METEOROLOGICAL GLOSSARY

Meteorological Glossary

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PREFACE TO THE FIFTH EDITION

When, in 1967, the *Meteorological glossary* came under consideration for reprinting, it was decided to ask Dr McIntosh to undertake a revised edition, with co-operation from within the Meteorological Office. The opportunity has been taken in this edition, to delete some terms which are considered no longer appropriate, and to include various new entries and revisions which stem from recent advances and practice.

Units of the Système International have been adopted in this edition. In some cases, however, the traditional British or metric units are also included because of existing World Meteorological Organization recommendations and for the convenience of user interests during the period before complete national and international adoption of SI units.

Meteorological Office, 1970.

PREFACE TO THE FOURTH EDITION

In 1916, during the directorship of Sir Napier Shaw, the Meteorological Office published two pocket-size companion volumes, the 'Weather map' to explain how weather maps were prepared and used by the forecasters, and the 'Meteorological glossary' to explain the technical meteorological terms then employed. With the advance of the science and the elaboration of its techniques the publications have been in continuous demand, many times reprinted and on several occasions completely revised. The second edition was in 1930, the third in 1938–39, and soon after World War II it was obvious that radical revision was necessary once again. In 1956 the fourth edition of the 'Weather map' was issued but, for the first time in forty years, it was not found possible to prepare simultaneously a new edition of the 'Meteorological glossary', which had become very much out-of-date and in need of a complete remodelling. For earlier editions the task had been shared amongst the professional staff of the Office and the result was an interesting and up-to-date volume containing much useful information, although the freedom allowed to the many contributors had led to a unique volume of quite uneven character with articles varying from brief dictionary definitions to encyclopaedic essays. For the fourth edition the number of new entries was to be larger than ever before and it was decided that the need was now for a more systematic reference work containing a brief definition of all the terms in ordinary use rather than for a compilation of miscellaneous articles giving information which would more properly be looked for in one of the many modern textbooks. For this purpose a single author, assisted if need be by expert referees, would, it seemed, be advantageous and the Office was fortunate in finding in Dr D. H. McIntosh of the University of Edinburgh a physicist and meteorologist of wide experience willing to undertake the major task. Before being passed for printing every article has been read critically by more than one member of the scientific staff of the Office and Dr. McIntosh has shown a remarkable readiness to compromise. In this way it is hoped that the excellence of the author's original draft has been fully retained while providing a work which will adequately meet the needs of the official service. It would, however, be too much to hope that no further improvement will be possible and the Office will be pleased to receive from any source criticisms and suggestions calculated to increase the value of the work, not only for the professional meteorologist, but for interested people everywhere.

Meteorological Office, 1962.

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A

ablation: The disappearance of snow and ice by melting and evaporation. The chief meteorological factor which controls the rate of ablation is air temperature; subsidiary factors are humidity, wind speed, direct solar radiation and rainfall. The rate of ablation of a snow-field is also affected by such non-meteorological factors as size, slope and aspect of snow-field, depth and age of snow, and nature of underlying surface.

abroholos: A violent squall on the coast of Brazil, occurring mainly between May and August.

absolute extremes: See EXTREMES.

absolute humidity: An alternative for VAPOUR CONCENTRATION.

absolute instability: See STABILITY.

absolute instrument: An instrument with which measurements may be made in units of mass, length, and time (or in units of a known and direct relationship to these) and against which other non-absolute instruments may be calibrated. See also STANDARD.

absolute stability: See STABILITY.

absolute temperature: See TEMPERATURE SCALES.

absolute vorticity: See VORTICITY.

absolute zero (of temperature): Temperature of $-273{\cdot}15°C$, the zero on the kelvin (absolute) scale. See TEMPERATURE SCALES.

absorption: Removal of radiation from an incident solar or terrestrial beam, with conversion to another form of energy—electrical, chemical or heat.

The absorption of radiation by the gases of the atmosphere is highly selective in terms of wavelengths and may depend also on pressure and temperature. Numerical expression is given by the law, variously known as Beer's, Bouguer's, or Lambert's law, applicable to monochromatic radiation:

$$I = I_0 e^{-\alpha m}$$

where I_0 is the intensity of incident radiation, I the intensity after passing through mass m of absorbing substance and α the absorption coefficient. An alternative expression is

$$I = I_0 e^{-\alpha x}$$

where x is the path length through the absorbing substance.

The effectiveness of a gas as an absorber of solar or terrestrial radiation depends on the width and strength (absorption coefficient) of the absorption lines and bands, the concentration of the gas, and the wavelength positions of the bands relative to the maximum of the Planck curve (see RADIATION) at solar or terrestrial temperature, respectively. The relative energies involved in atmospheric absorption processes are represented in Figure 1, in which the Planck curves appropriate to solar and terrestrial radiation temperatures (6000 and 250 K, respectively) are shown with equal areas to represent over-all balance of the two fluxes. Fine structure of the absorption bands is omitted. The main constituents of the atmosphere, N_2 and O_2, are almost completely transparent except in the far ultra-violet: minor constituents such as O_3, CO_2, H_2O, N_2O have intense absorption bands, mainly in the infra-red and longer wavelengths. The product of (*a*) and (*c*) in Figure 1 represents the energy absorbed by the stratosphere, and the product of (*a*) and ((*b*) − (*c*)) that absorbed by the troposphere.

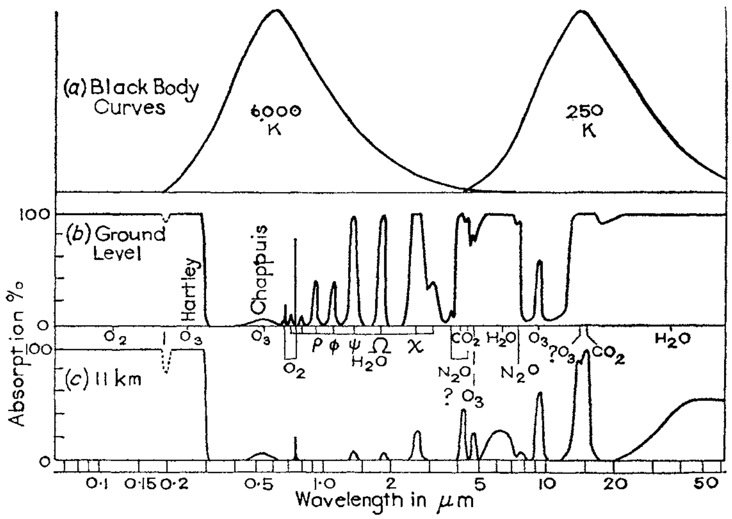

FIGURE 1—Relative importance of various absorptions in the atmosphere
(*a*) Black-body emission for 6000 and 250 K.
(*b*) Atmospheric absorption spectrum for a solar beam reaching ground level.
(*c*) Atmospheric absorption spectrum for a solar beam reaching the temperate tropopause.

ρ, φ, ψ, Ω and χ are the near infra-red bands of water vapour. In (*b*) and (*c*) no fine structure is shown although all the infra-red bands have in fact a very complex structure. Most of the bands shown have a broad doublet structure, but even this is smoothed out. It has been assumed that the atmosphere contains 3 mm of ozone at s.t.p., all above 11 km; that it contains 2 g/cm^2 of water vapour above ground level and 10^{-3} g/cm^2 above 11 km; that carbon dioxide and nitrous oxide are mixed in equal proportions with the atmosphere at all heights. The small window (dotted) at 0·2μm and the two ozone bands marked (?) have not yet been observed at the two levels concerned.

(GOODY, R. M. and ROBINSON, G. D.; Radiation in the troposphere and lower stratosphere. *Q J R Met Soc, London, 77*, 1951, p. 153.)

Since water has an appreciable absorption coefficient in solar radiation wavelengths greater than about one micrometre, thick clouds are able to absorb over 20 per cent of incident solar radiation. Towards terrestrial radiation, clouds and fog behave as almost perfect black bodies. The surface of the earth is very variable in its absorption of solar radiation (see ALBEDO) but absorbs nearly all incident terrestrial radiation.

acceleration: Rate of change of velocity with respect to time. Like velocity, acceleration has both magnitude and direction; thus uniform circular motion, involving change of direction without change of speed, implies acceleration ('centripetal acceleration'). The dimensions are $L\,T^{-2}$.

The 'absolute acceleration' of the air ($\dot{\mathbf{V}}_a$), acceleration measured relative to axes fixed in space, is equal to the force acting per unit mass of air (Newton's second law of motion). The important forces per unit mass in air motion are the PRESSURE GRADIENT FORCE $\left(-\frac{1}{\rho}\nabla p\right)$, the Newtonian force of GRAVITY directed towards the earth's centre ($\mathbf{g}_a$), and the 'frictional' forces arising from eddy VISCOSITY or molecular viscosity ($\mathbf{F}$). Thus we have the 'equation of absolute motion':

$$\dot{\mathbf{V}}_a = -\frac{1}{\rho}\nabla p + \mathbf{g}_a + \mathbf{F}.$$

The air's 'relative acceleration' ($\dot{\mathbf{V}}$), i.e. its acceleration measured with respect to axes fixed in the earth, may be shown to be related to $\dot{\mathbf{V}}_a$ and to two other accelerations, namely the CENTRIPETAL ACCELERATION of the coinciding point of the earth ($\dot{\mathbf{V}}_e$) and the CORIOLIS ACCELERATION ($-2\boldsymbol{\Omega}\wedge\mathbf{V}$, where $\boldsymbol{\Omega}$ is the earth's angular velocity and $\wedge$ denotes the vector cross product).

The relationship is

$$\dot{\mathbf{V}} = \dot{\mathbf{V}}_a - 2\boldsymbol{\Omega}\wedge\mathbf{V} - \dot{\mathbf{V}}_e.$$

Substitution for $\dot{\mathbf{V}}_a$ in the first equation gives

$$\dot{\mathbf{V}} = -\frac{1}{\rho}\nabla p + \mathbf{g}_a - \dot{\mathbf{V}}_e - 2\boldsymbol{\Omega}\wedge\mathbf{V} + \mathbf{F}.$$

Since also the force of gravity along the local vertical ($\mathbf{g}$) is given by $\mathbf{g} = \mathbf{g}_a - \dot{\mathbf{V}}_e$, we have, by substitution, the 'equation of relative motion'

$$\dot{\mathbf{V}} = -\frac{1}{\rho}\nabla p - 2\boldsymbol{\Omega}\wedge\mathbf{V} + \mathbf{g} + \mathbf{F}.$$

The relative acceleration of the air ($\dot{\mathbf{V}}$) is of fundamental importance in dynamical meteorology because it is directly related to the development of pressure systems. While, in theory, $\dot{\mathbf{V}}$ may be obtained from the equation of relative motion, this is not possible in practice because it is a small residual of much larger and imperfectly known terms.

The equation of relative motion has its most practical application in 'steady' motion ($\dot{\mathbf{V}} = \mathbf{0}$) in which all the forces acting on the air are balanced. In particular, when the flow is horizontal and frictionless, the forces $\mathbf{g}$ and $\mathbf{F}$ may be neglected and the equation becomes that for GEOSTROPHIC flow.

Common situations in which the air is subject to acceleration, with accompanying AGEOSTROPHIC component of wind, are (*a*) curved flow (see GRADIENT WIND), (*b*) change of pressure gradient in direction of flow (see CONFLUENCE), (*c*) local change of pressure gradient with time (see ISALLOBARIC WIND).

The degree of acceleration experienced in flight is usually expressed in the unit g, this being the acceleration produced by gravity at the earth's surface, namely $9{\cdot}8\ \mathrm{m/s^2}$.

acclimatization: The process of adjustment of an animal, normally with implied physiological effects, to a marked change of physical environment, such as to a large change of altitude or a change to extreme conditions of temperature and/or humidity.

accretion: In meteorology, this usually refers to the growth of an ice particle by collision with water drops. The term is also used in the more general sense of growth of water drops, or ice particles, by collision. See PRECIPITATION, ICE ACCRETION.

accumulated temperature: The integrated excess or deficiency of temperature measured with reference to a fixed datum over an extended period of time. If on a given day the temperature is above the datum value for n hours and the mean temperature during that period exceeds the datum line by m degrees, the accumulated temperature for the day above the datum is nm degree-hours or $nm/24$ degree-days. By summing the daily entries arrived at in this way, the accumulated temperature above or below the datum value may be evaluated for periods such as a week, a month, a season or a year.

In practice, daily values of accumulated temperature are derived not from hourly values but by a method involving the use of daily maximum (X) and minimum (N) temperatures: empirical formulae relating to X, N and the datum value (D) are used when D lies between X and N.

The datum value which has been used in relation to agriculture is 42°F (6°C); this is widely used as the critical temperature above which the growth of vegetation in a European climate is initiated and maintained. For the study of heating problems a datum value of 60°F is used by British engineers. Meteorological Office *Professional Note* No. 125* contains average monthly and yearly values of accumulated temperature with respect to datum values of 42°, 50°, 60° and 70°F at each of 49 stations in the British Isles for the period 1921–50. The data were derived by an empirical method which uses the average value and standard deviation of monthly mean temperature.

accuracy: In physical measurement, the closeness with which an observation of a quantity, or the mean of a series of observations, is considered to approach the unknown true value of the quantity. See also ERROR.

acoustic sounding: Investigation of the properties of the atmosphere by the propagation and reception of sound waves.

acre-inch: An obsolescent term for the volume of water (weighing about 100 tons ($\approx 10^5$ kg)) which would cover one acre to the depth of one inch (1 acre = $4046{\cdot}86\text{m}^2$. 1 inch = 25·4 mm).

actinic rays: Radiation which effects chemical changes, as in photography. The term is also loosely used to signify ULTRA-VIOLET RADIATION.

actinometer: An early name for an instrument which measures solar radiation, usually at normal incidence, as in the Linke–Fuessner and Michelson actinometers (see PYRHELIOMETER). The corresponding term for a recording instrument is 'actinograph'. The name 'actinometer' is also applied to an instrument which measures the intensity of ACTINIC RAYS. See also PYRANOMETER and PYRHELIOMETER.

actinon: Gas, of atomic mass 219 and atomic number 86, which is a radioactive isotope of RADON. It occurs in minute concentration in the atmosphere and plays a small part in the IONIZATION of the air at low levels.

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* SHELLARD, H. C.; Averages of accumulated temperature and standard deviation of monthly mean temperature over Britain, 1921–50. *Prof Notes Met Off, London*, **8**, No. 125, 1959.

adiabatic: An adiabatic process (thermodynamic) is one in which heat does not enter or leave the system. (Greek, *a* not, and *diabaino* pass through.)

Because the atmosphere is compressible and pressure varies with height adiabatic processes play a fundamental role in meteorology. Thus, if a parcel of air rises it expands against its lower environmental pressure; the work done by the parcel in so expanding is at the expense of its internal energy and its temperature falls, despite the fact that no heat leaves the parcel. Conversely, the internal energy of a falling parcel is increased and its temperature raised, as a result of the work done on the air in compressing it.

Observation shows that such processes determine, to a large extent, the vertical temperature distribution within the troposphere. It also supports the view that, to a first approximation, it is justifiable to treat the vertically moving, individual masses of air of indefinite size (termed 'parcels') as CLOSED SYSTEMS which move through the environment without unduly disturbing it or exchanging heat with it. Various non-adiabatic processes such as condensation, evaporation, radiation, and turbulent mixing also operate to produce temperature changes in the free atmosphere but their effects are generally negligible in comparison with those caused by appreciable vertical motion.

Such adiabatic or 'dynamical' temperature changes proceed at a definite rate. For dry (unsaturated) air the change in temperature per unit height change (i.e. the LAPSE rate) is given by the equivalent expressions:

$$\frac{\gamma - 1}{\gamma}\,\frac{g}{R} \text{ or } \frac{g}{c_p}$$

where R is the gas constant for air (287 J/kg degK), g the acceleration of gravity (9·8 m/s^2) and γ the ratio of specific heats of dry air at constant pressure (c_p) and constant volume (c_v) respectively (1·4), from which the 'dry adiabatic lapse rate' (DALR) is about 0·98 degC per 100 m or, with sufficient accuracy, 1 degC per 100 m (5·4 degF per 1000 ft).

For a saturated rising parcel the fall of temperature is checked by the latent heat liberated. The 'saturated adiabatic lapse rate' (SALR) is therefore less than that for unsaturated air by an amount which varies with temperature and pressure: at lower levels in temperate latitudes the SALR is about half that of the DALR. Since widespread vertical motion occurs in the TROPOSPHERE, the average lapse rate in this region lies between the DALR and SALR.

Two extreme types of process involving ascent of saturated air may be visualized: (i) a reversible, adiabatic ascent at the SALR, in which all products of condensation—cloud, rain, hail or snow—are retained within the ascending air, partake of the temperature changes of the air, and are available for evaporation at the appropriate stages on subsequent descent of the air, which is also at the SALR; (ii) an irreversible and, strictly, non-adiabatic process, in which all products of condensation are removed during ascent and in which subsequent descent of the air is at the DALR. The latter process corresponds much more closely to what happens in the atmosphere than does the former and is termed a pseudo-adiabatic process. Because of the loss of the heat content of the precipitated water, cooling on ascent in a pseudo-adiabatic process is at a rate slightly in excess of the SALR, but the difference between the rates is negligible; thus, saturated adiabatics and pseudo-adiabatics (lines on an AEROLOGICAL DIAGRAM representing the respective lapse rates) are, for practical purposes, identical. The important distinction between the pseudo-adiabatic and reversible processes lies in the different rates of temperature change undergone by the air on subsequent descent. See also ENTROPY, ISENTROPIC, ADIABATIC EQUATIONS.

adiabatic atmosphere: A hypothetical atmosphere characterized by the dry adiabatic lapse rate throughout. It is also termed 'neutral atmosphere' or 'convective atmosphere'. See ADIABATIC.

adiabatic diagram: An alternative for AEROLOGICAL DIAGRAM, or THERMODYNAMIC DIAGRAM.

adiabatic equations: The three (equivalent) relationships between the variables of state, p (pressure), v (specific volume), and T (temperature), of a PERFECT GAS in an ADIABATIC process.

They are:

(i) pv^{γ} = constant, (ii) $Tv^{\gamma-1}$ = constant, (iii) $Tp^{-(\gamma-1)/\gamma}$ = constant, where γ is the ratio of the specific heats, c_p/c_v. The third relationship is the one most often used in meteorology. For dry air at ordinary temperatures, $\gamma = 1{\cdot}40$ and

$$\frac{\gamma - 1}{\gamma} = \frac{c_p - c_v}{c_p} = \frac{R}{c_p} = 0{\cdot}286.$$

The same value may be used as an approximation for moist air. See SPECIFIC HEAT.

adiabatic region: That region of the atmosphere (the TROPOSPHERE) where the temperature LAPSE rate is determined mainly by vertical ADIABATIC motion of the air; it is also termed the 'convective region'.

adsorption: The penetration of a substance, e.g. gas or thin film of liquid, into the surface layer of a solid with which it is in contact.

advection: The process of transfer (of an air-mass property) by virtue of motion. In particular cases, attention may be confined to either the horizontal or vertical components of the motion. The term is, however, often used to signify horizontal transfer only.

advection fog: Fog formed by the passage of relatively warm, moist and stable air over a cool surface. It is associated mainly with cool sea areas, particularly in spring and summer, and may affect adjacent coasts. It may occur also over land in winter, particularly when the surface is frozen or snow-covered—sometimes then, however, in conjunction with RADIATION FOG.

advective change of temperature: That contribution to local temperature change which is caused by either (or both) horizontal or vertical ADVECTION of air. The horizontal component of change, which is generally the more effective in the troposphere, is proportional to the horizontal temperature gradient at the level concerned and to the wind speed in the direction of this gradient; the vertical component of change is proportional to the vertical wind velocity and to the static stability of the air and depends also on whether or not the air is saturated.

aerobiology: The study of the part played by the earth's atmosphere in the movement of living animal and plant organisms.

aerodrome meteorological minima: Limiting meteorological conditions prescribed for the purpose of determining the usability of an aerodrome either for take-off or for landing of aircraft.

aerodynamic roughness, smoothness: A physical boundary is 'aerodynamically rough' when fluid flow is turbulent down to the boundary itself. Over such a boundary the velocity profile and surface drag are independent of the fluid viscosity (ν) but depend on a ROUGHNESS LENGTH (z_0) which is related to the height and spacing of the roughness elements of the surface. A surface is 'aerodynamically smooth' if there exists a layer adjacent to it in which the flow is laminar and in which the velocity profile and surface drag are related to the fluid viscosity. A surface which is aerodynamically smooth at low speed of flow may become aerodynamically rough at a higher speed. A surface may thus be described as rough or smooth only in terms of the associated flow; alternatively, the flow itself may be described as aerodynamically rough or smooth.

In meteorology, nearly all surfaces are aerodynamically rough for any significant wind speed.

aerodynamics: The study of the forces and reactions arising from the motion of bodies, more particularly the parts of an aircraft, through the air. It is from such forces or reactions that the lifting power of an aircraft is obtained.

aerogram: An AEROLOGICAL DIAGRAM, due to A. Refsdal, in which the abscissa is log T and the ordinate $T \log p$.

aerological diagram: A graphical representation of the observations of pressure, temperature and humidity, made in a vertical sounding of the atmosphere.

The reference lines which facilitate the plotting of a sounding and its assessment after plotting are isobars, isotherms, dry adiabatics, saturated (pseudo-) adiabatics and saturation moisture lines. Each of the diagrams in common use—the tephigram, emagram and Stüve diagram—has its own particular advantage. Each has, exactly or very nearly, the property of being a true thermodynamic ('equivalent') diagram in that equal area represents equal energy at any point of the diagram; possession of this property simplifies energy and height (geopotential) calculations.

The tephigram (T–φ gram)—see Figure 2—has rectangular Cartesian co-ordinates in which the abscissa is temperature (T) and the ordinate ENTROPY (φ), (entropy is now normally designated S, not φ) i.e. log θ, where θ is the dry-bulb potential temperature; the dry adiabatics (θ = constant) are therefore straight lines perpendicular to the isotherms. The basic co-ordinates in the emagram are T and log p (p = pressure); in a 'rectangular' model the T and log p axes are perpendicular to each other; in the 'oblique' emagram these axes meet at an angle of 45°, thus making the dry adiabatics (slightly curved) and isotherms meet at an angle of about 90°. This latter is a decided advantage in assessing the static STABILITY of an ascent curve since the normal range of lapse rate of temperature in the troposphere is between the isothermal and dry adiabatic rates. In the Stüve diagram rectangular co-ordinates of T and p^{κ} ($\kappa = 0{\cdot}286$) are used; the dry adiabatics are then straight lines (as are the isobars and isotherms) but the property of strict equivalence of energy and area is sacrificed.

aerology: A word denoting the study of the atmosphere, but generally used in the sense of a study limited to the atmosphere above the surface layers.

aeronomy: A term sometimes used to denote that branch of atmospheric physics which is concerned with those regions, upwards of about 50 km, where DISSOCIATION and IONIZATION are fundamental properties.

aerosol: In meteorology, an aggregation of minute particles (solid or liquid) suspended in the atmosphere. See NUCLEUS.

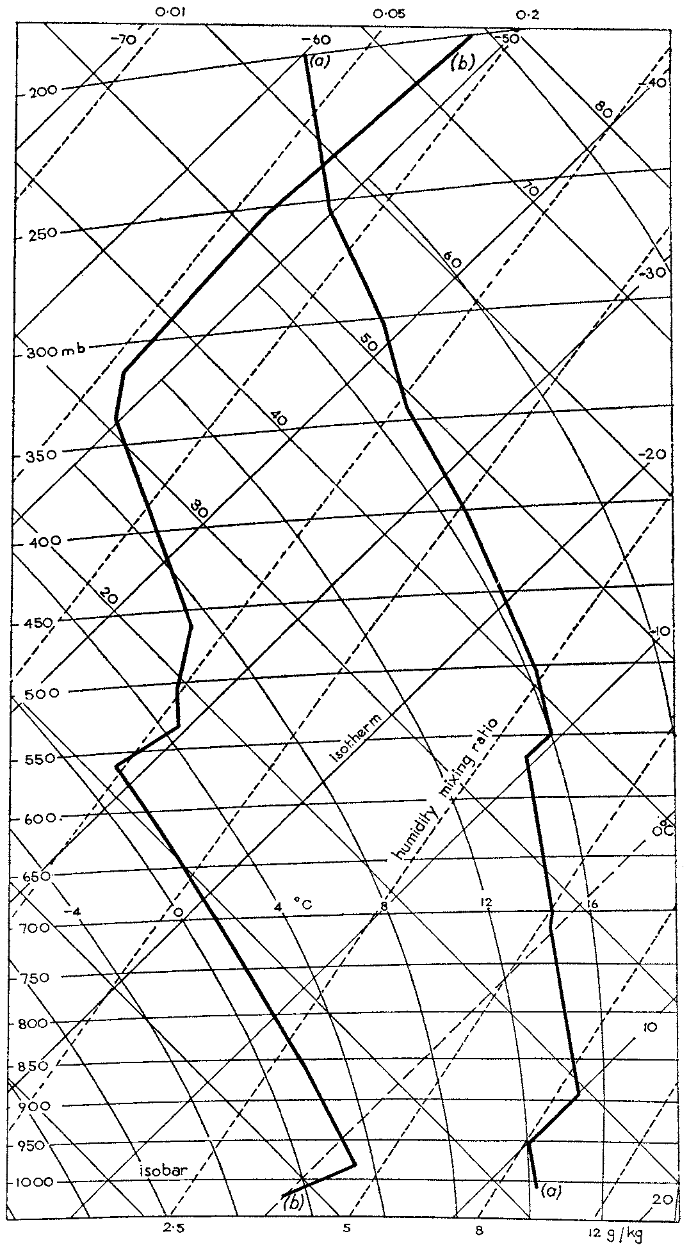

FIGURE 2—Aerological diagram (tephigram) illustrating pressure–temperature plots of two ascents made at Crawley (51° 05′ N, 0° 13′ W).
Curve (*a*): ascent made in maritime tropical air, 2330 GMT, 11 December 1961.
Curve (*b*): ascent made in Arctic air, 2330 GMT, 5 December 1961.

afterglow: See ALPINE GLOW.

ageostrophic wind: The VECTOR difference between the actual wind and the GEOSTROPHIC WIND (see Figure 3); it is also called the 'geostrophic departure' and 'geostrophic deviation'.

Actual wind = geostrophic wind + ageostrophic wind.

The ageostrophic wind is of fundamental importance in that it is necessarily associated with CONVERGENCE OR DIVERGENCE and vertical motion in the atmosphere. The ISALLOBARIC WIND is a particular example of ageostrophic wind; an ageostrophic component is also present in the SURFACE WIND and GRADIENT WIND.

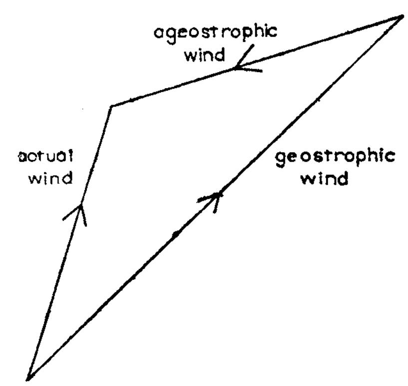

FIGURE 3—Ageostrophic wind.

aggregation: The process of growth of snowflakes or ice crystals by collision and adherence.

agroclimatology: The study of those aspects of climate which are relevant to the problems of agriculture. Such study involves types of data, e.g. earth temperature and accumulated temperature, which are often not considered in more general CLIMATOLOGY.

agrometeorology: Meteorology relevant to problems of agriculture. It is concerned, in particular, with the surface layers of the atmosphere and with the conditions in the top layer of the earth's surface which are associated with variations of the meteorological elements.

air: The mixture of gases which form the earth's ATMOSPHERE. In the absence of dust and water vapour, the composition of the air up to about 20 km is taken to be as shown in Table I; the percentage composition by volume and weight is given, i.e. FRACTIONAL VOLUME ABUNDANCE and MIXING RATIO.

Of the gases shown in Table I only carbon dioxide and ozone have appreciable local variations of concentration. There are also, mainly in the low atmosphere, minute variable quantities of such gases as radon, actinon, thoron, sulphur dioxide, hydrogen chloride, methane and nitrous oxide.

Ordinary (moist) air may be regarded as a mixture of dry air and water vapour. The concentration of water vapour in surface air varies from a small fraction of one per cent to over three per cent; in general the concentration decreases with increasing altitude.

TABLE I—*Composition of dry air*

	Molecular weight (^{12}C = 12·000)	Proportional composition By volume per cent	By weight per cent
Dry air	28·966	100·0	100·0
Nitrogen	28·013	78·09	75·54
Oxygen...	31·999	20·95	23·14
Argon	39·948	0·93	1·27
Carbon dioxide	44·010	0·03	0·05
Neon	20·183	$1{\cdot}8 \times 10^{-3}$	$1{\cdot}2 \times 10^{-3}$
Helium	4·003	$5{\cdot}2 \times 10^{-4}$	$7{\cdot}2 \times 10^{-5}$
Krypton	83·800	$1{\cdot}0 \times 10^{-4}$	$3{\cdot}0 \times 10^{-4}$
Hydrogen	2·016	$5{\cdot}0 \times 10^{-5}$	$4{\cdot}0 \times 10^{-6}$
Xenon	131·300	$8{\cdot}0 \times 10^{-6}$	$3{\cdot}6 \times 10^{-5}$
Ozone	47·998	$1{\cdot}0 \times 10^{-6}$	$1{\cdot}7 \times 10^{-6}$

air discharge: A term sometimes used to denote a lightning flash from cloud to air. See LIGHTNING.

airglow: General term for the radiation which is emitted continuously by the upper atmosphere. The day, twilight and night emissions are termed DAYGLOW, TWILIGHT-GLOW and NIGHTGLOW, respectively, the last being the most extensively studied.

airlight: The increase in apparent brightness of a distant object viewed in daylight, owing to scattering of light towards the observer by particles held in suspension in the atmosphere, and by air molecules, between the observer and object. Airlight, and therefore object brightness, increase with object distance owing to increase in the number of scattering agents. A critical point is reached, limiting daylight VISIBILITY, at which the brightness of a suitable object is just indistinguishable from its background. See also KOSCHMIEDER'S LAW, CONTRAST THRESHOLD OF THE EYE.

air mass: A body of air in which horizontal gradients of temperature and humidity are relatively slight and which is separated from an adjacent body of air by a more or less sharply defined transition zone (FRONT) in which these gradients are relatively large.

The horizontal dimensions of air masses are normally hundreds or even thousands of kilometres. The term is, however, also used in relation to phenomena of much smaller scale, e.g. the sea-breeze.

Homogeneity in a body of air is produced by prolonged contact, in a 'source region', with an underlying surface of uniform temperature and humidity. The main source regions are those in which occur the permanent or semi-permanent anticyclones, with rather indeterminate boundaries, which are a prominent feature of the GENERAL CIRCULATION—the subtropical, polar, and winter continental anticyclones. Slow transformation of the air-mass properties acquired at the source region is effected on subsequent movement of the air from the region, mainly through its contact with a different surface, but to an appreciable extent also by radiation and large-scale vertical motion. The synoptic meteorology of middle latitudes, in particular, is dominated by considerations of the air-mass properties originally acquired and the manner of their recent modification—whether warming or cooling, becoming more or less moist or more or less stable.

Air masses are classified into groups designated as 'polar' (*P*) or 'tropical' (*T*), maritime (*m*) or continental (*c*), defining the basic temperature and humidity characteristics, respectively; more generally, a twofold classification in terms of both elements, e.g. *mT* or *cP*, is used. Further divisions are sometimes made into Arctic or Antarctic (*A*) air and into classes of more local significance, e.g. Mediterranean air.

air-mass analysis: Synoptic identification of AIR MASSES and location of boundaries (FRONTS) between adjacent air masses.

The identifying of an air mass implies the finding of its source region and would appear to entail the retrospective tracking of the air back to such a region. In practice, such a procedure is very seldom required because of the continuity provided by a series of synoptic charts. An air mass moving from its source region usually has in early stages a well-defined front at its junction with the adjacent air mass. Further identification of the limits of the air masses is largely made in terms of the movement of this front which has a high degree of continuity with time.

The locating of fronts on a surface synoptic chart rests in part on identifying the line or zone of maximum horizontal gradient of air temperature and humidity, and in part on locating the physical and dynamical effects frequently associated with a junction of two air masses—precipitation, and discontinuities of pressure tendency and wind velocity. Cloud type, visibility, and lapse rate of temperature are further parameters in which there is normally a discontinuity at an air-mass boundary.

The locating of fronts on surface synoptic charts is made more difficult by the fact that, at land stations, such elements as temperature and, to a lesser extent, dew-point are not 'conservative', i.e. they are readily changed by such processes as radiational warming and cooling, often to very different degrees at different places. Wind velocity and, more particularly, visibility are other surface elements which at land stations may not be 'representative' of the air mass as a whole. Such lack of representativeness is much less true of observed elements in the upper atmosphere. Temperature and humidity of individual elements of air in the free atmosphere are, however, by no means conservative in vertical motion, and recourse is sometimes made, in identifying air masses, to such derived parameters as POTENTIAL TEMPERATURE and WET-BULB POTENTIAL TEMPERATURE which are conservative, or quasi-conservative, for certain specific processes to which the air may be subjected.

air-mass climatology: Description of climate in terms of the frequencies and properties of the different types of AIR MASS which affect a specified region in a specified period.

air-mass thunderstorm: A THUNDERSTORM which is formed by convection within an air mass, usually by heating of the lower layers. By implication, it is one in whose formation neither a front nor large-scale dynamical lifting of the air mass plays an important part.

air-meter: An instrument for measuring the flow of air. It consists of a light 'windmill' in which inclined vanes are carried on the spokes of a wheel arranged to rotate about a horizontal axis. A system of counters is provided to show the number of rotations of the wheel. Calibration is effected in terms of a speed unit so that the instrument acts as a convenient portable ANEMOMETER. Both 'sensitive' (low-speed) and 'high-speed' air-meters are used.

air pocket: An obsolescent term for a region of descending air in which an aircraft experiences a proportionate decrease of lift.

Air pockets are usually experienced in association with convective-type storms ('downdraughts') and, in strong and squally winds, on the leeward side of hills, buildings and other obstructions. The turbulence produced by an obstacle to wind flow extends to a height which increases with temperature lapse rate up to three or four times that of the obstacle.

Aitken nucleus: See NUCLEUS.

albedo: A measure of the reflecting power of a surface, being that fraction of the incident RADIATION (total or monochromatic) which is reflected by a surface.

Typical values of total albedo (per cent) of various surfaces are: forest 5 to 10; wet earth 10; rock 10 to 15; dry earth 10 to 25; sand 20 to 30; grass 25; old snow 55; fresh snow 80. The albedo of a water surface varies from about 5 per cent at high solar elevation to 70 per cent at low solar elevation. The albedo of clouds is difficult to measure but is known to depend on cloud type and thickness; estimates of an average value in time and space vary from 50 to 65 per cent.

The albedo of the earth–atmosphere system as a whole ('planetary albedo') is estimated to be about 0·4 (i.e. 40 per cent). This signifies that about four-tenths of the incident solar radiation is returned to space, without change of wavelength, by reflection from clouds and the earth's surface and by back scattering from air molecules and dust. A similar value, with real variations up to about 5 per cent, is inferred from photometric comparisons of the earth-lit and sun-lit segments of the moon.

albedometer: An instrument for measuring the ALBEDO of a surface.

Aleutian low: A depression, centred near the Aleutian Islands in the North Pacific, which is a conspicuous feature of the northern hemisphere surface mean pressure chart in winter. The depression has an average central pressure below 1000 mb in January, and represents the aggregate of the many depressions which affect this region in winter.

alidade: An instrument for measuring the angular elevation of an object, e.g. a cloud feature or a searchlight spot. The object is sighted by the observer along a rod whose angular position (0°–90°) with respect to the horizontal is obtained by reading from an engraved scale of degrees. Both fixed and portable (or 'hand') alidades are used.

alpha (or α) **particle:** A particle emitted spontaneously from the nuclei of certain radioactive elements. It is identical with a helium nucleus, comprising two neutrons and two protons, and therefore carries a positive charge of two units.

α particles are of such low penetrative power (only a few centimetres in air) that the particles emitted by radioactive materials in the earth's crust are insignificant in forming IONS. α particles are, however, also emitted from the radioactive gases, mainly RADON, ACTINON and THORON at low atmospheric levels, and are responsible for a significant part of the ionization of the air at these levels, over land. See also BETA PARTICLE, GAMMA RADIATION.

alpine glow: A series of phenomena seen in mountainous regions about sunrise and sunset.

Two principal phases are generally recognized:

(i) The true alpine glow. At sunset this phase begins when the sun is 2° above the horizon; snow-covered mountains in the east are seen to assume a series of tints from yellow to pink, and finally purple. As this phase is due mostly to direct illumination by the sun it terminates when the mountain tops pass into the SHADOW OF THE EARTH. The alpine glow is most striking when