navigation of the seas; OCEAN ANALYSIS, q. v., presents peculiar problems not encountered in forecasting the weather over land.

marine rainbow, *n.*—A rainbow seen in the spray of the ocean; sometimes called a SEA RAINBOW. It is essentially the same phenomenon, formed in the same way, as the ordinary RAINBOW, q. v.

Mariotte's law, *n.*—*See:* BOYLE'S LAW.

maritime, *adj.*—A designation applied to air masses originating over the oceans. *See:* AIR MASS (1).

Marsden chart, *n.*—A diagram introduced early in the nineteenth century for the purpose of showing world-wide meteorological data. A Mercator MAP PROJECTION, q. v., is used, meridians being drawn for every 10 degrees of longitude and parallels of latitude for every 10 degrees up to 80° N. and 70° S. lat. The squares thus formed are numbered in order to identify the data. The square between 0° and 10° west longitude and 0° and 10° north latitude is marked 1, and the numbering continues westward to 36. Square No. 37 is directly north of No. 1, No. 73 north of it, and the numbering so continues for all the 288 squares in the Northern Hemisphere. In the Southern Hemisphere, Square No. 300 is just south of Square No. 1, and the 252 squares are numbered in a similar fashion. *See:* BREESE CHART.

Matanuska wind, *n.*—Local name, taken from the Matanuska River, for a strong, gusty, northeast wind which occasionally occurs during the winter in the vicinity of Palmer, Alaska.

mathematical climate, *n.*—*See:* SOLAR CLIMATE.

maximum, *adj.* and *n.*—The highest value of a given METEOROLOGICAL ELEMENT, q. v., observed during a specified period; the lowest value is called the MINIMUM, q. v.

maximum thermometer, *n.*—A thermometer which automatically registers the highest temperature occurring since its last setting. There are several types, but that of Negretti and Zambra is the most widely used. It is similar to an ordinary exposed THERMOMETER, q. v., except that the bore of the tube is constricted near the bulb, so that, as the temperature rises, the mercury in the tube is forced past the constriction in small drops, but cannot retreat into the bulb when the temperature falls. This thermometer is usually exposed in a horizontal position. To read: lower the bulb-end gently, thus allowing the mercury in the upper part of the tube to slip to the constriction where it should stop; the top of the column indicates the maximum temperature. To set: the instrument is whirled by hand or spun upon a suitable support, thus forcing the mercury past the constriction into the bulb. When set, the thermometer should indicate the current temperature.

mb., *abbr.*—Abbreviation for MILLIBAR, q. v.

mean, *n.*—The sum of a set of individual values of any quantity, divided by the number of values in the set. Though essentially the same as the AVERAGE and the NORMAL, q. v., it is distinguished from the latter in meteorological usage; in processing temperature data, for example, the daily mean temperature is the average of the maximum and minimum temperatures for the day, while the normal temperature for the day is the average of the daily means over a long period of years.

"In meteorology, as in other sciences, the mean is used extensively to typify a distribution. In climatological tables values are given for the mean monthly temperature, the mean annual rainfall, etc. Mean pressures are given on mean pressure maps. Mean winds, are given, too, on climatological maps." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 165–166.) *See:* MEDIAN; MODE.

median, *adj.*—The value of the middle term of a series, if the number of terms in the series is odd, or the average of the middle two terms, if the number of terms is even. The median value should not be confused with the AVERAGE, q. v.

"The median is particularly useful in typifying a series with a small number of observations. The mode would seldom have meaning, and the mean value would be influenced greatly by one exceptional value. For example, if the series is 1, 1, 3, 4, 14, the median is more representative of the numbers than the mode, 1, or the mean, 5. Such series are found in the rainfall of some regions of the earth where rainfall is infrequent, but very heavy showers occur at infrequent intervals. The mean annual rainfall, in such a region, would not give as correct an impression of the lack of rain as would the median value for the series. In general, though, the median is not used to any great extent in the field of meteorology, partly because of the difficulty of computation, and partly because the mean is more suitable in most meteorological series." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 162–164.) *See:* MEAN; MODE.

medical climatology, *n.*—The study of the effects of weather on the health of human beings and animals, and of the effects experienced when they are transferred to a climate to which they are not native. It may also be extended to include the relations of weather to human energy and efficiency, and to the sciences of anthropology and psychology.

Mediterranean climate, *n.*—"A marine or littoral climate characterized by: (a) mild winters of light to moderate rainfall, because of westerly winds and traveling cyclones; (b) warm to hot summers, tempered by sea breezes, with a considerable period rainless or nearly so; (c) abundant sunshine during both winter and summer; (d) a natural vegetation consisting of broad-leaved evergreens and drought-resistant trees and shrubs, and a characteristic type of cultivated crops, notably citrus fruits and olives; (e) mean temperature of coldest month above 43°, and, more typically, about 50°." (T. A. Blair, Climatology, 1942, pp. 366–367.)

The lands bordering the Mediterranean Sea form the largest area having this type of climate, which, however, is "repeated in four other regions, the coast of California, the southwest corner of Australia, the district around Cape Town, and Central Chile." (W. G. Kendrew, Climate, 1930, p. 315.)

Mediterranean winds, *n.*—The winds which blow in the middle and south of the Mediterranean basin, and which may be grouped under the name SIROCCO, q. v.

megabarye, *n.*—A force equal to 1,000,000 baryes or 10^6 dyne/cm². *See:* BAR; BARYE; ATMOSPHERE.

megatemperature (or **megadyne temperature**), n.—Same as POTENTIAL TEMPERATURE, q. v.

megathermal zone, *n.*—In Köppen's classification, the region of the earth enjoying a winterless climate, where grow the megatherms, i. e., the tropical plants requiring continuous high temperatures and abundant rainfall. *See:* CLIMATIC CLASSIFICATIONS; MESOTHERMAL CLIMATE; MICROTHERMAL CLIMATE.

melting point, *n.*—The temperature at which FUSION, q. v., takes place. All crystalline solids have definite melting points under specified pressures.

meniscus, *n.*—(pl. menisci) The curved upper surface of a liquid observed in a tube when the latter is partially plunged into the liquid; it may be either concave or convex. The forming of a meniscus is a phenomenon of capillarity. If a tube is partially immersed vertically in a liquid, the upper surface of the liquid in the tube will be convex, if the liquid does not wet the tube, as in the case of mercury and glass; on the other hand, if the liquid does wet the tube, the upper surface of the liquid will be concave, as in the case of water and glass.

In the mercurial barometer, there are two menisci, one in the tube and another in the cistern. As mercury does not wet glass, the menisci are therefore, convex. The meniscus in the tube is very important as its top is actually lower than the hydrostatic equation between the weight of the mercurial column and the atmospheric pressure would indicate. The meniscus at the top of the mercurial column must then take a correction. *See:* Smithsonian Physical Tables, 1934, p. 187, tables 137 and 138, which give meniscus corrections; W. E. K. Middleton, Meteorological Instruments, 1942, pp. 34–35.

mercury, *n.*—A metallic liquid resembling silver in appearance, used in barometers as a weight, and in many thermometers as the expanding and contracting medium. Its melting point is −38.87° C. or −37.97° F., and its boiling point is 356.90° C. or 674.42° F. It is a chemical element; its symbol is Hg and its atomic number is 80.

meridional front, *n.*—A type of cold front in the area of New Zealand that lies on a roughly north-south line. *See:* C. E. Palmer, Synoptic Analysis over the Southern Oceans, Air Department, New Zealand Meteorological Office, Professional Note No. 1, February 1942, p. 17 ff.

mesothermal climate, *n.*—A type of climate marked by moderate temperature and rainfall and by ample sunshine. Regions having such a climate lie, in general, between 30° and 40° latitude, though they extend farther poleward on the west coast of the continents. The MEDITERRANEAN CLIMATE, q. v., is a distinct variety of this climatic type, which is named for the mesotherms, or that "great variety of plants of the lower middle latitudes requiring considerable heat, but tolerant of short cold winters and also of a dry season." (T. A. Blair, Climatology, 1942, p. 105.) *See:* MEGATHERMAL CLIMATE; MICROTHERMAL CLIMATE.

metallic click, *n.*—The sound heard when a MERCURIAL BAROMETER, q. v., is inclined to such an angle that the contained mercury strikes the top of the glass tube. It is believed that the sharpness of the click is a rough measure of the excellence of the vacuum.

meteor, *n.*—1. Originally a general term for any atmospheric phenomenon, and still sometimes used in this sense, particularly in such terms as HYDROMETEOR, OPTICAL METEOR, etc. 2. Now more commonly restricted to astronomical meteors—sometimes called "shooting" or "falling" stars—which are relatively small bodies of matter traveling through interplanetary space, and which are heated to incandescence by friction when they enter the atmosphere, and are either wholly or partially consumed; in the latter case they reach the earth's surface as meteorites. Their interest to meteorologists lies in the fact that observations of them give some information about the extreme upper atmosphere. "Meteors have been known to become visible at heights approaching 200 miles. At this height, then, some atmosphere must exist in sufficient quantities to raise their temperature to incandescence by friction." (J. G. Albright, Physical Meteorology, 1939, p. 32.)

meteorogram, *n.*—1. A record of two or more weather elements made by a METEOROGRAPH, q. v. 2. Sometimes applied to any diagrammatic representation of the time variations of several weather elements at a given station or group of stations—e. g., a chart of the meteorological data from hourly weather reports, for the purpose of detecting frontal passages.

meteorograph, *n.*—1. An instrument which automatically records on a single sheet the measurements of two or more meteorological elements, such as air pressure, temperature, humidity, precipitation, etc. 2. A self-recording meteorological instrument carried aloft by a plane, balloon, or other means, to furnish data on conditions in the upper air. The meteorograph now used in connection with a balloon usually transmits its data by electrical means to the surface observation station, and is known as a RADIOSONDE, q. v. Variant spellings are meteograph and meteorgraph.

meteorological acoustics, *n.*—A branch of meteorology concerned with sounds of a distinctly meteorological origin, such as the rumbling of thunder, as well as with the effects of various meteorological conditions on the travel, distribution, and audibility of all sounds, whatever their sources. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 338–349; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 415–449.

meteorological elements, *n.*—1. Six quantities—air temperature, barometric pressure, wind velocity (direction and speed), humidity, cloudiness (type and amount of clouds), and precipitation—which specify the state of the weather at any given time and place. 2. In addition to the above, any of the various other meteorological phenomena which distinguish the particular condition of the atmosphere, such as sunshine, visibility, radiation, halos, thunder, mirages, lightning, etc. *See:* CLIMATIC ELEMENTS.

meteorological equator, *n.*—Synonymous with HEAT EQUATOR, q. v.

meteorological optics, *n.*—*See:* ATMOSPHERIC OPTICS.

meteorological symbol, *n.*—1. A letter, number, diagrammatic sign or character used as a kind of shorthand to indicate, in weather records or on weather maps, the state of the weather or the occurrence of any hydrometeor or other meteorological phenomenon.

Symbols were first suggested and used by J. A. Lambert in 1771; his symbols included only clouds, rain, snow, fog, and thunder. Later (1781–1792) the observers of the Meteorological Society of the Palatinate devised and used a more elaborate set of thirty-two symbols.

The Smithsonian Meteorological Tables (5th rev. ed., 1939, p. 242), list and describe thirty-one symbols. Those used by the U. S. Weather Bureau include many additions to the present international list of symbols. Some of the symbols indicating current sky conditions are sent over the Weather Bureau teletype circuit, but they differ in general from those actually used on synoptic weather charts.

Some examples of meteorological symbols follow:

✳ snow
⌈↯ thunderstorm
T thunder without lightning
○ clear sky
o overcast sky
∫ unsteady barometer
• rain
⁂ rain and snow mixed

2. A letter used by dynamic meteorologists to represent one of the various meteorological quantities used in mathematical discussions, as, for instance: T for the absolute temperature; c_p for the specific heat of dry air under constant pressure; θ for the potential temperature, etc. There exists, however, no standardization among meteorologists in the use of these mathematical symbols.

meteorology, *n.*—Originally, knowledge and lore of the weather and all other phenomena of the atmosphere; now, often restricted to the branch of physics dealing only with the phenomena that are directly involved in the weather (cf. the METEOROLOGICAL ELEMENTS), with more or less of a distinction drawn between meteorology and CLIMATOLOGY, q. v., which is primarily concerned with average, not actual, weather conditions. Meteorology may be subdivided, according to the methods of approach and the applications to human activities, into the following special sciences, each of which is discussed under its individual entry: AEROLOGY, AERONAUTICAL METEOROLOGY, AGRICULTURAL METEOROLOGY, DYNAMIC METEOROLOGY, HYDROMETEOROLOGY, MARINE METEOROLOGY, MACROMETEOROLOGY, MICROMETEOROLOGY, PHYSICAL METEOROLOGY, SYNOPTIC METEOROLOGY. *See:* S. Petterssen, Introduction to Meteorology, 1941, pp. 1–2; E. W. Woolard, Physical Interpretation of the Weather, Journal of Applied Physics, vol. 9, 1938, p. 5.

meter, *n.*—A primary standard of length; originally defined as the ten-millionth part of the length from the Equator to the North Pole of the meridian passing through Paris, France, but now the length at the temperature of 0° C. of the platinum-irridium bar deposited at the International Bureau of the Weights and Measures at Sèvres, near Paris, France. The centimeter-gram-second unit of length is one-hundredth part of the meter, called a centimeter.

microbar, *n.*—The one-millionth part of a BAR, q. v., taken in meteorology as equal to a pressure of one dyne per square centimeter.

microbarogram, *n.*—The record or trace made by a MICROBAROGRAPH, q. v.

microbarograph, *n.*—A BAROGRAPH, q. v., designed to record very minute variations of atmospheric pressure, smaller than can be detected by the barographs in general use.

microclimate, *n.*—The detailed climate of a very small area of the earth's surface, e. g., a single forest or even a corn field, over which small variations exist from place to place, differing from the general climate of the surrounding region. To obtain records for microclimatic studies weather stations are spaced at short intervals, that is, from 1 to 5 miles apart, occasionally as close as a few feet apart. Microclimatic records are of value in studies relating to river-flood forecasting, plants, etc. *See:* MACROCLIMATE.

microclimatology, *n.*—The detailed study of the climate over a small area, as determined by location and environment; in many places, differences of soil, of soil climate, and of elevation lead to radically different climates in places only a few hundred feet apart. For many purposes, such as choice of crops, for example, or studies of flood control, these local differences are often of great importance. *See:* T. A. Blair, Climatology, 1942, pp. 122–123.

micrometeorograph, *n.*—A supersensitive airplane METEOROGRAPH, q. v.

micrometeorology, *n.*—The study of the variations in meteorological conditions over very small areas, such as hillsides, forests, river basins, even individual cities. *See:* MACROMETEOROLOGY.

micropluviometer, *n.*—An instrument for registering the occurrence of precipitation that is too light to be registered by an ordinary self-recording rain gage. In one type of micropluviometer the rain falls upon a moving sheet of paper which is treated chemically so as to change color when moistened. Thus even a trace of rain can be detected and recorded.

microthermal climate, *n.*—In Köppen's classification a type of climate found on the equatorward margins of the polar regions, distinguished by long, cold winters and short summers and named for "those plants such as the coniferous trees of high latitudes (microtherms) which thrive with short summers and long cold winters if the mean annual temperature is above freezing." (T. A. Blair, Climatology, 1942, p. 105.) *See:* CLIMATIC CLASSIFICATIONS; MEGATHERMAL ZONE; MESOTHERMAL CLIMATE.

middle clouds, *n.*—Family B of the international cloud classification, 1932, comprising the altocumulus and the altostratus clouds, with their subgenera and varieties. *See:* CLOUD CLASSIFICATION.

mil, *n.*—1. A unit of angular measure equivalent to 1/6400 of 360 degrees, used in gunnery to figure fire data. The direction of the wind when furnished by the meteorological units of the Army to the artillery is expressed in hundreds of mils. 2. A linear unit, 1/1000 of an inch, used for measuring the diameter of wires. It is not to be confused with the circular mil, which is equal to the area of a circle 0.001 inch in diameter, and is also used to measure wires.

millibar, *n.*—A subunit of pressure, being one one-thousandth of a BAR, q. v.; in meteorology it is equal to a force of 1,000 dynes per square centimeter. The values of atmosphere pressure are now usually expressed in millibars, and 1,013 millibars is standard atmospheric pressure.

minimum, *adj.* and *n.*—The lowest observed value of temperature, pressure, or other weather element during any given period. *See:* MAXIMUM.

minimum thermometer, *n.*—A thermometer that automatically registers the lowest temperature which occurs after it has been set. The type used at present was devised in its essential form by Rutherford in 1794. It is an alcohol-in-glass thermometer with an index of steel or glass immersed in the liquid; this index resembles a pin but has a head at both ends, and is about ½ inch long. The bulb end of the thermometer is raised, allowing the index to slide toward the top of the alcohol column where it rests, due to the surface tension. The thermometer is then placed in a horizontal position, and if the temperature falls lower than that prevailing at the moment of setting, the index is pushed toward the bulb end. The end of the index farthest from the bulb indicates the minimum temperature, and the top of the alcohol column of the instrument always indicates the current temperature. The instrument should be reset at every observation. *See:* W. E. K. Middleton, Meteorological Instruments, rev. ed., 1942, p. 67.

minuano, *n.*—A cold southwesterly wind of southern Brazil, occurring in the winter months, June to September, and named for the Minuano Indians who inhabit the region from which it blows.

mirage, *n.*—"An optical illusion due to the refraction of light as it passes through non-homogeneous layers of the atmosphere. Distant objects are seen in an unnatural position, sometimes elevated, sometimes depressed, and often inverted; the phenomenon occurs most frequently in hot climates over surfaces that are warmed by insolation, such as sandy plains." (J. G. Albright, Physical Meteorology, 1939, p. 355.) Mirages may occur, however, in any region, even on a city street. They are generally one or another of two types, the inferior mirage or the superior mirage. It is the former which is responsible for the delusion of a body of water in a desert or for the common illusion of a wet highway on a hot summer's day. The superior mirage, more spectacular but less frequent, causes distant objects—trees, ships, mountains, buildings—to appear inverted in the sky. Multiple mirages, such as the FATA MORGANA, q. v., have also been observed. A complete explanation of these phenomena may be found in W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 470–475.

mist, *n.*—1. A thin FOG, q. v., of relatively large particles. 2. A very fine rain, lighter than a drizzle, but more in the nature of a damp fog with falling particles which wet the skin.

mistbow, *n.*—A FOGBOW, q. v.

mistral, *n.*—A cold, dry wind blowing from the north over the northwest coast of the Mediterranean Sea, particularly over the Gulf of Lions. It blows when there is a low pressure area centered over the Gulf of Genoa and a high pressure area centered to the northwest, and often with force enough to overturn railroad trains. *See:* W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 276.

mixing ratio, *n.*—The mass of water vapor per unit mass of perfectly dry air in a humid mixture; given by the formula

$$w=622\frac{e}{p-e}$$

where w is the mixing ratio in grams of water vapor per kilogram of dry air, e is the partial pressure of the water vapor, and p is the total pressure of the air. Since the value of e is in most cases negligible compared to that of p, the mixing ratio is for all practical purposes numerically equal to the specific humidity (q), which is defined by the equation

$$q=622\frac{e}{p}$$

where e and p have the same values as before.

The mixing ratio of an air parcel is a conservative property, and hence extremely helpful in both air mass and isentropic analysis. It is invariant for both dry-adiabatic and dry non-adiabatic temperature changes. *See:* H. R. Byers, General Meteorology, 1944, pp. 155, 177–178, 182–183, 389–390.

Moazagotl, *n.*—A stationary bank of cirrus marking the upper portion of the system of standing waves formed in the warm, dry, foehn air descending the leeward slopes of the Sudetes Mountains in southeastern Germany. "The Moazagotl reaches its maximum development in the colder months, and especially in the autumn. It usually occurs when the air is conditionally unstable and the wind speed exceeds certain critical values." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 450.)

mock fog, *n.*—"A simulation of true fog by atmospheric refraction." (U. S. Weather Bureau, Instructions to Marine Meteorological Observers, Circular M, 6th ed., January 1938, p. 103.)

mock moon, *n.*—*See*: Paraselene.
mock sun, *n.*—A "sun dog" or Parhelion, q. v.
mock-sun ring, *n.*—Same as Parhelic Circle, q. v.
mode, *n.*—The value which occurs most frequently in a set of observed values of a quantity, and which may therefore be taken as a typical value. For instance, if in a monthly record of daily mean temperatures it were found that the mean temperature fell in the interval 65°–69° F. on more days than it fell in any other 5° F. interval, then the midpoint of this favored interval, 67° F., would be the mode of the daily mean temperatures for the month. *See:* E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 161–163; Mean; Median.
moisture-temperature index, *n.*—"A single index to represent both moisture and temperature conditions as related to plants." (B. E. Livingston, Physiological Researches, vol. 1, 1916, p. 428.)
mole, *n.*—A mass numerically equal to the molecular weight of the substance.

The gram-mole or gram-molecule is the mass in grams numerically equal to the molecular weight: for instance, a gram-mole of oxygen is 16 grams; of carbon dioxide, 44 grams.
monsoon, *n.*—A seasonal wind blowing from continental interiors (or large land areas) to the ocean in winter, and oppositely in summer. These winds result from the temperature differences arising between land and ocean; and their directions, since their paths are long, are greatly influenced by the earth's rotation. They are most pronounced over India, where they blow from the northeast in January and from the southwest in July, and are caused in the winter by the air blowing out of the high pressure area formed over southern Siberia and in the summer by the wind streaming into the heat low over Central Asia. Other places having noticeable monsoon winds are the Spanish peninsula, Australia, China, portions of Africa, and Texas in the United States.

The term monsoon is of Arabic origin and means season. It is used often in that sense in India, where the monsoon means the rain occurring from June to September; but the word monsoon in meteorology and climatology always refers to the wind. *See:* G. C. Simpson, The Southwest Monsoon, Quarterly Journal of the Royal Meteorological Society, July 1921.
monsoon air, *n.*—An air mass formed over India and the Bay of Bengal by "a direct and gradual transition of air from the Siberian polar continental source to the truly equatorial air of the Indian Ocean." (S. Petterssen, Weather Analysis and Forecasting, 1940, p. 163.) Monsoon air generally exhibits at least some of the following characteristics: (a) warm, moist to high levels; (b) absence of Trade Inversion, q. v.; (c) towering cumulus and cumulonimbus clouds; (d) good visibility; (e) showers and thunderstorms. *See:* Air Mass (1).
monsoon fog, *n.*—An advection type of fog, fundamentally a coastal phenomenon, which usually occurs "during periods at which a marked temperature contrast exists between adjacent land and water surfaces, when the air exhibits a relatively high specific humidity, and when the general cyclonic activity is weak enough so that the

monsoon circulation proceeds normally." (G. F. Taylor, Aeronautical Meteorology, rev. ed., 1943, p. 292.) *See:* ADVECTION FOG; FOG.

moonbow, *n.*—A lunar rainbow formed in the same manner as the ordinary rainbow, but by light coming from the moon instead of the sun. Colors are usually very difficult to detect in a moonbow. *See:* RAINBOW.

mother-of-pearl clouds, *n.*—Same as NACREOUS CLOUDS, q. v.

mountain barometer, *n.*—An instrument constructed exactly like the ordinary mercurial BAROMETER, q. v., except that the scale is longer, so that measurements of pressure may be made at both high and low altitudes. It is also provided with a leather case and straps suitable for carrying the instrument about, and with a light tripod stand for mounting.

mountain breeze, *n.*—A breeze that blows down mountain slopes, due to gravity flow of cooled air. It is of the same type as CANYON, GRAVITY, and KATABATIC WINDS, q. v.

mountain climate, *n.*—The climate on mountains, controlled primarily by the altitude factor, and distinct from that of valleys in many respects; and characterized by low pressure due to the elevation, by strong sunshine rich in ultraviolet rays, owing to the thin and clear air, and by uniformly low temperatures and humidity. The precipitation depends greatly on exposure, the windward slopes being the wettest. The temperature, while lower in general than that of the lowlands, is hot on sunny slopes at midday. The winds, in the absence of storms, flow up the slopes during the day and down at night. The Highlands of Kenya Colony in East Africa are an example of a region with mountain climate. *See:* W. G. Kendrew, Climates of the Continents, 3d ed., 1937, p. 67.

mountain sickness, *n.*—An ailment experienced by persons subjected to air pressures much less than that to which they are accustomed. As this sickness was first encountered by mountain climbers, it receives the name mountain sickness, although the same symptoms may be experienced in a balloon or airplane. These symptoms are: suffocation, exhaustion, nausea, headache, sleeplessness, bleeding at nose and lips, lapse of memory, and inability to think. It may occur with or without exertion, and is usually felt by people accustomed to living at or near sea level when they ascend to about 10,000 feet elevation.

N

N. (or **n.**). *abbr.*—1. Abbreviation for north. 2. Formerly the abbreviation for a nimbus cloud; replaced by Nb in the International Atlas of Clouds, 1932.

nacreous clouds, *n.*—Luminous, iridescent clouds that occasionally occur in the stratosphere at about the 25-kilometer level; also sometimes called mother-of-pearl clouds. They resemble cirrostrátus, and are seen before sunrise and after sunset while the observer's part of the earth is in shadow. Their luminosity is due to reflected sunlight, and the iridescence to diffracted light. It has been suggested that these clouds consist of extremely minute water droplets (0.0025 mm. in diameter) formed in the ascending branch of the general circulation in the stratosphere. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 307; Monthly Weather Review, August, 1933, p. 228; NOCTILUCENT CLOUD.

nashi, *n.*—Arabic name for a northeast wind which occurs in winter on the Iranian coast of the Persian Gulf, especially near the entrance to the Gulf, and also on the Makran coast; probably associated with an outflow from the central Asiatic anticyclone which extends over the high land of Iran; similar in character to the BORA, q. v., but not so severe.

nautical twilight, *n.*—*See:* TWILIGHT.

navigable semicircle, *n.*—The less dangerous half of a tropical cyclone (hurricane, or typhoon). Prior to recurvature, the navigable semicircle is the half nearest the Equator, or the left semicircle. (Note: The right and left semicircles lie on the right and left hands, respectively, of an observer standing on the storm track and facing in the direction the center is moving.)

For complete instructions for handling vessels within the storm area see American Practical Navigator, (originally by Nathanial Bowditch), Hydrographic Office Publication No. 9, U. S. Government Printing Office, Washington, 1938, pp. 290–294.

Nb., *abbr.*—Abbreviation for NIMBUS, q. v.

needle ice, *n.*—Same as FRAZIL ICE, q. v.

neon, *n.*—One of the rare gaseous constituents of the atmosphere, comprising 0.0018 percent of the whole atmosphere by volume. It is an inert gas; its atomic number and weight are 10 and 20.2. Its symbol is Ne.

nephelemeter, *n.*—An instrument for determining by optical methods the amount of matter suspended in a turbid medium. It is a kind of visibility meter. A form of this meter has been devised to measure the density of fog.

nephelescope, *n.*—1. An instrument devised by Espy for showing changes in the temperature of the air due to rarefaction and compression. 2. An instrument for viewing the upper strata of clouds. 3. Generic name of apparatus for producing cloudy condensation in the laboratory. 4. Synonymous with NEPHOSCOPE, q. v. An alternate spelling is nepheloscope.

nephology, *n.*—The study of clouds.

nephometer, *n.*—An instrument designed to measure the amount of cloudiness. It was invented by M. L. Besson of France, who called it a spherical mirror nephometer. The following description is from Sir John Moore's "Meteorology, Practical and Applied," (2d ed., 1910, p. 219): "The convex mirror is a hemisphere of 30 centimetres in diameter. The celestial hemisphere so formed is seen divided into six parts as follows: Two horizontal circles map out a zone of four-tenths on the horizon, another of four-tenths above the first, and a cap of two-tenths round the zenith. Two vertical great circles perpendicular to each other, divide each of the two annular zones into four parts; finally the zenith-cap is divided into two equal parts by an arc of a vertical great circle, making with the foregoing an angle of 45 degrees.

"The observer looks along an eyepiece fixed to the pedestal of the mirror. The observer's shadow obstructs only the three squares numbered 8, 9, 10. In order to make an observation, the amount of cloud in each of the seven squares 1 to 7 is noted. Then the instrument is turned through 180°, and in this new position the amount of cloud in the squares 2, 5, and 7 is noted, these now representing the regions of the sky which correspond to the squares 8, 9, and 10 in the first position."

nephoscope, *n.*—An instrument for determining the direction of cloud motions. There are various kinds, but they may be classified as direct-vision nephoscopes and mirror nephoscopes. Both types measure a cloud direction of movement; and if a timepiece is used in connection with them and if the cloud height is known, its speed may also be ascertained.

The direct-vision type is exemplified by the rake or comb nephoscope. The comb may be turned by the observer by means of a rope attached to a wheel. The observer simply observes a part of a cloud and turns the comb until the direction of motion coincides with the bar supporting the teeth of the comb.

There are many varieties of the mirror nephoscope, differing, however, only in small details, for all operate on the same principle. The type used by the U. S. Weather Bureau consists of (1) a black mirror mounted on a circular frame graduated in degrees, which must be adjusted until it is level; (2) a movable stand carrying two eyepieces, one 166⅔ mm. and the other 83⅓ mm. above the mirror. Either of these eyepieces may be shifted to any position, convenient to the observer, for viewing the cloud's image in the mirror. The observer orients the scale of the mirror so that the zero of the scale is toward true north. He then shifts the eyepiece until a part of the cloud is observed through the hole in the eyepiece at the center of the mirror. The cloud's direction is indicated by the scale where the observed part of the cloud's image leaves the mirror. For full instructions, *see:* U. S. Weather Bureau, Circular I, Instrument Division, 1936.

Neuhoff diagram, *n.*—A thermodynamic diagram developed by Neuhoff from Hertz's Diagram, q. v., in 1900, and forming the basis of the Adiabatic Chart, q. v. Its most common form has temperatures in degrees centigrade as abscissae, elevations in kilometers as ordinates, and pressure lines, nearly horizontal, sloping from right to left across the chart. Saturation curves and dry- and saturation-adiabatic curves, are also given. This network graphically represents "the relations that exist between temperature, elevation, pressure, and maximum humidity in adiabatic changes that occur when air is elevated; it is useful in the solving of problems that arise from the changing of the temperature and moisture content of the air as it is elevated." (J. G. Albright, Physical Meteorology, 1939, pp. 166–167.)

neutral points, *n.*—Points in the sky at which the light from the sky is not polarized. There are three notable ones, named after their discoverers, Arago, Babinet, and Brewster. Others have been observed at different times.

nevada, *n.*—Spanish name for a cold wind descending from a mountain glacier or snowfield.

névé, *n.*—Same as FIRN, q. v.

nieve penitente, *n.*—"Fields of pinnacled snow found on high mountains in many parts of the world . . . They are so-called because, as seen in the Andes, they bear some resemblance to throngs of kneeling human figures, robed and hooded in white and engaged in a religious ceremony." (C. F. Talman, A Book About the Weather, 1931, p. 69.) These peculiar formations are supposed to be due to action of the sun on a thick bed of well-compacted snow.

nimbostratus, *n.*—A low, amorphous, and rainy cloud layer, of a dark gray color, usually nearly uniform; feebly illuminated seemingly from within. When it gives precipitation, it is in the form of continuous rain or snow; but precipitation alone is not a sufficient criterion to distinguish the cloud, which should be called nimbostratus even when no rain or snow falls from it.

Often precipitation from nimbostratus does not reach the ground; in this case the base of the cloud is usually diffuse and looks wet on account of the general trailing precipitation (or virga) so that it is not possible to determine the limit of its lower surface.

The usual evolution of a nimbostratus cloud is as follows:—A layer of altostratus grows thicker and lower until it becomes a layer of nimbostratus. Beneath the latter there is generally a progressive development of very low ragged clouds, isolated at first, then fusing together into an almost continuous layer, in the interstices of which, however, the nimbostratus can generally be seen. These very low clouds are called fractocumulus or fractostratus according as to whether they appear more or less cumuliform or stratiform in development. Generally the rain only falls after the formation of these very low clouds, which are then hidden by the precipitation or may even melt away under its action. The vertical visibility then becomes very bad. In certain cases the precipitation may precede the formation of fractocumulus or fractostratus, or it may happen that these clouds do not form at all. Rather rarely a sheet of nimbostratus may form by evolution from stratocumulus.

nimbus, *n.*—Luke Howard's name for a rain cloud. It originally meant any thick layer of formless cloud from which rain or snow falls. It is not now in the international cloud classification, except as a combining term.

Nipher shield, *n.*—A shield placed around the mouth of a rain gage to obviate the effect of wind eddies which cause a deficiency in the catch. It is trumpet-shaped, and is placed around the gage with the mouth or flaring part opening upward, the upper level of the shield being 3 to 6 inches below the mouth of the gage. *See:* JEVONS EFFECT.

nitrogen, *n.*—One of the principal components of the earth's atmosphere; oxygen and nitrogen together account for 99 percent of the volume and mass of the air.

noctilucent cloud, *n.*—A luminous cloud about 82 kilometers above sea level; it resembles cirrus, is silvery or bluish-white, and is rendered luminous by the sun.

Noctilucent clouds were observed in the summer of 1885, and were first supposed to have originated from the dust ejected by the eruption of Krakatoa in 1883. They are first faintly seen from 15 to 25 minutes after sunset, and then in those parts of the sky that are illuminated by the twilight. It has been suggested that these clouds may be composed of frozen water particles. *See:* W. J. Humphreys, Nacreous and Noctilucent Clouds, Monthly Weather Review, vol. 61, 1933, pp. 228–229; NACREOUS CLOUD.

nocturnal radiation, *n.*—Synonymous with TERRESTRIAL RADIATION, q. v., which is the better term. Probably the term "nocturnal" has been used because the phenomenon is more apparent and more easily measured at night when incoming solar radiation is absent.

When the sky is overcast, radiation from the surface of the earth continues as with clear skies, since the rate of radiation depends only upon the nature and the temperature of the surface of the emitting substance. Radiational cooling, but not radiation itself, is hindered by the clouds, because heat radiated by the earth is absorbed by the clouds and in part reradiated back to the earth. *See:* D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 136, 138, 142, 145; B. Haurwitz, Dynamic Meteorology, 1941, pp. 106, 108–110.

nomograph, *n.*—A diagram for the graphical solution of problems that involve formulae in two or more variables, by means of a straightedge. For instance, a simple nomograph for determining relative humidity may be constructed as follows: a line having a scale of values of dry-bulb temperatures, another having a scale of wet-bulb temperatures, and still others with values of relative humidity at various barometric pressures are so arranged that a straightedge connecting the dry-bulb and the wet-bulb temperatures indicates the relative humidity on the proper barometric pressure curve. *See:* E. Berl and G. A. Sterbutzel, Nomographs for the Solution of Psychrometric Problems, Monthly Weather Review, June 1944, p. 135.

normal, *n.*—"The average value which, in the course of years, any meteorological element is found to have on a specified date or during a specified month or other portion of the year, or during the year as a whole. Also used as an adjective in such expressions as 'normal temperatures,' etc. . . . the normal serves as a standard with which values occurring in a particular year may be compared." (C. F. Talman, Our Weather, p. 378.)

The use of normal does not imply that there is a definite, fixed value of a climatic or meteorological element: no such absolute is possible, due to the large-scale fluctuations of climate that have almost certainly occurred. Hence, in all exact climatic studies, it is not only necessary to derive normals from a long period, say 35 years or more, but also to state the period taken, since a normal for the years 1800–1835 may very well differ from that for 1900–1935. Provisional normals are sometimes provided for stations with short-term records (less than 10 years), by transferring the normals of neighboring long-record stations to it, making due allowances for the differences discovered by a comparison of the average values since the establishment of the newest station. The results are quite accurate, provided that the weather characteristics of the neighboring stations are the same. *See:* C. F. Brooks, Definitions of "Mean," "Average," and "Normal," Monthly Weather Review, vol. 46, 1918, pp. 514–515; C. F. Marvin, Concerning Normals, Secular Trends and Climatic Changes, Monthly Weather Review, vol. 51, 1923, pp. 383–390.

normal barometer, *n.*—A mercury Barometer, q. v., whose every correction is known to a degree of accuracy satisfactory for the purposes of meteorological observation and record, so that it is independent of all other barometers, and hence is suitable for determining national and international standards of atmospheric pressure. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 23–24.

norte, *n.*—A Norther, q. v., especially in the Gulf of Mexico and Central America.

northeaster, *n.*—1. A wind or gale from the northeast. 2. A moderate to strong wind blowing from the northeast over the New England and Middle Atlantic States. 3. A steady northeast gale, which sometimes blows for three days, and with violent squalls, off New Zealand and the the coast of New South Wales (locally known as a black northeaster).

northeast trades, *n.*—*See:* Trade Winds.

norther, *n.*—1. In the southern part of the United States, in the Gulf of Mexico, the western Caribbean, and in Central America, a cold strong wind from a northerly quarter in winter; caused by the southward movement of a polar anticyclone in the wake of an intense cold front; attended by a rapid drop in temperature, possibly 25° F. in an hour or 50° F. in 3 hours (in the United States), and at times by a severe storm of rain, sleet, or snow. Thus, dry and wet northers have been distinguished.

In the Pacific the norther is known locally as the Tehuantepecer, q. v., in the Gulf of Tehuantepec, and as the Papagayo, q. v., on the northwest coast of Costa Rica. *See:* I. R. Tannehill, Wet and Dry Northers, Monthly Weather Review, vol. 57, 1929, pp. 136–142; W. E. Hurd, Northers of the Gulf of Tehuantepec, Ibid., pp. 192–194. 2. A strong dry northerly wind in California, most frequent in late spring and early autumn, of the same type as the Chinook or Foehn, q. v. In southern California it is locally known as the Santa Ana, q. v.

northern lights, *n.*—*See*: Aurora.

northwester (or **nor'wester**), *n.*—1. A wind or gale from the northwest. 2. Dry, warm, foehn-type wind, blowing east of the mountains of the Middle Island of New Zealand. 3. A Line Squall, q. v., in Bengal.

Notos, *n.*—Greek name for the south wind, or its personification.

NRM wind scale, *n.*—A wind scale adapted by the U. S. Forest Service for use in the forested areas of the Northern Rocky Mountains (NRM). It is an adaptation of the Beaufort Wind Scale, q. v. The difference between these two scales lies in the specifications of the effects of the wind; the force numbers and the wind speeds corresponding thereto are the same in both.

NRM WIND SCALE

Force number	Effects of wind	Wind velocity equivalents, miles per hour	Old scale
0	Smoke rises vertically; no movement of leaves on bushes or trees	Less than 1	Light
1	Leaves of quaking aspen in constant motion; small branches of bushes sway; slender branchlets and twigs of trees move gently; tall grasses and weeds sway and bend with wind; wind vane barely moves	1 to 3	Light
2	Trees of pole size in open sway gently; wind felt distinctly on face; loose scraps of paper move; wind flutters small flag	4 to 7	Light
3	Trees of pole size in open sway very noticeably; large branches of pole-size trees in open toss; tops of trees in dense stands sway; wind extends small flag; a few crested waves form on lakes	8 to 12	Gentle
4	Trees of pole size in open sway violently; while trees in dense stands sway noticeably; dust is raised in road	13 to 18	Moderate
5	Branchlets are broken from trees; inconvenience is felt in walking against wind	19 to 24	Fresh
6–7	Trees are severely damaged by breaking of tops and branches; progress is impeded when walking against wind; structural damage; shingles blown off	25 to 28	Strong

nucleation, *n.*—"The action of ions or other particles as centers of condensation." (L. D. Weld, Glossary of Physics, 1937, p. 157.)

nucleus, *n.*—1. In meteorology, a particle of any nature whatsoever on which condensation of atmospheric moisture occurs. Some of these particles consist of hygroscopic gases, such as oxides of sulphur and nitrogen, and some of inorganic and organic dust particles. 2. "That part of an atom which is supposed to be the seat of its effective mass and to control the motions of its orbital electrons. Current atomic theory assigns to the nucleus a structure which involves an excess positive charge." (L. D. Weld, Glossary of Physics, 1937, p. 157.)

nucleus counter, *n.*—*See:* Dust Counter.

N weather, *n.*—An abbreviation for "instrument weather," which means weather at an airport open to airplanes having navigational instruments if their pilots are also licensed for instrument flying. The term is defined by current Civil Aeronautics Administration regulations, with regard to the minimum requirements of ceiling and visibility for instrument flight.

O

o., *abbr.*—Abbreviation for overcast sky in the Beaufort Weather Notation, q. v.

ob., *abbr.*—Abbreviation of "meteorological observation." It may refer to a synoptic, an hourly airway, or a check observation.

observer, *n.*—In the U. S. Weather Bureau, a person (man or woman) who takes observations of the weather, of any kind whatsoever, and of river stages. In this organization there are several classes: (1) Civil Service employees who have special educational qualifications, and who are employed full time either in the Central Office at Washington, D. C., or at field stations. They take every variety of observations, as surface, balloon, kite, ballon-sonde, river, and special, and in addition perform many other duties, meteorological and climatological. (2) Special observers in the corn and wheat, cotton, sugar and rice, and cattle regions, who observe temperature, state of weather, and special phenomena as occurrence of frost, severe storms, etc. These observers are paid either for each observation or on a part-time basis. They report during the critical period of the year, daily or weekly, and generally by telegraph or telephone; but they serve during the whole year as Co-operative Observers, q. v. (3) Co-operative observers receive no money compensation for their services. There are about 4,500 in the United States, and they take observations daily of temperature, precipitation, wind, cloudiness, and miscellaneous phenomena, and render reports monthly. The reports from these observers, who perform a valuable public service, constitute the bulk of climatic statistics of this country. (4) River and rainfall observers take daily, and also at special times, observations of river stages and precipitation and state of the weather, and keep a complete daily record. Observations are telegraphed or telephoned to the district center when circumstances warrant it. These observers are paid on a part-time basis. (5) Marine observers are appointed by the masters of vessels, who co-operate with the U. S. Weather Bureau in ocean meteorology. These observers, in addition to keeping a complete log of the weather, send daily reports by radio which reports contain data of pressure, temperature (air and sea), humidity, wind, and weather.

occluded cyclone, *n.*—*See:* Occlusion.

occluded front, *n.*—The front formed when and where the cold front overtakes the warm front in an extratropical cyclone. *See:* Occlusion; Front.

occlusion, *n.*—1. The process in which the warm sector of an extratropical cyclone is gradually restricted in size, and ultimately lifted entirely from the earth's surface, as the cold front overtakes the warm front; the warm sector then exists as a trough of warm air aloft until the cyclone dissolves. 2. An extratropical cyclone in which the warm air is entirely aloft, so that the cold air masses originally in advance of the warm front (which has now vanished) and behind the cold front (also gone) are separated at the surface by an occluded front. Depending on the relative coldness of the two air masses, three types of occlusions are distinguished: (a) warm front type, in which the air in advance is colder than the air behind, (b) cold-front type, in which the air behind is colder, and (c) neutral type, in which both air masses are at approximately the same temperature. 3. Same as OCCLUDED FRONT, q. v. *See:* E. Gold, Fronts and Occlusions, Quarterly Journal of the Royal Meteorological Society, vol. 61, 1935, pp. 107–158.

ocean analysis, *n.*—The analysis of that part of the weather map which covers the oceans from the information given by the ship reports plotted thereon. It is considerably more difficult than the analysis over land areas because of the comparative paucity of the reports due to the fact that they tend to be restricted to the main ocean routes of travel, leaving large and meteorologically important stretches of the ocean bare. There are also in the reports errors in position and barometric pressure to which ship reports are especially prone.

oceanity, *n.*—The quality of a climate with respect to the degree to which it is affected by marine influences; its opposite is CONTINENTALITY, q. v. Thus one may speak of the oceanity or the continentality of a place according to influences of oceans or of continents. A small island in the middle of an ocean would be an example of full oceanity, just as the interior of western Asia is an example of full continentality.

oe, *n.*—A whirlwind off the Faeroe Islands.

on top, *n.*—A phrase meaning that the observer is above the clouds, where the sky (stars or moon, sun, or a high layer of clouds) is visible.

optical haze, *n.*—"Due to small-scale convection currents which result in the juxtaposition of small masses of air of different densities, and consequently of different refractive indexes." (W. E. K. Middleton, Visibility in Meteorology, 2d ed., rev., 1941, p. 110.) This condition causes momentary displacements of the line of sight between the observer and the object, and gives the latter a wavering, or even obscure appearance. It is also known as "shimmer."

optical meteor, *n.*—Any phenomenon of the atmosphere explained by the laws of light, such as a mirage. However, in this case the term meteor is used in the old sense for any atmospheric phenomenon.

orchard heater, *n.*—Any device for heating an orchard to protect the plants from frost. Different types of orchard heaters burn coal, oil, or wood. Their object is to add heat to the surface layer of air in order to replace that lost by radiation and conduction. *See:* Floyd D. Young, Frost and the Prevention of Frost Damage, U. S. Dept. of Agriculture, Farmers Bulletin, No. 1588, 1935.

orographic rainfall, *n.*—Rainfall resulting when moist air is forced to rise by mountain ranges or other land formations lying athwart the path of the wind. The best example in the United States is the abundant precipitation on the western sides of the Cascade Mountains in Washington and Oregon. Another very famous example is the 200-inch seasonal rainfall on the top of the Western Ghats (in southwest India): these mountains, situated near the coast, receive the full benefit of the monsoon winds which are saturated from their travel over thousands of miles of warm seas. *See:* RAIN SHADOW.

oscillation, *n.*—Any periodic recurrence of a meteorological phenomenon; some examples are the diurnal pressure changes (most noticeable in the tropics), and the annual variation in the mass of air over the northern and the southern hemispheres.

overcast, *adj.*—The state of the sky when more than nine-tenths of the visible canopy is covered with clouds.

overtrades, *n.*—The planetary winds that some observations indicate exist above the ANTITRADES, q. v., at an elevation of about 20 kilometers. They blow toward the equator from the northeast. *See:* N. Shaw, Manual of Meteorology, 1932, vol. 1, pp. 101, 290.

oxygen, *n.*—A chemical element: its symbol is O, atomic number 8, and atomic weight 16.000. It is an odorless and colorless gas, freezing at and melting at −218.4° C. It comprises about one-fifth of the earth's atmosphere in uncombined molecular form; and chemically combined with other elements, about one-half of the earth's crust. It is only slightly soluble in water, but in chemical combination with hydrogen, forms water whose symbol is H_2O.

ozone, *n.*—A form of molecular oxygen, each molecule consisting of three atoms; it is colorless, but has a characteristic odor. Ozone is produced in the high atmosphere principally by the action on oxygen of the ultraviolet radiation from the sun. It is variable in amount, but the total is equivalent to a layer about 3 mm. thick at normal pressure and temperature. Its greatest density is at 25 kilometers and its greatest volume percentage at 35 kilometers. Since it speedily reverts to ordinary oxygen in the presence of organic material, only traces are found at the surface of the earth.

Recent investigations seem to show a correlation between the amount and distribution of ozone with surface weather changes. *See:* B. Haurwitz, The Physical State of the Upper Atmosphere, 1937, pp. 56–69.

P

p., *abbr.*—Abbreviation for PASSING SHOWERS in the BEAUFORT WEATHER NOTATION, q. v.

pack, *n.*—A body of drift ice consisting of separate pieces, the complete extent of which cannot be seen; the term open pack is used when the pieces do not touch, and close pack when they are pressed together.

painter, *n.*—Name for a "dirty fog frequently experienced on the coast of Peru. The brownish deposit from it is sometimes called 'Peruvian paint'." (C. F. Talman, Our Weather, p. 378.)

palaeoclimatology, *n.*—The science which treats of the climates of the world throughout the geological ages. Its data are the distribution of glacier deposits; nature of plant and animal fossils; topography and geography of former periods; and character of sedimentary rocks.

pampero, *n.*—A wind of gale force blowing from the southwest across the pampas of Argentine and Uruguay. It is comparable with the NORTHER, q. v., of the United States.

Papagayo, *n.*—A violent north wind, similar to the TEHUANTEPECER, q. v., occurring in the Gulf of Papagayo along the northwestern coast of Costa Rica. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, pp. 95–97.

parallax, *n.*—The change in apparent position of an object as seen from two different points. Observers in reading some meteorological instruments must take care that their line of sight is perpendicular to the scale so as to avoid errors of parallax. This is particularly true in the case of liquid-in-glass thermometers, for reading with the eye below the true level of the mercury will give too high a temperature, while reading from above will give a value below the actual.

paranthelion, *n.*—A mock sun, similar to a Parhelion, q. v., but occurring generally at a distance of 120° (occasionally 90° and 140°) from the sun, on the Parhelic Circle, q. v.

paraselene, *n.*—The technical term for mock moon. *See:* Mock Sun.

paraselenic circle, *n.*—In halo nomenclature, the horizontal circle passing through the moon, corresponding to the Parhelic Circle, q. v., and due to the reflection of moonlight from ice crystals.

parhelia, *n.* (singular, parhelion)—Mock suns or sundogs; that is images of the sun appearing as two, colored, bright spots at 22° from the sun, one to the right, the other to the left, on the parhelic circle and at the same altitude as the sun. Parhelia occur at several different positions in the parhelic circle, as 46°, 90°, 120°, and others. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 510, 526, 542–543.

parhelic circle, *n.*—A halo consisting of a faint white circle passing through the sun and parallel to the horizon, and therefore at the same altitude as the sun, produced by simple reflection of sunlight from vertical faces of ice crystals.

partial potential temperature, *n.*—The temperature to which the dry air component would come if reduced from its partial pressure to 1,000 mb. That is,

$$\Theta_d = \frac{T}{\left(\frac{p_d}{P}\right)^k} = T\left(\frac{1000}{p-e}\right)^{0.288}$$

where Θ_d=partial potential temperature; T=absolute temperature of air; p_d=partial pressure of dry air; P=standard pressure; k=0.288; p=total air pressure; and e=partial pressure of air vapor.

passing shower, *n.*—An Instability Shower, q. v.; that is, rainfall of short duration, alternately heavy and light, and marked by at least partial clearing of the sky between rain gusts. It occurs when a current of air passes over warmer ground and is heated from below, causing convection, instability, and local precipitation. In the Beaufort Weather Notation it is denominated *p*.

pause, *n.*—Used in various compound words to indicate a stopping or discontinuity; e. g., tropopause, the surface separating the stratosphere from the troposphere.

peak (of the warm sector), *n.*—In a mature wave cyclone, the point of intersection of the cold and warm fronts. *See:* Front; Cyclone; Cyclone Model; Warm Sector.

pearl lightning, *n.*—Same as Beaded Lightning, q. v.

pea soup, *n.*—Popular name for a very Dense Fog, q. v.

pendulum anemometer, *n.*—An early form of anemometer invented by Robert Hooke or Sir Christopher Wren about 1667. It consists essentially of a small metallic plate suspended from a horizontal axis. A vane on a vertical shaft keeps the plate facing the wind, the force of which deflects the plate from its normal vertical position. The deflections of the plate, measured on an empirically graduated quadrant, indicate the force of the wind. *See:* Anenometer.

penetrating radiation, *n.*—Rays of the gamma and cosmic and X-ray types which pass through substances opaque to ordinary light rays. *See:* Cosmic Radiation.

pentad, *n.*—In meteorology, usually a period of 5 days. Some climatologists have given temperature data in terms of the mean for each pentad.

penthemeron, *n.*—Same as Pentad, q. v.

percolation, *n.*—1. "The downward movement of water in laminar flow and usually at low velocities, through interconnected openings of saturated granular material under hydraulic gradients commonly developed underground." 2. "The flow or trickling of a liquid downward through a relatively coarse filtering medium. The liquid usually does not fill the pores of the medium." 3. "The water lost from an unlined conduit through its sides and bed." *See:* Hydrologic Nomenclature, National Resources Planning Board, Washington, D. C., Feb. 1, 1940.

pericyclonic ring, *n.*—A belt of slightly higher pressure surrounding a tropical cyclone; it "usually has a pressure of about 30.1 inches. It will be remembered that the occurrence of this high pressure was one of the first signs of the coming of the cyclone." (W. I. Milham Meteorology, 1936, p. 268.) The term was probably introduced by W. M. Davis. Ferrel was the first to call attention to the phenomenon, but did not use this term.

perihelion, *n.*—That point on the earth's orbit which is nearest the sun. It is now reached by the earth on about January 1, but the date varies irregularly from year to year and also has a slow secular change. *See:* Aphelion.

periodogram analysis, *n.*—A method of analyzing data in searching for periodic variations, developed by Arthur Schuster and so named by him. It has had many applications by many different writers.

"Schuster's method consists, first, of passing sine curves, of arbitrarily selected periods, through data in such manner as best to represent them by each. These periods must be so closely chosen that there shall be no intermediate ones untried that can have a large final disagreement in phase from the next neighboring one chosen for examination. The second part of the method consists of plotting the intensities of these curves as ordinates of another curve whose abscissae are the periods so chosen. This last curve he calls the periodogram." (Dinsmore Alter, Application of Schuster's Periodogram to Long Rainfall Records, Beginning 1748, Monthly Weather Review, Vol. 52, 1924, p. 479.)

personal equation, *n.*—A systematic error in observations due to the characteristics of the observer, which error is the difference between the true reading and that made by the observer. It may be ascertained very approximately (if the observer is a good one) by the personal equation machine. It is not applied in meteorological observations, as generally other errors obscure that due to an observer's characteristics.

phase, *n.*—1. In wave motion, an angular measure of the stage reached by the vibration in its progress through its cycle. Waves of the same phase travelling in the same path reinforce each other, while waves of opposite phases tend to destroy each other. A transverse wave, when reflected, is reversed in phase. 2. "One of the two or more dissimilar components of a body of matter . . . ; e. g., two immiscible liquids in contact, as the solid, liquid, and vapor phases of one substance in three-phase equilibrium." (L. D. Weld, Glossary of Physics, 1937, pp. 168–169.) For the phases of water, *see* TRIPLE POINT. *See:* N. Shaw, Manual of Meteorology, Vol. II, 1928, pp. xxxii–xxxiii.

phenology, *n.*—The science which treats of the interrelations of climatological and meteorological conditions with biological phenomena, both plant and animal. The data of phenology may be very detailed, as, for instance, in the case of trees and shrubs, the dates of (1) budding, (2) first leaf formed, (3) in full leaf, (4) first bloom, (5) full bloom, (6) fruit ripe, (7) complete change of foliage, (8) all leaves gone, (9) quantity and quality of fruit; in the case of grain, the dates of (1) planting, (2) appearance above ground, (3) in blossom, (4) ripe, (5) ready for use, (6) quantity and quality of the crop. Records of the habits of migrating birds are also kept: these records may be extended to include the habits of all wild life. Phenological records are of greatest value when a weather record is simultaneously made. From phenological records, Hopkins developed the BIOCLIMATIC LAW, q. v. *See:* C. F. Talman, The Realm of the Air, 1931, pp. 275–283.

photometer, *n.*—An instrument for measuring the intensity of luminosity of any source of light. *See:* ILLUMINOMETER.

photometry, *n.*—The science of measuring light intensity. *See*: PHOTOMETER; TELEPHOTOMETER.

physical climate, *n.*—SOLAR CLIMATE, q. v., as modified by the oceans, mountains, and other surface features of the earth. "These surface features react upon the atmosphere, and thus interfere with the uniform arrangement of the climatic zones, and with the simple demarcation by parallels of latitude which would exist in a purely solar climate. The chief causes of this interference with the regular solar climatic zones are (a) the irregular distribution of land and water upon the earth's surface, (b) the aerial and oceanic currents, which are thereby compelled to follow certain definite paths, and (c) the difference in altitude of the land above sea level." (J. Hann, Handbook of Climatology, Part I, tr. R. D. Ward, 1903, p. 128.)

physical climatology, *n.*—The science which, in contradistinction to DESCRIPTIVE CLIMATOLOGY, q. v., seeks the causes and effects of climate in climatic data, the facts of physical geography, and the laws of physics. It also employs observation, experiment, and mathematical analysis to arrive at its conclusions. It endeavors to explain the various kinds of climates, such as marine, continental, desert, monsoon, etc.; to set forth the reasons why, for instance, places on the same parallel of latitude have different climates, and to answer many other questions suggested by the study of descriptive climatology.

physical meteorology, *n.*—The branch of meteorology which seeks to explain all atmospheric phenomena by the accepted principles of physics. It, therefore, deals with the mechanics and thermodynamics of the atmosphere, and also explains electrical, optical, and acoustical phenomena.

pibal, *n.*—An artificial word, blended from and meaning pilot balloon observation. *See:* BALLOON; PILOT BALLOON.

Piché evaporimeter, *n.*—A form of EVAPORIMETER, q. v.

piezotropy, *n.*—A condition of the atmosphere, in which the density of an individual element of air continuously depends only on its pressure. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 131, 133.

pileus, *n.*—A cap or hood; applied principally to cumulus or cumulonimbus clouds which have a veil-like structure partially obscuring the bulging or cauliflower heads.

pilot balloon, *n.*—A small rubber balloon which, when inflated with hydrogen and released and observed with a theodolite during its ascent, furnishes data from which may be calculated the direction and speed of the wind at all levels from the surface to the end of its flight.

pilot chart, *n.*—A chart published for each of the oceans, by the Hydrographic Office of the Navy Department in co-operation with the U. S. Weather Bureau, for the benefit of navigators. There are six of these charts issued—for the North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian Oceans, and for Central American waters—of which all are published monthly except the South Atlantic and South Pacific charts, which appear as quarterlies. The Hydrographic Office collects and compiles data for such purely maritime factors as steam and sail routes, gale and storm warnings, ocean depths, ice (coastwise, field, and berg), wrecks and derelicts, ocean and tidal currents, rocks and shoals, etc. The Weather Bureau supplies the following information: average conditions of wind and weather, storm tracks, air and sea surface temperature, average direction and force of wind by 5° squares, percentage of calms, gales, fogs, atmospheric pressure.

pirep, *n.*—An artificial word, abbreviated from pilot report, and referring to information on conditions in the atmosphere supplied by airplane pilots.

Pitot tube, *n.*—"A tube with an end open square to a fluid stream. It is exposed with the open end pointing upstream to detect an impact pressure. It is usually associated with a coaxial tube surrounding it, having perforations normal to the axis for indicating static pressure; or there is such a tube placed near it and parallel to it, with a closed conical end, and having perforations in its side. The velocity of the fluid can be determined from the difference between the impact pressure and the static pressure, as read by a suitable gage. This instrument is often used to determine the velocity of an aircraft through the air." (National Advisory Committee for Aeronautics, Nomenclature for Aeronautics, Report No. 91, 1921.) *See:* Venturi Tube.

pivoting high, *n.*—A type of Anticyclone, q. v., which has been described as follows: "Anticyclones that make their first appearance in the Mackenzie Valley move southward and southeastward over Saskatchewan and Manitoba with an extension southward over the eastern slope of the Rocky Mountains and the Plains States, sometimes as far south as Oklahoma and northern Texas. The main center remains over Saskatchewan and Manitoba, while the southern extension swings to the eastward. This pivoting over Saskatchewan and Manitoba and the swinging eastward of the southern part of the axis in most cases presages the development of a LOW in the Southwest and the rapid development of general rains over the Gulf States and rains or snows in the Ohio and middle Mississippi valleys. This type has a number of variations, due to the location of the HIGH axis, but they all have similar subsequent behavior." (R. H. Weightman, Forecasting from Synoptic Weather Charts, April, 1936, U. S. Department of Agriculture, Miscellaneous Publication No. 236, p. 43.)

Planck's law, *n.*—An equation expressing the variation of the intensity of black-body radiation with wave length at a given temperature; it may be written:

$$J_\lambda = \frac{c_1 \lambda^{-5}}{e^{\frac{c_2}{\lambda T}} - 1}$$

where J_λ is the energy emitted per unit area per unit time at a certain wave length λ, T is the absolute temperature, e is the base of natural logarithms, and c_1 and c_2 are constants. *See:* Radiation; Radiation Laws.

plum rains, *n.*—The rainy season of Japan and eastern China, occurring during their summer. *See:* Bai-u.

pluvial, *adj.*—Relating to rain; but generally, in climatology, with reference to former periods of abundant rains, such as the pluvial periods of any region. Great Salt Lake in Utah is the remnant of the once larger Lake Bonneville whose elevation was 1,000 feet above that of Great Salt Lake and covered 20,000 square miles during an ancient pluvial period.

pluvial index, *n.*—The amount of precipitation falling in one day, or other specified period, that is likely to be equalled or exceeded at any given place once in 100 years. This is an arbitrary definition set up for a practical purpose by the Miami Conservancy District (*see* Technical Report, pt. 5, p. 80 ff.). It is apparent that a pluvial index may be differently defined for any purpose at hand. *See:* Isopluvial.

pluviometric coefficient, *n.*—"The ratio of the actual precipitation in any month to what would have fallen had the rainfall been uniformly distributed throughout the year. To obtain this, the percentage of the annual rain falling in a given month is calculated; and the ratio of this to the percentage that would fall in a month of that length, were the rainfall uniform, is the hyetal (or pluviometric) coefficient. For instance, the mean annual rainfall of Paris is 527 mm. (20.7 inches), and the mean January rainfall is 36 mm. (1.4 inches) or 6.8 percent of the annual. Were the rainfall uniform, 8.5 percent would fall in a month like January with thirty-one days. The hyetal (pluviometric) coefficient is therefore 6.8/8.5 or 0.80." (Bartholomew's Physical Atlas, Vol. III, Atlas of Meteorology, ed. A. Buchan, 1899, p. 22.) *See:* RAININESS.

pocky cloud, *n.*—Same as a mammiform cloud. *See:* MAMMATUS.

pogonip, *n.*—An American Indian word applied to frozen fog of fine ice needles occurring in the mountain valleys of western United States.

The pogonip is no different from frozen fog in other districts, but has become noted because of the Indian tradition that breathing it is very injurious to the lungs, although there seems to be no basis in fact for this belief.

S. B. Doten says of the pogonip: "This frost fog is the pogonip, a peculiar and interesting phenomenon which may occur in any of the cold months from November to the middle of March. It is most common in December, January, and February, often appearing early in the morning and disappearing again before noon. At times, however, when there is no wind, the pogonip may linger in the valley for days together, hiding the sun and shrouding everything in a white coat of frost. Then telegraph wires become snowy ropes. Every twig of every tree is heavy and white with crystals. Even last year's cobwebs become a dainty lace of frost.

"In the midst of a pogonip one may leave the valley and, climbing up the mountain side, come out above the fog into brilliant winter sunshine and a cloudless sky. The pogonip is far below in the valley, a sea of cloud breaking in white billows along the mountain slopes." (S. B. Doten, Nevada State University, Agricultural Experiment Station Bulletin 59, 1905, p. 15.)

point, *n.*—1. In Australia, a unit used in measuring rainfall; equal to one one-hundredth of an inch. In the published tables the rainfall there is given always in points, not in inches and hundredths. 2. In France, a unit of length, equal to $\frac{1}{12}$ ligne, (0.0074 inch or 0.19 mm.). 3. In England, a unit of length, equal to $\frac{1}{6}$ line, (0.0139 inch or 0.353 mm.) 4. In nautical parlance, a measurement of direction, equal to $11\frac{1}{4}$ degrees, there being 32 points of division on the compass card. 5. Position or time of occurrence, as in boiling point and freezing point.

Poisson's equation, *n.*—The equation expressing the relation between the pressure and the temperature of a perfect gas in an adiabatic process;

$$\frac{T}{T_0}=\left(\frac{p}{p_0}\right)^{0.287}$$

where T and p represent the absolute temperature and the pressure respectively, and T_0 and p_0 their initial values. When p_0 is taken as 1,000 mb., T_0 becomes θ, the POTENTIAL TEMPERATURE, q. v.

polar air, *n.*—Cold, dry air formed in the subpolar anticyclones, and divided into two types of air masses, POLAR CONTINENTAL (*cP*) and POLAR MARITIME (*mP*), which are discussed under separate entries. *See:* AIR MASS (1); SOURCE REGION.

polar continental air, *n.*—An air mass, designated *cP* in the Bergeron classification, formed in the northern regions of Europe, Asia, and North America, and characterized by: (1) Low surface temperature; (2) Stability in the lower layers; very often a temperature INVERSION, q. v.; (3) Very low moisture content, the value of the mixing ratio being seldom more than 1 gram per kilogram; (4) Shallow vertical extent, often less than 3 km. *cPk* air, that is, polar, continental air which is colder than the underlying surface, receives added heat and moisture, and tends to instability. It is accordingly marked by convective clouds, turbulence, good visibility, rain or snow showers, and gusty winds. Polar continental air that is warmer than the ground (*cPw*) is characterized by stratiform clouds, poor visibility, drizzle, and a temperature inversion. These features follow from the increased stability due to surface cooling. *See:* AIR MASS (1); AIR MASS MODIFICATIONS; CONSERVATIVE (AIR MASS) PROPERTY; *also* J. Namias, Air Mass and Isentropic Analysis, 5th ed., 1940, pp. 81–88.

polar front, *n.*—The frontal zone between air masses of polar origin and those of tropical origin, located in the mean at a latitude of about 60°. Byers describes it as follows:

"The so-called polar front is the meeting place of these two currents—westerlies from low latitudes and northeast winds from the pole. If there is a piling up of air in the polar region, an accumulation of polar air will push the front southward, forming a wave in it. . . . This will give the initial development of an extratropical cyclone which may draw the air far to the south, sometimes even pushing it into the trade-wind circulation.

"The southward movement of the polar front results in a disturbance of the west-wind flow of middle latitudes, brings about the cold waves of these latitudes, and causes the large scale changes in the weather observed in these regions." (H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 70 and 71.)

polarimeter, *n.*—An instrument used in meteorology for measuring the percentage of polarization of the light from any point of the sky. *See:* POLARISCOPE.

polariscope, *n.*—An instrument for detecting polarized light and investigating its properties. In meteorology, a polariscope, mounted on a quadrant, is used to determine the angular position, with respect to the sun, of the neutral points of Arago, Babinet, and Brewster. *See:* POLARIZATION; NEUTRAL POINT.

polarization, *n.*—A state of radiant energy in which the transverse electromagnetic vibrations take place in a regular manner—e. g., all in one plane, or in an ellipse or some other definite curve. Normally radiation is unpolarized, and must have been subjected to special conditions in order to have become polarized.

In the sky, there are three NEUTRAL POINTS, q. v., named after Arago, Babinet, and Brewster, the light from which is unpolarized; otherwise, "part of the light from nearly all points in a clear sky is plane polarized, whatever the season, location, altitude of the sun, or other conditions." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 574; cf. pp. 571–575.)

polar maritime air, *n.*—An air mass, denominated *mP* in the Bergeron classification, which originates over the polar seas and has initial properties similar to those of POLAR CONTINENTAL AIR, q. v. During its passage equatorward over progressively warmer water, however, prolonged heating and moistening change the air mass "from a cold, dry, extremely stable condition to one of marked conditional instability with a comparatively high moisture content in the lower strata." (J. Namias, Air Mass and Isentropic Analysis, 5th ed., 1940, p. 88.) *See:* AIR MASS (1); *mPw* air, therefore, resembles *cPw* air (*see* CONTINENTAL POLAR AIR); but *mPk* air, i. e., maritime polar air colder than the sea surface, has the following special characteristics: (1) Increasing temperature and humidity; (2) Steep lapse rate and instability; (3) Turbulence, gusts, and squalls; (4) Cumulus and cumulonimbus clouds; (5) Variable sky, changing from dark and threatening to bright or clearing; (6) Showery precipitation that commences and ceases abruptly; (7) Good visibility between showers; (8) Height of the base of the clouds moderate, but rarely less than 1,000 feet. *See:* S. Petterssen, Introduction to Meteorology, 1941, p. 129.

pole star recorder, *n.*—An instrument used to determine the amount of cloudiness during the dark hours, consisting of a fixed long-focus camera so mounted that the pole star is permanently in its field. If no clouds cover that part of the sky during the night, the circular trail of the north star will be continuous; the amount of cloudiness is approximately indicated by the proportion of the trail not recorded.

poorga, *n.*—Same as PURGA, q. v.

potential dew-point temperature, *n.*—The DEW POINT, q. v., which an element of moist air would have at a pressure of 1,000 millibars, i. e., at a temperature equal to its POTENTIAL TEMPERATURE, q. v.

potential energy, *n.*—The capacity of a body to do work due to its position or dynamical configuration. Water in a dam has potential energy due to its position, and a bent spring possesses potential energy because of its configuration.

potential gradient, *n.*—The difference of electric potential per unit distance vertically, between the earth and a point in the atmosphere; it "varies greatly with location, season, hour and weather conditions. It even reverses signs, frequently, during thunderstorms and often reaches 10,000 volts per meter, but its general average over the sea and level land areas, during fine weather, appears to be of the order of 100 volts per meter, in response to a negative surface charge." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 397.)

potential instability, *n.*—Same as CONVECTIVE INSTABILITY, q. v.

potential pseudo-equivalent temperature, *n.*—The temperature that would be assumed by an element of moist air (i. e., air with water vapor) after it had moved (a) upward dry-adiabatically to its condensation level, (b) pseudo-adiabatically upward until all the water vapor had been condensed, (c) dry-adiabatically downward to the standard pressure of 1,000 mb. It is strictly conservative with respect to both dry- and moist-adiabatic changes, and quasi-conservative for evaporation from falling rain.

potential pseudo-wet-bulb temperature, *n.*—The temperature that would be assumed by an element of moist air after it had been moved upward dry-adiabatically to its condensation level and thence downward moist-adiabatically to the standard pressure of 1,000 mb.; it has the same properties as the conservative POTENTIAL PSEUDO-EQUIVALENT TEMPERATURE, q. v. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 23–25.

potential temperature, *n.*—The temperature to which air would come were it reduced adiabatically to the standard pressure of 1,000 millibars. It is invariant for dry-adiabatic ascent and descent provided no condensation or evaporation occurs. Shaw calls it megatemperature or megadyne temperature. Its value is

$$\theta = T\left(\frac{1000}{p}\right)^{0.288}$$

where θ=potential temperature, T=absolute temperature of the air, p=pressure (total) of the air.

"In 1888 the late Professor von Helmholtz incidentally introduced the term 'waermegehalt' in connection with his investigations on atmospheric motions. According to him the 'waermegehalt' or the actual heat contained in a given mass of air is to be measured by the absolute temperature which the mass would assume if it were brought adiabatically to the normal or standard pressure. It remained for the late Professor von Bezold, however, to perceive the full significance of this term and to reveal its important bearing in the discussion of meteorological phenomena.

"As the quantity really involved in this new term is not a quantity of heat, von Bezold suggested that the term be replaced by the evidently more appropriate one of 'potential temperature.' This met with von Helmholtz's approval." (L. A. Bauer, The Relation between "Potential Temperature" and "Entropy," The Physical Review, Vol. XXVI, 1908, p. 177.)

potential vorticity, *n.*—The VORTICITY, q. v., which a column of air between two adjacent isentropic surfaces would have if it were brought to an arbitrary "standard" latitude and then stretched or shrunk to an arbitrary "standard" thickness; used as a conservative air mass property for identifying air and tracing its movement. *See:* V. P. Starr and M. Neiburger, Potential Vorticity as a Conservative Property, Journal of Marine Research, Vol. III, No. 3, 1940; M. Neiburger, Vorticity Analysis of a Thunderstorm Situation, Bulletin of the American Meteorological Society, vol. 22, 1941, pp. 1–5.

potential wet-bulb temperature, *n.*—*See:* Wet-Bulb Potential Temperature.

prairie, *n.*—A geographic type of region intermediate between forest and grassland, usually capable of becoming deciduous forest; the vegetation, largely grasses, is still distinct from that of the Savanna, q. v., and the swampy grasslands.

precip., *abbr.*—Abbreviation used in meteorological station parlance for Precipitation, q. v.

precipitation, *n.*—A general term for all forms of falling moisture, which, more specifically, include rain, snow, hail, sleet, and their modifications. The more common term, rainfall, is also used in this general sense; for instance, it is commonly stated that the average annual rainfall at Washington, D. C., is 42.16 inches, which includes rain, and the water equivalent of snow, hail, sleet, etc.

precipitation area, *n.*—A region over which rain or snow is falling; shown on a manuscript weather map by green shading or hatching, according as the precipitation is continuous or intermittent, and on printed U. S. Weather Bureau maps by a black dot shading.

precipitation effectiveness, *n.*—A climatic element in Thornthwaite's classification of climates, which measures the ability of precipitation to promote plant growth, and "grades from a maximum in the tropical rain forest to a minimum approaching zero in the tropical desert." (C. W. Thornthwaite, The Climates of the Earth, The Geographical Review, vol. 23, 1933, p. 433.)

The precipitation effectiveness ratio of a single month is given by the formula

$$\frac{P}{E}=11.5\left(\frac{P}{T-10}\right)^{\frac{10}{9}}$$

were P is the monthly precipitation in inches, E the monthly evaporation in inches, and T the mean monthly temperature in degrees Fahrenheit. To obtain the precipitation effectiveness of a given station the sum of the twelve monthly P–E ratios is taken. *See:* Temperature Effectiveness; Rainfall Effectiveness; C. W. Thornthwaite. The Climates of North America According to a New Classification, The Geographical Review, vol. 21, 1931, pp. 633–655.

precipitation gage, *n.*—*See:* Rain Gage.

pressure, *n.*—1. Force per unit area; in meteorology, most commonly expressed either in terms of the length in inches of the column of mercury sustained by the force, or in terms of millibars, though dynes per square centimeter and millimeters of mercury are sometimes used. 2. Commonly used for Atmospheric Pressure, q. v.

pressure altitude, *n.*—A phrase used in air navigation, defined as: "The altitude indicated by an altimeter when the barometric scale is adjusted to the standard sea-level atmosphere pressure of 29.92 inches." (Thoburn C. Lyon, Practical Air Navigation, Civil Aeronautics Bulletin No. 24, 1940, p. 26.)

pressure gradient, *n.*—*See:* Gradient.

pressure of radiation, *n.*—*See:* Radiation Pressure.

prevailing wind, *n.*—The direction from which the wind blows during the greatest proportion of the time. It is sometimes defined as that direction from which the wind blows with greatest frequency; but since the frequency is usually taken from automatic records which indicate the direction once every minute, the "greatest frequency" corresponds to the "greatest length of time."

primary circulation, *n.*—The prevailing fundamental atmospheric CIRCULATION, q. v., that occurs on a planetary scale because of the fact that in equatorial regions the earth's surface and the atmosphere gain heat from solar radiation, whereas in higher latitudes (beyond about 40 degrees) there is a net loss of heat by radiation from the earth and the atmosphere. This net equatorial heating and polar cooling lead to an interzonal circulation of air, in which heat energy is transferred from equator to pole by the actual transport of air. Due to the deflecting influence of the earth's rotation, this meridional circulation has a system of zonal circulations superimposed upon it; and the effect of land and sea distribution is to render the general circulation even more complex by setting up the semi-permanent centers of action—such as the Aleutian Low and the Siberian High—with their resultant large-scale wind and pressure patterns.

In Rossby's theory, the primary circulation in both the northern and the southern hemisphere resolves itself into three cells: (1) In the trade-wind cell, between the equator and approximately 35°, the heated air rises at the equator and flows poleward with an eastward component as the antitrade winds, until it settles to the earth, creating a set of high pressure cells in the so-called horse latitudes. The northeast and southeast trade winds, blowing toward the equator, complete the circulation of this cell; they converge and rise above the surface as they near the equator, producing the moist, cloudy, and squally doldrums. (2) In the middle cell, between 35° and 60° on the average, part of the subsiding antitrades escapes poleward in the form of the westerlies of middle latitudes. At the polar front, located in the mean at 60° north and south latitude, they are forced aloft, and either return equatorward aloft and subside at the horse latitudes (to close the circulation of the middle cell), or continue poleward at high levels. (3) In the polar-front cell, between 60° and the poles, the poleward-moving air stream just mentioned settles to the surface at the poles and returns equatorward as the polar easterlies. Thus the primary or general circulation is in its broad outlines consummated; and the SECONDARY and the TERTIARY CIRCULATION, q. v., constitute the relatively smaller wind systems which complete the vast and complicated structure of our ever-moving atmosphere. *See:* H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 63–75; C. W. Barber, An Illustrated Outline of Weather Science, 1943, pp. 80–86; B. C. Haynes, Meteorology for Pilots, 2d ed, 1943, pp. 125–128; C. G. Rossby, The Scientific Basis of Modern Meteorology, Climate and Man, 1941 Yearbook, U. S. Department of Agriculture, pp. 599–610.

probabilities, *n.*—A term used in the early years of the U. S. Weather Bureau, with the same meaning as FORECAST, q. v.

projection, *n.*—*See:* MAP PROJECTION.

projector, ceiling, *n.*—*See:* CEILING LIGHT.

pseudoadiabatic chart, (or **diagram**), *n.*—An ADIABATIC CHART, q. v., to which two more sets of lines are added—curves of constant saturation mixing ratio, and pseudoadiabats. The abscissa is temperature in degrees centigrade, the ordinate is the 0.288 power of the pressure in millibars; dry adiabats are shown by the sloping, straight lines. On this chart, both dry- and pseudo- (or saturated) adiabatic motions of air may be determined, and many useful data derived, such as the dew point, condensation level, a rough estimate of the possible precipitation to be derived from the air, etc. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 49–54; C. W. Barber, An Illustrated Outline of Weather Science, 1943, pp. 54–76.

pseudoadiabatic process, *n.*—A process wherein all of the condensation that occurs in a rising element of moist air immediately falls out. This process differs from an ADIABATIC PROCESS, q. v., in that it is nonreversible, and in the fact that the hail stage does not occur, since all the condensed moisture falls out; therefore, a rising element of air undergoing the pseudoadiabatic process and returning to its original position becomes somewhat warmer and drier than before. The rise in temperature is due to the heat of condensation, and the increased dryness is due to the loss of some of its original moisture by precipitation.

pseudo-equivalent temperature, *n.*—The temperature that would be assumed by an element parcel of moist air which had (a) been moved upward dry-adiabatically to its condensation level, (b) then upward pseudoadiabatically until all its water vapor content had been condensed, and (c) finally returned dry-abiabatically downward to its original pressure.

pseudo front, *n.*—A FRONT, q. v., possessing some of the characteristics of a normal front but without any definite air-mass discontinuity.

pseudo wet-bulb temperature, *n.*—The temperature that would be assumed by an element parcel of moist air which had been moved upward dry-adiabatically to its condensation level, and thence returned moist-adiabatically down to its original pressure. It has also been called the adiabatic wet-bulb temperature. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, p. 25.

psychrometer, *n.*—An instrument first suggested by Gay-Lussac (1778–1850), and now widely used at meteorological observatories to determine the amount of atmospheric moisture. It consists essentially of two thermometers, one of which has its bulb covered with a closely fitting jacket of clean muslin which is saturated with water when an observation is about to be taken. Both thermometers are well ventilated, either by whirling them, or by blowing or drawing air past them. Because of evaporation, the reading of the moistened thermometer is lower than that given by the dry-bulb, and the difference in degrees between them is called the depression of the wet-bulb. This, used with the atmosphere pressure, gives a measure of the humidity. By reference to appropriate tables the dew point, relative humidity, and vapor pressure may be obtained.

The SLING PSYCHROMETER, q. v., is widely used, but the Assmann aspiration psychrometer is the most nearly perfect in design, because the air is drawn equally past all parts of both bulbs, and both thermometers are shielded to minimize radiation effects. *See:* W. J. Humphreys, Remarks on the Theory of the Psychrometer, Monthly Weather Review, vol. 61, 1933, p. 300 ff.; Psychrometric Tables, U. S. Weather Bureau, 1941, pp. 5–14.

psychrometric chart, *n.*—A nomograph for graphically obtaining relative humidity, absolute humidity, and dew point from wet- and dry-bulb thermometer readings. "The temperatures of the dry bulb are plotted along the horizontal direction and are represented by the vertical lines, the values of which are indicated at the top. The differences between the wet- and dry-bulb thermometer temperatures are plotted along the vertical direction and are represented by the horizontal lines, the values of which are indicated at the left. Relative humidities are represented by the solid lines that slope upward to the right; their values are indicated at the right margin. Absolute humidities are represented by the broken lines that slope upward more sharply to the right; their values are indicated at the bottom of the chart." (J. G. Albright, Physical Meteorology, 1939, p. 153; cf. pp. 154–155.)

psychrometric formula, *n.*—An equation expressing the relation between the actual vapor pressure and the saturated vapor pressure at the temperature of the wet bulb of the PSYCHROMETER, q. v., and used in the preparation of PSYCHROMETRIC TABLES, q. v., in the following simplified form due to William Ferrel:

$$e=e'-AB(t-t')$$

where t is the air temperature as given by the dry bulb, t' is the wet-bulb temperature, e is the vapor pressure, e' is the saturated vapor pressure at t', B is the barometric pressure, and A is a quantity which, for the same instrument and for certain conditions, is a constant, or a function depending in a small measure on t'. Ferrel determined its value to be

$$A=0.000660(1+0.00115t')$$

and thus obtained the following final form of the equation, in which temperatures are measured in Fahrenheit degrees and pressures in inches:

$$e=e'-0.000367\,B(t-t')\left(1+\frac{t'-32}{1571}\right)$$

See: J. G. Albright, Physical Meteorology, 1939, pp. 141–156; Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. lxviii–lxx.

psychrometric tables, *n.*—Tables prepared from the PSYCHROMETRIC FORMULA, q. v., and used for obtaining the vapor pressure, relative humidity, and dew point from the readings of the wet- and dry-bulb thermometers. *See:* C. F. Marvin, Psychrometric Tables, U. S. Weather Bureau, 1941; Smithsonian Meteorological Tables, 5th rev. ed., 1939, pp. 180–201.

puff, *n.*—*See:* CAT'S PAW.

pumping of the barometer, *n.*—The oscillation of the mercury column in a barometer when it is exposed to gusts of wind from open doorways, windows, or chimneys; also the more violent oscillations of the mercury column on board ship, due to the motion of the vessel; pumping occurs even when a barometer is carried in an upright position in the hand. *See:* BAROMETER.

purga (or **poorga**), *n.*—A storm, similar to the blizzard of North America and the buran of south Russia and central Siberia, which rages in the tundra regions of northern Siberia in the winter. *See:* BURAN.

purple light, *n.*—"The purple or rosy glow observed over a large area of the western sky after sunset and the eastern sky before sunrise; it lies above the bright segment that borders the horizon." (Instructions for Marine Meteorological Observers, Circular M, 1938 U. S. Weather Bureau, p. 105.)

pyranometer, *n.*—An instrument designed to measure the intensity of incoming radiation from a part, or from the complete hemisphere, of the sky; also to measure the ALBEDO, q. v., of the many varieties of the earth's surface. In this instrument, used by Abbot and Aldrich, two strips of manganin are exposed to the incoming radiation, and the amount of heat received on them is measured by balancing electric currents from thermoelements in the strips. *See:* The Pyranometer—An Instrument for Measuring Sky Radiation, C. G. Abbot and L. B. Aldrich, Smithsonian Miscellaneous Collection, vol. 66, No. 7.

pyrgeometer, *n.*—An instrument used to measure NOCTURNAL RADIATION, q. v. *See:* H. H. Kimball, Nocturnal Radiation Measurements, Monthly Weather Review, vol. 46, 1918, pp. 57–70.

pyrheliometer, *n.*—An instrument for measuring the intensity of incoming radiation from the sun or the sky, or both.

To measure the total incoming radiation (sun and sky), a device equally sensitive to all wave lengths is required; and since absorbed energy is converted into heat, an instrument which will indicate the quantity of heat received is suitable. The pyrheliometer is such an instrument. There are several varieties; but, with one exception (the water-flow type), they all employ either one or two pieces of metal upon which the radiation is received and converted into heat.

In the case of the one-piece pyrheliometer, the metal is alternately exposed to and shaded from the sun, and the difference in temperature obtained under the two conditions is taken as a measure of the radiation received. The temperatures under the two conditions are determined either by a thermometer or by electrical means such as a thermopile or a resistance thermometer.

If two metal pieces are used, one is exposed to the incoming radiation while the other is shaded, and the difference in temperature of the two pieces is indicated electrically. The Eppley type is used by the United States Weather Bureau; it consists of two concentric circular rings of metal of equal area, one blackened and the other white-coated. The hot junctions of a multiple-couple thermopile of gold-palladium and platinum-rhodium alloys are attached to the lower side of the black ring, and the cold junctions are fastened to the lower side of the white ring. The difference in temperature between the rings when radiation falls upon them creates an electromotive force that is nearly proportional to the intensity of radiation received. The electromotive force of these instruments has been calibrated in terms of gram-calories per square centimeter per minute, as measured by a Smithsonian silver-disk pyrheliometer.

The determination of the standard pyrheliometric scale is based upon observations using the Abbot water-flow black-body pyrheliometer, which is the primary standard. The scales of secondary instruments, such as the Abbot silver-disk pyrheliometer and the modified form of the Angstrom electrically-compensated pyrheliometer, are determined by comparison with the water-flow pyrheliometer. Among the measurements made with a pyrheliometer are: (1) The duration of direct solar radiation; (2) The intensity of direct solar radiation; (3) The intensity of the total radiation, direct and diffuse, received on a horizontal surface; (4) The intensity of diffuse solar radiation.

Q

q., *abbr.*—Abbreviation for squally weather in the Beaufort Weather Notation, q. v.

R

r., *abbr.*—Abbreviation for Rain in the Beaufort Weather Notation, q. v.

R., *abbr.*—Abbreviation for Réamur (temperature). *See:* Temperature Scale.

rabal, *n.*—A portmanteau word, signifying records of upper wind speed and direction and obtained by following the progress of radiosonde balloons by a theodolite.

radiant energy, *n.*—*See:* Radiation.

radiant heat, *n.*—1. Heat in transit in the form of electromagnetic radiation. Radiant heat may be reflected, refracted, and polarized the same as light. When it strikes any absorbing substance, heat is produced (i. e., molecular vibration), and the substance will reradiate heat waves of the same character as the incident radiation. Radiant heat may also, if of the proper wave length, cause the sensation of vision. 2. Heat resulting from transformation of radiant energy into heat energy (molecular vibration). Thus the warmth resulting from the radiation from a fireplace is often called radiant heat.

radiation, *n.*—1. Radiant energy. 2. The process by which energy is transferred through space or through a material medium from one place to another in the form of electromagnetic waves.

In meteorology and climatology, radiation from the sun, earth, and atmosphere, and the absorption of radiation by the earth and atmosphere, are of fundamental importance. Solar radiant energy is manifested by three physical effects—thermal, chemical, and optical; but since any radiation when absorbed is transformed into heat, the total radiation from the sun or any particular wave-length band of it may be measured by the PYRHELIOMETER, q. v. The three effects just enumerated are each strongest in a certain part of the spectrum, but overlap; for example, the chemical effect, although strongest in the violet and ultraviolet, occurs also in other wave lengths.

The intensity of *insolation* on any part of the earth depends upon the value of the solar constant or output, the distance of the earth from the sun, the directness of the rays, and the amount absorbed by the atmosphere. *See:* RADIATION LAWS; TERRESTRIAL RADIATION; AIR MASS (1).

radiational cooling, *n.*—*See:* NOCTURNAL RADIATION.

radiation fog, *n.*—*See:* FOG.

radiation laws, *n.*—Physical laws which state general fundamental principles to which radiation phenomena conform. The more important are: (1) Kirchoff's law: The ratio of the emissive power of any radiating body to its absorbing power at the same given wave length depends only on the wave length and the absolute temperature of the body. (2) Stefan-Boltzmann's law: The total radiation intensity of a BLACK BODY, q. v., is equal to a constant multiplied by the fourth power of the body's absolute temperature. (3) Wien's law: In black-body radiation, the wave length at which the intensity is a maximum is inversely proportional to the absolute temperature of the radiating body. (4) Planck's law: A law of spectral distribution of intensity in black-body radiation expressed by equation,

$$E_\lambda = \frac{C_1 u^{-5}}{e^{\frac{C_2}{T}} - 1}$$

where E_λ=energy radiated at wave length λ; C_1 and C_2 are constants; T=absolute temperature; and e=the base of natural logarithms. These laws are more fully discussed under separate entries.

radiation pressure, *n.*—"A pressure exerted upon a surface exposed to light or other electromagnetic radiation, the value of which is proportional to the radiant energy density in the space to which the surface is exposed." (L. D. Weld, Glossary of Physics, 1937, p. 188.)

radio-atmometer, *n.*—An instrument designed to compare the varying intensities of sunlight on plant foliage, "being affected in much the same manner as are plants by the two aerial factors, evaporating power of the air and the intensity of radiation." (B. E. Livingston, A Radio-Atmometer for Comparing Light Intensities, Plant World, vol. 14, 1911, pp. 98–99.) It is "merely the common form of porous clay atmometer with the clay surface so modified that it absorbs a considerable amount of the radiant energy falling upon it. Two forms of cup are available, one made of colored clay, the other coated with lampblack . . . the dark cups function as does the white one (in an ordinary ATMOMETER, q. v.), to integrate the effects of the evaporating power of the air, and they add to these the effects of their more complete absorption of radiant energy." (Ibid. pp. 97–98.)

radiometeorograph, *n.*—A device for automatic radio transmission of the indications of a set of meteorological instruments, installed in a sounding balloon, airplane, etc. *See:* Radiosonde.

radiometer, *n.*—1. An instrument for measuring radiant energy. The type designed by W. H. Dines was intended "to determine the radiation from the sky by finding the temperature of a full radiator which produces the same radiation effect upon the instrument as the actual radiation from the sky. The instrument consists of an ether differential thermometer, one bulb of which is exposed to the sky, and the other to a source of heat or cold, which is radiating fully, of which the temperature is measured. When a balance is secured the temperature of the radiating source is the 'equivalent radiating temperature' of the sky." (A Dictionary of Applied Physics. ed. R. T. Glazebrook, Vol. III, 1923, p. 514.) 2. Another type of radiometer is one invented by Sir William Crookes, consisting "essentially of a horizontal bar delicately suspended in a properly exhausted vessel. At each end of the bar is attached a thin glass disk blackened on one side." The radiation, upon striking the black surface, produces heat, and the black disk is repelled. This type is often seen in opticians' windows. It has been used to measure the pressure exerted by a sunbeam. *See:* Henry Crew, General Physics, 1916, p. 304.

radiosonde, *n.*—An instrument equipped with elements for determining the pressure, temperature, and relative humidity of the upper air, and with radio units for automatically transmitting the measurements to ground stations. Radiosondes are carried aloft by balloons to elevations of 15 to 18 kilometers, and during such flights, signals are continually transmitted to indicate the conditions of pressure, temperature, and relative humidity prevailing in the air through which the instrument passes. The balloon rises to its bursting point, and the radiosonde returns to earth by means of a parachute. *See:* W. E. K. Middleton, Meteorological Instruments, 1942, pp. 191–206.

Radio Weather Aids, *n.*—A publication of the Hydrographic Office of the U. S. Navy Department, which gives, among other information useful to seamen, the call letters and wave lengths of stations which broadcast weather summaries and forecasts. *See:* Pilot Chart; Sailing Directions.

rain, *n.*—Precipitation which reaches the earth's surface as water droplets, and which may be classified for convenience in reporting as: (a) light, the rate of fall being from a Trace, q. v., to 0.10 inch per hour; (b) moderate, from 0.11 to 0.30 inch per hour; (c) heavy, over 0.30 inch per hour; (d) Shower, q. v., characterized by the suddenness with which the rain starts or stops and by rapid changes in its intensity.

There are various kinds of colored rain, such as blood, black, yellow rain, etc., due to foreign matter in the atmosphere picked up by the rain in its descent. *See:* C. F. Talman, The Realm of the the Air, 1931, pp. 272–274. —*v.* To fall on the earth as drops of water, no matter in what form the precipitation leaves the clouds.

rain and snow, mixed, *n.*—Concomitant precipitation of rain and snow. In England and some parts of North America, this hydrometeor is called Sleet, q. v. See: Hydrometeor; Precipitation; Rain; Snow.

rainbow, *n.*—A circular arc of concentric spectrally-colored bands, seen on a sheet of water drops—rain, fog, spray, etc.—the common center of which "is on the line connecting the observer's eye with the existing light (sun, moon, electric arc, etc.) or rather, except rarely, on that line extended in the direction of the observer's shadow. . . . A very great number of rainbows are theoretically possible . . . though only three (not counting supernumeraries) certainly have been seen on sheets of rain. The most brilliant bow, known as the primary, with red outer border of about 42° radius and blue to violet inner border, appears opposite the sun (or other adequate light); the next brightest, or the secondary bow is concentric with the primary bow, but the order of its colors is reversed and its radius, about 50° to the red, is larger; the third or tertiary bow, having about the same radius as that of the primary, and colors in the same order, lies between the observer and the sun, but is so faint that it is rarely seen in nature. Obviously, the common center of the primary and secondary bows is, angularly, as far below the observer as the source (sun generally) is above, so that, usually, less than a semi-circle of these spectral arcs is visible, and never more, except from an eminence." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 476; cf. pp. 476–500.) The rainbow is caused by refraction, internal reflection, and diffraction of sunlight or moonlight by the water droplets.

Travelers on airplanes often report having seen the complete circle. If the sun is near the horizon, then to see the complete circle, the observer's elevation must be about nine-tenths of his distance from the curtain of rain; i. e. if rain is falling one mile away, the observer should be at least 4,800 feet above the earth's surface. *See:* N. Shaw, Manual of Meteorology, Vol. III, p. 88; J. G. Albright, Physical Meteorology, 1939, pp. 363–370; T. Preston, Theory of Light, 5th ed., 1928, pp. 572–584; C. F. Talman, A Book About the Weather, 1931, pp. 120–129; R. W. Wood, Physical Optics, 3d ed., 1934, pp. 388–394.

rain cloud, *n.*—Any cloud from which rain falls. In the older classifications of clouds, any cloud from which rain or snow was falling was called Nimbus, q. v.

rain day, *n.*—A period of twenty-four hours, commencing at 9 a. m., in which 0.01 inch (or 0.2 mm.) or more of rain is recorded. *See:* Rainy Day.

raindrop, *n.*—A drop of liquid water formed in the atmosphere from Cloud Particles, q. v.; formerly thought to be merely an oversized cloud particle, produced by continued condensation and coagulation, but now believed to originate in a much more complex and still imperfectly understood fashion. The salient fact is that a raindrop reaches the ground before it evaporates, while a cloud particle does not. This fact is due to the relative sizes of these water droplets, for an average-sized cloud particle, 0.01 mm. in diameter, has a rate of fall so small that it would take forty hours to fall to the ground from a height of two kilometers, and hence "floats" in the air. At the critical diameter of 2×10^{-2} cm., however, a drop can fall 150 meters before evaporating; and this has been taken as the lower limit of size of a true raindrop. Various explanations have been offered by the writers cited below to account for the growth of a cloud particle into a raindrop. According to Tor Bergeron, the principal cause of growth, at least for rain in temperate latitudes, is the vapor pressure difference existing between liquid water and ice at subfreezing temperatures, which permits the ice crystal to enlarge at the expense of the other, until it falls, melts, and reaches the ground as a raindrop. This hypothesis, however, has not been accepted by all meteorologists. *See:* T. Bergeron, On the Physics of Clouds and Precipitation, Memoirs of the Meteorological Association, International Union for Geodesy and Geophysics, Lisbon, 1933; vol. 2, Paris, 1935, pp. 156–175; H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 176–185; W. Findeisen, Physics of Condensation and Precipitation, tr. A. R. Stickley (of the 3d of Findeisen's papers), U. S. Weather Bureau, 1939; G. C. Simpson, On the Formation of Clouds and Rain, Quarterly Journal of the Royal Meteorological Society, vol. 67, 1941, pp. 99–133; A. R. Stickley, An Evaluation of the Bergeron-Findeisen Precipitation Theory, Monthly Weather Review, vol. 68, 1940, pp. 272–280.

rain factor, *n.*—A measure of RAINFALL EFFECTIVENESS, q. v., "obtained by dividing the amount of rain (expressed in millimeters) by the mean temperature (expressed in degrees centigrade). This is for application climatically to large areas and assumes that evaporation is approximately proportional to mean temperature; other factors which are subject to much local variation are disregarded." (T. A. Blair, Climatology, 1942, p. 39.)

rainfall, *n.*—1. The amount of water falling from the clouds during a rainstorm. 2. Synonymous with PRECIPITATION, q. v. Rainfall (or precipitation) data for any place are given in a variety of ways, usually (a) the average monthly and annual amounts, (b) the greatest and least monthly and annual amounts, (c) the greatest hourly amounts, etc.

rainfall cloud, *n.*—*See:* RAIN CLOUD.

rainfall density, *n.*—*See:* RAINFALL INTENSITY.

rainfall effectiveness, *n.*—The ability of rainfall to promote vegetation; governed by the amount of rain absorbed by the soil and thus made available to the plant roots; controlling factors are (1) the total amount and character of the rainfall, (2) its rate of fall and seasonal distribution, (3) the losses due to RUN-OFF and EVAPORATION, q. v., (4) the character and condition of the soil and of the vegetation.

"Whether light or heavy rains are more valuable (for plant growth) depends on many conditions. In heavy downpours, most of the rain runs off the surface, carrying valuable soil with it, and does not become available to the plant roots. On the other hand, small amounts of rain followed by warm and sunny weather are quickly lost by evaporation and do not penetrate to sufficient depths to be of value. Light rains with cloudiness and high humidity, lasting several days, are effective in adding to the soil moisture, as are also moderate amounts at intervals." (T. A. Blair, Climatology, 1942, pp. 37–39.) *See:* PRECIPITATION EFFECTIVENESS; RAIN FACTOR.

rainfall intensity, *n.*—The average rainfall for each rainy day, obtained by dividing the total amount of rainfall for any period by the number of rainy days in the same period. Thus, if the rainfall for a place for July was 2.40 inches and there were 12 rainy days, the rainfall intensity would be 0.20 inch. *See:* RAININESS.

rain field, *n.*—"The area over which rain is falling at any specified time." (C. Salter, Rainfall of the British Isles, 1921, p. 289.)

rain (and **snow**) **gage,** *n.*—An instrument designed to measure the vertical depth of rain or snow (or its water equivalent). Due to the difficulty of obtaining exact measurements from a simple pan with vertical sides, exposed during the period of precipitation, and also because of the loss of water by evaporation, most gages are designed to magnify the depth of rainfall so that its real depth may be measured to the nearest hundredth of an inch or millimeter, and also to prevent evaporation as much as possible.

The rain gage types used by the Weather Bureau are the "8-inch gage," "tipping bucket gage," and "weighing rain and snow gage."

The 8-inch gage consists of a receiver in the form of a funnel whose diameter is exactly 8 inches at the wide end, an overflow can 24 inches in height upon which the receiver fits, a measuring tube 20 inches high and 2.53 inches in diameter into which the small end of the funnel fits, and a measuring stick graduated in proportion to the difference in area between the receiving-piece and the measuring tube. The actual catch is magnified ten times by this instrument. Snow is collected in the overflow can, with the funnel and measuring tube removed; the snow catch is melted and poured into the measuring tube and then measured the same as rain.

The tipping bucket gage has a receiving funnel also. The rainfall drips from the end of the funnel into one side of a delicately balanced bucket which is partitioned in the center and balanced upon a horizontal axis. When an amount of water equivalent to 0.01 inch of precipitation has collected in the bucket, it tips over, the water falls into the bottom of the gage, and the other half of the bucket automatically moves under the funnel spout. Each tip is recorded electrically on a moving drum. When the rain ends the amount collected in the bottom of the gage may be drained off, measured, and checked against the amount recorded. Snowfall is not measured in this gage.

The weighing rain and snow gage collects rain and snow in a suitable receiving bucket which is balanced upon springs. Within the gage is a drum, driven by clockwork, upon which a constant record of the accumulated precipitation is made. The lever system is so designed and so calibrated that the pen automatically reverses when it reaches the end of the drum and thus continues recording. This gage is more suitable for obtaining cumulative records than for short-term intervals and is less widely used by the Weather Bureau than the 8-inch and tipping bucket gages.

rain gush, *n.*—The sudden and heavy downpour of rain which occurs soon after a sharp clap of thunder, and which as been explained as follows: "In the violent turmoil of the cloud mass there is at times a sudden increase in the rate of condensation of moisture, and the resulting increase in the number of drops present sets off a lightning discharge, which of course produces the thunder." (W. R. Gregg, Aeronautical Meteorology, 1930, p. 212.) *See:* W. J. Humphreys, Physics of the Air, 1940, pp. 358–359.

raininess, *n.*—1. Same as RAIN INTENSITY, q. v. 2. "The average rainfall for rainy days, rainy day being defined in turn as one with 0.01 inch or more of rain or melted snow." (E. R. Miller, Raininess Charts of the United States, Monthly Weather Review, vol. 61, 1933, p. 44.) 3. Name given by Brooks and Glasspoole (British Floods and Droughts, 1928, pp. 186 and 191) to a measure of precipitation calculated for each century before actual measurements of precipitation began, from information in historical writings and by the following formula:

$$R=100+\frac{2(1.8w-d)}{\sqrt{n}}$$

where R is the raininess, w and d the number of years of great rains and of droughts respectively, and n the total number of all meteorological records during the century for which R is to be calculated. *See:* PLUVIOMETRIC COEFFICIENT.

rainless, *adj.*—Without precipitation; or sometimes simply without rain. As far as records indicate there seem to be no places where precipitation (rain or snow) never occurs, even though some years may be absolutely dry. At Arica, Chili, seventeen years of records with only three measurable showers show a yearly average of only 0.02 inch; and in Upper Egypt as many as ten years pass without measurable rain, though some very light sprinkles occur. In parts of Antarctica no rain falls, since all moisture occurs in the form of ice and snow.

rain shadow, *n.*—The region of diminished rainfall on the lee side of a mountain or mountain range, where the rainfall is noticeably less than on the windward side. A good example of rain shadow in the United States is the country east of the Sierra Nevadas, for the prevailing westerlies deposit most of their moisture on the western slopes of the range. *See:* OROGRAPHIC RAINFALL.

rain stage, *n.*—The interval in adiabatic ascent of air that extends from the point where saturation has been attained, when the dew point is above 32° F., to the point where the air has cooled to the freezing point at the saturation-adiabatic rate. *See:* ADIABATIC PROCESS.

rain trees, *n.*—(1) Trees abounding in insects which secrete moisture and afterwards exude it, causing a falling mist under the trees. (2) Trees and bushes which in foggy countries catch copious amounts of moisture from the air, which moisture sometimes falls so abundantly to the ground that it amounts to a moderate shower; this is simply FOG-DRIP, q. v.

rainy day, *n.*—An expression technically defined as a day with 0.01 inch or more of rain, but popularly considered as a day with more or less continuous rain.

It is the practice in the U. S. Weather Bureau to use the term "day with 0.01 or more" (of precipitation). In England the expression "rain day" or "day of rain" is used, and is defined, as a day with 0.01 inch or more of precipitation.

rainy season, *n.*—One of the two seasons in the tropics, i. e., the dry and the rainy seasons; the latter in some parts of the tropics is called winter. *See:* M. P. Nilsson, Primitive Time-Reckoning, 1920, pp. 54 and 55.

range, *n.*—A measure of the VARIABILITY, q. v., of a quantity, being the difference between the largest and the smallest values in the sequence of values of the quantity.

In meteorology, range is most commonly used in connection with temperature. The daily range is the difference between the highest and lowest temperatures recorded on a particular day; the mean daily range is the difference between the averages of the highest and lowest temperatures recorded for the same day over a long period of years. The absolute monthly range is the difference between the highest and lowest temperatures experienced during a particular month. The annual range is the difference between the mean temperatures of the warmest and coldest months of the year. The absolute range is the difference between the highest and lowest temperatures ever recorded. *See:* T. A. Blair, Climatology, 1942, pp. 14–19.

raob, *n.*—An artificial word introduced as an abbreviated term for "radiosonde observation," and coined from the initial letters of these words.

rating curve, *n.*—A curve which expresses graphically the relation between mutually dependent quantities; for example, in hydrology the relation between the stage of a stream and its discharge.

rawin, *n.*—A winds aloft observation made by balloon and radio methods, without optical aid.

receiver, *n.*—*See:* RAIN GAGE.

recurrence, *n.*—In reference to the weather, the supposed annual occurrence of certain irregularities, such as the January thaw, the cold period in May, and many others, which are fully discussed by C. F. Talman, Monthly Weather Review, vol. 55, 1919, pp. 555–565. *See:* H. Arctowski, Normal Anomalies of the Mean Annual Temperature Variation, Philosophical Magazine, June 1917, pp. 487–495.

recurvature (or **recurve**), *n.*—1. The action of a HURRICANE, q. v., in curving away from its generally westward path and heading instead in a poleward and then an easterly direction. 2. The action of a low pressure center in swerving toward the northeast from its original southeastward course on the east side of the Rocky Mountains.

red snow, *n.*—Snow colored red by the presence in it either of minute organisms or of dust particles of that color; "a great rarity in the United States, so far as anybody knows, though it is not uncommon in the polar regions, and has often been reported from the Alps and some other mountainous districts abroad." (C. F. Talman, A Book About the Weather, 1931, pp. 69–70.) *See:* SNOW; BROWN SNOW; YELLOW SNOW.

reduced pressure, *n.*—The ACTUAL or STATION PRESSURE, q. v., reduced to the value that would have been observed at sea level or some other specified plane. "The reduction of pressure to sea level . . . depends not only on the height of the station, but also on the temperature of the intervening stratum of air. The mean temperature of the air is, in the case of Dr. Buchan's maps, assumed to be the mean temperature of the station and its sea-level equivalent, i. e., 1° F., is added to the temperature of the station for every 540 feet . . . it lies above sea level." (Bartholomew's Physical Atlas, Vol. III, Atlas of Meteorology, ed. A. Buchan, 1899, p. 13.) *See:* U. S. Weather Bureau, Instrument Division, Circular F, Barometers and the Measurement of Atmospheric Pressure, 7th ed., 1941, p. 68; Smithsonian Meteorological Tables, 5th revised ed., 1939, pp. xlii–xxiii.

reduced temperature, *n.*—The temperature of a place reduced to the value that would have been observed on some standard plane such as sea level. The temperature data on weather maps used in forecasting are the actual observed temperatures; but on many climatic charts, temperatures are reduced to sea level, for then the altitude factor is eliminated and the maps are much less complicated.

The reduction of temperature to sea level is a difficult matter, since the rate of temperature increase with descending elevation varies with the region, the seasons, and the meteorological conditions. Different rates are used at the same point for reducing maximum, minimum, and mean temperatures. *See:* Bartholomew's Physical Atlas, Vol. III, Atlas of Meteorology, ed. A. Buchan, 1899, p. 6; Smithsonian Meteorological Tables, 5th revised ed., 1939, pp. xxxiii; 76–77.

reflection, *n.*—1. The process by which part of the radiation impingent upon any interface separating two media of different densities is in general turned back into the first medium. If the surface is smooth, the reflection is regular or mirror (specular) reflection; if the surface is rough or discontinuous, it produces DIFFUSE REFLECTION or SCATTERING, q. v. "A considerable portion of the solar radiation that falls upon the earth is reflected or scattered, and about 40 percent of it is lost in this way. Water, snow, and clouds are the best reflectors of solar radiation, the earth and dusty air reflects some radiation, and pure air almost none. The reflection that occurs from the water surfaces of the earth consists largely of regular reflection, while the reflection from snow, clouds, earth, dust, and so on is almost wholly scattered. . . . Astronomers have been able to calculate the reflecting power (albedo) of the earth, and have obtained a value of about 0.45 for the visible part of the spectrum. The total amount reflected from all wave lengths, however, is slightly less, about 0.42." (J. G. Albright, PHYSICAL METEOROLOGY, 1939, p. 113.) 2. The action by which sound waves are similarly turned back at an interface, causing echoes. *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 422–427.

reflectivity, *n.*—The ratio of the radiant energy reflected to the total amount incident. The many different surfaces of the earth reflect radiant energy in different amounts, varying from the high reflectivity of snow to the low reflectivity of woods and plowed fields. *See:* ALBEDO.

refraction, *n.*—The change in direction of propagation that occurs when sound or light waves pass obliquely from one medium to another of different density.

In meteorology, many optical and aural phenomena are due to refraction. Refraction of light causes twinkling of stars, optical haze, mirages, halos, sun dogs, rainbows, and other similar effects. Refraction of sound waves causes (1) scattering in passing through clouds, and (2) changes in the direction of travel in passing through layers of air of different densities. *See:* REFRACTION LAW.

refraction law, *n.*—A law verified experimentally by Willebord Snell (1591–1626), and stated by Descartes as follows: "The incident and refracted rays are in the same plane with the normal to the surface; they lie on opposite sides of it, and the sines of their inclination to it bear a constant ratio to one another."

This law, called Snell's law, is expressed mathematically by the following equation:

$$\frac{\sin i}{\sin r} = \text{a constant, called the index of refraction between the two media,}$$

where i is the angle of incident ray with the normal, and r is the angle of refracted ray with the normal. The index of refraction varies with different substances, and also with like substances having different densities, such as two layers of air having different temperatures but the same pressure. It is also equal to the ratio of the speed of the wave in the first medium to its speed in the second.

regelation, *n.*—A double phenomenon consisting of, first, the melting of contiguous surfaces of ice under pressure, and second, their refreezing when the pressure is reduced. Due to the fact that substances which expand on freezing also melt when pressure is applied, ice melts under pressure and refreezes when that pressure is removed; e. g., it melts under the pressure of a skater, causing his skates to be lubricated and slide along easily.

régime, *n.*—In climatological studies of precipitation, a term used in characterizing the seasonal distribution of rainfall at any place; "the régime can be well expressed graphically by the curve of the amount of rain month by month through the year . . . ; (it) is the same over wide areas though the amount of rain may vary greatly, and the boundary between different régimes is often capable of sharp delimitation." (W. G. Kendrew, Climate, 1930, p. 136; cf. pp. 136–163.)

register pen, *n.*—*See:* BAROGRAPH.

relative humidity, *n.*—1. The ratio of the amount of moisture in a given volume of space to the amount which that volume would contain were it in a state of SATURATION, q. v. 2. The ratio of the actual vapor pressure to the saturation vapor pressure. *See:* WATER VAPOR.

relative wind, *n.*—"The velocity of the air with reference to a body in it. It is usually determined from measurements made at such a distance from the body that the disturbing effect of the body upon the air is negligible." (Nomenclature for Aeronautics, Report 474, 1937. U. S. National Advisory Council for Aeronautics; p. 29.)

removal correction, *n.*—"The correction (to a barometer reading) necessitated by the removal of an office, and based on the difference between the actual elevation of the barometers in the new location and the adopted elevation for the station in question." (U. S. Weather Bureau, Instrument Division, Barometers and the Measurement of Atmospheric Pressure, Circular F, 7th ed., rev., 1941, p. 68.)

representative (air mass) **property,** *n.*—Any property "which characterizes an extensive region of the atmosphere adjacent to the point of observation. For example, the temperature at any level in a uniform air mass is representative. On the other hand, the temperature at the surface below a nocturnal inversion varies with the cloudiness and wind and so cannot be considered a representative property." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 222.) *See:* CONSERVATISM; CONSERVATIVE (AIR MASS) PROPERTY.

réseau, *n.*—A collective term applied to all stations belonging to a single meteorological service, or to a group of meteorological stations cooperating for any purpose or acting under a common direction.

réseau mondial, *n.*—A world-wide organization for the study of the general circulation and large-scale atmospheric phenomena from observations of the meteorological elements on the surface and in the upper air by means of stations in positions properly selected over the whole globe, including equatorial, tropical, temperate, and polar regions." (N. Shaw, Manual of Meteorology, Vol. I, 1932, pp. 160–161; cf. pp. 160–169.)

residual, *n.*—The amount by which the value of a meteorological element at a given instant or for a given interval differs from the smoothed value or consecutive mean for the same instant or interval. Hence a residual represents the short-period fluctuations that are eliminated in the process of SMOOTHING, q. v.

resultant wind, *n.*—The vectorial average of all wind directions and speeds at a given place for a certain period, as a month.

Instructions for calculating the resultant wind are contained in Circular O, Aerological Division, U. S. Weather Bureau, 1942, pars. 142–144. *See:* LAMBERT'S FORMULA.

retreater, *n.*—A maximum thermometer which retreats, i. e., the mercury recedes into the bulb with a fall of temperature. A maximum thermometer may at first be an excellent one in all respects, but may become a retreater through some inadvertence of the user; therefore all maximum thermometers should be carefully watched for this defect while in service.

return stroke (or **return lightning**), *n.*—The "relatively small electrical discharge which takes place here and there from objects on the surface of the earth coincidently with lightning flashes, and as a result of the suddenly changed electrical strain. This discharge is always small in comparison with the main lightning flash, but at times is sufficient to induce explosions, to start fires and, even, to take life." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 370.)

reversible cycle, *n.*—A sequence of changes in a thermodynamic system, "such that if the order in time of the changes is reversed, the only alteration in the corresponding changes in energy is reversal of sign." (L. D. Weld, Glossary of Physics, 1937, p. 198.)

revolving storm, *n.*—Popular designation of any storm which seems to be composed of a revolving mass of air, but the name does not adequately or precisely describe any particular class of actual storms; the terms, Tropical Cyclone, Extratropical Cyclone and Tornado, q. v., are more exact and should preferably be used.

rhumb line, *n.*—A navigational term defined as "a curved line on the surface of the earth, crossing all meridians at a constant angle." (Civil Aeronautics Bulletin, No. 24, 1940.)

ribbon ice, *n.*—*See:* Ice Fringe.

ribbon lightning, *n.*—A broad ribbon-like streak of lightning on a photograph "due to accidental movements of the apparatus during exposure—such as an involuntary start of the operator, in case the camera is held in the hands—though a certain amount of spreading of the image is sometimes caused by what photographers call 'halation'." (C. F. Talman, Our Weather, p. 147.) Also known as band lightning or fillet lightning. Professor W. J. Humphreys, in the Journal of the Franklin Institute, August 1926, writes as follows: "The well-known 'ribbon lightning' is a more or less continuous discharge along the same lightning path for an appreciable length of time. When it is photographed with a moving camera, a ribbon-like picture is obtained with narrow cross-stripes; hence the descriptive name. Often, there are lengthwise stripes also, producing a plaid effect, due no doubt to variations in the strength of the current."

ridge (of high pressure), *n.*—An anticyclonic center which is greatly elongated; or, the elongated extension of an anticyclone, cf. Trough.

rime, *n.*—A white or milky opaque, granular deposit of ice, which forms on airplanes, fences, trees, telegraph poles, and other exposed objects at temperatures below the freezing point. "Its surface is ordinarily relatively rough. It has a granulated or crystalline-splintery-like structure. When dissected its interior shows it to be composed of very tiny opaque ice pellets or grains, frequently intermixed with a frost formation of light feathery crystalline structure." (B. C. Haynes, Meteorology for Pilots, 2d ed., 1943, p. 68.)

roaring forties, *n.*—The region of the southern oceans between 40° and 50° S. lat., characterized by prevailingly strong westerly winds. Due to the uninterrupted expanse of ocean, not found in the northern latitudes, these winds blow with great constancy; they are often stormy, and near the austral continents their directions are modified.

rocket lightning, *n.*—A rare form of Lightning, q. v., which shoots through the air at about the apparent speed of a skyrocket. It occurs on those infrequent occasions when "the ionization of the air is so incomplete or deficient that the growth of the discharge path, which is usually very swift, is so retarded that it actually takes on the appearance of a rocket in flight; hence the name." (J. G. Albright, Physical Meteorology, 1939, p. 333.)

root-mean-square error, *n.*—The square root of the average value of the square of the errors. *See:* STANDARD DEVIATION; ERROR.

Rossby diagram, *n.*—A diagram used in identifying air masses and named after its inventor, C. G. Rossby; the ordinate is partial potential temperature on a logarithmic scale and the abscissa is mixing ratio on a linear scale; lines of constant equivalent-potential temperature appear as curves running diagonally across the diagram. "No pressure or temperature lines appear on the chart, and the lack of these may be inconvenient at times. It is not an equal or proportional area transformation of a *p-v* diagram, and therefore it cannot be used to study energy relationships. The Rossby diagram was intended primarily as a tool to assist in air mass analysis, and it is most useful when employed for that purpose. It is better in distinguishing between air masses than other diagrams in general use, since curves representing dry cold air appear to the far left of the diagram, while those representing warm moist air are found to the right. Differences between intermediate air masses are brought out clearly." (Hewson and Longley, Meteorology Theoretical and Applied, 1944, pp. 64–65.) *See:* C. G. Rossby, Thermodynamics Applied to Air Mass Analysis, Massachusetts Institute of Technology, Meteorological Papers, Vol. I, No. 3, 1932.

rs., *abbr.*—Abbreviation for sleet in the BEAUFORT WEATHER NOTATION, q. v.

run-off, *n.*—That portion of the precipitation falling upon a drainage area which is discharged from the area to the sea as surface water in stream channels.

S

s., *abbr.*—Abbrevation for SNOW in the BEAUFORT WEATHER NOTATION, q. v.

S., *abbr.*—Abbreviation for south.

saddle, *n.*—Synonymous with COL, q. v., the region of lower pressure between two highs. A. J. Henry (Weather Forecasting in the United States, 1916, p. 75), writes of the saddle as follows:

"In the saddle-shaped depression of the pressure between two neighboring regions of high pressure the pressure is generally pretty equally distributed, the gradients are trifling, the winds weak, the weather calm and more or less dull or cloudy. In summer the pressure saddle is more frequently the seat of local thunderstorms, which are repeated as long as this distribution of pressure lasts. It is the best breeding place for summer-afternoon thunderstorms."

sailing directions, *n.*—A publication of the Hydrographic Office of the U. S. Navy Department, consisting of fifty-five separate volumes, each of which describes a definite area of the oceans for the benefit of navigators. Among the conditions described are the meteorological elements—winds, pressure, air and sea surface, temperature, visibility, etc. *See:* PILOT CHART; RADIO WEATHER AIDS.

St. Elmo's fire, *n.*—A luminous brush discharge of electricity from pointed objects on the earth to the air; a phenomenon often seen under stormy conditions. It appears most strongly developed at such exposed points as a ship's masts and spars and on steeples, but may be seen on mountaintops, and even on the ears of horses, the heads of their riders, horns of cattle, brass bed posts, blades of grass, et al. It is also known as CORPOSANT, q. v.

St. Swithin's Day, *n.*—A meteorological KEY DAY, q. v., or control day, July 15. An old proverb says that if it rains on St. Swithin's Day, rain will continue for 40 days.

sand auger, *n.*—A sand whirl in Death Valley, California.

sand mist, *n.*—*See:* BAI.

sandstorm, *n.*—A windstorm on the desert which raises and carries along quantities of sand often so dense as to render the visibility practically nil. *See:* DUSTSTORM.

sansan, *n.*—A crest cloud in the Canadian Rockies. *See:* CLOUD CREST.

Santa Ana, *n.*—Local name for a FOEHN WIND, q. v., in southern California, which in winter often markedly affects the weather of that region. It is called the Santa Ana because of its association with the pass and river valley of that name. It is the same as the NORTHER (2), but, under topographical control, may blow from other directions. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, p. 94; W. A. Mason, The Santa Ana or Desert Storm of Southern California, Proceedings, U. S. Naval Institute, Jan. 1935, pp. 56–66; R. D. Ward, The Climates of the United States, 1925, pp. 415–418.

sastrugi, *n.* (sing. sastruga)—Snow ridges, characteristic of windswept polar plains where the wind tends to blow constantly in one direction. *See:* C. F. Talman, The Singular of "Sastrugi," Monthly Weather Review, vol. 43, 1915, pp. 85–86.

saturated-adiabatic lapse rate, *n.*—The rate of decrease of temperature of a parcel of saturated air as it rises. This rate is less than that for dry air due to the liberation of latent heat as condensation occurs. This rate is not constant, but varies inversely with the temperature and somewhat with change of pressure. *See:* ADIABATIC PROCESS; ADIABATIC GRADIENT.

saturation, *n.*—The condition in which the pressure exerted by water vapor is equal to the maximum vapor pressure possible at the prevailing temperature.

Experiment has shown that there is an upper limit to the amount of water vapor that can exist in any given volume of space at a given temperature. This amount increases with temperature, and when a given space contains the maximum amount of water vapor for a given temperature, the partial pressure exerted by the water vapor will also be at a maximum; and both the space and the vapor are said to be saturated. This saturation is 6.11 mb. at 0° C. (32° F.), and 66.34 mb. at 38° C. (100.4° F.).

Oftentimes, the expression, "the air is saturated," is used, which means the same thing but is less exact than the expression, "the space is saturated." When the space (or air) is saturated the RELATIVE HUMIDITY, q. v., is 100 percent.

saturation adiabat, *n.*—A curve on an adiabatic chart which indicates the temperature-height or temperature-pressure curve along which a parcel of saturated air will travel. *See:* ADIABAT; SATURATION CURVE.

saturation-adiabatic process, *n.*—*See:* ADIABATIC PROCESS.

saturation curve, *n.*—A curve on an ADIABATIC CHART, q. v., giving for various temperatures the saturation moisture content of the atmosphere in grams of water vapor per kilogram of dry air, or the saturation vapor pressure corresponding to a given temperature. *See:* SATURATION.

saturation deficit, *n.*—1. The difference between the actual vapor pressure and the saturation vapor pressure at the existing current temperature; also known as the vapor pressure deficit. 2. The additional amount of water vapor needed to produce SATURATION, q. v., at the current temperature and pressure, expressed in grams per cubic meter. 3. "The ratio of the vapor pressure deficit to the saturation pressure; in that sense it becomes unity minus the relative humidity, or if the relative humidity is expressed in percent, Saturation deficit=100−Relative Humidity." (J. G. Albright, Physical Meteorology, 1939, p. 134.) 4. The physiological saturation deficit: "The difference between the amount of vapor actually present in the air (i. e., the absolute humidity) and the amount that saturated air at body temperature contains (viz. about 45 gm. per cubic m.)." (W. G. Kendrew, Climate, 1930, p. 189.)

savanna, *n.*—"A tropical, open, level grassland of tall grasses, interspersed with trees and shrubs. The vegetation is drought tolerable—able to survive a hot dry season of considerable length." (T. A. Blair, Climatology, 1942, p. 127.) The savanna regions, in general, lie between the doldrums and the trade wind belts; thus they are transitional in their rainfall, temperature, vegetation, winds, etc.; some examples are the Llanos of the Orinoco Valley and the Veld of southern Africa. *See:* G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 214–224; R. D. Ward, Climate, 2d ed., 1918, pp. 251–253.

savanna climate, *n.*—A type of rainy climate similar to the tropical rain forest CLIMATE, q. v., but differing from the latter chiefly in that it has a slightly higher annual range of temperature, a smaller annual amount of rainfall, and distinct wet and dry seasons; whereas the tropical rainforest climate has no marked dry season. *See:* G. T. Trewartha, An Introduction to Weather and Climate, 1937, pp. 214–219.

Sc.—An abbreviation for STRATOCUMULUS.

scalar, *n.*—A quantity having magnitude only. "Typical scalar quantities are mass, volume, density, temperature, electric potential, charge, etc. The complete specification of a scalar quantity requires (i) a unit of the same kind and (ii) a number stating how many times the unit is contained in the quantity. For example, to express the mass of a given body we require to know whether the unit is the pound, the ton, the gramme, etc., and also how many of the chosen units represent the given mass. Scalar quantities are manipulated by applying the rules of ordinary algebra to their numerical magnitudes; for this reason the algebra of ordinary positive and negactive numbers is often called *scalar algebra* and the numbers themselves *scalars*." (B. Hague, An Introduction to Vector Analysis, London, 1939, p. 1.) *See:* VECTOR.

scarf cloud, *n.*—A thin, cirrus-like cloud, sometimes observed above a developing cumulus, "caused by the elevation and consequent expansion and cooling of the air immediately, and to some distance above, the rising mass of the cumulus." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 304.)

scattering, *n.*—A diffuse reflection of light: it occurs when a beam of light falls upon an irregular surface, as a piece of paper, in which case the reflected rays are scattered in all directions. Another common example is the scattering of light by air particles far too small to give mirror reflection and explaining the origin of the blue of the sky. *See:* REFLECTION.

scintillation, *n.*—The twinkling of stars and the analogous irregular fluctuation in brightness and color of distant terrestrial lights caused by the effect of winds and convection currents in bringing across the line of sight elements of air of different densities, and therefore of different refractive indices, in rapid succession. Scintillation is more pronounced near the horizon and decreases toward the zenith. *See:* OPTICAL HAZE; SHIMMER; REFRACTION.

scirocco, *n.*—A spelling used in Great Britain for SIROCCO, q. v.

Scotch mist, *n.*—A combination of thick mist and heavy drizzle occurring frequently in Scotland, and in parts of England, where it is generally known by the same term. However, in the Devon-Cornwall peninsula the same phenomenon is known as "mizzle." *See:* Meteorological Glossary, Meteorological Office, London, ed. 1939, p. 166.

screen, *n.*—An English term for a meteorological instrument shelter; sometimes called a STEVENSON SCREEN. *See:* INSTRUMENT SHELTER.

scud, *n.*—Low, ragged, detached fragments of cloud, with elevation from 100 to 300 meters, usually associated with nimbostratus and a stormy sky.

sea, *n.*—In marine meteorology, a term equivalent to "state of the sea"; described as calm, smooth, slight, moderate, etc., according to the approximate height of the waves. *See:* U. S. Weather Bureau, Instructions to Marine Meteorological Observers, Circular M, 1938, p. 54.

sea breeze, *n.*—The breeze that blows from the sea to the land on many coasts from about 10 or 11 a. m. to sunset on sunny days in summer; due to the diurnal heating of the shore and its surface layer of air. *See:* LAND BREEZE.

sea ice, *n.*—Ice formed by the freezing of sea water. In the process of freezing the ice retains some of the salt constituents of the water, but not in the same ratio as they exist in the liquid state, and some are completely eliminated. As sea-ice ages, the salt migrates to the surface. Sea ice is white and less brittle than fresh-water ice.

Sea ice is found in the Arctic Ocean, in the Sea of Okhotsk, and in the seas bordering the ice- and snow-covered Antarctic Continent.

In the cold season there may be zones of sea ice hundreds of miles wide. *See:* Table Iceberg.

sea fog, *n.*—Fogs formed at sea, and caused by the transport of air from a warm-water surface to a cold-water surface, with subsequent cooling: *See:* Fog; H. C. Willett, Fog and Haze: Their Causes, Distribution, and Forecasting, Monthly Weather Review, November, 1928, p. 451; H. C. Willett, Synoptic Studies in Fog, Massachusetts Institute of Technology, Meteorological Papers, vol. 1, 1930, p. 1.

sea level, *n.*—A term commonly used informally in meteorology when mean sea level is actually meant. The latter is defined as the average of the actual heights of the sea surface over a long period.

searchlight, *n.*—Synonymous with Projector, q. v., an apparatus for directing a beam of light vertically upward, and used in the measurement of cloud heights.

season, *n.*—1. A division of the year generally determined by some annually recurrent natural phenomenon, such as the state of vegetation or the meteorological conditions. Various different divisions into seasons have been in use among different peoples according to the particular vegetal, meteorological, or other phenomenon taken as a basis.

The number of seasons may vary from two to as many as there are months in the year (the case with the Melanesians). We have in the middle latitudes four divisions or seasons of the year based upon times of planting, maturing, and withering of plants, which we call spring, summer, autumn (or fall), and winter. In the tropics there are only two, the dry and rainy seasons. In Labrador the Eskimos distinguish the two seasons, summer and winter. The Comanche Indians and other North American Indian tribes have a cold and a warm season. The Scandinavians have two seasons, summer and winter, as did the Anglo-Saxons. A year divided into three seasons is not uncommon: in Burma, there is the cold, the hot, and the rainy season; in India, there is the cold or winter monsoon, the hot or transition season, and wet or summer monsoon. Five seasons are uncommon but are the fashion with some Indian tribes, such as the Thompson and Shuswop Indians of British Columbia. In northeast Siberia, the Yukaghi have six seasons, which do not correspond to months, but accord with certain Greek Orthodox holidays: they are summer, autumn, winter, first spring, second spring, and third spring.

Some primitive tribes designate their divisions of the year by months, which are named by what is being done and what is happening. 2. In some instances a subdivision of one of the major seasons; the rainy season, for example, may be subdivided into the little and the great rainy seasons, and summer may be subdivided according to many changes in vegetation, such as the blooming, flowering, and fruiting seasons. *See:* Martin P. Nilsson, Primitive Time-Reckoning, 1920, pp. 45–85. 3. A term popularly used in the same sense as spell: thus we speak of a rainy season, meaning a period or spell of damp weather. *See:* Spring; Summer; Autumn; Winter.

seca, *n.*—A term used in Brazil to mean a drought.

seclusion, *n.*—A variant of the process of Occlusion, q. v., which occurs under certain orographic conditions; for instance, when the motion of the lower portion of a warm front is retarded by high hills or mountains, and the cold front overtakes the warm front first at this point, leaving an island of warm air "secluded" farther to the north. "This development sometimes occurs on the west coast of Norway, where the coastal range juts westward in the southern part of the country, retarding advancing warm fronts at this point." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 279.)

secondary, *n.*—A small low pressure center accompanying a Primary Cyclone, q. v., around which it travels in a counterclockwise direction in the northern hemisphere. It usually originates as a wave formation on the cold front of the primary cyclone, and the first sign of formation is a distortion of the isobars, which may develop into a separate closed circulation. As the secondary grows, "it uses up the supply of warm air necessary for the maintenance of its parent cyclone, so that the latter gradually loses its intensity and finally becomes smoothed out, (and) the net result of the whole process is a transfer of all the cyclonic activity from the main cyclone to its secondary." (D. Piston, Meteorology, 2d ed., 1941, pp. 125–126.) —*adj.* Used in the expressions Secondary Cyclone, secondary depression, Secondary Low, etc., with the same meaning as that given above; also in the terms Secondary Circulation and Secondary Cold Front, q. v. *See:* Admiralty Weather Manual, 1938, pp. 344–345; D. Brunt, Weather Study, 1942, pp. 204–205.

secondary circulation, *n.*—A collective name for such wind systems as the monsoons, tropical and extratropical cyclones, and anticyclones, which, together with the trade winds, prevailing westerlies, etc., of the planetary or Primary Circulation, q. v., comprise the most important of the large-scale atmospheric motions. *See:* C. W. Barber, An Illustrated Outline of Weather Science, 1943, pp. 86–92.

secondary cold front, *n.*—A cold front which forms in back of the original cold front; the essential features for its development are "the rapid movement of a mass of cold air, and a strong latitudinal temperature gradient." (G. F. Taylor, Aeronautical Meteorology, 1938, p. 232.) These secondaries may occur in series, about 300 miles apart, and are caused either by the formation of temperature discontinuities or subsidence within the cold air. *See:* C. W. Barber, An Illustrated Outline of Weather Science, 1943, pp. 146–147; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 198–199, 232–233; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 286–287.

secondary cyclone, *n.*—*See:* Secondary.

secondary front, *n.*—A term applied to the one or more fronts which not infrequently form behind and follow an active advancing front. Secondary fronts usually form during the later history of the primary front, are initially weaker, but sometimes become stronger than the primary front. They appear most frequently behind rapidly moving cold and occluded fronts. Rapidly moving upper-level fronts not infrequently cause frontogenesis at the ground in advance of a primary front, but fronts formed in this manner usually retain the designation of upper-level fronts rather than being called secondary fronts.

secondary low, *n.*—*See:* SECONDARY.

second law of thermodynamics, *n.*—*See:* THERMODYNAMICS.

sector, *n.*—*See:* WARM SECTOR.

seepage, *n.*—"The percolation of water through the soil; infiltration. Seepage from a canal or reservoir represents a loss that is conveniently expressed as a depth over the surface or wet perimeter in a given time. Seepage into a body is referred to as influent seepage; that away from a body, as effluent seepage." (Letter Symbols and Glossary from Hydraulics, by Special Committee on Irrigation Hydraulics, Oct. 13, 1935.)

seiche, *n.*—An oscillation of the surface of a lake or other land-locked body of water, varying in period from a few minutes to several hours, and caused by minor earthquakes, winds, or variations in atmospheric pressure.

Seistan, *n.*—A strong northerly wind which blows in summer in the Seistan Basin in eastern Persia, sometimes reaching gale force. It continues for about 4 months and is known as "the wind of 120 days."

selective absorption, *n.*—The process in which a substance absorbs, either completely or partially, only certain wave lengths of incident radiation, and freely transmits the other regions of the radiation spectrum. A familiar example is furnished by red glass, which transmits radiation in the red and some in the infrared portions of the spectrum, but absorbs all other wave lengths.

Of the constituents of the atmosphere, ozone, carbon dioxide, and water vapor exert the greatest selective absorption. Ozone absorbs only five percent of the incoming solar radiation, but cuts off the solar spectrum sharply at a wave length of about 0.29μ, and hence "is of eminent biological importance, on account of the fact that short wave ultraviolet has a pernicious effect on organisms." (V. Conrad, Fundamentals of Physical Climatology, 1942, p. 3.) Carbon dioxide has an intense but narrow absorption band at about 15μ; hence, like ozone, its quantitative effect on solar radiation is small. Water vapor, on the contrary, is the most active absorbing medium in the atmosphere; its effect may be summarized as follows:

Wave length (in microns)	Absorption
Below 4	=Negligible
4 to 5.5	=Partial
5.5 to 7	=Intense
7 to 8.5	=Partial
8.5 to 11	=*Negligible*
11 to 14	=Partial
Above 14	=Intense

The selectivity of water vapor as an absorbing agent shown in this table, results in the GREENHOUSE EFFECT, q. v., and has vital importance in determining the atmospheric HEAT BALANCE, q. v.

selective stability, *n.*—Refers to the condition of indeterminate vertical stability of the atmosphere when the vertical lapse rate lies between the dry adiabatic and the saturation adiabatic. Under this condition the sign of the acceleration of the vertical motion of a body of saturated air which suffers an initial upward impulse depends upon the lapse rate and upon the relative sizes of the ascending mass of air and of the compensating descending mass of surrounding air, in such a manner that the steeper the lapse rate and the smaller the ratio of mass of ascending to descending air, the greater is the upward acceleration of the rising air, and vice versa. This means effectively that when the atmosphere is in conditionally unstable equilibrium as defined by the temperature lapse rate, actually it is selectively unstable or stable for the vertical ascent of saturated air, depending upon the lapse rate and upon the relative masses of the ascending and descending components of the vertical motion which is established; i. e., it may be stable to vertical impulses of one size, and unstable to those of another size.

semiarid, *adj.*—Pertaining to a subdivision of climate in which the associated ecological conditions are distinguished by short grass (whereas a subhumid climate is characterized by tall grass), and best exemplified by the climate of the STEPPE, q. v.

semitropical, *adj.*—Pertaining to the climate prevailing at the tropical margins of the temperate zones. Synonymous with SUBTROPICAL, q. v.

sensible temperature, *n.*—1. The apparent temperature indicated by the sensations of the human body, as distinguished from the actual physical air temperature given by a thermometer; is subjective, and varies with different people, obviously depending on their bodily condition, dress, and climatic environment, as well as upon four meteorological elements: dry-bulb air temperature, relative humidity, air movement, and radiation. Of these factors, the importance of the first three in determining bodily sensations of heat or cold is commonly recognized; the effect of radiation is often overlooked, but may be realized if one reflects that a room temperature of 68° F. may be very comfortable when the outside air is at 68° F. also, while the same room temperature with freezing conditions outside will feel cold, due to the net loss of heat by radiation to the colder environment. 2. The wet-bulb temperature, taken as a convenient index to the degree of heat actually felt by the human body. *See:* J. Hann, Handbook of Climatology, Part I, (tr. R. D. Ward), 1903, pp. 43–46.

serein, *n.*—1. The phenomenon of fine rain falling from an apparently clear sky, the clouds, if any, being too thin to be visible. Frequently fine rain is observed with a clear sky directly overhead, but clouds to windward clearly indicate the source of the drops. Also defined as fine rain falling from a clear sky after sunset, referring probably to early dew; a survival of the early belief that dew falls. *See:* G. Hellmann, Classification of Hydrometeors, Monthly Weather Review, 1917, p. 13.

service ceiling, *n.*—"The height above sea level, under standard air conditions, at which a given airplane is unable to climb faster than a small specified rate (100 feet per minute in the United States and England). This specified rate may differ in different countries." (Nomenclature for Aeronautics, Report No. 474, National Advisory Committee for Aeronautics, 1937, p. 11.) *See:* CEILING; ABSOLUTE CEILING; BALLONET CEILING; STATIC CEILING.

settled, *adj.*—Applied to weather, as in the phrase, "settled weather," to indicate a period during which no storms are expected to occur at the locality.

severity, *n.*—A term often used in connection with weather and climate, but having no precise technical meaning. It is evident that some winters and some summers are more severe than others, and attempts have been made to grade them according to arbitrarily chosen degrees of severity. The elements to be considered in the grading are temperature and precipitation, the former being more important; but in considering the severity of winters it seems that frequency of storms is also an important element. The criteria used in one part of the world do not apply in another: for example, a severe winter in San Francisco would not vary as much from normal as one in Chicago. Methods of estimating the severity of summers include: (a) the classical method, in which the hottest summer is considered to be the one during which the maximum temperature has been recorded; (b) the Angot method, in which the severity is graded according to the value reached by the sum of the excess of the daily maxima above 34° C. (94° F.); and (c) the frequency method, in which the number of times that the maximum temperature has equalled or exceeded 34° C. (94° F.) determines the severity of a summer.

shamal, *n.*—A northwesterly wind, blowing in summer over the Mesopotamian plain; it is often strong during the daytime but decreases at night.

shearing instability, *n.*—The instability of frontal waves in the atmosphere, which is inherent in the wind shear which exists in the frontal zone. This instability is directly proportional to the wind shear. Its effect, so far as it is not compensated by any stabilizing effect, is to cause occlusion of the wave formation. *See:* SHEAR OF WIND.

shear of wind, *n.*—The rate of change of wind velocity (speed and direction) with distance. The distinction is usually made between the vertical wind shear $\frac{\partial v}{\partial z}$ and the horizontal wind shear $\frac{\partial v}{\partial u}$; where v is the total horizontal wind velocity, z is the vertical direction and u the horizontal direction normal to v. The wind shear may be expressed by the shear vector, which is the vector difference of the wind velocity at two points divided by the distance between them. If the wind shear is nearly linear, i. e., the second derivative of the wind velocity with distance is small, then the wind shear vector is approximately the vector difference of the wind velocity at two points which are unit distance apart. *See:* SHEARING STRESS.

shear-stability ratio vector, *n.*—The vector given by the ratio of the vertical wind shear to the vertical stability, as expressed by $\frac{\frac{\partial v}{\partial z}}{\frac{1}{\theta}\frac{\partial \theta}{\partial z}}$, where v is the total horizontal wind, θ the potential temperature, and z the vertical coordinate. The direction of this vector is parallel to the isotherms and its magnitude depends on the vertical wind shear and the vertical stability. It is used to draw the isobars (height lines) on an isentropic surface (constant θ) in the same manner that the wind velocity vector is used to draw isobars on a constant level chart.

shearing stress, *n.*—In the atmosphere, refers to the tangential force which exists, by reason of the viscosity or internal friction of the air, between two layers of air which are in relative motion, i. e., in any layer of wind shear. The shearing stress as expressed per unit area of boundary surface between the air layers, and is directly proportional to the coefficient of internal friction and to the wind shear. Thus the total vertical shearing stress is given by $\tau_z=\mu\frac{\partial v}{\partial z}$, where v is the total horizontal wind velocity and μ is the coefficient of friction of the air. *See:* SHEAR OF WIND.

sheet lightning, *n.*—A form of LIGHTNING, q. v., most conspicuous when seen in a distant thundercloud at night, which appears as "beautiful illuminations, like great sheets of flame, that usually wander, flicker and glow in exactly the same manner as does streak lightning, often for well nigh a whole second, and, occasionally, even longer. In the daytime and in full sunlight, the phenomenon, when seen at all, appears like a sudden sheen that travels and spreads, here and there, over the surface of the cloud. Certainly in most cases, so far as is known in all cases, this is only reflection from the body of the cloud of streak lightning in other and invisible portions." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 369.) *See:* STREAK LIGHTNING.

shelf ice, *n.*—A thick formation of fresh-water ice, extending from the land and usually attached thereto, and fed in part by one or more glaciers; it may be afloat or aground, and is found in large bays, or along a continental glacier at a place determined by prevailing storm winds.

shield, *n.*—An attachment often put on rain gages, to overcome the difficulty encountered with an unshielded gage in securing a true catch because of gage eddies. The HENRY SHIELD, and the NIPHER SHIELD, q. v., are the best known. The former consists of a horizontal sheet of metal soldered to the mouth of the gage, making it resemble an inverted hat. The Nipher shield is trumpet-shaped, with the mouth or flaring part opening upward and at about the same height as the mouth of the gage. *See:* RAIN GAGE.

shift, *v. i.*—As applied to the wind, to change in direction. The wind is said to "veer" when it changes direction clockwise; to "back" when it changes direction anticlockwise; and to "shift" regardless of the direction of the change. —*n.* The act of the wind in changing direction, or the change in direction.

shimmer, *n.*—Same as Dry Haze, q. v.

shoot the balloon, *v.*—A slang phrase used at observing stations; meaning, "take a balloon observation." It is also interchangeable with the phrase "take a run."

shower, *n.*—Precipitation of a convective origin, and hence distinct from ordinary frontal or orographic precipitation. "Showers are characterized by the suddenness with which the precipitation (rain, snow, snow pellets, etc.) starts or stops and its rapid changes of intensity; but also by the aspect of the sky—rapid changes between dark, threatening clouds and clearings of the sky (of short duration, often with an intensely blue sky). Sometimes no definite clearing occurs between the showers, or the precipitation does not even stop entirely between them; the showery character of the precipitation is then revealed by the more or less rapid alterations of lighter and darker clouds." (U. S. Weather Bureau, Circular N, Instructions for Airway Meteorological Service, 5th ed., 1941, p. 41.) *See:* Instability Shower.

silver frost, *n.*—Same as Silver Thaw, q. v.

silver storm, *n.*—Same as Silver Frost, q. v.

silver thaw, *n.*—A deposit of ice on trees, shrubs, and other exposed objects; synonymous with Glaze, q. v., and silver frost, but applied more particularly to a very thin coating of ice. The term, then, does not aptly designate the phenomenon, for it is not a thaw.

simoom, *n.*—An intensely hot and dry wind of Asian and African deserts—the Sahara, Palestine, Syria, and the desert of Arabia—most often so laden with dust and sand as to be almost stifling, though some authorities state that it may be dust-free. Some alternative spellings are: samoom, samoun, samum, samun, semoom, semoun, simoon, simoun.

single station analysis, *n.*—A technique of forecasting from the data available at just one station, recently developed at the University of Chicago in order to enable military meteorologists at isolated bases to gain some idea of coming weather. It is based on surface observations and pilot balloon and radiosonde reports. "Essentially, the Chicago technique is based on realization of the fact that the vertical distribution of wind direction and wind velocity, when carefully studied and compared with the requirements imposed by the geostropic wind balance, the hydrostatic balance, and certain simple kinematic considerations, gives a great deal of information concerning the horizontal distributions of temperature, pressure, and vertical stability, and also tells us a great deal concerning the rate of propagation of the circulation patterns eastward." *See:* W. W. Jones, Weather-Map Construction and Forecasting . . . from Single-Station Aerological Data, Miscellaneous Report No. 7, Institute of Meteorology, University of Chicago, 1943, p. 1.

sinking, *n.*—1. An optical phenomenon, the opposite of Looming, q. v., in which an object on or slightly above the geometrical horizon apparently sinks below it; caused by the temperature distribution of the air being such that the density of the air increases upward rather than downward as is usually the case, thus decreasing the curvature of the light rays so that an object normally visible on the horizon is bent down beneath it. *See:* W. J. Humphreys, Physics of the Air, 1940, p. 470. 2. Same as SUBSIDENCE, q. v.

siphon barograph, *n.*—*See:* BAROGRAPH.

siphon barometer, *n.*—*See:* BAROMETER.

sirocco, *n.*—1. A name locally used in the Latin countries of southern Europe to designate a FOEHN wind, q. v. *See:* J. Hann, Handbook of Climatology, Part I, tr. R. D. Ward, 1903, pp. 262–263. 2. The hot southerly wind in advance of a low center moving eastward across the Mediterranean Basin; at first dry and dust-laden (since it originates in the Sahara or the desert of Arabia), but rendered excessively humid by its passage across the sea. Its heat is often intensified by the foehn effect: "If the sirocco descends from mountains its heat and dryness are intensified by compression. This is the case on the north coast of Sicily, where the highest temperature ever recorded at Palermo, 114° (F.), occurred during a sirocco, and 95° may be exceeded even in the midnight hours." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 278).

skewness, *n.*—The lack of symmetry of an assymetrical frequency distribution; a numerical measure or index of this lack of symmetry.

sky, *n.*—The meteorological term for sky condition, or state of the sky in respect to amount, kind, height and direction of movement of clouds present. Skies are classified as clear, scattered, broken, and overcast, with many subdivisions and variants. In the International Cloud Atlas, 1932, the states of the sky are described very minutely, using classifications based upon what is known of the physical processes involved and upon synoptic study of weather disturbances. *See:* U. S. Weather Bureau, Circular N, 5th ed., 1941, pp. 30–33.

sky radiation, *n.*—That portion of the sun's radiant energy that comes indirectly to the earth from the air, or from the clouds and dust particles that float in the air. The ratio of sky radiation to the total radiation received at the earth's surface with a cloudless sky varies with the solar altitude, time of year, and conditions of haziness. *See:* N. Shaw, Manual of Meteorology, Vol. III, 1930, pp. 127–142, 149.

sleet, *n.*—1. " . . . transparent, globular, hard grains of ice, ranging from 1/25 to 4/25 inch in size; they rebound when falling on hard surfaces. Formed by the freezing of raindrops." U. S. Weather Bureau, (Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 40). 2. Used also by engineers and the public at large in the United States in the same sense as glaze, i. e., an ice coating formed by rain freezing instantly to all exposed objects. 3. In British terminology, and colloquially in some localities of the United States, a mixture of snow and rain falling together.

sling psychrometer, *n.*—The most common type of PSYCHROMETER, q. v., which "consists essentially of two thermometers, mounted in a frame which can be rotated rapidly about an axis at right angles to its length." (W. E. K. Middleton, Meteorological Instruments, 1941, p. 91.) It is sometimes called a *whirling psychrometer*.

sling thermometer, *n.*—A variety of thermometer, which obtains the true temperature of the air in a few minutes. It consists of a mercury thermometer, placed in a cylindrical case, well perforated at the lower end, and with two loops to attach a cord and enable one to swing it rapidly around.

slope of a front, *n.*—The tangent of the angle formed by the FRONTAL SURFACE, q. v., with a horizontal plane, most frequently the surface of the earth; given approximately by the well-known Margules formula, which may be written:

$$\tan \theta = \frac{\lambda T'}{g} \frac{\Delta v}{\Delta T}$$

where θ is the angle, λ the CORIOLIS PARAMETER, q. v., g the acceleration of gravity in cm/sec^2, T' the mean temperature in absolute degrees of the two air masses separated by the frontal surface, Δv the difference in cm/sec between the wind velocity components parallel to, and on either side of, the frontal zone, and ΔT the difference in absolute degrees between the temperatures of the two air masses. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 171–173; S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 276–279.

slush, *n.*—Snow on the ground that has been reduced by a warm spell or by rain to a soft, watery mixture.

small hail, *n.*—A HYDROMETEOR, q. v., which falls almost exclusively in showers, in the form of "semi-transparent, round, or sometimes conical grains of frozen water, about .08–.20 in. in diameter. They generally consist of a snow pellet as a nucleus, with a very thin ice layer around it, which gives them a glazed appearance. They are not easily compressible or crisp, and, even when falling on hard ground, they ordinarily do not rebound or burst, as they are generally wet." (U. S. Weather Bureau, Definitions of Hydrometeors and Other Phenomena, 1943, p. 23.) Small hail falls from broken shower clouds, which helps to distinguish it from SLEET, q. v., since the latter generally falls from a solid layer of clouds. Small hail often occurs with rain, and almost always when the temperature is above freezing. It is not to be confused with true HAIL, q. v., which is of a different size and structure, and hardly ever falls but in a thunderstorm.

smog, *n.*—A term coined in 1905 by Dr. Des Voeux to signify a mixture of smoke and fog; as yet neither technically defined nor adopted into standard meteorological usage.

smoke, *n.*—"The presence of particles of foreign matter in the air resulting from combustion. In light amounts, it may be confused with haze or fog but usually can be easily differentiated from these by its odor." (U. S. Weather Bureau, Circular N, Instructions for Airway Meteorological Service, 5th ed., 1941, p. 45.)

smokes, *n.*—Dense white mists common in the dry season on the Guinea coast of Africa. *See:* W. G. Kendrew, Climate, 3d ed., 1937, pp. 58–59.

smoothing, *n.*—The process of eliminating, from tabular or graphical data, irregularities that are without significance or importance for the immediate object; it may be accomplished either graphically or by arithmetical formulas.

smudging, *n.*—A term used in connection with orchard heating in anticipation of frost; properly, it means the production of heavy smoke, supposed to prevent cooling by radiation, but it is generally applied to the operations both of heating and of smoke production.

snap, *n.*—A brief period of cold weather; thus the phrase, a "cold snap."

snow, *n.*—A form of precipitation composed of ICE CRYSTALS, q. v. When atmospheric water vapor condenses at temperatures below 0° C., ice crystals may be formed and may fall to the ground as single crystals, though it is more usual for them to fall as snowflakes, which are aggregations of individual ice crystals. Observers have reported many modifications of the common SNOWFLAKE, such as TAPIOCA SNOW, q. v.

Freshly fallen snow varies greatly in density; generally a depth of snow of from five to twenty inches equals one inch of water. When it is not convenient or possible to obtain the exact water equivalent, it is the rule in the U. S. Weather Bureau that ten inches of snow equal one inch of water. In snow fields, however, snow densities may vary from as little as 5 percent to as much as 50 percent.

The color of snow is normally white because of the many reflecting surfaces of the ice crystals. Snow of a reddish or bluish or other color has been observed, but any color other than white results from the presence of foreign matter such as dust or bacterial growths. *See:* YELLOW SNOW; RED SNOW.

Snow transmits solar radiation in decreasing amounts as the depth increases, and this transmission also varies with density. Its thermal conductivity is a function of its density, as the insulation depends largely upon the quantity of air contained in the snow. Therefore, the depth to which the diurnal changes of temperature extend depends upon the compactness of the layers of snow, but in general is about one meter.

Climatologically, the effects of snow are more far-reaching than simply the moisture it supplies to a region. Snow reflects a large proportion of incident solar radiation, its temperature cannot rise above freezing, and it is an excellent radiator as well, and thus the air temperature over a wide area may remain lower than would be the case were the ground exposed; it prolongs the cold season in polar, plateau, and mountain climates; and it has many important relations to flood control, transportation, forestry, and agriculture. *See:* SNOW COVER; HYDROMETEOR; BLOWING SNOW; DRIFTING SNOW.

snow and rain, mixed, *n.*—*See:* RAIN AND SNOW, MIXED.

snowball, *n.*—*See:* SNOW ROLLER.

snow bin, *n.*—A box for measuring the amount of snowfall. *See:* F. H. Bigelow, The Catchment of Snowfall by Means of Large

Snow Bins and Towers, Monthly Weather Review, vol. 38, 1910, pp. 968–973.

snow blindness, *n.*—Temporary blindness caused by the glaring light reflected from snow surfaces. Travellers prevent this by wearing dark glasses.

snow-board, *n.*—A sheet of thin white board, about 16 inches square, with a layer of cotton flannel tacked on to its surface, nap uppermost. It has been shown that more snow is caught on this board than with a can; hence it is useful for measuring snowfall. The snow-board is similar to the SNOW MAT, q. v.

snow burn, *n.*—The tanning of the skin by light rays reflected from snow surfaces.

snow cover, *n.*—Fallen snow which covers the earth's surface; in northern latitudes a snow cover generally remains throughout the winter. The snow cover of Siberia and Canada, the source regions of POLAR CONTINENTAL AIR, q. v., is an important factor in producing this air mass. "The duration of snow cover on the ground is also of great climatological importance. Scarcely any radiation from the sun will be absorbed by the soil, while it is covered with snow, because of the great reflecting power of snow. In fact, a snow cover will tend to accentuate the extreme temperatures by radiating heavily at night and reflecting during the day. . . : Winters with an extended snow cover tend to be more severe because of these peculiar radiation properties of snow." (H. Landsberg, Physical Climatology, 1941, p. 131.)

snow crystal, *n.*—*See:* ICE CRYSTALS.

snow fence, *n.*—A board fence 5 to 10 feet high, placed about 50 feet away from and on the windward side of railway tracks and highways. Where snow conditions are severe, three or four lines of fences are used in parallel about 100 feet apart. By breaking the force of the wind, the fence causes the snow to be precipitated on the leeward side, i. e., between the fence and the track, leaving the latter comparatively clear. In lieu of fences some railroads plant a row of trees for a WINDBREAK, q. v. *See:* A. H. Palmer, Snow and Railway Transportation, Monthly Weather Review, 1919, p. 698.

snowflake, *n.*—A single ice crystal, or, much more usually, an aggregation of them, formed by the condensation of atmospheric water vapor at some temperature below the freezing point. Snowflakes may be very small or very large. Some have been observed in Berlin with diameters 8 to 10 cm. (3 to 4 inches); and at Fort Keogh, Mont., 38 cm. by 20 cm. across (15 by 8 inches). *See:* C. Abbe, Gigantic Snowflakes, Monthly Weather Review, 1915, p. 73.

snow gage, *n.*—*See:* RAIN (SNOW) GAGE.

snow garland, *n.*—A rare and beautiful phenomenon in which snow is festooned from trees, fences, etc. in the form of a rope of snow, about three feet long and seven inches thick, formed and sustained by the fact that "the snow crystals, being wet, are strongly drawn each to its adjacent neighbors, by the surface tension of a water film, and thus through film and flake the whole snow-garland tenaciously holds together from end to end." (W. J. Humphreys, Snow Garlands, Monthly Weather Review, vol. 63, 1935, p. 162.)

snow grains, *n.*—White, opaque particles, like snow in structure, and resembling SNOW PELLETS, q. v., but more or less flat or oblong and generally less than 0.04 inch across in at least one direction; they do not noticeably rebound or break when falling on hard ground. Snow grains are the frozen part of DRIZZLE, q. v., and so never fall in showers but usually in very small quantities from low stratified clouds. They consist mostly of tiny snow crystals which have acquired a rime-like coating during passage through supercooled cloud or fog. They may be distinguished from snow pellets by their much smaller size and by the fact that they rarely, if ever, fall like the latter under showery conditions. *See:* U. S. Weather Bureau, Definitions of Hydrometeors and Other Atmospheric Phenomena, 1943, p. 27.

snow line, *n.*—1. Climatic or vertical snow line. "The altitude to which the continuous snow cover of high mountains retreats in summer . . . chiefly controlled by the depth of the winter snowfall and by the temperature of the summer." (J. Hann, Handbook of Climatology, Part I, tr. R. D. Ward), 1903, p. 310. 2. Orographic snow line. "The lower limit of snow fields and of névé patches, which occur as isolated patches, or in considerable numbers, and which owe their permanent preservation essentially to favorable orographic surroundings." (Ibid, p. 311.) 3. Temporary snow line: a line sometimes drawn on a weather map during the winter, showing the southern limit of the SNOW COVER, q. v.

snow mat, *n.*—A device consisting of a piece of white duck twenty-eight inches square, having in each corner triangular pockets in which are inserted slats placed diagonally to keep the mat taut and flat. The mat is an aid in marking the surface between old and new snow. The depth of the snow on the mat is measured in the usual manner. *See:* SNOW BOARD.

snow melt, *n.*—The water that results from the melting either of snow fields, or of snow on trees and shrubs; this water may evaporate, seep into the ground, or become a part of the RUN-OFF, q. v.

snow pack, *n.*—A term used locally in the Rocky Mountain region of the United States to mean a field of naturally packed snow, which gives a steady supply of water for irrigation throughout the growing season, and is also useful in furnishing water power; also known as SNOW STORAGE.

snow pellets, *n.*—"White, opaque, round or seldom conical grains of snow-like structure, about .02–.20 in. in diameter in all directions. They are crisp and easily compressible; they rebound when falling on hard ground, and thereby often burst." (U. S. Weather Bureau, Definitions of Hydrometeors and Other Atmospheric Phenomena, 1943, p. 22.) This HYDROMETEOR, q. v., also called GRAUPEL or TAPIOCA SNOW, falls almost exclusively in showers, often before or together with snow, and occurs chiefly on occasions when the surface temperature is at or slightly below freezing.

snow roller, *n.*—A mass of snow shaped somewhat like a lady's muff, common in mountainous or hilly regions, and occurring when the snow is moist enough to make it cohesive. It forms when the wind blows down a slope, picking up some snow, and rolls it onward and downward until it either becomes too large or until the ground levels off too much for the wind to propel it further. The area cleared of snow is V-shaped, accounting for the snow roller's peculiar shape, which is cylindrical with concave ends. The dimensions of snow rollers vary from very small cylinders to some as long as 3 or 4 feet, and seven feet in circumference. *See:* J. Moore, Meteorology, 2d ed., 1910, pp. 251–252; 466.

snow sampler, *n.*—Any device for collecting a vertical section of snow as it lies on the ground, which section may then be measured, and the density of the snow sample thus determined; valuable in making snow surveys in watersheds whose snow storage is used for irrigation or other purposes.

The snow sampler used in the U. S. Weather Bureau consists of a 3-inch duralumin cylinder, varying in length from 2 to 6 feet. Its lower or cutting end is turned to an inside diameter of 2.655 inches, the outside being beveled in order to make a sharp cutting edge so that it may easily be inserted into the snow. After it has been withdrawn from the snow, the tube, with the snow core, is weighed, using a spring balance whose graduations give inches and tenths of inches of water equivalent directly.

snow scale, *n.*—*See:* Snow Stake.

snow shed, *n.*—A structure, formerly constructed of wood, and now often of concrete, erected over railroad tracks as a protection not only against snow slides but also against snowstorms, because if a train were stopped for any reason during a storm, the snow would pile up around the wheels and block its progress within a short time. The concrete sheds are in sections of uniform construction, and may be moved to any desired location. Snow sheds are also built, usually of wood, over sled roads in logging regions.

snow stage, *n.*—*See:* Adiabatic Process.

snow stake, *n.*—A wooden stick either driven into the ground or held upright by guy wires, used in regions of deep snowfall to indicate the depth of snow, which is read directly from graduations in inches on the stake. *See:* U. S. Weather Bureau, Instrument Division, Circular E, Measurement of Precipitation, 4th ed., 1936, p. 18.

snow survey, *n.*—A determination of the total amount of snow lying over a watershed or a particular area, by measurements of both the depth and the water content of the snow, for the purpose of predicting the amount of water that will be available for irrigation or other purposes.

snow tube, *n.*—*See:* Snow Sampler.

socked in, *adj.*—A slang expression used at landing fields, usually meaning that the field is befogged and the visibility and ceiling are zero, so that no air traffic is possible.

soft hail, *n.*—White, opaque, round pellets of snow.

soil atmosphere, *n.*—The air and other gases below the surface of the earth; all soils are more or less porous, and contain in their interstices gases which form the soil atmosphere and which are necessary for plant life. These gases may come from the chemical activity of the earth's materials, from biological processes, or from the earth's atmosphere itself. The quantity of soil atmosphere varies because of several factors operating singly or together. Wind or air pressure, since both vary, may drive air in or draw it out; rain or irrigation, by filling the interstices, will force it out; or evaporation may allow more air to be absorbed; temperature changes, which cause compression and expansion, perform similar functions. At great depths, say 5 or 6 miles, the pressure of the overlying layers of earth is so large that further penetration of gases is impossible, and hence no soil atmosphere exists.

soil thermograph, *n.*—A thermograph arranged to record temperatures at a distance, say 10 feet, used to measure the temperature of soil, water, or other substances, at various depths.

soil thermometer, *n.*—Also called EARTH THERMOMETER, q. v., and used, as the name implies, to measure the temperature of soils. It consists of an ordinary thermometer fused into an outer protecting sheath of glass.

solano, *n.*—An east wind on the southeast coast of Spain, dreaded by the Spaniards because of its heat, dust, and moisture.

solar climate, *n.*—1. The hypothetical climate that would prevail if determined solely by the amount of solar radiation received according to latitude and season; also called mathematical climate, because it can be calculated for a given place from radiational, astronomical and geographic data. If the earth were a perfect spheroid, had no atmosphere, and possessed a homogeneous surface, its climate would be controlled entirely by astronomical relations to the sun, and a solar climate alone would prevail. *See:* J. Hann, Handbook of Climatology, tr. R. D. Ward, Part I, 1903, pp. 91–127. 2. In modern climatology, the actual distribution of the intensity, duration, and spectral qualities of sunshine, measurements of which can be made with suitable instruments.

solar constant, *n.*—The rate at which solar radiant energy is received outside the atmosphere on a surface normal to the incident radiation, at the earth's mean distance from the sun. The value of the mean solar constant is 1.94 gram calories per minute per square centimeter.

solar radiation, *n.*—Radiation received directly from the sun. As emitted from the sun, its spectral distribution is characterized by a maximum intensity in the blue-green part of the spectrum at 0.5μ; and hence it is often called short-wave radiation to distinguish it from the predominantly longer wave TERRESTRIAL RADIATION, q. v. As received at the surface of the earth, the spectral distribution is characterized by numerous intense telluric absorption lines and bands; the most important of which are produced by O_2, O_3, CO_2, and H_2O.

solenoid, *n.*—In meteorology, the column of atmosphere bounded by two isobaric and two isosteric (constant specific volume) surfaces. The unit solenoid is the column bounded by two adjacent unit isobaric and unit isosteric surfaces. A vertical cross section through a solenoid field shows the solenoids approximately as a system of contiguous rectangles. The density of the solenoid field in the atmosphere obviously is directly proportional to the slope of the isobaric relative to that of the isosteric surfaces, i. e., to the horizontal temperature gradient. The significance of this solenoid concept lies in the fact that the acceleration of circulation in the atmosphere is proportional to the density of the solenoid field, or the acceleration of the circulation about any closed path in the atmosphere is numerically equal to the number of unit solenoids enclosed by that path (Bjerknes' Circulation Theorem).

solstices, *n.*—Points on the ecliptic midway between the equinoxes, or points where the sun attains its greatest north and its greatest south declinations. The summer solstice, or the sun's most northern point of the ecliptic, occurs about June 22; and the winter solstice, or the sun's most southern point of the ecliptic, occurs about December 22.

Sonora storm, *n.*—A summer thunderstorm in the mountains and deserts of Lower and Southern California. *See:* Dean Blake, Sonora Storms, Monthly Weather Review, 1923, pp. 585–588; SONORA WEATHER.

Sonora weather, *n.*—Summer weather characterized by showers frequently very intense and generally extremely localized in their effects. *See:* G. F. Taylor, Aeronautical Meteorology, 1938, pp. 151–152.

soroche, *n.*—Spanish term for MOUNTAIN SICKNESS, q. v.

sound, *n.*—*See:* METEOROLOGICAL ACOUSTICS.

sounding, *n.*—1. In meteorology, the process of determining the conditions in the free atmosphere at various heights, commonly now by means of a RADIOSONDE, q. v. Also, the graph which results when the values of temperature, pressure, and specific humidity thus determined are plotted on an ADIABATIC CHART, q. v., or other diagram. 2. In nautical usage, the measurement of the depth of water under a ship.

sounding balloon, *n.*—A free, unmanned balloon carrying a set of self-registering meteorological instruments, used in sounding or exploring the atmosphere to determine its physical characteristics, principally temperature, pressure, and humidity, at various levels.

Hermite and Besancon in 1893 used open balloons made of silk or paper. The closed India rubber balloon was first used by Professor Assmann, who discovered the stratosphere at the same time as Teisserenc de Bort, 1899–1902.

Now (1942), the sounding balloon is generally used in conjunction with a RADIOSONDE.

soupy, *adj.*—Densely foggy or cloudy.

source region, *n.*—Any extensive area of the earth's surface characterized by essentially uniform surface conditions and so placed with respect to the general atmospheric circulation that an air mass may remain in contact with it long enough to acquire its characteristic properties. Petterssen classifies source regions: first, by the nature of the underlying surface (arctic ice fields and snow-covered land; continental regions without snow cover; large oceanic expanses, warm and fairly homogeneous); then, according to the relation of these zones to the general circulation in summer and winter, he divides the northern hemisphere into source regions for the different types of air masses. Examples are (a) the Atlantic Ocean, roughly between 20°–35° N. lat. where the calm conditions in the sub-tropical high pressure area and the uniform temperature of the sea surface lead to the formation of maritime polar (*mP*) air masses in both summer and winter and (b) the northern reaches of Asia, in winter controlled by a polar anticyclone, the Siberian high, and covered with snow, so that vast quantities of polar continental (*cP*) air are there produced. *See:* AIR MASS (1); S. Petterssen, Weather Analysis and Forecasting, New York, 1940, pp. 138–166.

southerly burster, *n.*—In Australia, a cold wind from the south. "After a day or more of hot sultry weather with a northerly wind, there is a short lull; and then very suddenly, when the line of lowest pressure has passed, a strong, often violent, wind sets in from the south. A striking roll of cumulus cloud may accompany the burster, and there is usually heavy rain. Temperature drops suddenly, generally as much as 20°. The phenomenon is most frequent in spring and summer." (W. G. Kendrew, The Climates of the Continents, 3d ed., 1937, p. 428.)

specific heat, *n.*—The amount of heat required to raise the temperature of unit mass of a substance by unit amount; it varies slightly with temperature, and may depend greatly on the conditions under which the heat is added. In the case of gases, the only specific heats usually considered are the specific heat at constant volume and the specific heat at constant pressure.

The specific heat of water expressed as the amount of heat required to raise one gram of water from 15° to 16° C. is the standard CALORIE, q. v.

The specific heat of air at constant pressure varies according to its temperature. For instance from −30° C. to 10° C., it is 0.2377 calories, and from 20° C. to 800° C., it is 0.2430 calories. The specific heat of air at constant volume is 0.1696 at 20° C., and 0.1723 at 500° C.

specific humidity, *n.*—The mass of water vapor in a unit mass of moist air, usually expressed as so many grams per gram or per kilogram of moist air.

Specific humidity must be distinguished from MIXING RATIO, q. v., which is the mass of water vapor per unit mass of absolutely dry air.

$$\text{Specific humidity} = q = 0.622\frac{e}{p}\text{ grams per gram, or}$$

$$q = 622\frac{e}{p}\text{ grams per kilogram.}$$

$$\text{Mixing ratio} = w = 622\,\frac{e}{p-e}\text{ grams per kilogram,}$$

where e = partial pressure of water vapor, and p = total pressure of moist air (i. e., air with water vapor).

Hence, the mixing ratio is very nearly numerically equivalent to the specific humidity. Indeed, the hygrometric errors in aerological soundings are generally much greater than the difference between the two quantities.

Specific humidity and mixing ratio are important CONSERVATIVE PROPERTIES, q. v., of an air mass, as each "is conservative for those processes involving a variation in temperature. It is not, though, conservative for those changes involving a change in water vapor content, i. e., for evaporation and condensation and turbulent mixing processes. Specific humidity thus finds a wide use in meteorological analysis." (E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, p. 225.) *See:* HUMIDITY; WATER VAPOR.

spectre of the Brocken, *n.*—*See:* BROCKEN SPECTRE.

spectropyrheliometer, *n.*—"An instrument used for the determination of the spectral distribution of the total solar radiation." (L. D. Weld, Glossary of Physics, 1937, p. 215.)

spectrum, *n.*—1. A dispersion or separation, into a linear sequence according to wave length, of the individual simple waves into which any complex wave disturbance may be resolved.

The rainbow, e. g., is a spectrum of sunlight, formed through the refractive action of raindrops in dispersing the mixture of light waves of different wavelengths which together make up sunlight, into its component colors. The range of electromagnetic waves that comprise visible light is only a very small part of the complete electromagnetic spectrum, which includes gamma rays, X-rays, ultraviolet radiation, visible light, infrared radiation, and radio waves, with continuous gradations from one to another. The range of wave lengths in visible light is from about 4,000 to 8,000 angstroms, or from 0.00003934 cm. to 0.00007594 cm. 2. The spectrum of sound audible to the human ear ranges from about 16 to 16,000 cycles per second.

speed, *n.*—The numerical magnitude of a velocity; speed is a scalar quantity, whereas velocity involves direction as well as magnitude, and is a vector quantity.

spell, *n.*—A period during which fairly constant weather conditions prevail in a region where variable weather is ordinarily expected. Thus, the long protracted periods of uniform weather in the tropics are not considered spells; but, in the temperate zones, there may be spells of warm, or rainy, or cold weather, and so on.

spout, *n.*—In former times, a term applied to any column of cloud extending downward to the surface of the earth, whether on sea or land. If at sea, it was known as a WATERSPOUT, q. v., which term is still used; if on land, it was called a landspout, which name has been replaced by TORNADO, q. v.

spring, *n.*—1. A SEASON, q. v., of the year which in the north temperate zone is commonly regarded in meteorology as including the months of March, April, and May. 2. In astronomy the period extending from the time of the vernal equinox to the summer solstice. Note: The "advent of spring" from the agricultural viewpoint may be said to occur when the life of plant cells begins to stir, i. e., when the temperature is 42.8° F. or 6° C.

squall, *n.*—A wind of considerable intensity caused by atmospheric instability; it comes up and dies down quickly, and is sometimes accompanied by thunder, lightning, and precipitation; and it is distinguished from a GUST, q. v., which is simply a momentary increase in the mean wind speed due to turbulence set up by some surface obstacle. A squall is often named after the special weather phenomenon which accompanies it: thus there are rain, snow, and hail squalls, etc. Squalls are very common in the doldrums, over the oceans, where several may be visible from a ship at one and the same time; they occur in many parts of the world, and are often known by local names, such as the PAMPERO, q. v., of South America. Squall winds vary greatly in intensity, from moderately heavy to very violent. A noted squall, of the line squall type, in 1878 capsized a British man-of-war. Squalls may be divided into two classes: those with straight winds and those with rotary winds. Under the first category may be named line squalls and thundersqualls; under the second, arched, black, typhoon, and white squalls. An account of each of these will be found under the appropriate entry.

squall cloud, *n.*—A small cloud sometimes formed below the front edge of a thunderstorm cloud, "as a sort of eddying whirl between the upward and downward currents on either side of it." (J. G. Albright, Physical Meteorology, 1939, p. 319.) The upward current of warm air blows into the thunderstorm, and the downward cold current blows out of it; vortices form between them, and the lowest one, made visible by condensation of the moist air, and rotating on a horizontal axis, is the squall cloud. *See:* W. J. Humphreys: Physics of the Air, 3d ed., 1940, p. 354.

squall line, *n.*—1. The cold front of the Bjerknes CYCLONE MODEL, also known as the WIND-SHIFT LINE, q. v.; the line of discontinuity at the forward edge of the advancing cold air mass which is displacing warmer air in its path. The most notable characteristic of the squall line is the sharp change of wind, from the southerly to the westerly or northwesterly quadrant. In certain cases, severe squalls and thunderstorms may extend along it for hundreds of miles. 2. A line of squalls other than that occurring at a severe cold front, often found in the WARM SECTOR, q. v., some 50 to 200 miles ahead of and roughly parallel to the front; hence it may also be called a prefrontal or pre-cold front squall line.

squall surface, *n.*—*See:* KATAPHALANX.

St., *abbr.*—Abbreviation for STRATUS (cloud), q. v.

stability, *n.*—A state of vertical equilibrium in which the vertical distribution of temperature is such that an element of air will resist displacement from the level at which it is in equilibrium with its environment. In dry air the LAPSE RATE, q. v., necessary for stability is less than the dry adiabatic; in saturated air, the lapse rate must be less than the saturation adiabatic. *See:* ADIABATIC PROCESS; INSTABILITY.

standard atmosphere, *n.*—A conventional vertical structure of the atmosphere, used principally in aeronautics and ballistics, characterized by a uniform decrease of temperature (T) with height up to the level at which $T=-55°$ C., its assumed limit, according to the equation

$$T=15-0.0065\ h,$$

in which T=the temperature in centigrade degrees at the height h in meters above sea level. Further specifications for the standard atmosphere are given in the following table:

STANDARD ATMOSPHERE-STANDARD VALUES

	Symbol	Metric	English
Standard temperature	t	15° C	59° F.
Standard temperature absolute	T	288° A	550.4° F.
Standard pressure	p	760 mm of Hg	29.92117 in. of Hg.
Standard pressure	p	10332.276 kg/m²	2116.229 lb/ft.²
Standard gravity	g	9.80665 m/sec²	32.1740 ft/sec.²
Standard specific weight	gp	1.2255 kg/m³	0.07651 lb/ft.³
Standard density	p	0.124966 kg/m/sec	0.002378 lb/ft/sec.
Standard temperature gradient	a	0.0065° C/m	0.00356617° F./ft.
Standard isothermal temperature	t_i	−55° C	−67° F.
Standard gas constant for air	R	29.2708	53.33089.

See: National Advisory Committee for Aeronautics, Technical Reports, Nos. 218, 246, 538; W. R. Gregg, Aeronautical Meteorology, rev. ed., 1930, pp. 76–78; W. J. Humphreys, Physics of the Air, 1940, p. 75; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 23–24, 409.

standard density, *n.*—The adopted values for the densities of mercury and air are given below:

(1) Mercury:

The standard density of mercury adopted by the International Bureau of Weights and Measures is 13.5951 gm/cc at a temperature of 0° C. This value is used by the U. S. Weather Bureau in converting heights of mercurial columns under standard conditions to pressures in mbs., or dynes/cm². (This value is within the probable error of the best value cited by Birge; $13.59505_0 \pm 0.00005_7$ gm/cc at 0° C. and under one normal atmosphere pressure.) *See:* Smithsonian Meteorological Tables, 1939, p. xxii; R. T. Birge, A New Table of Values of the General Physical Constants, Reviews of Modern Physics, vol. 13, No. 4, pp. 233–239.

In Great Britain, a value of 13.5955 gm/cc has been adopted as the standard density of mercury. *See:* Computer's Handbook, Introduction, Great Britain Meteorological Office, 233, 1921, p. 7.

(2) Air:

The standard density of dry air under standard conditions of pressure, temperature, and gravity is as follows: (a) dry air, CO_2 free: 1.2928×10^{-3} gm/cc; (b) dry air, containing 3 parts of CO_2 per 10,000: 1.29301×10^{-3}; (c) dry air containing 4 parts of CO_2 per 10,000: 1.29307×10^{-3}. The value usually considered to be best for meteorological work is that for dry air containing 3 parts of CO_2 per 10,000.

standard deviation, *n.*—A measure of the extent to which individual values of a series are scattered about their average value; computed by taking the square root of the arithmetic mean of the squares of the departures of the various items from the arithmetic mean of the group. The square of the standard deviation is known as the variance or mean square. The standard deviation is expressed algebraically as follows:

$$s=\sqrt{\frac{\Sigma(T-M)^2}{n-1}}$$

where $(T-M)$ expresses an individual departure; Σ, the summation of all the departures, and n is the number of items in the series.

Calculation of the standard deviation of temperature, for example, is performed by (a) computing the sum of the squares of the individual monthly departures from the mean monthly temperature, (b) dividing by $(n-1)$ which is the number of independent departures, and (c) extracting the square root of the resulting quantity to find s, the standard deviation of the mean monthly temperature.

standard gravity, *n.* (i. e., acceleration of gravity)—Standard gravity is a conventional value of the acceleration of gravity widely adopted for use as a reference basis in barometry and other physical fields. The value of gravity adopted by the Service International of the International Bureau of Weights and Measures, called the standard value, is 980.665 cm/sec^2. At the time of its adoption, this value was assumed to apply for latitude 45° and sea level. Actually, however, 980.665 cm/sec^2 is not the mean value of the acceleration of gravity at latitude 45° at sea level, but must be regarded as an arbitrary, conventional value.

In barometry, it is used mainly for two purposes: (1) to provide a reference standard for the acceleration of gravity by means of which a given barometric height under standard conditions always represents the same pressure, thus insuring comparability between heights of mercurial columns; and (2) to provide a reference standard for the acceleration of gravity by means of which the unit of pressure and the normal atmosphere may be defined in conjunction with the value for the standard density of mercury at 0°C. (The standard or normal atmosphere is the pressure exerted by a vertical column of pure mercury which has a length of 76.0 cm. when at a temperature of 0°C., while under the influence of standard gravity. This normal atmosphere should be carefully distinguished from the standard atmosphere defined by the National Advisory Committee for Aeronautics, and the International Committee of Aerial Navigation.) It should be noted that the International Geodetic Association at Stockholm (1930) adopted the following formula to represent the theoretical value of the acceleration of gravity (g_ϕ) at the latitude ϕ and at sea level. (This formula neglects the local effects due to the distribution of topographic masses with relation to the given point and the distribution of isostatic variations of density in the earth's crust.)

$$g_\phi=978.0490\ (1+0.0052884\ \sin^2\phi-0.0000059)$$

According to this formula, the theoretical, international value of gravity at latitude 45° at sea level is 980.6294 cm/sec^2, which is different from the value for standard gravity given above.

The reduction of barometric heights observed at a given point depends upon the ratio of the value of true local gravity at the point to the value of standard gravity. The local acceleration of gravity may be measured by means of a gravimeter. At any given point on the earth, its value depends upon the latitude, elevation, distribution of topographic masses with relation to the given point, and upon the distribution of isostatic variations of density in the crust of the earth. Local gravity may be reduced from theoretical gravity at sea level at the latitude of the station by applying corrections for the elevation and for topography, isostatic compensation, and gravity anomaly.

The U. S. Weather Bureau and some other national meteorological organizations do not use the ratio given above for the reduction of barometric heights. Instead, a ratio is used which is derived through the use of a formula given in the International Meteorological Tables. The formula is a first approximation to the ratio of local gravity to gravity at 45°.

The International Meteorological Organization, meeting at Berlin in 1939, adopted for meteorological usage, the value of 980.62 cm/sec ^{2} for the acceleration of gravity at latitude 45° and sea level.

Many scientists, especially those working with gases, use gravity at latitude 45° as one of the factors in the specification of the normal atmosphere. *See:* Smithsonian Meteorological Tables, 1939, pp. xxi, xxii, xxxviii, and xxxix, and tables 48, 49, 50, 90, and 91; Smithsonian Physical Tables, 1934, pp. 566, 567; C. H. Swick, Pendulum-Gravity Measurements and Isostatic Reduction, U. S. Department of Commerce, Coast and Geodetic Survey, Special Publication No. 232, Washington, D. C. (1942); International Meteorological Tables, Paris, 1890; Hugh L. Dryden, A Re-examination of the Potsdam Absolute Determination of Gravity, Journal of Research, vol. 29, No. 5, U. S. Bureau of Standards (1942); Report of the Resolutions of the International Meteorological Organization, No. 50, Addition A, 1943; Raymond T. Birge, The General Physical Constants, Reports on Progress in Physics, Vol. VIII, 1941, p. 90.

standard pressures, *n.*—Adopted values of pressure used for specific purposes. (1) The value of a standard pressure of one atmosphere, used in the determination of gas densities, is defined as the pressure produced by a column of pure mercury 76.0 cm. in height at a temperature of 0° C. under standard gravity. (2) The value of 1,000 mb. has been adopted as the reference pressure to which the POTENTIAL TEMPERATURE, q. v., corresponds. The potential temperature of dry air is the temperature which the air would attain if it were brought dry-adiabatically from its existing conditions of temperature and pressure to a pressure of 1,000 mb.

standard temperatures, *n.*—Arbitrarily adopted values of temperature at which physical magnitudes are defined, and to which measurements made at other temperatures are corrected: (a) 62° F. The British yard is defined as the distance between two lines on a bronze bar when the temperature of the bar is 62° F. Brass scales in English units on mercurial barometers are graduated to be true at 62° F.

(b) 0° C. (1) The meter is defined as the distance, measured at a temperature of 0° C., between two lines scratched on a platinum-iridium bar which is deposited at the International Bureau of Weights and Measures at Sèvres, France. Brass scales in metric units on mercurial barometers are graduated to be true at 0° C. (2) Barometric heights are defined in terms of the height of the mercurial column when the mercury is at a temperature of 0° C. under standard gravity. (3) To facilitate direct comparison and application of the data to calculations involving the gas laws, gas densities are usually defined under the standard conditions of temperature and pressure; namely, 0° C. and one STANDARD ATMOSPHERE, q. v., respectively.

standard time, *n.*—Time used at a place, in accordance with a plan agreed upon by an international conference in 1884. This plan states that standard meridians will be used at intervals of 15 degrees (or one hour) east and west of Greenwich, England, and the ideal standard time at any place would be the local civil time of the standard meridian nearest that place; i. e., when it is noon at any standard meridian, it is conventionally noon at all places 7½ degrees east of and 7½ degrees west of that standard meridian. In actual practice, however, the standard time of a place is the time of the meridian chosen for convenience. For instance, the standard time for the whole state of Ohio is the time of the 75th meridian, whereas only the eastern half is in the 75th meridian time zone, but it has been found convenient to have the whole state use the same time meridian.

standing cloud, *n.*—Synonymous with a stationary cloud over a mountain, such as a banner or cap cloud. *See:* CREST CLOUD.

state of the sky, *n.*—The aspect of the sky in reference to the cloud cover. The state of the sky is fully described when the amounts, kinds, directions, and heights of all clouds are given.

static, *n.*—Electromagnetic waves that interfere with radio reception; also called ATMOSPHERICS and STRAYS, q. v. They have various sources, among which are thunderstorms and other severe atmospheric disturbances.

static ceiling, *n.*—"The altitude in standard atmosphere, at which an aerostat is in static equilibrium after removal of all dischargeable weight." (Nomenclature for Aeronautics, Report No. 474, National Advisory Committee for Aeronautics, 1937, p. 11.) *See:* CEILING; STANDARD ATMOSPHERE; ABSOLUTE CEILING; BALLONET CEILING; SERVICE CEILING.

station, *n.*—*See:* WEATHER STATION.

stationary cyclone, *n.*—1. A large, more or less stationary and semi-permanent low pressure area, such as the ALEUTIAN LOW, q. v. 2. A migratory cyclone which becomes very slow-moving, or one which develops and fills up on the spot without apparently moving.

stationary front, *n.*—A FRONT, q. v., along which one of the two air masses separated by it is not displacing the other.

station elevation, *n.*—In the U. S. Weather Bureau, the elevation above sea level adopted for a station as the basis to which all pressure observations at the station correspond. *See:* STATION PRESSURE; ACTUAL ELEVATION.

station pressure, *n.*—In the U. S. Weather Bureau, that pressure corresponding to an adopted STATION ELEVATION, q. v., which may differ slightly from the actual elevation of the barometer. *See:* ACTUAL PRESSURE.

station model, *n.*—A term applied to the arrangement of data (figures and symbols) around the station circle on a weather chart, which arrangement is in accordance with the international station model.

staubosphere, *n.*—Synonymous with konisphere, the "dust atmosphere" of the earth; a term introduced by S. Cyril Blacktin in "Dust," 1934, p. 9.

steam, *n.*—In meteorology, visible condensed vapor rising from ground or water, best exemplified by the steaming of rivers in times of intense frost, of asphalt roads when the sun shines after a sudden cold shower, and the rising of clouds of condensed vapor over the open sea in the Arctic regions.

steam fog, *n.*—Fog formed when cold air having a low vapor pressure passes over warm water. Steam fogs are observed in the Arctic where they are also called ARCTIC SEA SMOKE, q. v., and over inland lakes and rivers where they are very important as they interfere with aviation.

steam mist, *n.*—The result of STEAMING, q. v., over open water, such as lakes and rivers; often occurs in the United States on clear, autumn mornings; in the Arctic it is called ARCTIC SEA SMOKE, or FROST SMOKE, q. v.

steering, *n.*—The directing influence exercised on the trajectories of surface disturbances by the flow patterns at 10,000 feet or some other upper level.

steering-line, *n.*—Identical, in the Bjerknes CYCLONE MODEL, with the WARM FRONT, q. v., the line of discontinuity at the forward edge of an advancing current of relatively warm air which is displacing a retreating cold air mass; so called because at the point where it joins the cold front its direction indicates the momentary direction of propagation of the cyclone. *See:* FRONT; CYCLONE.

steering surface, *n.*—*See:* ANAPHALANX.

Stefan's law, *n.*—Sometimes called Stefan-Boltzmann's law, which states that the amount of energy radiated per unit time from a unit surface of a black body is proportional to the fourth power of the absolute temperature of the black body; that is,

$$J=\sigma T^4$$

where J=energy radiated; T=absolute temperature of the black body; σ=Stefan's constant; $\sigma=5.735\times10^{-5}$ ergs per cm^2 per sec per deg^4; $\sigma=5.735\times10^{-12}$ watts per cm^2 per sec per deg^4; $\sigma=82\times10^{-12}$ gram-calories per cm^2 per min per deg^4. *See*: Smithsonian Physical Tables, 1934, p. 104; WIEN'S LAW; RADIATION LAWS.

stellar lightning, *n.*—LIGHTNING, q. v., consisting of several flashes radiating from a single point. A particular form of stellar lightning is described under VOLCANIC LIGHTNING, q. v.

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steppe, *n.*—A physiographic and climatic term, first applied by the Russians to their grasslands, but since broadened by some authors to include brushland. It is, then, a semiarid region characterized by grasses, and is not the same as prairie which develops in subhumid areas. This term is generally applied to lands in Europe and Asia which are covered with vegetation in the spring, but in summer are very dry.

Stevenson screen, *n.*—An English term for the standard housing for meteorological thermometers.

stikine wind, *n.*—A local term for the severe, gusty (williwaw) east-northeast wind named after the Stikine River near Wrangell, Alaska, which is produced under the same conditions as a TAKU WIND, q. v.

still-well, *n.*—That portion of the standard equipment for measuring evaporation, used in the United States Weather Bureau, which with the hook gage enables the observer to measure accurately the height of the water in the evaporation pan.

Stokes' law, *n.*—A law in physics which gives the steady rate of fall, or terminal velocity of small spheres falling through a viscous fluid:

$$v=\frac{2}{9}g\,r^2\left(\frac{\sigma-p}{u}\right)$$

where v = the terminal velocity in centimeters per second, g = the value of gravity in c. g. s. units, r = the radius of the particle in centimeters, σ = the density of the particle, p = the density of the fluid, and u = the viscosity of the fluid.

According to this law, a raindrop of 0.001 cm. diameter has a limiting velocity of fall in the atmosphere of approximately 0.0091 centimeters per second, and hence would take about three hours to settle one meter. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 19–21; W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 279.

stooping, *n.*—An optical phenomenon in which "rays from the base of an object are curved down by atmospheric refraction much more rapidly than those from the top, with the obvious result of apparent vertical contraction, and the production of effects quite as odd and grotesque as those due to towering." (W. J. Humphreys, Physics of the Air, 1940, p. 470.) *See:* TOWERING.

storm, *n.*—1. In general, a disturbance of the ordinary average conditions of the atmosphere which unless specifically qualified, may include any or all meteorological disturbances, such as wind, rain, snow, hail, thunder, etc. This general term may be further restricted by some descriptive adjective, as e. g., sandstorm, duststorm, hot wind (such as the Khamsin or foehn or chinook), cold windstorm (such as the norther and the pampero), cold rainstorm, a heavy snowstorm without wind, or one with wind (such as the blizzard). 2. Wind force of 11 in the BEAUFORT WIND SCALE, q. v.

storm cave, *n.*—A natural or an artificially constructed shelter for protection from tornadoes; also known by various other names, such as TORNADO PIT or CYCLONE CELLAR, q. v. In some sections storm caves, while built primarily as a refuge from tornadoes, are also constructed to serve as storage places.

storm cellar, *n.*—*See*: STORM CAVE.

storminess, *n.*—A term with no recognized precise meaning, usually defined by each writer who uses it; generally it refers to that quality of the climate of a place which is evidenced by the frequency of cyclones or their violence, and may also include factors of cloudiness and precipitation.

storm paths, *n.*—Lines drawn on maps indicating the paths of the centers of all the lows for a certain period, or the average tracks or paths for each of the various types of lows; also called storm tracks, tracks of lows, etc.

storm tide, *n.*—*See*: TIDAL WAVE.

storm tracks, *n.*—*See*: STORM PATHS.

storm warnings, *n.*—Displays of signals on masts or on other high structures to indicate the approach of a storm. For this purpose, flags and lanterns are used in the United States, cones in Great Britain.

storm-warning tower, *n.*—A tower generally constructed of steel, for displaying storm warnings by means of semaphores, flags, or lanterns.

storm wave, *n.*—A rise of the sea over low coasts not ordinarily subject to overflow; also included under the term TIDAL WAVE, q. v., though it is caused primarily by wind, and has no relation to the tide brought about by gravitational forces except that the two may combine. More than three-fourths of all the loss of human lives in tropical cyclones has been caused by these inundations and not by the winds directly. It is reported that the storm wave which occurred with a cyclone on October 7, 1737, at the Hooghly Branch of the mouth of the Ganges River, on the Bay of Bengal, rose 40 feet, destroyed 20,000 craft, and killed 300,000 people.

straight blow, *n.*—A wind of considerable force which blows for a long distance (say over 100 miles) in a straight direction; known by various names, such as line blow, straight-line gale, long-path or geostrophic wind.

"Occasionally blows reach strong or even gale force, on the southern side of an anticyclone, even when no low is in evidence, especially along the middle and south Atlantic coasts. Such blows have been termed 'line blows,' probably because there is little shifting of the wind direction during the blow as contrasted with cyclonic winds." (R. H. Weightman, Forecasting from Synoptic Weather Charts, U. S. Weather Bureau, 1940, p. 37.)

straight isobar, *n.*—1. A term used by forecasters in describing a type of pressure distribution in which the isobars lie in nearly parallel lines on a barometric slope; but isobars appearing parallel (or nearly so) on one map might appear differently on another map of different projection. 2. An isobar lying along a great circle.

straight-line gale, *n.*—*See*: STRAIGHT BLOW.

stratification of the atmosphere, *n.*—"The separation of the atmosphere into more or less nearly horizontal layers which mark separate steps in the change of some particular element with height. Evidence of stratification in the atmosphere, apart from the continuous variation of pressure, is shown by layers of cloud as well as by notable changes in curves representing the variation with height of water-vapour, temperature, or wind-velocity." (N. Shaw, Manual of Meteorology, Vol. II, 1928, p. xxxvi.) *See:* W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 48–49.

stratiform, *adj.*—Applied to clouds having the form of stratus clouds.

stratocumulus, *n.*—A cloud layer (or patches) composed of laminae, globular masses or rolls; the smallest of the regularly arranged elements are fairly large; they are soft and gray, with darker parts. These elements are arranged in groups, in lines, or in waves, aligned in one or in two directions. Very often the rolls are so close that their edges join; when they cover the whole sky, they have a wavy appearance.

From the definition it follows that stratocumulus comprises two kinds: 1. Stratocumulus translucidus—A not very thick layer; in the interstices between its elements either the blue sky appears, or at any rate there are much lighter parts of the cloud sheet, which in these places is thinned out on its upper surface. 2. Stratocumulus opacus—A very thick layer made up of a continuous sheet of large dark rolls or rounded masses; their shape is not merely seen by a difference in transparency, but the rolls stand out in real relief from the under surface of the cloud layer.

There are also transitional forms between stratocumulus and altocumulus on the one hand and between stratocumulus and stratus on the other.

EXPLANATORY REMARKS

The difference between stratocumulus and ALTOCUMULUS is given under the latter, q. v.

It should also be noted that the cloud sheet called altocumulus by an observer at a small height might appear as stratocumulus to an observer at a greater height.

It often happens that stratocumulus is not associated with any clouds of the second or third families; but it fairly often coexists with clouds of the fourth family.

The elements of thick stratocumulus (stratocumulus opacus) often tend to fuse together completely, and the layer can, in certain cases, change into nimbostratus. The cloud is called nimbostratus when the cloud elements of stratocumulus have completely disappeared and when, owing to the trails of falling precipitation, the lower surface has no longer a clear-cut boundary.

Stratocumulus can change into stratus, and vice versa. Since the stratus is lower, the elements appear very large and very soft, so that the structure of regularly arranged globular masses and waves disappears as far as the observer can see. The cloud should be called stratocumulus as long as the structure remains visible.

SPECIES

Among the principal species of stratocumulus may be mentioned:

1. Stratocumulus vesperalis—Flat elongated clouds which are often

seen to form about sunset as the final product of the diurnal changes of cumulus. 2. Stratocumulus cumulogenitus—stratocumulus formed by the spreading out of the tops of cumulus clouds, which latter have disappeared; the layer in the early stages of its formation looks like *stratocumulus opacus.*

VARIETIES

The cloud called roll cumulus in England and Germany is designated *stratocumulus undulatus*; its wave system is in one direction only. It must not be confused with flat cumulus clouds ranged in line. Stratocumulus often has a mammatus (festooned) character; that is to say, there is a high relief on the lower surface where pendant rounded masses or corrugations are observed, and at times these look as though they would become detached from the cloud. Care must be taken not to confuse this cloud with some kinds of *altostratus opacus* whose under surface may appear to be slightly corrugated or mammillated; *altostratus opacus* is distinguished by its fibrous structure.

stratocumulus cumulogenitus, *n.*—*See:* STRATOCUMULUS.

stratocumulus mammatus, *n.*—*See:* MAMMATUS.

stratocumulus opacus, *n.*—*See:* STRATOCUMULUS.

stratocumulus translucidus, *n.*—*See:* STRATOCUMULUS.

stratocumulus undulatus, *n.*—*See:* STRATOCUMULUS.

stratocumulus vesperalis, *n.*—*See:* STRATOCUMULUS.

stratosphere, *n.*—The region of the upper atmosphere characterized by little or no temperature change with altitude; there may even be a slight increase of the temperature upward. (B. Haurwitz, The Physical State of the Upper Atmosphere, 1937, p. 87); also known as the isothermal region.

The stratosphere is separated from the lower atmosphere by the TROPOPAUSE, q. v., the height of which varies with the latitude, the seasons, and the passage of cyclones. The temperature at the tropopause ranges from approximately −55° C. above the Poles to about −75° C. over the Equator. An important constituent of the stratosphere is ozone, which plays an important role in the phenomenon of SELECTIVE ABSORPTION and seems to have a significant correlation with surface weather conditions.

The stratosphere is free from the clouds and convective currents of the troposphere. Its upper limit is as yet uncertain. *See:* J. G. Albright, Physical Meteorology, 1939, pp. 172–175; W. J. Humphreys, Physics of the Air, 3d ed., 1940, pp. 51–66, 77; S. Petterssen, Introduction to Meteorology, 1941, pp. 6–10; G. F. Taylor, Aeronautical Meteorology, pp. 2–5. Note: The term stratosphere was introduced by L. Teisserenc de Bort, and was probably used for the first time in his paper, "La division de l'atmosphère en troposphère et stratosphère d'après les résultats de l'exploration de la haute atmosphere," read at the eleventh general meeting of the German Meteorological Society, Hamburg, September 29, 1908. This paper appears never to have been published.

stratosphere coupling, *n.*—Refers to the mechanism of the interaction between atmospheric changes in the stratosphere and those in the troposphere. The mechanism of this coupling action has not been determined even to the point of definitely locating its initiation in the stratosphere or in the troposphere; but it acts in such a manner that opposite effects are usually produced in the upper and in the lower atmosphere. This tendency for strong changes in the troposphere to be offset in their net effect at the ground by opposite changes in the stratosphere above is sometimes referred to as stratospheric compensation. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 320–334.

stratospheric steering, *n.*—The directing or "steering" influence which, according to Stüve's theory, is exerted on the motion of pressure systems at the surface by the pressure distribution at high levels, especially in the stratosphere. *See:* THERMOCYCLOGENESIS; B. Haurwitz, Dynamic Meteorology, 1941, pp. 327–330.

stratus, *n.*—A low uniform layer of cloud, resembling fog, but not resting on the ground. When this very low layer is broken up into irregular shreds it is designated FRACTOSTRATUS, q. v.

A veil of true stratus generally gives the sky a hazy appearance which is very characteristic of the type but which in certain cases may cause confusion with nimbostratus. When there is precipitation, the difference is manifest: nimbostratus gives continuous rain (sometimes snow), precipitation composed of drops which may be small and sparse, or else large and close together, while stratus gives only a drizzle, that is to say, small drops very close together. When there is no precipitation, a dark and uniform layer of stratus can easily be mistaken for nimbostratus. The lower surface of nimbostratus, however, has always a wet appearance (widespread trailing precipitation, "virga"); is quite uniform, and it is not possible to make out definite detail. Stratus, on the other hand, has a drier appearance, and, however uniform it may be, shows some contrasts and some lighter transparent parts, that is, places which are less dark where the cloud is thinner, corresponding to the interstices between the rolls and globular masses of stratocumulus, but considerably larger; while nimbostratus seems only to be feebly illuminated, as though lit up from within.

Fractostratus sometimes originates from the breaking up of a layer of stratus, sometimes forms independently and develops until it forms a layer below altostratus or nimbostratus, which latter may be seen in the interstices. A layer of fractostratus may be distinguished from nimbostratus by its darker appearance, and by its being broken up into cloud elements. If these elements have a cumuliform appearance in places, the cloud layer is called FRACTOCUMULUS, q. v., and not fractostratus.

strays, *n.*—*See:* STATIC.

streak lightning, *n.*—The ordinary sinuous form of LIGHTNING, q. v., most commonly observed; it is often conventionally but erroneously represented in zigzag fashion. "Streak lightning is also likely to be forked and have several paths through which the discharge occurs; often it very closely resembles in form a river and its tributary system. Its sinuous form is due to the fact that the electrical field through which the discharge occurs is not uniform but heterogeneous, and the ionization is unequal, causing the breakdown to proceed in a random and irregular manner." (J. G. Albright, Physical Meteorology, 1939, p. 332.)

stream function, *n.*—A scalar function of space and time associated with two-dimensional fluid motion. It can be represented by $\Psi(p, q; t)$, where p and q are surface co-ordinates on the surface in which the motion takes place. If n is a unit vector normal to this surface, then the fluid velocity is

$$c = n \times \text{grad } \Psi$$

where grad Ψ is the surface gradient of Ψ. If the surface is a plane, this is equivalent to

$$u = -\frac{\partial \Psi}{\partial y}, \; v = +\frac{\partial \Psi}{\partial x}$$

where u and v are the velocity components in cartesian coordinates x, y. The velocity is parallel to the line Ψ=constant.

streamlines, *n.*—Lines which are everywhere parallel to the instantaneous direction of motion in a fluid. Thus, if u, v, w are the velocity components in cartesian coordinates, the differential equations of the streamlines are:

$$\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w}$$

The streamline field is customarily constructed in such a way that the spacing of the streamlines at a given point is inversely proportional to the speed of the motion at this point.

structure of the atmosphere, *n.*—The arrangement and interrelations of subdivisions of the atmosphere in respect to their physical characteristics, as temperature, pressure, density, humidity, movement, etc. It is, therefore, the instantaneous picture of the static and dynamic conditions at any given time.

The term is commonly used to refer to the large-scale structure in the vertical which, as regards arrangement, is characterized by the following subdivisions; troposphere, tropopause, stratosphere, ionosphere, and extreme outer layers.

Further, one may describe the structure of any atmospheric phenomena as the structure of the winds, tornadoes, cyclones, ice crystals, etc.

Stüve diagram, *n.*—That form of the adiabatic or pseudoadiabatic diagram which has the absolute temperature on a linear scale as abscissas, and as ordinates the pressure plotted on an exponential scale decreasing upward in terms of $p^{0.228}$. This particular form of the adiabatic diagram has the advantage of making dry adiabatic (isentropic) processes appear as straight lines. *See:* H. R. Byers, General Meteorology, 1944, pp. 165–167.

subarid, *adj.*—Synonymous with SUBHUMID, q. v., meaning moderately arid.

subgradient winds, *n.*—Wind whose velocity is less than that indicated by the existing pressure gradient; it occurs most frequently when air is moving to a region of increasing pressure gradient (converging isobars). It should be evidenced by a component of the wind across the isobars towards lower pressure.

subhumid, *adj.*—Pertaining to a type of climate too dry for natural forest growth, as the prairie region of the United States or the pampas of South America, and yet not so dry as to require irrigation; its original native vegetation is tall grass.

This subdivision of climate may be broken down still further into moist subhumid and dry subhumid climates, of which Iowa is an example of the former and the eastern Dakotas of the latter.

sublimation, *n.*—The transition of a substance directly from the solid state to the vapor state, or vice versa, without passing through the intermediate liquid stage.

subsidence, *n.*—The slow settling or sinking of a stagnant mass of air, generally accompanied by DIVERGENCE, q. v., in the lower layers. In its slow movement downwards, the air is compressed and warmed at the dry adiabatic rate, so that its thermal structure is changed and its stability enhanced.

Subsidence usually occurs on a large scale in stagnating anticyclones, where thousands of square miles may be affected. Conditions are also favorable for it under cold frontal surfaces, in high pressure wedges, and in regions of isallobaric maxima. If the subsiding air is simultaneously warmed from below, a SUBSIDENCE INVERSION, q. v., is formed, and is important in determining to a large extent the weather of the underlying region. *See:* D. Brunt, Physical and Dynamical Meteorology, 1939, pp. 384–386; H. R. Byers, Synoptic and Aeronautical Meteorology, 1937, pp. 38–41, 59–60, 108–109; J. Namias, Subsidence Within the Atmosphere, 1934, pp. 7—10; S. Petterssen, Weather Analysis and Forecasting p. 457.

subsidence inversion, *n.*—An increase in temperature vertically through a layer of the atmosphere, caused by SUBSIDENCE, q. v.

"Subsidence inversions can generally be distinguished from frontal inversions in that the specific humidity generally increases upward through a frontal inversion and decreases through a subsidence inversion. . . .

"Subsidence inversions extend over a large area. Their structure is essentially that of a dome-shaped surface." (J. Namias, Subsidence Within the Atmosphere, 1934, p. 59.)

substratosphere, *n.*—A term loosely applied to levels in the high atmosphere just under the STRATOSPHERE, q. v.

subtropical (or **subtropic**), *adj.*—1. Pertaining to a type of climate which is found at the tropical margins of the temperate zones. 2. Designation applied to the belts of high pressure and of calms or variable winds in the general vicinity of 30° N. and 30° S. lat.

subtropics, *n.*—Another name for the subtropical regions, which lie at the equatorward side of the temperate zones.

Suestado, *n.*—A storm with southeast gales, caused by intense cyclonic activity off the coasts of Argentina and Uruguay, which affects the southern part of the coast of Brazil in the winter.

sultry, *adj.*—Term used to describe weather which is hot and humid.

sumatra, *n.*—In the Malacca Straits a squall with violent thunder, lightning, and rain, which blows at night usually during the southwest monsoon and is intensified by strong mountain breezes. *See:* W. G. Kendrew, The Climate of the Continents, 1937, p. 165.

summer, *n.*—A SEASON, q. v., of the year—the warmest in temperate and polar regions, the dry season in the tropics. Meteorologically, the summer is most commonly regarded as including the months of June, July, and August; in astronomical practice, however, it extends from the summer solstice, about June 21, to the autumnal equinox, about September 22.

To meteorologists, summer is notable in that it marks the dwindling of the large continental anticyclones which tend to dominate the weather during the rest of the year, the development and northern extension of the oceanic subtropical anticyclones, and the general slow-down of the atmospheric circulation. In the United States, and in Russia and Central Siberia, summer, contrary to popular thought, is almost as unpleasant a time of year as winter, by reason of the heat waves and droughts which may cause widespread suffering, even death, commensurate with that resulting from a blizzard or cold wave. *See:* C. F. Brooks, Why the Weather?, 1935, pp. 90–91; C. J. Root and R. G. Stone, Deaths During the Heat Wave of July 1936 at Detroit, Bulletin of the American Meteorological Society, vol. 13, 1937, pp. 232–236.

sun cross, *n.*—*See:* CROSS.

sundog, *n.*—Popular name for a PARHELION, q. v.

sun drawing water, *n.*—Popular name for the phenomenon of CREPUSCULAR RAYS, q. v.

sun pillar, *n.*—A glittering shaft of light, white or reddish, extending above and below the sun, most frequently observed at sunrise or sunset; it may extend to about 20° above the sun, and generally ends in a point. Sun pillars observed at sunset may be entirely red; but as a rule they are of a blinding whiteness and show a marked glittering. Occasionaly these white columns appear simultaneously with a portion of the white mock-sun ring, or parhelic circle, and so form another very remarkable phenomenon, viz., the SUN CROSS, q. v. *See:* Report of the Second Meeting of the International Meteorological Committee at Innsbruck, September 1905, p. 87.

sunrise, *n.*—1. The phenomenon of the sun's appearance on the eastern horizon as a result of the earth's rotation. 2. Short expression for the "time of sunrise" which is defined by the U. S. Weather Bureau as the instant when the upper limb of the sun appears on the ideal or sea level horizon. In Great Britain the center of the sun's disk is used instead of its upper limb.

The time of sunrise as defined above is the apparent or observed time; the time of geometric sunrise is somewhat different, owing to the fact that the refraction of sunlight by the atmosphere causes the apparent time of sunrise to be earlier than that given by geometric theory. The times of sunrise and sunset given in tables are calculated for sea level. Therefore, the topography of a place may be responsible for a considerable difference between the tabular and the actual times, as, for example, when the point of observation is in a valley or at a considerable elevation.

The time of sunrise over the earth varies with the latitude and with the seasons. *See:* SUNSET.

sunset, *n.*—1. The phenomenon of the sun's disappearance below the western horizon as a result of the earth's rotation. 2. Short expression for the "time of sunset" which is defined by the U. S. Weather Bureau as that instant when the upper limb of the sun disappears below the ideal or sea level horizon. This time is somewhat later than geometric sunset owing to the refraction of sunlight by the atmosphere. *See:* SUNRISE.

sunshine, *n.*—The condition at the earth's surface when the sun casts a well-defined shadow.

sunshine integrator, *n.*—An instrument for determining the possible duration of sunshine in any locality.

sunshine recorder, *n.*—An instrument designed to record the duration of sunshine, without regard to its intensity; it may operate by reacting to either the heat energy or the photographic effect of the sun's rays.

There are two types of sunshine recorders which use the solar heat energy. One employs a spherical glass which is focussed upon a curved strip of suitable paper ruled into hourly intervals; and the record consists of a burned track made whenever the sun's rays are sufficiently strong to make a well-defined shadow. Another type, called the electrical contact recorder used by the U. S. Weather Bureau, is essentially a Leslie differential thermometer; the sun's rays strike the blackened bulb of the thermometer and heat it so that the contained air and alcohol vapor expand and force a column of mercury to rise, and close an electric circuit. A pen writing upon paper wrapped around a revolving cylinder is thus actuated and makes a stepwise record when the sun is shining and a straight line when it is not.

The photographic type of sunshine recorder consists of a light-tight box with a pinhole through which the sun may shine, leaving a track upon the sensitized paper within. The position of the pinhole is changed each day, and a record of a whole month may be made without changing the paper, but the usual practice is to change the photographic paper twice a month.

sunspot numbers, *n.*—The numbers of sunspots apparent on the sun at different times; they are sometimes called "Wolf's sunspot numbers."

Sunspots have been observed and their number recorded, from 1610, by many observers under different conditions. They cannot, therefore, be directly compared unless re-evaluated. To do this, Wolf devised the "sunspot relative numbers" by which observations by different observers were reduced to a system. His formula is,

$$r=k\ (10g+f),$$

in which r=the Wolf relative sunspot number, g=the number of groups and single spots observed, f=the total number of spots which can be counted in these groups and single spots combined, and

k=a multiplier which depends upon the conditions of the observations and the telescope used.

The sunspot numbers, when plotted, indicate cyclic characteristics; the average length of time between sunspot maxima is about 11.2 years. *See:* C. G. Abbot, The Sun, 2d ed., 1929, Ch. V.

sunstroke, *n.*—A summer malady affecting those whose body mechanism does not accommodate itself to the excessive heat. The first danger sign is the cessation of perspiration resulting in fever and often coma. *See:* C. A. Mills, Medical Climatology, 1939, ch. 10.

superadiabatic lapse rate, *n.*—A temperature lapse rate in the free atmosphere such that the potential temperature decreases with height, or such that any air particle which is displaced adiabatically upward or downward from its initial position finds itself increasingly warmer or colder, respectively, than the surrounding atmosphere.

supercooled water droplets, *n.*—Liquid water droplets whose temperatures are below 0° C. These have been observed in fogs having temperatures as low as −40° C. and in clouds nearly as low. Supercooled water seems to be dependent upon the undisturbed condition of the water molecules; for, when distributed, as by contact with a solid surface, solidification takes place at once.

supergradient wind, *n.*—A wind velocity in excess of that required by the gradient wind balance of forces, or greater than the gradient velocity for the existing pressure gradient. It occurs most frequently when the air moves in the direction of decreasing pressure gradient (diverging isobars) and should be evidenced by a component of the wind across the isobars towards higher pressure.

supérieur air, *n.*—An extremely dry air mass formed by subsidence in anticyclonic eddies in the free atmosphere, and therefore unique among air masses in that it has no direct relation to properties of the earth's surface. It is generally found above a layer of tropical maritime air, from which it is separated by the TRADE INVERSION, q. v.; and it rarely descends to the surface of the earth. Denoted by the symbol S. *See:* AIR MASS (1).

supersaturation, *n.*—The condition existing in a given space when it contains more water vapor than is needed to cause SATURATION, q. v., i. e., when its temperature is below that required for condensation to take place; a condition which can probably occur only when no water or ice is immediately present, and when the space contains no dust or condensation nuclei.

superstratosphere, *n.*—A term sometimes applied to the region of the atmosphere above the stratosphere. *See:* STRUCTURE OF THE ATMOSPHERE.

surface tension, *n.*—A phenomenon peculiar to the surface of liquids, in which the surface molecules seem to have a greater cohesion for one another than do the molecules in the body of the liquid, so that the surface acts like a stretched elastic film.

Surface tension depends on the nature of the liquid, its purity, its temperature, the kind of gas surrounding it, and possibly on other factors. It is measured by the magnitude of the force of contraction acting across a line of unit length in the surface. The following liquids are named in order of the strength of their surface tensions: mercury, water, olive oil, alcohol, and ether.

In meteorology, surface tension is exemplified in the shape of raindrops, and in the action of the alcohol MINIMUM THERMOMETER, q. v.

surge, *n.*—1. Used by Abercromby to mean any change of pressure over a wide area, the precise cause of which is unknown, but which is not due to the passage of a low or a high pressure area or to diurnal barometric variation. 2. In relation to wind, a variation of its mean velocity occurring about once in a minute or some longer period, the mean velocity being calculated for one minute or the longer period.

sweat, *n.*—Condensed water vapor on such artificial objects as water pipes, pavements, water tumblers, etc.; fundamentally the same as DEW, q. v., the only difference being the fact that the latter forms on such natural objects as leaves and blades of grass.

swell, *n.*—A wave in the ocean caused by wind. The elements of a wind wave, or swell, are period, height, length, and velocity. The period of a swell varies from 6 to 10 seconds, the length from 65 to 130 meters, the height may be as much as 12 meters, and the velocities vary from 11 to15 meters per second.

The swell is one of the most valuable precursory signs of the tropical cyclone, and may be noted when the storm is hundreds of miles distant. *See:* I. R. Tannehill, Hurricanes, 1938, p. 88; H. U. Sverdrup, Oceanography for Meteorologists, 1943, pp. 135–146.

sylphon, n.—The trade name of the evacuated cell used in some aneroid barometers, barographs, and altimeters; also in other non-meteorological devices where air pressure must be taken into consideration. *See:* BAROMETER; ANEROID.

symbols, meteorological, *n.*—*See:* METEOROLOGICAL SYMBOLS.

synchronous, *adj.*—Applied to weather charts, etc., which show atmospheric conditions at different places at the same given moment of time, though in practice, so-called synchronous charts are sometimes based on observations taken at somewhat different hours. Properly, a synchronous chart is one kind of synoptic chart. *See:* SYNOPTIC.

synoptic, *adj.*—Atmospheric conditions existing at a given time over an extended region, e. g., a synoptic weather map, which is drawn from observations taken simultaneously at a network of stations over a large area, thus giving a general view of weather conditions.

synoptic analysis, *n.*—The process of analyzing the atmospheric conditions by studying synoptic charts arranged in chronological sequence. *See:* SYNOPTIC CHART.

synoptic chart, *n.*—1. A map of a limited region of the earth, which contains data of weather conditions at many observation points taken simultaneously, or nearly so. 2. A map showing the change of one or more of the meteorological elements at a number of points from one hour of observation to another, or showing the distribution of accumulated precipitation during the period between observations. 3. A map exhibiting the mean or normal value of one or more of the meteorological elements at a number of points during some selected period of time, as for instance, maps showing the normal temperatures at the times of observations.

synoptic meteorology, *n.*—A branch of METEOROLOGY, q. v., concerned with the problem of interpreting collective meteorological observations made simultaneously at the surface or aloft at a number of places over a large area of the earth.

T

t., *abbr.*—Abbreviation for thunder in the BEAUFORT WEATHER NOTATION, q. v.

T., *abbr.*—Abbreviation for trace of precipitation, used in the U. S. Weather Bureau when rain to the amount of less than 0.005 or snow of less than 0.05 of an inch occurs.

Tablecloth, *n.*—A local name for a form of CREST CLOUD, q. v., that occurs over Table Mountain in South Africa. "The 'Tablecloth' that occasionally covers the flat top of Table Mountain, in South Africa, is probably the most famous individual cloud in the world, having been described in numerous books of travel since the latter part of the seventeenth century. It consists of a dense cloud-sheet, formed when warm moisture-bearing winds are forced up the steep slope of the mountain, especially in summer. The cloud often pours over the brow of the mountain, like a mightly cataract, and is dissolved as the wind is warmed by compression in descending to a lower level. The effects produced by this rolling mass of vapor are sometimes indescribably grand, and the phenomenon is all the more striking because a perfectly clear sky generally prevails over the surrounding country while the Tablecloth overspreads the mountain." (C. F. Talman, The Realm of the Air, 1931, pp. 45–46.)

table iceberg, *n.*—Iceberg that has broken off from shelf ice, which is formed along a polar coast, in shallow bays and inlets, where it often reaches the bottom and becomes fastened to the shore, and may grow hundreds of miles out to sea; it breaks off in long flat sheets of considerable area. *See:* Irving Schell, Polar Ice as a Factor in Seasonal Weather, Monthly Weather Review, Supplement 39, Reports on Critical Studies of Methods of Long-Range Weather Forecasting, 1940, pp. 27–51.

tabular iceberg, *n.*—A mass of ice calved from SHELF ICE, q. v., having a flat upper surface, and at least the upper portion formed from stratified snow or NÉVÉ, q. v. Its characteristics are (a) vast size, often measured in miles, (b) rectangular block cleavage, (c) relatively large air-content concentrated within the granules, and (d) white color and lustre.

taiga, *n.*—A Russian word; applied to the cold, swampy, forested region of the north, particularly Siberia, which begins where the tundra leaves off, and also to like regions in Europe and South America.

Taku wind, *n.*—Local name given to a strong, gusty east-northeast wind which may occur in the vicinity of Juneau, Alaska, between October and March. At the mouth of the Taku River (whence it takes its name), it sometimes attains hurricane speeds. "Taku" conditions are produced when a strong pressure gradient exists between the Gulf of Alaska and the interior of the continent. *See:* STIKINE WIND.

Tehuantepecer, *n.*—A violent north wind, frequent in the winter in the region around the Gulf of Tehuantepec in Mexico, and similar to the BORA and MISTRAL, q. v.; caused by the outpouring of air which has travelled from the North American continent, across the Gulf of Mexico, and through the seventy-mile-wide gap in the high cordillera which exists in the Isthmus of Tehuantepec. *See:* W. E. Hurd, Northers of the Gulf of Tehuantepec, Monthly Weather Review, vol. 57, 1929, pp. 192–194.

telemeteorograph, *n.*—Any meteorological instrument, the recording apparatus of which is located at some distance from the operating instrument itself, a common example being the TELETHERMOMETER, q. v. A later development of the same basic idea in the field of radiometeorography is the RADIOSONDE, q. v.

telemeteorography, *n.*—The science of constructing and operating meteorographical instruments whose recording devices are at a considerable distance from the indicating or measuring units; communication of the measurements to the recorders may be by any means, such as electric current, radio, compressed air, light, etc.; also known as TELEMETEOROLOGY, with special reference to a network of stations connected by teletype, radio, etc., for the dissemination of weather information.

telemeteorology, *n.*—*See:* TELEMETEOROGRAPHY.

telephotometer, *n.*—A modified PHOTOMETER, q. v., used to measure the illumination on objects distantly located, say one-half mile away.

telephotometry, *n.*—A measurement of light intensities on objects distantly located.

telethermometer, *n.*—A type of resistance THERMOMETER, q. v., in which the thermometric element is kept outdoors, and the recording drum in the weather station for convenience, the indications of the thermometric unit being transmitted and recorded by electricity.

telethermoscope, *n.*—Usually, an electrical-resistance thermometer whereby temperatures at a distance may be determined—but not recorded. It consists essentially of two parts, the thermic element and the indicating apparatus. The thermic element is a resistance of 100 ohms at ordinary temperature, and is made of pure nickel wire. The indicating apparatus is sometimes in the form of a Wheatstone bridge; the thermic element forms one of the arms, and its resistance, which varies with temperature, is indicated on a scale graduated in degrees of temperature instead of in ohms. At meteorological stations, the thermic element of this instrument is placed in the instrument shelter, and the indicating apparatus in the office of the observer.

temperature, *n.*—1. The thermal state of a substance with respect to its ability to communicate heat to its environment. 2. The measure of this thermal state on some arbitrarily chosen numerical scale. *See:* TEMPERATURE SCALE; CENTIGRADE; FAHRENHEIT; etc. 3. A quantity directly proportional to the mean kinetic energy of translation of the molecules of a substance.

temperature anomaly, *n.*—The difference between the mean temperature of a place and that of the parallel of latitude on which it is situated.

temperature belt, *n.*—The strip formed by drawing on a thermograph trace a line connecting the crests of the trace and another connecting the troughs. Such belts are useful in climatic studies, since they smooth out the diurnal variations of temperature, so as to show a progressive rise or fall.

Similar belts may be drawn for pressure and humidity.

temperature correction, *n.*—The correction applied to a mercurial barometer reading to allow for expansion or contraction of the mercury column and the metal scale. The barometer reading is corrected to what it would be were the mercury at 0° C., and the metal scale at 62° F., if the readings of the scale are taken in inches; if, however, the readings are taken in millimeters, the standard temperature is 0° C. for both the mercury and the metal scale.

temperature (or **thermal) efficiency,** *n.*—1. A climatic element in Thornthwaite's classification of climates, corresponding to the PRECIPITATION EFFECTIVENESS, q. v.; it expresses the degree to which the temperature of a place favors plant growth, and ranges from zero on the polar limit of the TUNDRA, q. v., to a maximum in the tropics.

The monthly index of temperature efficiency (the T–E ratio, i. e., the ratio of temperature to evaporation) is given by i' in the formula

$$i' = \frac{T-32}{4}$$

where T is the mean monthly temperature in Fahrenheit degrees. *See:* C. W. Thornthwaite, The Climates of North America, The Geographical Review, vol. 21, 1931, pp. 633–654. 2. The most favorable degree or range of temperature for human activities; the best temperature for work seems to be between 48° and 68° Fahrenheit. *See:* R. D. Ward, Climate, 1918, chs. 8–10; E. Huntington, Climate and Civilization, 1924, ch. 5.

temperature gradient, *n.*—The rate of change of temperature with distance in any given direction at any point. The average rate of change of temperature between two points is the difference between their temperatures divided by the distance between them.

The vertical temperature gradient or LAPSE RATE, q. v. (which latter term is preferred); is the rate of change of the temperature of the air with elevation. The temperature at the surface of the earth normally decreases with elevation above sea level, and the rate of decrease on the average is approximately 1° C. for each 180 meters on mountains, 200 meters on hills, and 200 meters on plateaus. *See:* W. J. Humphreys, Physics of the Air, 1940, p. 43. In the free air of the troposphere the vertical temperature gradient, as shown by curves of vertical distribution of temperature, averages about 1° C. per 100 meters. Near the surface, say below the 3-kilometer level, and upon approach to the tropopause, the rate becomes less. Occasionally the lapse rate may be negative, i. e., the temperature increases with elevation; this INVERSION, q. v., is especially common in the stratosphere, and near the surface in early morning after a clear winter night. In wintertime in both the Arctic and Antarctic regions the gradient in the lower atmosphere is less because of radiational cooling and the lack of convectional currents.

temperature scale, *n.*—An arbitrary numerical scale of thermal states for measuring TEMPERATURE, q. v. The scales of temperature in common use in meteorology are the Fahrenheit and centigrade; their fiducial points are the freezing and boiling points of water under standard conditions. For calculations in theoretical meteorology, the ideal temperature scale, known as the THERMODYNAMIC, ABSOLUTE, or KELVIN scale, is used. It differs from the centigrade and Fahrenheit scales in a manner shown by the following table:

Scale	Ice point	Boiling point	Symbol
Centigrade	0°	100°	C.
Fahrenheit	32	212°	F. or Fahr.
Réaumur	0	80	R.
Thermodynamic [1] Absolute [1] Kelvin [1]	273.18 C.± 491.7 F.±	373.18 C.± 671.7 F.±	A. or K.
Approximate absolute	273	373	A. A.

[1] Names strictly synonymous and strictly one ideal scale.

The conversion from centigrade to Fahrenheit temperatures and vice versa may be accomplished by using the following formulae:

$$C.^\circ = \tfrac{5}{9}\,(F.^\circ - 32^\circ)$$
$$F.^\circ = \tfrac{9}{5}C^\circ + 32^\circ$$

temperature zone, *n.*—1. An area or latitudinal belt on the earth delimited by given temperature conditions. Supan's temperature zones are five, namely: the hot belt, which is bounded on the north and south by the isotherm representing the mean annual temperature of 20° C. (68° F.); the temperate belts, between the isotherm of 20° C. and the isotherm of 10° C. (50° F.) for the warmest month; and the cold caps covering the poles and extending equatorward to the isotherm of 10° C. (50° F.) for the warmest month. 2. A term also applied to a zone in the vertical, as on mountainsides, delimiting regions of various types of vegetation from tropical to polar. High mountains at or near the equator may have many zones ranging from those where rubber and banana trees grow, to regions of pines and firs. In all, there may be on a mountain having an elevation of 18,000 feet, six zones, namely: the zones of tropical crops, of coffee, of grains, of uncleared forests, of Alpine meadows, and lastly, the zone of permanent snow.

tendency, *n.*—*See*: BAROMETRIC TENDENCY.

tension, *n.*—A term synonymous with pressure in the phrase VAPOR PRESSURE, q. v. The term vapor tension, or tension of vapor, is frequently encountered in the older writings on meteorology.

tephigram, *n.*—A THERMODYNAMIC DIAGRAM, q. v., used in estimating the quantity of available convective energy in an overlying air column, e. g., in forecasting the probability of thunderstorms; the ordinate is entropy or the logarithm of potential temperature, and the abscissa is absolute temperature. This chart was devised by Sir Napier Shaw, who also coined its name. *See:* N. Shaw, Manual of Meteorology, Vol. III, 1930, pp. 269–301; C. M. Alvord and R. H. Smith, The Tephigram—Its Theory and Practical Use in Weather Forecasting, Monthly Weather Review, vol. 57, 1929, pp. 361–370.

tercentesimal thermometric scale, *n.*—Sir Napier Shaw's name for the APPROXIMATE ABSOLUTE TEMPERATURE SCALE, q. v.; obtained by adding 273° to the centigrade temperature. Its abbreviation is tt.

terrestrial radiation, *n.*—The energy which is radiated by the earth and its atmosphere. "Black body radiation at terrestrial temperatures of roughly 300° A. will be contained within the limits 3μ and 80μ, having its maximum intensity at 10μ; and black-body radiation at stratospheric temperatures of about 200° A. will be contained within the limits 4μ and 120μ, having its maximum intensity at 15μ. Thus black-body radiation at atmospheric and terrestrial temperatures is in the far infra-red part of the spectrum. Since this range of wave-lengths is widely separated from that of incoming solar radiation, it is customary to call it 'long-wave' radiation, to distinguish it from direct solar radiation, which is called 'short-wave' radiation." (D. Brunt, Physical and Dynamical Meteorology, 1939, p. 109.)

tertiary circulation, *n.*—A term used in some classifications of wind movements which subdivide atmospheric motions into the primary or planetary circulation, comprising the permanent winds; the secondary circulation, comprising cyclones, anticyclones, and monsoons; and the tertiary, comprising the numerous variable winds, land and sea breezes, thunderstorm winds, etc.

thaw, *v. i.*—To melt; when ice or snow melts, it is said to thaw.—*v. t.* To cause to melt, as to thaw ice or frozen water pipe.—*n.* A weather condition when ice and snow melts, as a "January thaw," so called in parts of the New England and Middle Atlantic States. *See:* SILVER THAW.

theodolite, *n.*—An optical instrument in which a telescope rotates around vertical and horizontal axes and is equipped with graduated circles to measure horizontal and vertical angles. The type used in the U. S. Weather Bureau has its telescope bent at an angle of 90° at the point where the vertical axis and the horizontal axis meet. Light from a distant point enters the object glass, is bent by a prism at the meeting of the axes, and emerges in a horizontal beam at the eyepiece.

In meteorology, the theodolite is used principally to make observations on pilot balloons for the purpose of determining wind direction and speed at various altitudes; also the height, direction, and speed of clouds whenever the balloons enter their bases. The observations are plotted on a GRAPHING BOARD, q. v., and the data computed from the graph.

theoretical meteorology, *n.*—*See:* DYNAMIC METEOROLOGY.

therm, *n.*—A heat unit equal to 100,000 B. t. u.; equal to 2.52×10^7 gram calories; equal to 3.0380×10^{10} ergs.

thermal, *adj.*—Term applied to weather phenomena which are caused by heat, such as a thermal (or heat) low, or to a THERMAL BELT (or ZONE, q. v.)—*n.* Popular expression, in connection with gliding, for an ascending air current of thermal origin.

thermal belt, (or **zone**), *n.*—The portion of a slope above a valley floor, usually extending to the summits of short slopes, that is marked by relatively high night temperatures. The height of its center varies on different slopes and on different nights, depending upon topography and the various meteorological factors that cause the inversion.

A thermal belt occurs most frequently on clear, quiet nights, but also, occasionally, on partly cloudy and even on cloudy nights. It is caused by the stratification of the air: the cooled air of the slopes slips down the mountainside displacing and raising the warmer air of the valley floor.

Interest in thermal belts is due to the success achieved in growing hardy fruits in those areas. Synonyms are verdant zones; frostless belts; green belts; and thermal zones.

thermal capacity, *n.*—The number of calories required to raise the temperature of a body 1° C., or the quantity of heat which is given up when the temperature is lowered 1° C., provided in both cases that there is no change of state. If a body contains only 1 gram of mass, then its thermal capacity is practically the same as the specific heat of the substance composing it. Thermal capacity is synonymous with heat capacity.

thermal climate, *n.*—The climatic type in a system of classification based on actual temperatures and consisting of a number of temperature zones; delimited by selected annual isotherms instead of parallels of latitude. *See:* TEMPERATURE ZONE.

thermal constant, *n.*—The quantity of heat required to bring a plant from seed to maturity; or through any other phase, as from bud to fruit; not a fixed quantity, for it varies not only with the plant and location, but with investigators. Réaumur (about 1735) was the first to make measurements of this constant, and he employed the sum of the mean daily temperatures of the air over the period of time for the phase studied. It may also be measured by means of the DAY DEGREE, q. v. The thermal constant is also called the "thermometric constant." *See:* C. Abbe, Relations Between Climates and Crops, U. S. Weather Bureau, Bulletin 36, pp. 168–294.

thermal equator, *n.*—"(1) The region of the earth inclosed within the annual isotherms of 80° F. This belt includes the northern part of South America and the greater part of Africa and India; (2) Also the middle line of this belt." (Webster's New International Dictionary, 1939.) Neither the belt nor the line is continuous around the globe.

thermal gradient, *n.*—1. The rate of variation of temperature from the surface of the earth downward. Its value is not well known; "from Van Orstrand's data the average is 30° C. per km. depth, but may be very different; variations observed are from 9 (Johannesburg, South Africa) to 54 degrees (Queensland) C. per km. depth. Maximum depth measured, 2,286 m." (Smithsonian Physical Tables, 1934, p. 569.) 2. Term occasionally applied to the vertical TEMPERATURE GRADIENT, q. v.

thermal slope, *n.*—The rate of decrease of temperature from the equator towards either pole. A diagram indicating such a slope may be drawn from average temperature data or from instantaneous values as, for instance, those that are indicated on the daily weather charts. *See:* R. Abercromby, Weather, 1907, pp. 204–209; THERMAL GRADIENT; TEMPERATURE GRADIENT.

thermal wind, *n.*—The component of the vectorial variation of the wind with height that is due to the horizontal temperature gradient; or, in more recent practice, to the isobaric temperature gradient. *See:* H. R. Byers, General Meteorology, 1944, pp. 211–214, 465–467; E. W. Hewson and R. W. Longley, Meteorology Theoretical and Applied, 1944, pp. 98–101, 298–299.

thermal zone, *n.*—*See:* THERMAL BELT (or ZONE).

thermisopleth, *n.*—*See:* THERMOISOPLETH.

thermocouple, *n.*—An instrument in which heat energy is changed directly into electrical energy. In its simplest form it consists of two bars of different metals so formed that they may be joined together in series and make a circuit. If one joint of this metallic circuit is maintained at a temperature different from the other joint, an electric current will flow through the circuit. The strength of the current depends upon the difference in temperature and the metals used. The effect may be mũtiplied for purposes of measurement by devising a thermocouple with several pairs of metallic bars, thus making several joints.

This instrument is used in detecting and measuring very faint radiant energy such as that from stars. In meteorology, it is used in many devices for measuring radiation.

thermocyclogenesis, *n.*—The generation of atmospheric disturbances in the lower levels by variations of pressure and temperature in the upper atmosphere. *See:* STRATOSPHERIC STEERING; B. Haurwitz, Dynamic Meteorology, 1941, pp. 327–330.

thermodynamic diagram, *n.*—Any diagram which satisfies the condition that area on it represents work; hence used in meteorology "to compute the energy available for convective activity in the atmosphere if an aerographic sounding is available." (G. F. Taylor, Aeronautical Meteorology, 1938, p. 64.) The AEROGRAM, EMAGRAM and TEPHIGRAM, q. v., are the most widely used types. They are also known collectively as energy diagrams. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 78–84; G. F. Taylor, Aeronautical Meteorology, 1938, pp. 52–69.

thermodynamics, *n.*—The branch of physics which considers the processes involved in the transformation of heat into mechanical or other forms of energy, and of other forms of energy into heat.

If work is done on a body, it cannot be assumed that all the work is transformed into heat; the work performed, for instance, may be spent in part in overcoming gravity, developing friction or its equivalent in heat, causing electrical or magnetic phenomena, etc.

The two laws, or principles, upon which thermodynamics is based are: (a) Energy may be changed in form but not destroyed; also known as the conservation of energy; (b) the second law, which is also called the law of entropy, states that heat cannot pass from one body to another of higher temperature without the expenditure of work.

thermodynamic scale, *n.*—*See:* TEMPERATURE SCALE.

thermodynamic temperature, *n.*—*See:* ABSOLUTE TEMPERATURE.

thermogram, *n.*—The trace made by a thermograph.

thermograph, *n.*—An instrument designed to make an automatic record of temperature. The thermometric element is most commonly either a bimetallic strip or a metal tube filled with a liquid. In the first case, the bimetallic element has the form of a helical coil, one end being rigidly fastened to the instrument and the other to the pen. In the second case the metal tube is made with a tendency to curl. It is generally filled with alcohol, the movement of the pen being accomplished by a deformation of the tube. In some types of thermographs, mercury in steel is used. In all types the pen writes the record of temperature on a ruled sheet which is wrapped around a cylinder revolved by enclosed clockwork, and from the TRACE, q. v., thus made the instantaneous behavior of the temperature may be determined.

thermograph correction card, *n.*—A table of corrections for quickly and accurately reducing the reading of a THERMOGRAPH, q. v., to that of the more accurate dry-bulb thermometer at the same time and place.

thermohaline circulation (or **convection**), *n.*—Circulation in water caused by changes in density brought about by the effect of variations in temperature, or in salinity (through evaporation, condensation, precipitation, or addition of fresh water from rivers), or both.

thermoisohyp, *n.*—An isogram of temperature not reduced to sea level. *See:* ISOGRAM.

thermoisopleth, *n.*—A line showing the variation of temperature in relation to two co-ordinates, generally hours of the day for the ordinate, and months of the year for the abscissa.

thermometer, *n.*—An instrument for measuring temperature. It is most commonly based on the change in volume of some substance with changes in temperature.

The ordinary LIQUID-IN-GLASS THERMOMETER consists of a glass tube with a bulb at one end. A liquid is inserted in the capillary bore, all the air is exhausted, and the other end of the tube is sealed. A numbered scale gives the degrees of temperature with reference to the expansion difference between the liquid and the glass with variations of heat and cold. The liquids commonly used are mercury and alcohol.

There are also deformation thermometers, electrical thermometers, etc. For a discussion of these instruments, *see:* W. E. K. Middleton, Meteorological Instruments, Toronto, 1942, pp. 51–84.

thermometer screen, *n.*—Synonymous with THERMOMETER SHELTER, q. v.

thermometer shelter, *n.*—A structure in which thermometers are exposed in order that they may attain, as closely as possible, the same temperature as that of the free air. A thermometer indicates its own temperature, and this may be very different from that of the air surrounding it, as is the case when one is hung in the sunshine. It is the function of an instrument shelter to shield thermometers from the radiation of the sun and other objects; and even then it is necessary to ventilate them before each reading in order that they may as nearly as possible assume the temperature of the air.

This term is synonymous with thermometer screen, used in Great Britain and Canada.

thermometer support, *n.*—A device used in the U. S. Weather Bureau to hold both the maximum and minimum thermometer, together with attachments by which the former may be whirled and the latter raised to the proper position for setting after each observation.

thermometric scale, *n.*—*See:* TEMPERATURE SCALE.

thermometry, *n.*—The science of measuring the temperature of any substance employing any of the various types of thermometers.

thin, *adj.*—A term used in weather reports "in describing the cloudiness whenever the solar or lunar disk or stars are faintly visible through them." (U. S. Weather Bureau, Instructions for Airway Meteorological Service, Circular N, 5th ed., 1941, p. 33.)

threatening, *adj.*—A term applied to the sky or weather, having no official definition or meaning, but used in popular speech to signify an appearance of the atmosphere which seems to betoken a storm.

three-kilometer chart, *n.*—*See:* 10,000-foot chart.

thunder, *n.*—The sound accompanying lightning; caused by the action of the lightning in heating and ionizing, and therefore rapidly expanding the air along its path, and sending out a compressional wave. Thunder may be heard at a distance of about 15 miles (25 kilometers), but generally to lesser distances.

thunderbolt, *n.*—Literally, a lightning flash accompanied by a material bolt or dart, the legendary cause of the damage done by lightning; still used as a popular term for a lightning discharge when accompanied by thunder.

thundercloud, *n.*—Synonymous with cumulonimbus or well-developed cumulus; a thunderstorm-cloud mass. *See:* CUMULONIMBUS.

thunderhead, *n.*—"A rounded mass of cumulus cloud, with shining white edges, often appearing before a thunderstorm." (Webster's New International Dictionary, 1939.)

This type of cloud is not listed in the International Classification, but appears in earlier works on meteorology and in popular speech.

thundersquall, *n.*—The wind which rushes out from the lower part of the thunderstorm SQUALL CLOUD, q. v.; experienced in all well-developed thunderstorms.

thunderstorm, *n.*—The U. S. Weather Bureau defines a thunderstorm as: "Thunder heard and lightning seen at the station, with not more than 10 seconds difference of time," and "a day with a thunderstorm is one in which thunder is heard." But it may be more specifically defined as a local storm accompanied by lightning, thunder, and often by strong gusts of wind, heavy rain, and sometimes hail; usually of short duration, about 2 hours, though a locality may be visited by a succession of thunderstorms which may lengthen considerably the duration of thunderstorm conditions. A thunderstorm frequently has its beginnings in unstable moist air which gives rise to strong convectional currents and the development of cumulonimbus clouds.

If a thunderstorm is advancing toward a station, the observer notices that the wind is blowing away from him to the storm, and that the barometer is falling. As the storm approaches, the barometer rises a few millimeters, the wind changes to the opposite direction, now blowing toward the observer because of the outrushing squall wind. Heavy rain of the shower type soon begins, and decreases as the storm passes.

In the United States, thunderstorms are most frequent along the Gulf Coast with a secondary maximum centered near Santa Fe, N. Mex. They are least frequent along the Pacific Coast.

thunderstorm cirrus, *n.*—Cirrus extending from a cumulonimbus cloud and composed of the debris of the upper parts of these clouds above the freezing level; also called CIRRUS NOTHUS, q. v. *See:* CIRRUS.

thundery sky, *n.*—A state of the sky characterized by an overcast and chaotic aspect, a general absence of wind except during the showers, a mammatus appearance of the lower clouds, and dense cirrostratus and altocumulus above.

tidal wave, *n.*—1. In meteorological and popular usage, a large, isolated, travelling ocean wave which suddenly inundates the land, most frequently caused by a seismic disturbance; or a rapid abnormal rise in sea level caused by the strong winds associated with a hurricane or severe gale, often reinforced by the astronomical tide, and also known as a STORM WAVE, q. v. 2. In astronomical usage, restricted to the periodic variations of sea level produced by the gravitational attractions of the sun and the moon.

tidal wind, *n.*—A light breeze caused by the tide at places where the tidal rises and falls are very large; in rising, the tide displaces considerable air which flows away, and in falling leads to a return of the air. Similarly, landslide and avalanche winds are caused by the displacement of masses of earth or snow.

tide, *n.*—*See:* ATMOSPHERIC TIDE.

timber line, *n.*—The line in high latitudes poleward of which, and on mountains in all latitudes above which, trees do not grow; there is also a lower limit of forests in arid regions below which the earth is treeless. These limits are determined by temperature, precipitation, humidity, soil, severity of winter storms, slope of surface, degree of exposure to the sun, depth of snow, etc., of which the dominant factors are temperature and precipitation.

tlr., *abbr.*—Abbreviation for thunderstorm with rain, in the BEAUFORT WEATHER NOTATION, q. v.

tls., *abbr.*—Abbreviation for thunderstorm with snow, in the BEAUFORT WEATHER NOTATION, q. v.

tornado, *n.*—1. A rotary storm, one of the most violent types of storms known, of small diameter, which travels across the country and leaves great devastation along a narrow path; known popularly as a "twister" in the Central United States where it most frequently occurs, and also as a "cyclone." Its chief characteristics are: (a) Under a heavy cumulonimbus cloud there hangs a funnel-shaped cloud which marks the vortex and, as the storm moves along, may or may not touch the earth. (b) Heavy precipitation and (usually) hail occur, with thunder. In addition to the thunder, there is the roar attending the tornado cloud when it touches the surface. (c) The winds blow spirally upward around the axis of the tornado cloud; their speeds have never been directly measured, but have been calculated from their effects to be as high as, or in many instances higher than, 300 miles an hour. The updraft within the funnel cloud may have a speed of 100 or 200 miles an hour. (d) The speed of the storm itself in travelling over the earth is comparatively slow—25 to 40 miles an hour; its path is short, averaging about 300 miles. 2. Name given in West Africa to the squall which accompanies a thunderstorm.

tornado belt, *n.*—That portion of the central United States where tornadoes are most frequent.

"The Mississippi, Ohio, and lower Missouri Valleys are the regions of greatest frequency. The states in which the greatest numbers occur are, in order of frequency, based on 52 years of record: Kansas, Iowa, Texas, Arkansas, Illinois, and Missouri. Tornadoes are frequent also in Oklahoma, Nebraska, Mississippi, Alabama, Ohio, Indiana, Georgia, Minnesota, Wisconsin, and southern Michigan. They are rare but not unknown in other parts of the United States and other parts of the world. The number reported in the United States averages about 75 a year." (T. A. Blair, Weather Elements, 1942, p. 224.)

"In the main, the inner coastal plain, the Mississippi Valley, the middle-lake region, and the eastern half of the High Plains area would include ninety-odd per cent of United States tornadoes, especially the more destructive ones." (C. U. Brown and W. O. J. Roberts, The Distribution and Frequency of Tornadoes in the United States from 1880 to 1931," Transactions of the American Geophysical Union, Part I, National Research Council, 1935, p. 151.) These authors state that most U. S. tornadoes occur in May and September, and that "roughly about one-quarter billion direct property damage has resulted from tornadoes in the half century before 1931." (Ibid., p. 157.)

tornado cave (or **cellar**), *n.*—*See:* STORM CAVE.

Torricellian vacuum, *n.*—The vacuum above the mercurial column in a BAROMETER, q. v.

Torricelli's experiment, *n.*—The experiment first performed by Torricelli in 1643, in which he found "that, when a tube 33 inches long, filled with mercury and closed at one end, was inverted in a dish of mercury, the mercury stood at a height of about 30 inches in the tube, thus leaving a valuum above." (A. W. Duff, ed., Physics for Students of Science and Engineering, 8th ed., 1937, p. 143.)

Torricelli's tube, *n.*—An early, and once universal, name of the mercurial BAROMETER, q. v.

torrid zone, *n.*—The CLIMATIC ZONE, q. v., lying between the TROPICS, q. v., and hence also called the Tropic or Tropical Zone; it is the largest of the climatic zones, embracing nearly one-half the earth's area.

This zone has the least annual variation of, and also the maximum amount of, solar radiation. Because of meteorological and orographic factors, it also has a great diversity of climates; but the weather changes are due mostly to the daily and annual march of the sun, and are even more regular over the oceans than on land.

torsion hygrometer, *n.*—A variety of the HAIR HYGROMETER, q. v., invented by Nils Russeltvedt of the Norwegian Meteorological Institute, and used in Amundsen's Antarctic Expedition because it has no bearings to be rusted, soiled, or filled with rime or drift snow.

Toussaint's formula, *n.*—A rule proposed by Toussaint for the linear decrease of temperature with altitude, on the hypothesis of a temperature of 15° C. at sea level and −50° C. at an altitude of 10,000 meters; used to obtain temperature values in the STANDARD ATMOSPHERE, q. v. The formula reads:

$$T=15-0.0065\,Z$$

in which T=temperature in centigrade degrees; Z=altitude in meters.

Tower of the Winds, *n.*—A stone structure in Athens, Greece, built about 100 B. C., which is still standing. It is octagonal in shape, the eight walls bearing sculptured symbolical figures representing the winds of the eight points of the compass with their names: Boreas, Kaikias, Apeliotes, Euros, Notos, Lips, Zephyros, and Skiron. Each of the eight sides also bears a sundial. Originally the tower was surmounted by a brass wind vane, and inside was a water clock, so that it served as a public timepiece as well as a primitive weather station. For an illustration of this remarkable building, see the frontispiece to J. G. Albright's "Physical Meteorology," 1939.

trace, *n.*—1. A term taken from chemistry, and meaning in meteorology the fall of less than 0.005 inch of rain or less than 0.05 inch of snow, i. e., an amount too small to be measured. 2. The record made by any self-registering instrument. For instance, in meteorology one may speak of the thermograph trace.

trade air, *n.*—Another name for TROPICAL MARITIME AIR, q. v.

trade inversion, *n.*—A sharp increase in temperature, or at least a rapid decrease in moisture, through a layer of air in a subtropical high pressure cell, marking the boundary zone between the dry, subsiding supérieur air aloft and the moist tropical maritime air below. *See:* SUPÉRIEUR AIR; TROPICAL MARITIME AIR.

trade-wind desert, *n.*—A desert, such as the Sahara, formed by the drying action of the TRADE WINDS, q. v.; characterized by almost negligible cloudiness and extreme range of temperature, both annual and diurnal. *See:* W. G. Kendrew, Climate, 1930, pp. 52–54, 199–201.

trade winds, *n.*—1. The planetary winds that blow from the belts of high pressure centered at about 30° N. and 30° S. latitude toward the equator. Thus there are two belts of trade winds, the northeast trades in the northern hemisphere, and the southeast trades in the southern. The word trade, as first applied to these winds, meant to blow constantly, and then had no reference to commerce.

These winds are a part of the primary or general circulation of the earth, generated by the solar heating of the equatorial regions. The rotation of the earth causes their movements to be from the northeast and southeast. *See:* Coriolis Force. They are most pronounced over the oceans where they blow with considerable steadiness throughout the day and night all year round. These winds are not, however, as steady as is generally thought: in the northern hemisphere their direction varies from N to SSE, and their average speed varies from 6 miles per hour in August to 11 in April, while in the southern hemisphere the speed variation is from 10 miles per hour in May to 15 in September. 2. A name given to the prevailing westerlies in California, and in Oregon to the northwest winds of summer.

trajectory, *n.*—*See:* Air Trajectory.

tramontana, *n.*—"A local name for a northeasterly or northerly wind which in winter is prominent on the west coast of Italy and fairly prevalent off the north of Corsica. It is a fresh wind of the fine-weather mistral type, and does not often reach gale force. It is associated with a depression over the Adriatic simultaneously with an anti-cyclone farther west." (Admiralty Weather Manual, 1938, p. 213.)

tree line, *n.*—*See:* Timber Line.

trigger action, *n.*—The collective name for the processes necessary to set off convection in an unstable condition of the atmosphere, such as surface heating or sudden forced lifting at mountain ranges or frontal surfaces. *See:* N. Shaw, Manual of Meteorology, Vol. III, 1930, pp. 280–283.

triple point, *n.*—The point on a pressure-temperature phase diagram at which all three phases—solid, liquid, and vapor—of a pure substance are in mutual equilibrium. The triple point is the intersection of three curves: For water, there are the three saturation curves—fusion, vaporization, and sublimation curves—and they intersect at a pressure of 0.006 of an atmosphere and a temperature of 0.0075° C.

tropical air, *n.*—Warm air formed in the subtropical anticyclones; divided into two types of air masses, Tropical Continental (cT) and Tropical Maritime (mT), which are discussed under individual entries. *See:* Air Mass (1); Source Region.

tropical continental air (cT), *n.*—Any air mass originating over a land area in low latitudes, characterized by extreme dryness and warmth, and convective instability; cT air is of little importance in the United States, for the only source regions are north-central

Mexico, western Texas, and eastern New Mexico. In the Eastern Hemisphere, where it is more prevalent, the source regions are northern Africa and southern Asia. When *cT* air moves toward a colder region, the increased stability in the lower levels is often counteracted by the addition of moisture, and severe convective activity frequently results. *See:* AIR MASS (1); SOURCE REGION.

tropical cyclone, *n.*—A cyclonic storm of great intensity, that originates in the tropics over the oceans; and first moves westward, then recurves to the northeast (toward the southeast in the southern hemisphere). The central pressure is usually below 28 inches (949 mb.), but in one instance a minimum pressure of 26.19 inches (886.8 mb.) was observed. These low pressures result in very high winds which in the northern hemisphere blow counterclockwise and spirally toward the center. These storms vary from 25 to 600 miles in diameter. At the outer edge of the storm the wind is moderate, but increases toward the center where a velocity as high as 150 miles per hour (67.1 m. p. s.) has been recorded. At the center, there is an area averaging about fourteen miles in diameter, called the "eye of the storm," where the winds are very light, the seas are confused and mountainous, the sky is often clear, and drizzle may occur.

Unlike the extratropical cyclone, the tropical cyclone is nearly circular, and the elements of wind, temperature, pressure, humidity, and rain vary little in the different quadrants. The winds increase from the outer limits to the "eye of the storm;" the temperature rises and the humidity falls at the center; the rain is in the form of showers at the outer limits, becomes heavier toward the center, and is usually heaviest in the right front quadrant. These storms are often attended by great wind tides which inundate the land and cause more damage than do the wind and rain.

Tropical cyclones form over all tropical oceans except the South Atlantic, but not over continents. They are common in the West Indies where they are known as hurricanes, and in the western Pacific where they are known as typhoons, except west of Australia where they are called willy-willies. *See:* I. R. Tannehill, Hurricanes, 1938; I. M. Cline, Tropical Cyclones, 1936; C. E. Depperman, Typhoons in the China Sea, 1938, and Temperature Conditions in the Eye of Some Typhoons.

tropical maritime air (*mT*), *n.*—An air mass that originates over an ocean area in the tropics, especially over the broad reaches of the Atlantic and the Pacific between 20° and 45° N. lat. The summer type differs somewhat from that of winter, because when *mT* air "invades a warm continent in summer, instability develops rapidly; the air changes from a warm mass to a cold mass. In winter on the other hand, the stability is increased and deep layers of fog (advection fog) may cover large areas." (S. Petterssen, Introduction to Meteorology, 1941, p. 131.) Petterssen lists the characteristics of this air as follows:

1. Stable lapse rate or inversions in the lower layers.
2. Slight turbulence. Steady wind.
3. Poor visibility.

4. High relative humidity.
5. Stratus, mist or fog, and haze.
6. Drizzle.

See: Air Mass (1) ; Source Region; Supérieur Air; Trade Inversion.

tropical rainforest climate, *n.*—A type of climate prevailing in the zone between 5°–10° N. and S. latitudes, the two distinguishing characteristics of which are "(a) uniformly high temperatures and (b) heavy precipitation distributed throughout the year, so that there is no marked dry season," (G. T. Trewartha, An Introduction to Weather and Climate, 1937, p. 200.) The Amazon Valley, the Congo Basin, and the Guinea Coast of Africa exemplify this type of climate. *See:* Savanna; Savanna Climate.

Tropics, *n.*—1. A collective name commonly given to both the Tropic of Cancer and the Tropic of Capricorn. They are small circles, parallel to the equator, the former about 23°27′ north and the latter about 23°27′ south of the equator. 2. The area or belt of the surface of the earth bounded by the Tropics of Cancer and Capricorn; also called the Torrid Zone, q. v.

tropopause, *n.*—The boundary or zone of transition between the Troposphere, and the Stratosphere, q. v. Its height is variable: it is highest, say 17–18 km., over the equator, and lowest, about 6–8 km., over the poles. Its height also changes with the seasons and with the passage of cyclones and anticyclones. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 111, 320–334.

troposphere, *n.*—The region of the atmosphere extending from the surface up to the Tropopause, q.v.; characterized by convective air movements and a pronounced vertical temperature gradient, in contrast to the convectionless and almost vertically isothermal Stratosphere, q.v., above the tropopause.

trough, *n.*—An elongated area of relatively low pressure, extending from the center of a Cyclone, q. v. "The trough may have **U**-shaped or **V**-shaped isobars, the latter being associated with fronts." (S. Petterssen, Introduction to Meteorology, 1941, p. 109.) *See:* **V**-Shaped Depression.

trough line, *n.*—A line in a trough of a low pressure area. It is the locus of points in the isobars where the curvature is at a maximum. It may be also located by noting the wind directions and pressure values; the winds on the east side of the line are southerly, while on the west side they are northerly; and the pressure rises from the line to the east and also to the west. Its counterpart in a high pressure area is the Wedge Line, q. v.

tsuyu, *n.*—The rainy season in Japan; the same as Bai-u, q. v.

tt., *abbr.*—Abbreviation for Tercentesimal Temperature, q. v.

tundra, *n.*—A treeless plain, between the shores of the polar seas and the Taiga, q. v.; it has a growth of mosses, lichens, small shrubs such as birches and willows, and sedges, ceres, and the like. The tundra is continuously cold and damp, and generally overlies areas of perpetual underground frost. When it develops at high elevation, it is subject to the same seasonal and diurnal changes as in other nonpolar regions.

tundra climate, *n.*—The climate peculiar to the tundra regions in the northern parts of Eurasia and North America (mostly above the Arctic circle), and in the extreme southern part of South America. The limits of the tundra type of climate are the mean isotherms of 32° F. on the north and 50° F. on the south, drawn for the warmest month of the year. *See:* W. G. Kendrew, Climate, 1930, pp. 61, 163; TUNDRA.

turbidity, *n.*—A condition of the atmosphere caused by wind and vertical currents, and characterized by a more or less hazy effect from the presence of smoke, dust, haze, and clouds, or by peculiar optical qualities of the atmosphere brought about by layers of air having different densities, hence different indices of refraction; under these conditions, it may be more or less difficult to see through the air.

turbidity factor, *n.*—In meteorological physics, a quantity defined by Linke as the "ratio of the atmospheric extinction coefficient to the molecular extinction coefficient. Since atmospheric depletion of solar radiation is due not only to molecular scattering but also to dust scattering and absorption by water vapor, the Linke factor is always greater than unity. It is defined mathematically as

$$T=\frac{1}{a_m m}\log_e\frac{I_o}{I}=P(m)\log_{10}\frac{I_o}{I},$$

where I_o is the solar constant corrected to actual solar distance; I is the total intensity of the direct solar radiation; m is the optical air mass computed from the solar altitude; and a_m is the molecular scattering coefficient and is a function of m." The values of $P(m)$ are given in the second reference, p. 23. Hence, by observing I and m, T may be easily computed. (H. Wexler, Turbidities of American Air Masses and Conclusions Regarding the Seasonal Variation in Atmospheric Dust Content, Monthly Weather Review, 1934, p. 397). *See:* B. Haurwitz, Daytime Radiation at Blue Hill Observatory in 1933, Harvard Meteorological Studies, No. 1, 1934.

turbulence, *n.*—1. "Irregular motion of a moving fluid, caused by an impediment in the stream, by friction, or by vortex action." (L. D. Weld, Glossary of Physics, 1937, p. 239.) 2. In the atmosphere, the irregular local transitory variations in the general airflow, which, when vigorous as in a thunderstorm, are manifested by bumpiness, updrafts, downdrafts; and when less intense, as gustiness. Such irregular air motion "is made up of a number of small eddies that travel with the general air current, superimposed on it." (S. Petterssen, Introduction to Meteorology, 1941, pp. 69–70.) *See:* Ibid., pp. 118, 119; R. C. Sutcliffe, Meteorology for Aviators, 1940, pp. 87–88, 97, 105.

turbulence inversion, *n.*—An INVERSION, q. v., of temperature in the atmosphere between a turbulent layer and the layer immediately above which is unaffected by turbulence. "This type of inversion is developed when air originally with a stable lapse rate for dry air flows over a rough surface after having flown over a relatively smooth one. A dry adiabatic lapse rate is then established by turbulence in the layer near the surface, while aloft the original lapse rate prevails. The top of the turbulent layer is therefore colder than the bottom of the air layer immediately above which was not subjected to turbulence. An inversion is thereby created between the two layers." (L. P. Harrison, Meteorology, 1942, p. 104.)

turbulent mixing, *n.*—The vertical stirring by turbulence of a layer of the atmosphere, producing a Turbulence Inversion, q. v., beneath which the lapse rate approximates the dry adiabatic if the air is unsaturated, the saturated adiabatic if it is saturated, and in the upper part of which a stratiform cloud may form. *See:* S. Petterssen, Weather Analysis and Forecasting, 1940, pp. 93–95.

twilight, *n.*—The intervals of incomplete darkness following sunset and preceding sunrise; the time at which evening twilight ends or morning twilight begins is determined by arbitrary convention. Astronomical morning twilight begins when the sun is 18° below the eastern horizon, and astronomical evening twilight ends when it is 18° below the western horizon. Civil twilight, which is much shorter in duration, begins and ends when the sun is 6° below the eastern and the western horizon, respectively. Nautical twilight is the interval beginning in the morning when the center of the sun's disk is 12° below the eastern horizon to sunrise; and in the evening from sunset to the time when the center of the sun's disk is 12° below the western horizon.

The limits of astronomical twilight were chosen to correspond as closely as possible to the beginning and ending of complete darkness; and the limits of civil twilight, to the times when there is sufficient light for ordinary outdoor work. The actual illumination, however, varies widely with haze, cloudiness, and other weather conditions.

The duration of twilight depends upon latitude and time of year. *See:* H. H. Kimball, Monthly Weather Review, vol. 66, p. 279, September 1938; W. J. Humphreys, Physics of the Air, p. 567.

twilight arch, *n.*—Same as Counterglow, q. v.

twilight correction, *n.*—The difference between the time of sunrise for the latitude of a station, and the standard time in local use at which a record of sunshine first began to be made by the sunshine recorder; and, correspondingly, the difference between the standard time in local use at which the sunshine recorder ended its record, and the time of sunset, provided in each case, that the sky was clear during the period; otherwise the time interval during which the sun was obscured must be deducted.

twister, *n.*—Same as Tornado, q. v.

typhoon, *n.*—*See:* Tropical Cyclone.

typhoon squall, *n.*—A form of Waterspout, q. v., and similar, in its excessive violence, to a real typhoon; but seldom more than a few hundred yards in diameter and a few minutes in duration.

U

u., *abbr.*—Abbreviation for ugly or threatening appearance of the sky in the Beaufort Weather Notation, q. v.

ubac, *n.*—The shady side of an Alpine mountain; also called the schattenseite. *See:* Adret; W. G. Kendrew, Climate, 1930, p. 226.

Ulloa's ring, *n.*—1. A glory. 2. A halo (also called Bouguer's Halo, q. v.), surrounding a point in the sky diametrically opposite the sun; sometimes described as a "white rainbow." (Instructions to Marine Meteorological Observers, U. S. Weather Bureau, Circular M, 6th ed., 1938, p. 108.)

ultraviolet, *adj.*—Applied to the radiation wave band just beyond the violet end of the visible spectrum and extending to the X-rays; one may speak of ultraviolet light, though it is not visible to the eye. It may be made to give visible effects, as for instance, when it causes fluorescence in uranium glass, or when it is directed on photographic printing paper. Owing to its actinic effect, and also to its therapeutic value, ultraviolet light is very important to mankind. —*n.* A short expression for ultraviolet radiation: one commonly refers to the "ultraviolet."

undulatus, *adj.*—Applied to clouds composed of elongated and parallel elements, like waves on the sea.

unsettled, *adj.*—Term occasionally used in forecasts to describe weather which may be fair at the time but is liable to develop into rainy, cloudy, or stormy conditions.

updraft, *n.*—An upward-rushing air current caused by convection and usually found in the front portion of a heavy to violent thunderstorm. Some idea of the great vertical velocity of an updraft may be gained from the fact that a velocity of 116 miles per hour is needed to form a hailstone three inches in diameter, "a size that is by no means rare, nor even the largest known." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 360.)

upper air, *n.*—A general term, denoting not a definite region of the atmosphere but that part at a greater or less elevation above the earth's surface. Sometimes restricted to the region which is inaccessible to such ordinary means of observation as balloons and airplanes, and which must be studied by cloud, meteor, magnetic, and other indirect methods of observation. *See:* B. Haurwitz, The Physical State of the Upper Atmosphere, reprint from the Journal of the Royal Astronomical Society of Canada, 1937.

upper air charts, *n.*—Charts depicting the weather conditions at various levels as 3,000, 5,000, 10,000, and 20,000 feet. They are drawn much the same as charts of surface conditions and exhibit all data obtained from kites, balloons, radiosondes, etc. They are used in conjunction with the surface maps in analyzing the atmospheric conditions.

upper front, *n.*—A front at some level in the free air instead of at the surface, which as it passes aloft often produces at the surface some of the characteristic phenomena of a frontal passage at the ground, such as cloudiness, pressure changes, and precipitation. An upper front is generally the remnant of an old Occlusion, q. v.: the two cold air masses which had forced the intervening warmer air aloft attain homogeneity, so that the front on the ground dissolves and all that is left is the trough of warm air aloft. Sometimes, also, a cold front or occlusion moves up over another frontal system, and an upper front is thus produced.

upper inversion, *n.*—*See:* Inversion.

V

v., *abbr.*—Abbreviation indicating unusual visibility of distant objects in the Beaufort Weather Notation, q. v.

vacuum correction, *n.*—The correction to the reading of a mercurial Barometer, q. v., necessitated by the fact that the vacuum above the mercury column is never perfect.

"It is generally assumed that the space in a barometer tube above the mercurial column is a perfect vacuum, and that there is no downward pressure upon the top of the column of mercury. This, however, is not strictly the case in any instance, and often an appreciable quantity of air or water vapor is present. Any vapor that the mercury may give off is, of course, always present.... If, therefore, any such pressures exist upon the top of the column it will be depressed, and a correction, which may be properly called correction for imperfect vacuum or reduction to imperfect vacuum, should be applied. Such a correction will vary with both the temperature and the volume of the space." (U. S. Weather Bureau, Instrument Division, Circular F, Barometers and the Measurement of Atmospheric Pressure, 7th ed., rev., 1941, p. 17. *See:* Barometry.

valley breeze, *n.*—A gentle wind blowing up a valley or mountain slope in the absence of cyclonic or anticyclonic winds; it is caused by the warming of the mountainside and valley floor by the sun. *See:* W. J. Humphreys, Physics of the Air, 1940, pp. 155–157.

Van der Waals' equation, *n.*—The best known of the many laws which have been proposed to describe the thermodynamic behavior of real gases and their departures from the ideal gas law. It states:

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

where a and b are constants, dependent upon the gas, P is the pressure in atmosphere, V is the volume (measured in units of the volume of the gas at normal temperature and pressure), R is the universal gas constant, and T is the absolute temperature.

vane, *n.*—An instrument which indicates the direction of the wind. *See:* Wind Vane.

vapor, *n.*—The gaseous phase of any substance below its critical temperature. Above the critical temperature, it becomes a Gas, q. v., and no amount of pressure will produce any condensation; but in a vapor, increasing pressure can eventually cause liquefaction. A saturated vapor does not obey Boyle's Law, q. v., but an unsaturated vapor tends to do so.

The critical temperature of water is 374° C., so it never occurs naturally as a gas on the earth. On the other hand, the critical temperature of air is −140.7° C., so it is always a gas under natural conditions.

vapor pressure, *n.*—1. "The pressure of the vapor of a liquid kept in confinement so that the vapor can accumulate above it." (L. D. Weld, Glossary of Physics, 1937, p. 243.) 2. The partial pressure of the water vapor in the atmosphere. Its symbol is e. The units used to express vapor pressure are the same as those for the total air pressure. The pressure of saturated water vapor over water or ice at 0° C. is 6.11 mb., and over water at 100° C., 1,013.3 mb.

Vapor tension was formerly widely used for this term but is no longer in common use.

vapor tension, *n.*—*See:* VAPOR PRESSURE.

variability, *n.*—1. The scattering of the values of a frequency distribution, often measured by the STANDARD DEVIATION, q. v. For example, the variability of the monthly mean January temperatures at Washington, D. C., with a standard deviation 4.9° F., is more than twice as great as the variability of the mean July monthly temperatures, standard deviation 2.0° F. 2. The mean of the differences, without regard to sign, of temperature (or some other meteorological element) from one day to the next for a whole month. "The value thus obtained represents the mean difference of temperature between two successive days in the same month, and the mean of these differences during the same month, for a series of years, is the normal variability of temperature for the given station and the given month." (J. Hann, Handbook of Climatology, tr. R. D. Ward, 1903, Part I, p. 20.) When the differences between the monthly mean values of the element are taken, the term "variability of the monthly means" is used.

variables, *n.*—A name sometimes applied to the prevailing west winds of middle latitudes.

variance, *n.*—A measure of the amount of spread or dispersion of a set of values around their mean, obtained by calculating the mean value of the squares of the deviations from the mean, and hence equal to the square of the STANDARD DEVIATION, q. v.

variation, *n.*—1. The manner and degree of change in value of a meteorological or climatological element throughout any given period such as a day or a year; e. g., the average march of temperature throughout the day, in which the temperature is lowest about sunrise, becoming higher until about 2 p. m. in winter and 4 p. m. in summer, and then becoming lower until the next sunrise. The normal temperature variation for any day is given by the composite thermograph trace for that date for several years. The normal annual variation of temperature may be represented by plotting the normal daily temperatures to scale and connecting the points by a smooth curve.

Similarly, there is an annual variation of rainfall which may be ascertained by plotting the normal monthly amounts; for a given place, the annual variation of rainfall is synonymous with its rainfall type or REGIME, q. v. *See:* W. G. Kendrew, Climate, 1930, pp. 41, 42, 52; R. D. Ward, The Climates of the United States, 1925, pp. 187–199. 2. Sometimes used interchangeably with VARIABILITY, q. v.

vector, *n.*—A quantity represented by a line which has magnitude and direction. Vectors are more rigidly and completely defined on p. 1 of "An Introduction to Vector Analysis," 1939, by B. Hague: "Vector quantities have magnitude and direction. Familiar examples are displacement, force, velocity, acceleration, stress, electric force, magnetic induction, etc. A vector quantity requires for its specification (i) a unit of the same kind, disregarding direction, (ii) a number giving the magnitude of the quantity in terms of this unit and (iii) a statement of direction. For example, the velocity of a moving body is stated by saying (i) that the unit is miles per hour, kilometres per second, etc.; (ii) how many of the chosen units express the magnitude of the velocity and (iii) the sense in which the velocity is directed, e. g., due north. The combination of conditions (ii) and (iii) constitutes the geometric conception of a directed magnitude or vector, quite independent of the kind of vector quantity specified by the unit. The directional element will prevent the manipulation of vectors by the simple numerical algebra applying to scalars; it is essential, therefore, to devise a *vector algebra* by means of which vectors may be handled in a way consistent with the physical problems in which vector quantities occur. The laws of vector algebra differ in several important respects from those of scalar algebra. . . ."

veer, *v. i.*—With respect to the wind, to shift in a clockwise direction in the Northern Hemisphere and in an anticlockwise direction in the southern; used in the opposite sense of to Back, q. v.

velocity, *n.*—1. The vector-time rate of change of position, including both direction of motion and rapidity. 2. Often, though inexactly, used as a synonym for speed, which is the magnitude of the time rate of motion without reference to direction.

velocity potential, *n.*—A scalar function of space and time, $\Phi\ (x, y, z; t)$ whose negative gradient at any point is equal to a velocity at this point. Thus, if $b.f.$ is a velocity,

$$b.f. = -grad\Phi \qquad \Phi = L^2/T$$

If u, v, w are the velocity components in cartesian co-ordinates x, y, z, this is equivalent to

$$u=-\frac{\partial\Phi}{\partial x}, \quad v=-\frac{\partial\Phi}{\partial y}, \quad w=-\frac{\partial\Phi}{\partial z};$$

the velocity is perpendicular to the surfaces; $\Phi=$ constant.

velocity pressure, *n.*—Synonymous with Wind Pressure, q. v.

velo cloud, *n.*—A type of high fog frequent in the United States along the seacoasts, especially in southern California. *See:* T. A. Blair, Weather Elements, 1942, p. 132.

Venturi tube, *n.*—A tube designed to measure the rate of flow of fluids; used in water-flow meters and in measuring the speed of aircraft in the air.

It is "a short tube of varying cross section. The flow through the venturi causes a pressure drop in the smallest section, the amount of the drop being a function of the velocity of flow." (National Advisory Committee for Aeronautics, Report No. 474, 1937, p. 28.)

verification, *n.*—The determination, generally by statistical methods, of the degree of accuracy of a Forecast, q. v.

verification process, *n.*—Usually shortened to "verification"; the computation of a Verification Score, q. v.

verification score, *n.*—The ratio of the forecasts, which are authenticated by comparison with the facts, to the total number of forecasts made.

vernier, *n.*—An instrumental device applied to any graduated scale, linear or circular, which provides a means, when the index (a part of the vernier) is not exactly opposite one of the graduation marks of the scale, for estimating the portion of the division indicated by the index. Verniers are found on barometer and theodolite scales.

vertical anemometer, *n.*—An instrument designed to measure the vertical component of the speed of air currents in the atmosphere.

vertical anemoscope, *n.*—An instrument used for observing the vertical speed of balloons relative to the surrounding air and also for observing the vertical component of the speed of air currents in the atmosphere. *See:* ANEMOSCOPE.

virga, *n.*—Wisps, or falling trails of precipitation, frequently seen hanging from altocumulus and altostratus clouds; thus one may observe altocumulus with virga.

virtual temperature, *n.*—The temperature at which dry air would have the same pressure and same density as air with the current humidity and temperature; given by the formula

$$T=\frac{T}{1-0.379\ (e/p)}$$

where T is the absolute temperature of the moist air, e its vapor pressure, and p its total pressure.

Virtual temperature was introduced into meteorology by Guldberg and Mohn, in their "Studies of the Movements of the Atmosphere," Christiania, 1876, revised 1883. *See:* Mechanics of the Earth's Atmosphere (collection of translations by Cleveland Abbe), 3d collection, 1910, pp. 123–124.

viscosity, *n.*—The internal friction of fluids. The COEFFICIENT OF VISCOSITY of a fluid substance is the ratio of the shearing stress to the rate of shear under this stress, and is constant for each fluid at any given temperature. Fluid viscosity is produced by the molecular motions in gases and liquids; and in the atmosphere, in addition to this molecular viscosity, there is eddy viscosity due to turbulence. *See:* EDDY VISCOSITY; SHEAR; H. R. Byers, General Meteorology, 1944, pp. 594–599.

visibility, *n.*—A meteorological element defined as follows in U. S. Weather Bureau practice: "The mean greatest distance toward the horizon that prominent objects, such as mountains, buildings, towers, etc., can be seen and identified by the normal eye unaided by special optical devices, such as binoculars, telescopes, glare-eliminators, goggles, etc., and which distance must prevail over the range of more than half of the horizon." (U. S. Weather Bureau, Circular N, 5th edition, 1941, p. 34.)

In this technical meteorological usage, the term means simply visual range. The actual visibility of an object depends upon its size, distance from the observer, contrast between the object and surrounding objects, glare, transparency of the atmosphere, the illumination of the intervening atmosphere; and, of course, upon the condition of the observer's eye. Measurement of visibility began with the advent of aviation, and was very seriously studied and observed during the First World War when it was desired not only for aviation but for gunnery and observation balloons, etc. Visibility is obtained at each station from a table of various prominent objects that may be seen from the usual observation point, together with their actual distances; at night, lights at known distances are used. From the point of observation the mean visibility, i. e., the average visibility, in all directions is determined by noting the farthest objects in this table that may be seen. It is evident that there can be no precise uniformity with this procedure, but it serves very well for practical purposes.

Visibility or visual range can be measured by instruments and therefore be standardized to a much greater degree than is possible under the above system. Instruments have been devised to do this and are used; but for the purposes for which visibility values are desired, it is felt that the empirical methods still serve very well.

Another use of visibility measurements is for the identification of air masses. Stable air will have poor visibility due to dust held in the lower layers, while unstable air will be clear. *See:* W. E. K. Middleton, Visibility in Meteorology, 1941.

visibility meter, *n.*—An instrument for measuring visibility. *See:* A. H. Thiessen, Measuring Visibility, Monthly Weather Review, 1919, pp. 401–402.

volcanic lightning, *n.*—*See:* LIGHTNING.

vorticity, *n.*—1. In a general sense, rotational circulation of air about a center, the axis of rotation being in any direction whatsoever; usually applied, however, to the circulation in whirling storms, such as cyclones and tornadoes, and in anticyclones. In the northern hemisphere, when the movement is clockwise, the vorticity is considered negative; and when anticlockwise, positive. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 137–138. 2. In the technical hydrodynamical sense, a synonym for CURL, q. v.

V point, *n.*—The point on the horizon towards which stripes of clouds apparently converge; also called their vanishing point, or radiant point.

V-shaped depression, *n.*—A CYCLONE, q. v., in which the isobars are more or less V-shaped, the point of the V usually being towards the south or southwest, and the trough-line being curved with the convex side toward the east. *See:* D. Piston, Meteorology, 2d. ed., 1941, pp. 123–124.

W

w., *abbr.*—Abbreviation for dew in the BEAUFORT WEATHER NOTATION, q. v.

wailer, *n.*—A fallen tree lying in the fork of another tree and causing a howl or wail, produced by friction, when the wind produces movement of the two trees. *See:* C. M. Botley, The Air and Its Mysteries, 1940, p. 54.

warm braw, n.—A foehn wind in the Schouten Islands north of New Guinea.

warm front, n.—The line of discontinuity along the earth's surface, or a horizontal plane aloft, where the forward edge of an advancing current of relatively warm air is replacing a retreating colder air mass. *See:* FRONT.

warm-front type occlusion, *n.*—An occlusion formed when the air in the rear of a front is somewhat warmer than the air in advance of the front. This occurs in regions adjacent to the west coasts of northern continents, where the air in the rear of the front comes from the oceans, and that in advance of the front from a cold continent, and hence the former will overrun the latter. *See:* OCCLUSION; COLD-FRONT TYPE OCCLUSION; S. Petterssen, Weather Analysis and Forecasting, 1940, p. 323.

warm sector, *n.*—The area at the earth's surface bounded by the cold and warm fronts of a CYCLONE, q. v., over which relatively warm air is present, and which gradually narrows and ultimately disappears in the process of OCCLUSION, q. v.

warning stage, *n.*—The elevation at which damage or inconvenience begins locally, as where certain interests are harmfully affected by river stages that are below flood stage.

water, *n.*—A chemical compound, symbol H_2O, in which each molecule consists of two hydrogen atoms and one oxygen atom; found in nature in the liquid, solid (ice, snow, etc.) and gaseous (water vapor) states; and hence an object of meteorological study in all three phases.

HYDROMETEOROLOGY, q. v., is concerned with liquid water in the atmosphere, with precipitation and its effects on flood control, agriculture, etc. Ice and snow are also studied in this connection, but are likewise important in other applications: for instance, ICING, q. v., is a vital factor in aeronautical meteorology, SNOW COVER, q. v., profoundly affects the formation of polar air masses, and GLACIERS have large-scale relationships with world climate.

Water vapor is, to the meteorologist, perhaps the most important constituent of the atmosphere. Its amount and distribution determine to a large extent the weather of a given locality. Water vapor varies in amount with temperature and several other factors; its percentage by volume may range from the merest trace in the upper atmosphere and in the Arctic Regions to almost 5 percent on a hot, humid day in the tropics. The fact that it selectively absorbs radiant energy is of fundamental importance in physical climatology. *See*: ABSORPTION; HEAT BALANCE; SELECTIVE ABSORPTION.

water atmosphere, *n.*—The separate atmosphere composed of the water vapor which is diffused among the permanent atmosphere gases through the space above the solid and liquid portions of the earth.

waterspout, *n.*—A small whirling storm over the oceans or inland waters, whose chief characteristic is a funnel-shaped cloud extending, in a fully developed spout, from the surface of the water to the base of a cumulus type cloud. The water in a spout is mostly confined to its lower portion, and may be either fresh water resulting from condensation, or salt spray drawn up by the action of the vortex. Waterspouts usually rotate counterclockwise, i. e., in the same sense as do cyclones, but clockwise rotation may sometimes occur. They are found most frequently in tropical regions, but are not uncommon in higher latitudes.

Waterspouts may be divided into two classes, according to their different origin and appearance. In the first class, that of the true waterspout, the vortex is formed in clouds by the interaction of air currents flowing in opposite directions; this type occurs mainly in advance of a SQUALL LINE, q. v., and is similar to a tornado in formation and aspect. The second class of "pseudo-waterspouts" is of a different nature; it originates just above the water surface in convectively unstable air, and builds upward, frequently under clear skies; this type is identical with the whirling pillars of sand and dust often seen on deserts.

Waterspouts vary in height from a few hundred feet to several thousand feet, and in diameter from a few feet to several hundred feet. Some assume fantastic shapes and may even seem to coil about themselves. Since they are often inclined to the vertical, their actual length may be much greater than their measured height. The highest waterspout on record is one of 5,014 feet observed in New South Wales, Australia, on May 16, 1898. *See:* W. E. Hurd, Waterspouts, Monthly Weather Review, vol. 56, 1928, pp. 207–211; C. F. Talman, The Realm of the Air, 1931, pp. 167–176.

water table, *n.*—The upper limit of ground water; it may be found at any level from the surface to a considerable distance underground.

water vapor, *n.*—The gaseous form of WATER, q. v.; one of the most important constituents of the atmosphere. Its amount varies, and is expressed by any one of the following quantities, each of which is discussed in a separate entry: ABSOLUTE HUMIDITY, RELATIVE HUMIDITY, SPECIFIC HUMIDITY, MIXING RATIO, SATURATION DEFICIT. *See:* VAPOR PRESSURE; DEW POINT.

wave, *n.*—1. Any propagated disturbance in a continuous medium (R. B. Lindsay, General Physics, 1940, p. 385.) In nature, examples are: light waves, sound waves, ocean waves; and the localized deformation of a FRONT, q. v., which is of special interest to the meteorologist and is discussed under CYCLONE WAVE. 2. A term also used synonymously with SPELL, q. v., in the expressions cold wave and warm wave.

wave cloud, *n.*—Same as BILLOW CLOUD, q. v.

wave cyclone, *n.*—Same as EXTRATROPICAL CYCLONE, q. v.; so called because it first develops as a wave along a front. *See:* CYCLONE WAVE.

wave length, *n.*—The least distance between particles situated in the same phase of vibration in wave motion. The wave length is measured in the direction of propagation of the wave, usually from the midpoint of a crest or trough to the midpoint of the next crest or trough. Its reciprocal is the WAVE NUMBER, q. v.

wave motion, *n.*—Any undulatory motion whether periodic or aperiodic. In meteorology, the following kinds of wave motion are studied: the propagation of light and sound, the perturbations on the boundary surface beteen two air masses, the natural oscillations of the atmosphere as indicated by the semidiurnal and terdiurnal pressure variations, etc. *See:* CYCLONE WAVE.

wave number, *n.*—"The reciprocal of a wave length, i. e., the number of waves per unit distance in the direction of propagation." (L. D. Weld, Glossary of Physics, 1937, p. 250.)

weather, *n.*—1. The state of the atmosphere, defined by measurement of the six meteorological elements, viz, air temperature, barometric pressure, wind velocity, humidity, clouds, and precipitation. 2. The state of the sky—clear or cloudy, rainy or fair, etc. 3. Also commonly used to mean bad weather: a meteorologist may say "We're going to have weather" when a storm is approaching. —*v. t.* To endure successfully, as, for example, in the expression "to weather a storm." —*adj.* Synonymous with windward; the weather side of a ship is its windward side.

weather analysis, *n.*—*See:* AIR-MASS ANALYSIS.

weather gage, *n.*—Same as a BAROMETER, q. v.

weather glass, *n.*—Formerly the popular name for a mercurial BAROMETER, q. v., but applied more generally to those barometers having indications near the scale of the character of the weather to be expected. An example of such barometers is the "Dutch weather glass," which resembles a teapot with its spout extending from near the bottom up to the level of the top. Liquid is poured into the vessel through the spout; and the level in the vessel will be in general somewhat lower than that in the spout. As a storm comes on, the atmospheric pressure falls, and the level of the liquid in the spout rises. With the advent of anticyclonic conditions, the atmospheric pressure rises, and the level of the liquid in the spout subsides.

weather map, *n.*—A map showing the weather conditions prevailing over a considerable area, constructed from the results of weather observations taken at the same time at a number of stations; so known as a synoptic chart. The weather elements are shown by figures and symbols, and usually include temperature, pressure, precipitation, state of the weather, wind, air masses, fronts; and often other data differing according to the practices of the various weather organizations. This kind of map may be called "the general weather map." Since weather data needed for forecasting purposes are too numerous to be all included on the general map, it is the custom to make additional maps showing temperature changes and pressure changes; isentropic charts; charts of conditions at the 5,000-foot and 10,000-foot and higher levels; and pilot balloon data of the winds at various levels. Cross sections of the atmosphere and pseudoadiabatic diagrams or other thermodynamic charts are also prepared.

The first daily weather map (i. e., one made and published the same day the information was received by electric telegraph), was drawn in England for 9 a. m., August 8, 1851. The first weather maps ever made, however, were left in manuscript by those nineteenth-century meteorologists who investigated the mechanism of storms, as was the case with Dove, Redfield, and Espy from 1820 on.

In those days there were no organized weather services and, of course, no synoptic weather observations; therefore, investigators were obliged to hunt for data which were taken only approximately at the same time.

The earliest maps in the United States made from telegraphic reports were constructed by the Smithsonian Institution, as early as 1849, although manuscript maps were drawn by Espy for that institution probably as early as 1843 from the monthly returns of meteorological observers scattered over the country. Although Brandes had proposed the making of weather maps from telegraphic reports in 1817, they were not so made in this country until 1856 by the Smithsonian Institution in Washington, D. C. Professor Cleveland Abbe at Cincinnati, Ohio, made weather maps from telegraphic reports in 1869; and the first of the official United States tridaily maps was made in manuscript on November 1, 1870. The printing of weather maps began in the United States on May 2, 1871.

weather stations, *n.*—In the U. S. Weather Bureau, places where weather observations are taken for various purposes; these are described briefly in the "Weather Elements," 1942, by T. A. Blair, in Chapter XV. He says: "The organization outside of Washington consists of seven administrative regions, with a regional director in charge over each, over 200 first-order stations, a large number of lesser stations of many different classes. The regional offices serve as co-ordinating agencies between the central office and the field stations, and between the various types of service. They handle many administrative details in connection with supplies, equipment, inspection, and personnel. The first-order stations are local public offices of the Weather Bureau, manned by one to several professional and subprofessional employees, at which complete meteorological records are kept. Most of them send daily telegraphic reports of observations and issue forecast cards or weather bulletins, and many make weather maps and local forecasts. Many offices are at airports; in other cases, city offices are maintained.

"The numerous substations fill a great variety of special needs. Substations are divided into the following classes: second-order stations, maintained primarily as weather observation stations, make daily telegraphic reports for the forecast and warning service; third-order stations telegraph daily weather observations at certain times for special purposes; river substations make and forward river stage and precipitation observations; snowfall substations make snow-depth and sometimes snow-density measurements; display substations display storm or hurricane signals or disseminate forecasts and warnings; crop substations make and telegraph observations for weather and crop bulletins, or for frost forecasts. Climatological substations make observations for record or climatological purposes but do not telegraph them; airway substations make a record of weather conditions along the airways and transmit reports at stated times; co-operative substations are maintained primarily for climatological purposes and make daily observations of rainfall or of temperature and rainfall and send monthly reports by mail to section centers."

weather type, *n.*—A set of large-scale atmospheric conditions, identifiable by certain prominent characteristics, recurring with sufficient frequency to be recognized and to allow future developments to be anticipated from it.

In the Krick method of weather typing, Pacific weather maps are classified into types according to the location, orientation, and intensity of the eastern cell of the Pacific subtropical anticyclone, the so-called "control cell" for North American weather. According to the variations in this cell, a catalogue of weather types has been prepared, and this is used in forecasting for long-range periods in the United States. In the Russian method, developed by B. P. Multanovski, European weather maps are typed according to the trajectories of the anticyclones which enter from the west, northwest, and northeast. By means of this system, also known as the COMPOSITE MAP METHOD, q. v., forecasts are issued under certain conditions for as much as 5 months ahead. *See:* WEATHER TYPING.

weather typing, *n.*—Any statistical process by which various types of weather are characterized and identified by some easily applied criterion. A simple criterion is adopted, but is so chosen that the general characteristics of the corresponding weather type are very nearly the same in different individual examples. The ZONAL INDEX, q. v., may be considered as a form of weather typing. *See:* WEATHER TYPE.

wedge, *n.*—1. An elongated high pressure area, or an extension of a high between two lows; its analogy in a low pressure area is called a TROUGH, q. v. *See:* V-SHAPED DEPRESSION. 2. An air mass whose advancing forward position in back of the cold front is shaped like a wedge; also the retreating cold air mass in advance of the warm front.

wedge line, *n.*—A line in a pressure field normal to the anticyclonically curved isobars and passing through the points where the curvature is a maximum. This line is found running approximately through the center of a wedge of high pressure from point to hilt. *See:* TROUGH LINE.

weighting, *n.*—A statistical method of adjusting the results of observations by taking into consideration the fact that not all the data may be of equal reliability; e. g., in processing data, the results of observations made under the least favorable conditions may be counted only once, while those made in more favorable circumstances may be counted several times.

wet-bulb potential temperature, *n.*—The WET-BULB TEMPERATURE, q. v., which a sample of air would assume if it were brought adiabatically to the standard pressure of 1,000 millibars. It is "invariant with respect to dry- or moist-adiabatic changes and to evaporation at constant pressure; it is another conservative property of the air." (B. Haurwitz, Dynamic Meteorology, 1941, p. 7.)

wet-bulb temperature, *n.*—The lowest temperature to which air can be cooled by evaporating water into it at constant pressure, when the heat required for evaporation is supplied by the cooling of the air. This temperature is given by a well-ventilated WET-BULB THERMOMETER, q. v.

wet-bulb thermometer, *n.*—One of the two thermometers comprising the SLING (or whirling) PSYCHROMETER, q. v.; its bulb is covered with muslin which is wetted just before an observation is taken; hence its name.

whirlies, *n.*—Small violent storms, a few yards to 100 yards or more in diameter, frequent in Antarctica near the time of the equinox. "They approach the tornado in violence, and, since they occur in otherwise calm air and spin almost like a solid—just a few feet between hurricane wind and dead calm—they must originate between passing currents overhead and from there burrow down, as vortices do, until plugged up by the surface beneath." (W. J. Humphreys, Physics of the Air, 3d ed., 1940, p. 155.)

whirlwind, *n.*—Any revolving mass of air, including at one extreme the hurricane and at the other the dust whirl of our street corners, but usually applied to small wind eddies of local origin, such as dust or sand whirls, often seen during a dry spell anywhere, and especially on level deserts.

white squall, *n.*—A type of SQUALL, q. v., encountered in tropical and subtropical regions; so called either because it makes the ocean foam or because it occurs under a bright, cloudless sky; sometimes called a bull's-eye squall, particularly on the coast of Africa, on account of the small, isolated cloud which may form at the top of the disturbance or because of the white spot observed near the zenith during the storm.

wide open, *n.*—A phrase applied to an airport when the weather conditions are favorable for all types of air traffic.

Wien's law, *n.*—A radiation law which states that the wave length of maximum radiation intensity is inversely proportional to the absolute temperature of the radiating body; or

$$\lambda_m = \frac{a}{T}$$

where a is a numerical constant, equal to 0.2892 cm. deg. when λ_m is measured in microns and T is expressed in degrees absolute.

This law shows that the wave length of maximum radiation shifts with variation of temperature, i. e., it moves toward the violet end of the spectrum with increasing temperature, and in the opposite direction with a temperature decrease. Wien's law further shows that the intensity of radiation of every wave length increases directly with the temperature.

It is interesting to note that calculations from this law give the sun's "color" temperature as 6090° A., a value in good agreement with the "effective" temperature of 5760° A. given by STEFAN'S LAW, q. v. *See:* B. Haurwitz, Dynamic Meteorology, 1941, pp. 86–88; R. H. Baker, Astronomy, 1938, pp. 299–301.

Wild fence, *n.*—A wooden inclosure about 16 feet square and 8 feet high with a rain gage in its center; the function of which is to minimize eddies around the rain gage receiver, and thus insure a catch which will be representative of the actual precipitation.

williwaws, *n.*—Violent squalls in the Strait of Magellan.

willy-willies, *n.*—Revolving storms which originate over the Timor Sea and move, first southwest, then southeast, across the interior of Western Australia. They are similar to a HURRICANE, q. v. *See:* W. G. Kendrew, The Climates of the Continents, 1937, pp. 426–427.

wind, *n.*—1. In general, air in natural motion relative to the surface of the earth, in any direction whatever and with any velocity. 2. In meteorology, the component of air motion parallel to the earth's surface, the direction of which is indicated by the weather vane, wind cone, etc., and the speed of which is measured commonly by the anemometer. Any other component of airflow is usually distinguished by the name AIR CURRENT, q. v.

wind-barometer table, *n.*—A table for determining weather changes is indicated by the fluctuations of the barometer and the associated varying directions and intensities of the wind. *See:* E. B. Garriott, Wind-Barometer Table, Monthly Weather Review, vol. 25, 1897, p. 204.

windbreak, *n.*—*See:* SNOW FENCE.

wind cone, *n.*—A tapered fabric sleeve, shaped like a truncated cone and pivoted at its larger end on a standard, for the purpose of indicating wind direction: since the airflow enters the fixed end, the small end of the cone points away from the wind.

wind corrosion, *n.*—The loosening and removal of rock material, in a kind of sand-blasting effect, by the action of dust and sand particles carried with the wind.

wind-divide, *n.*—A ridge of high pressure, on either side of which winds from two different directions prevail.

"In summer, Asia is a region of low pressure, but a tongue of high pressure projects from the Atlantic over the center of Europe towards Siberia. It is of only slight intensity, but sufficient to form a 'wind-divide' . . . of fundamental importance in separating the north European climate, with its prevailing moist westerly winds, and cloudy skies, from the bright Mediterranean climate, with northeast winds." (W. G. Kendrew, The Climates of the Continents, 2d ed., 1927, p. 203.)

window frost, *n.*—Frost formed on the inside of windowpanes when moisture is present and the temperature outdoors is below freezing. Bentley names eleven types of window frost, all presenting beautiful forms varying from those like granules to those resembling tree ferns. There seems to be no explanation for the various forms. It is known that frost forms readily where there are scratches in the windowpane, but this fact accounts for only those frost figures which follow the scratched pattern, and does not explain why they follow it. *See:* Bentley and Humphreys, Snow Crystals, 1931, pp. 18–20, and figures on pp. 212 to 218.

window ice, *n.*—The name given to ice crystals "that develop within a very thin film of liquid water on the windowpanes within dwellings, offices, etc., and are cases of true ice crystallization." (W. J. Bentley, Studies of Frost and Ice Crystals, Monthly Weather Review, vol. 35, 1907, p. 440.)

wind pressure, *n.*—The pressure exerted on the exposed surface of an object by the moving air, called the VELOCITY PRESSURE, q. v., combined with the decrease of pressure on its sheltered side; usually expressed, for engineering purposes, in pounds per square foot of surface normal to the wind, and approximately given, for a flat surface, by the formula

$$P=a\,V^2$$

where V is the wind speed in miles per hour, and a is a numerical constant whose value varies with the density of air, though the value 0.0048 holds for most flat surfaces near sea level. This formula should be used with caution. The net pressure is the resultant of pressure on the windward surface and suction on the leeward; and the actual value depends on the shape of the object and nature of environment. For objects not presenting a flat surface to the wind, such as bridges and chimneys, complicating factors are introduced which make the above formula invalid. The wind pressure on a chimney of circular cross section, for example, at a given wind speed is a function of the ratio of the height of the chimney to its diameter and possibly of the roughness of its surface. *See:* Bureau of Standards, Research Papers Nos. 221, 301, 523; C. L. Harris, Influence of Neighboring Structures on the Wind Pressure on Tall Buildings, Bulletin No. 43, 1934.

wind rose, *n.*—A diagram which indicates, at a given station, the average percentage of winds coming from each of the principal compass points, together with the percentage occurrence of calm air. It usually consists of a central circle, in which the figure indicating calm is written and from which emanate eight lines, whose lengths are proportional to the percentage occurrence of the winds they represent. Wind roses are also made for other purposes. For example, on a rain wind rose the lengths of the lines are proportional to the quantity of rain that falls when each wind is blowing.

wind scale, *n.*—A numerical scale for expressing the different degrees of wind speed, in a fashion suitable for easy communication and rapid plotting on a weather map; the form in almost universal use is the BEAUFORT WIND SCALE, q. v.

wind-shift line, *n.*—A line which may be drawn through a low pressure system, and is particularly marked in the case of the type of low known as the V-SHAPED DEPRESSION, q. v., east of which the winds are warm and southerly, west of which they are northerly and cold. It is identical with the SQUALL LINE (1) or the COLD FRONT of the BJERKNES' CYCLONE MODEL, q. v.

wind sleeve, *n.*—*See:* WIND CONE.

wind sock, *n.*—*See:* WIND CONE.

wind structure, *n.*—The nature, arrangement, and interrelation of the detailed variations in the physical characteristics of a wind stream, including all the mechanical properties of wind, such as its variations in speed and direction from the surface to higher levels; the origins and effects of eddies, turbulence, etc.

wind vane, *n.*—An instrument used to indicate wind direction; known by various other names, weather vane and weather cock among them. The commonest form consists of an arrow which is mounted at its center of gravity on a vertical axis, and which points into the wind because the area (hence resistance) of the barbed end is smaller than that of the feathered end.

wind velocity equations, *n.*—Formulae for calculating the wind speeds to be expected from given pressure gradients and pressure patterns, under given assumptions: (1) The velocity at which the gravitational force due to the pressure gradient, CORIOLIS FORCE, q. v., and centrifugal force are in equilibrium is given by the gradient wind equation:

$$\frac{dp}{dn}=2\rho v\omega \sin \phi \pm \frac{\rho v^2}{r} \qquad \text{(A)}$$

where dp is the pressure difference between isobars in dynes per square centimeter, dn is the distance between isobars in centimeters. ρ is the air density, v is the gradient wind velocity, ω is the angular velocity of the earth, ϕ is the geographic latitude, and r is the radius of curvature of the trajectory of the air. The equation is strictly true only for steady frictionless motion.

For cyclonic circulation, the sign of the last term is positive, and equation (A) may be solved for the velocity of the gradient wind in a cyclone,

$$v=\sqrt{(r\omega \sin \phi)^2+\frac{r}{\rho}\frac{dp}{dn}}-r\omega \sin \phi.$$

For anticyclonic circulation, the sign of the last term is negative. Hence:

$$v=r\omega \sin \phi-\sqrt{(r\omega \sin \phi)^2-\frac{r}{\rho}\frac{dp}{dn}},$$

where v is the gradient wind velocity in an anticyclone. (2) If the curvature of the isobars is neglected, the last term in equation (A) drops out, and the equilibrium conditions between the pressure gradient force and the Coriolis force are given by the geostrophic wind equation,

$$v=\frac{1}{2\rho\omega \sin \phi}\frac{dp}{dn}$$

where v is the geostrophic wind velocity. (3) When the radius of curvature is small, the term ($2\rho v\omega \sin \phi$) in equation (A), which contains the Coriolis force, may be neglected. The winds in a tropical cyclone, therefore, obey the cyclostrophic wind equation,

$$\frac{v^2}{r}=\frac{1}{\rho}\frac{dp}{dr},$$

provided that the isobars are circular.

wind zones, *n.*—Geographical areas delimited by the prevalence of certain wind systems; thus one may speak of the zone of the trade winds, the zone of the westerlies, etc. Classifications of climate according to these zones have been attempted. *See:* R. D. Ward, Climate, 2d ed., 1918, pp. 30–32.

winter, *n.*—1. One of the four seasons recognized in the temperate zones; usually regarded in the popular mind as comprising the months of December, January, and February in the north temperate zone, though the astronomical winter extends from the winter solstice, about December 22d, to the vernal equinox, about March 22d.

In the northern hemisphere, winter is marked by the southward migration of the various segments of the POLAR FRONT, and by the building up of the polar anticyclones of Canada and Siberia. The resultant clashes between cold polar or arctic air and the warm air of southerly latitudes is responsible for the cold waves, blizzards, ice storms, gales, etc., which characterize the season in middle latitudes. 2. The name often given in the tropics to the RAINY SEASON, q. v.

winter day, *n.*—A day on which the temperature does not rise above the freezing point, even during the afternoon. (J. Hann, Handbuch der Klimatologie, 3d ed., 1908, Vol. I, p. 36.)

woolpack, *n.*—Name applied to cirrocumulus by Ralph Abercromby, and to altocumulus by R. H. Scott, because these cloud forms have a fleecy appearance and resemble flocks of sheep or lambs.

world meteorology, *n.*—The study of weather phenomena and their interrelations that involve the whole or a large portion of the earth and extend over time intervals of weeks, months, or seasons. H. H. Clayton's "World Weather" and Sir Gilbert Walker's works on long-range forecasting are some examples.

X

x., *abbr.*—Abbreviation for hoarfrost in the BEAUFORT WEATHER NOTATION, q. v.

X weather, *n.*—Phrase used to signify that an airport is closed for flying because of bad weather; defined by current Civil Aeronautics Administration regulations which give the limits of ceiling and visibility at which the field becomes open for instrument flight.

Y

y., *abbr.*—Abbreviation for dry air in the BEAUFORT WEATHER NOTATION, q. v.

year, *n.*—1. The period between two successive passages of the sun in its apparent motion around the celestial sphere, through an adopted co-ordinate reference point. Several kinds of years—tropical year, sidereal year, anomalistic year—are therefore distinguished according to the reference point chosen. 2. An arbitrary period, more or less conforming to some one of the preceding, adopted for practical chronological purposes. In meteorology, the ordinary Gregorian civil or calendar year is used; and monthly or yearly summaries of observational data are published in accordance with it. In climatology, however, it is often convenient to choose beginning dates other than January 1st. For example, it is convenient in a study of yearly rainfall to have the year begin with the rainy season; this type of year is applicable to the Pacific Coast of the United States, where the summer months are definitely dry.

year-climate, *n.*—1. The climate of a region during a particular year, as distinguished from its average or prevailing climate during a long series of years. 2. Name given to what should properly be termed a CLIMATIC YEAR, q. v. *See:* H. M. Kendall, Notes on Climatic Boundaries in the Eastern United States, Geographical Review, vol. 25, January 1935, pp. 117–124.

yellow snow, *n.*—Snow given a golden or yellow appearance by the presence in it of pine or cypress pollen. *See:* A. W. Greely, American Weather, 1888, pp. 73–74.

Z

z., *abbr.*—Symbol for haze in the BEAUFORT WEATHER NOTATION, q. v.

zephyr, *n.*—1. In general, a gentle breeze. 2. A warm summer breeze, especially one from the west. 3. The west wind, personified, or the god of the west wind. *See:* ZEPHYRUS. 4. Facetiously, applied at one time in the western United States to a violent wind, e. g., Washoe zephry of Virginia City in Mark Twain's "Roughing It."

Zephyrus, *n.*—Ancient Greek name for the west wind, or its personification; the corresponding term in Latin is Favonius.

zerp zerp, *n.*—A term used at observing stations, meaning "ceiling and visibility zero"; derived from the early teletype machines, which—when not shifted on the last letter—would print "zerp zerp" for zero (ceiling) zero (visibility).

zigzag lightning, *n.*—*See:* LIGHTNING.

zodiacal counterglow, *n.*—*See:* GEGENSCHEIN.

zodiacal light, *n.*—A cone of faint light, most frequently observed stretching along the ecliptic after the sunset twilight has faded in the western sky. It is caused by the reflection of sunlight "by meteoric material which has a strong preference for a plane not much inclined to the ecliptic, and which is more concentrated within the earth's orbit than without it. Russel estimates that the zodiacal light can be accounted for, if the space within the earth's orbit contains particles one twenty-fifth of an inch in diameter and five miles apart." (R. H. Baker, Astronomy, 1938, p. 248.)

zonal index, *n.*—A measure of the intensity of the west-east component of the general atmospheric circulation, usually between 35° and 55° N. lat. expressed either by the difference in millibars between the mean pressures prevailing along these latitude circles, or by the mean geostrophic zonal wind velocity corresponding to this pressure difference; taken as positive when the pressure is higher at 35° N. than at 55° N. and the circulation component is directed eastward. When the index amounts to something like +15 millibars, indicating a strong eastward flow in middle latitudes, it is called a "high index."

Conversely, when the pressure difference between the latitude circles is small, or when the pressure may happen to be lower at 35° than at 55°, this "low index" shows that the west-east flow is negligible or even reversed. A "low index" may range from about +5 to −2 mb.

zonda, *n.*—1. Also called sondo: a sultry and enervating north wind in Argentina. 2. A hot, dry, foehn-type west wind that occurs in winter in Argentina on the eastern slopes of the Andes.

zone, *n.*—In the old classifications of climate, a latitudinal band encircling the earth—such as the Torrid Zone, which was the entire area between the tropics of Cancer and Capricorn. *See:* CLIMATIC CLASSIFICATION. 2. In present-day usage, any area of the earth's surface or layer of the atmosphere, regarded as a meteorological entity. Thus there are rainfall zones, climatic zones, frontal zones, wind zones, zones of convergence, etc.