

## APPENDIX I

# GLOSSARY

**ABSOLUTE INSTABILITY**—The state of a column of air in the atmosphere when it has a superadiabatic lapse rate of temperature. An air parcel displaced vertically would be accelerated in the direction of the displacement.

**ABSOLUTE STABILITY**—The state of a column of air in the atmosphere when its lapse rate of temperature is less than the saturation adiabatic lapse rate. An air parcel will be denser than its environment and tend to sink back to its level of origin.

**ADVECTION**—The horizontal transport of an atmospheric property solely by the mass motion (velocity field) of the atmosphere.

**ADVECTION FOG**—Fog caused by the advection of moist air over a cold surface, and the consequent cooling of that air to below its dew point.

**AIR MASS**—A widespread body of air that is approximately homogeneous in its horizontal extent, with reference to temperature and moisture.

**ANABATIC WIND**—An upslope wind; usually applied only when the wind is blowing up a hill or mountain as the result of surface heating.

**ANTARCTIC FRONT**—The semi permanent, semi continuous front between the Antarctic air of the Antarctic Continent and the polar air of the southern oceans; generally comparable to the arctic front of the Northern Hemisphere.

**ANTICYCLOGENESIS**—The strengthening or development of an anticyclonic circulation in the atmosphere.

**ANTICYCLOLYSIS**—The weakening of an anticyclonic circulation in the atmosphere.

**ANTICYCLONE**—A closed circulation in the atmosphere that has a clockwise rotation in the Northern Hemisphere and a counterclockwise rotation in the Southern Hemisphere. Used interchangeably with *high*.

**ANTICYCLONIC**—Refers to the rotation pattern of anticyclones. See ANTICYCLONE.

**ARCTIC FRONT**—The semi permanent, semi continuous front between the deep, cold arctic air and the shallower, basically less cold polar air of northern latitudes; generally comparable to the Antarctic front of the Southern Hemisphere.

**AUTOCONVECTIVE LAPSE RATE**—The temperature lapse rate in an atmosphere where density is constant with height.

**BACKING**—A change in wind direction in a counterclockwise manner in the Northern Hemisphere and a clockwise manner in the Southern Hemisphere.

**BLOCKING HIGH**—An anticyclone that remains stationary or moves slowly westward so as to effectively block the movement of migratory cyclones across its latitudes.

**BUYS BALLOT'S LAW**—The law describing the relationship of horizontal wind direction to pressure: In the Northern Hemisphere, with your back to the wind, the lowest pressure will be to your left; in the Southern Hemisphere, the reverse is true.

**CENTER OF ACTION**—Any one of the semi permanent high or low-pressure systems.

**CENTRAL PRESSURE**—The atmospheric pressure at the center of a high or low; the highest pressure in a high, the lowest in a low.

**CHROMOSPHERE**—A thin layer of relatively transparent gases above the photosphere of the Sun.

**CLOSED HIGH**—A high that is completely encircled by an isobar or contour line.

**CLOSED LOW**—A low that is completely encircled by an isobar or contour line.

**COLD-CORE HIGH**—Any high that is generally characterized by colder air near its center than around its periphery at a given level in the atmosphere.

**COLD-CORE LOW**—Any low that is generally characterized by colder air near its center than around its periphery at a given level in the atmosphere.

**CONDENSATION**—The physical process by which a vapor becomes a liquid or solid.

**CONDITIONAL INSTABILITY**—The state of a column of air in the atmosphere when its temperature lapse rate is less than the dry adiabatic lapse rate but greater than the saturation adiabatic lapse rate.

**CONVECTION**—Atmospheric motions that are predominantly vertical, resulting in the vertical transport and mixing of atmospheric properties.

**CORONA**—(1) A set of one or more prismatically colored rings of small radii, concentrically surrounding the disk of the Sun, Moon, or other luminary when veiled by a thin cloud. A corona may be distinguished from the relatively common 22° halo by its color sequence, which is from blue inside to red outside, the reverse of that of the 22° halo. Diffraction and reflection of light from water droplets produce coronas. (2) The pearly outer envelope of the Sun.

**COUNTERRADIATION**—(also called back radiation) The downward flow of atmospheric radiation passing through a given level surface, usually taken as Earth's surface. It is the principal factor in the GREENHOUSE EFFECT.

**CUT-OFF HIGH**—A warm high displaced and lying poleward of the basic westerly current.

**CUT-OFF LOW**—A cold low displaced and lying equatorward of the basic westerly current.

**CYCLOGENESIS**—Any development or strengthening of cyclonic circulation in the atmosphere. The initial appearance of a low or trough, as well as the intensification of an existing cyclonic flow.

**CYCLOLYSIS**—Any weakening of cyclonic circulation in the atmosphere.

**CYCLONIC**—A counterclockwise rotation in the Northern Hemisphere and a clockwise rotation in the Southern Hemisphere.

**DISPERSION**—The process in which radiation is separated into its component wavelengths. It results when an optical process, such as diffraction, refraction, or scattering, varies according to wavelength. All of the coloration displayed by atmospheric optical phenomena are the result of dispersion.

**DOLDRUMS**—A nautical term for the equatorial trough, with special reference to the light and variable nature of the winds.

**DOWNWIND**—The direction toward which the wind is blowing; with the wind.

**DRY AIR**—In atmospheric thermodynamics and chemistry, air that contains no water vapor.

**ELECTROMAGNETIC WAVES**—Disturbances in electric and magnetic fields in space or in material media, resulting in the propagation of electromagnetic energy (radiation).

**EQUINOX**—(1) Either of the two points of intersection of the Sun's apparent annual path and the plane of Earth's equator. (2) Popularly, the time at which the Sun passes directly above the equator; the "time of the equinox." In the Northern Hemisphere, the vernal equinox falls on or about 21 March, and the autumnal equinox on or about 22 September. These dates are reversed in the Southern Hemisphere.

**EVAPORATION**—The physical process by which a liquid or solid is transformed to the gaseous state.

**FRONT**—The interface or transition zone between two air masses of different density. Since temperature distribution is the most important regulator of atmospheric density, a front almost invariably separates air masses of different temperature.

**FRONTAL INVERSION**—A temperature inversion in the atmosphere, encountered upon vertical ascent through a sloping front.

**FRONTAL SURFACE**—Refers specifically to the warmer side of the frontal zone.

**FRONTAL SYSTEM**—Simply, a system of fronts as they appear on a synoptic chart. This is used for (a) a continuous front and its characteristics along its entire extent, including its warm, cold, stationary, and occluded sectors, its variations of intensity, and any frontal cyclones along it; and (b) the orientation and nature of the fronts within the circulation of a frontal cyclone.

**FRONTAL ZONE**—The transition zone between two adjacent air masses of different densities bounded by a frontal surface.

**FRONTOGENESIS**—The initial formation of a front or frontal zone.

**FRONTOLYSIS**—The dissipation of a front or frontal zone.

**GENERAL CIRCULATION**—(also called planetary circulation) In its broadest sense, the complete statistical description of atmospheric motions over Earth.

**GESTROPHIC FLOW**—A form of gra-dient flow where the Coriolis force exactly balances the horizontal pressure force.

**GESTROPHIC WIND** The wind velocity for which the Coriolis acceleration exactly balances the horizontal pressure force. The geostrophic wind is directed along the contour lines on a constant-pressure surface (or along the isobars in a geopotential surface) with low pressure to the left in the Northern Hemisphere and to the right in the Southern Hemisphere.

**GESTROPHIC-WIND SCALE**—A graphical device used for the determination of the speed of the geostrophic wind from the isobar or contour line spacing on a synoptic chart.

**GRADIENT**—The space rate of decrease of a function. It is often used to denote the magnitude of pressure change in the horizontal pressure field.

**GRADIENT WIND**—Any horizontal wind velocity tangent to the contour line of a constant-pressure surface (or the isobar of a geopotential surface) at the point in question. At such points, where the wind is gradient, the Coriolis acceleration and centripetal acceleration together exactly balance the horizontal pressure force.

**GRAVITY WIND**—(also called drainage wind; sometimes called katabatic wind) A wind (or component thereof) directed down the slope of an incline and caused by greater air density near the slope (caused by surface cooling) than at the same levels some distance horizontally from the slope.

**GREENHOUSE EFFECT**—The heating effect exerted by the atmosphere upon Earth by virtue of the fact that the atmosphere (mainly, its water vapor) absorbs and re-emits infrared radiation. In detail: The shorter wavelengths of insolation are transmitted rather freely through the atmosphere to be absorbed at Earth's surface. Earth then re-emits this as long-wave (infrared) terrestrial radiation, a portion of which is absorbed by the atmosphere and again emitted as atmospheric radiation. The water vapor (cloud cover) acts in the same way as the glass panes of a greenhouse; the heat gained during

the day is trapped beneath the cloud cover, and the counter-radiation adds to the warming of Earth.

**HALO**—Any one of a large class of atmospheric optical phenomena (luminous meteors) that 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 falling ice crystals. The halos experiencing prismatic coloration are produced by refraction of light by the ice crystals, and those exhibiting only whitish luminosity are produced by reflection from the crystal faces.

**HEAT BALANCE**—The equilibrium, which exists on the average, between the radiation received by Earth and its atmosphere and that emitted by Earth and its atmosphere.

**HEATING DEGREE-DAY**—A form of degree-day used as an indication of fuel consumption; in United States usage, one heating degree-day is given for each degree that the daily mean temperature departs below the base of 65°F.

**HEAT TRANSFER**—The transfer or ex-change of heat by radiation, conduction, or convection in a fluid and/or between the fluid and its surroundings. The three processes occur simultaneously in the atmosphere, and it is often difficult to assess the contributions of their various effects.

**HIGH**—An “area of high pressure,” refer-ring to a maximum of atmospheric pressure in two dimensions (closed isobars) on the synoptic surface chart, or a maximum of height (closed contours) on the constant-pressure chart. Highs are associated with anticyclonic circulations, and the term is used interchangeably with anticyclone.

**HORSE LATITUDES**—The belts of latitude over the oceans at approximately 30 to 35 degrees north and south where winds are predominantly calm or very light and the weather is hot and dry.

**ICELANDIC LOW**—The low-pressure center located near Iceland (mainly between Iceland and southern Greenland) on mean charts of sea-level pressure. It is a principal center of action in the atmospheric circulation of the Northern Hemisphere.

**INACTIVE FRONT**—(or passive front) A front or portion thereof that produces very little cloudiness and no precipitation, as opposed to an active front.

**INFERIOR MIRAGE**—A spurious image of an object formed below the true position of that object by abnormal refractive conditions along the line of sight; one of the most common of all types of mirage, and the opposite of a superior mirage.

**INSOLATION**—(contracted from *incoming solar radiation*) In general, solar radiation received at Earth's surface.

**INSTABILITY**—A property of the steady state of a system such that certain disturbances or perturbations introduced into the steady state will increase in magnitude, the maximum perturbation amplitude always remaining larger than the initial amplitude.

**INSTABILITY LINE**—Any non-frontal line or band of convective activity in the atmosphere.

**INVERSION**—The departure from the usual decrease or increase with altitude of the value of an atmospheric property. The layer through which this departure occurs is known as the inversion layer, and the lowest altitude at which the departure is found is known as the base of the inversion. The term is almost always used in reference to temperature, but may be applied to moisture and precipitation.

**KATABATIC WIND**—Any wind blowing down an incline; the opposite of anabatic wind. If the wind is warm, it is called a foehn; if cold, it may be a fall or gravity wind.

**KINETIC ENERGY**—The energy that a body possesses as a consequence of its motion, defined as the product of one-half of its mass and the square of its speed,  $1/2mv$  squared.

**LAND BREEZE**—A coastal breeze blowing from land to sea, caused by the temperature difference when the sea surface is warmer than the adjacent land.

**LAPSE RATE**—The decrease of an atmospheric variable with height, the variable being temperature, unless otherwise specified.

**LATERAL MIRAGE**—A very rare type of mirage in which the apparent position of an object appears displaced to one side of its true position.

**LIGHT**—Visible radiation (about 0.4 to 0.7 micron in wavelength) considered in terms of its luminous efficiency.

**LOOMING**—A mirage effect produced by greater-than-normal refraction in the lower atmosphere, thus permitting objects to be seen that are usually below the horizon.

**LOW**—An “area of low pressure,” referring to a minimum of atmospheric pressure in two dimensions (closed isobars) on a constant-height chart or a minimum of height (closed contours) on a constant-pressure chart. Lows are associated with cyclonic circulations, and the term is used interchangeably with *cyclone*.

**MACROCLIMATE**—The general large-scale climate of a large area or country, as distinguished from the mesoclimate and microclimate.

**MAGNETIC NORTH**—At any point on Earth's surface, the horizontal direction of the Earth's magnetic lines of force (direction of a magnetic meridian) toward the north magnetic pole, i.e., a direction indicated by the needle of a magnetic compass. Because of the wide use of the magnetic compass, magnetic north, rather than TRUE NORTH, is the common  $0^\circ$  (or  $360^\circ$ ) reference in much of navigational practice, including the designation of airport runway alignment.

**MARITIME AIR**—A type of air whose characteristics are developed over an extensive water surface and which, therefore, has the basic maritime quality of high moisture content in at least its lower levels.

**MEAN SEA LEVEL**—The average height of the sea surface, based upon hourly observation of tide height on the open coast or in adjacent waters which have free access to the sea. In the United States, mean sea level is defined as the average height of the surface of the sea for all stages of the tide over a 19-year period.

**MESOCLIMATE**—The climate of small areas of Earth's surface that may not be representative of the general climate of the district. The places considered in mesoclimatology include small valleys, “frost hollows,” forest clearings, and open spaces in towns, all of which may have extremes of temperature differing by many degrees from those of adjacent areas. The mesoclimate is intermediate in scale between the microclimate and microclimate.

**MESOPAUSE**—The top of the mesosphere. This corresponds to the level of minimum temperature at 70 to 80 km.

**MESOSPHERE**—The atmospheric shell between about 20 km and about 70 or 80 km, extending from the top of the stratosphere to the upper temperature minimum (the menopause). A broad temperature maximum at about 50 km characterizes it, except possibly over the winter polar regions.

**METEOROLOGY**—The study dealing with the phenomena of the atmosphere. This includes not only the physics, chemistry, and dynamics of the atmosphere, but is extended to include many of the direct effects of the atmosphere upon Earth's surface, the oceans, and life in general.

**MICROCLIMATE**—The fine climate structure of the air space that extends from the very surface of Earth to a height where the effects of the immediate character of the underlying surface no longer can be distinguished from the general local climate (mesoclimate or microclimate).

**MIGRATORY**—Moving; commonly applied to pressure systems embedded in the westerlies and, therefore, moving in a general west-to-east direction.

**MILLBRAE**—(abbreviated MB) A pressure unit of 1,000 dynes per centimeter, convenient for reporting atmospheric pressures.

**MIRAGE**—A refraction phenomenon wherein an image of some object is made to appear displaced from its true position.

**MOISTURE**—A general term usually referring to the water vapor content of the atmosphere, or to the total water substance (gas, liquid, and solid) present in a given volume of air.

**MONSOON**—A name for seasonal wind. It was first applied to the winds over the Arabian Sea, which blow for 6 months from the northeast and 6 months from the southwest, but it has been extended to similar winds in other parts of the world.

**MONSOON CLIMATE**—The type of climate that is found in regions subject to monsoons. It is best developed on the fringes of the tropics.

**NEUTRAL STABILITY**—The state of an unsaturated or saturated column of air in the atmosphere when its environmental lapse rate of temperature is equal to the dry-adiabatic lapse rate or the saturation-adiabatic lapse rate, respectively. Under such conditions a parcel of air displaced vertically will experience no buoyant acceleration.

**OCCLUDED FRONT**—(commonly called occlusion; also called frontal occlusion) A composite of two fronts, formed as a cold front overtakes a warm front or quasi-stationary front. This is a common process in the late stages of wave cyclone development, but it is not limited to occurrence within a wave cyclone.

**OCCLUSION**—Same as OCCLUDED FRONT.

**OROGRAPHIC LIFTING**—The lifting of an air current caused by its passage up and over mountains.

**OVERRUNNING**—A condition existing when an air mass is in motion aloft above another air mass of greater density at the surface. This term is usually applied in the case of warm air ascending the surface of a warm or quasi-stationary front.

**PARTIAL PRESSURE**—The pressure of a single component of a gaseous mixture, according to Dalton's Law.

**PERTURBATION**—Any departure introduced into an assumed steady state of a system. In synoptic meteorology, the term most often refers to any departure from zonal flow within the major zonal currents of the atmosphere. It is especially applied to the wave-like disturbances within the tropical easterlies.

**PHOTOSPHERE**—The intensely bright portion of the Sun visible to the unaided eye. It is a shell a few hundred miles in thickness marking the boundary between the dense interior gases of the Sun and the more diffuse cooler gases in the outer portions of the Sun.

**PLANETARY BOUNDARY LAYER**—(also called friction layer or atmospheric boundary layer) That layer of the atmosphere from Earth's surface to the geostrophic wind level, including therefore, the surface boundary layer and the Ekman layer.

**PLANETARY CIRCULATION**—The system of large-scale disturbances in the troposphere when viewed on a hemispheric or worldwide scale. Same as GENERAL CIRCULATION.

**POLAR AIR**—A type of air whose characteristics are developed over high latitudes, especially within the subpolar highs. Continental polar air (cP) has low surface temperature, low moisture content, and, especially in its source regions, great stability in the lower layers. It is shallow in comparison with arctic air.

**POLAR EASTERLIES**—The rather shallow and diffuse body of easterly winds located poleward of the subpolar low-pressure belt. In the mean in the Northern Hemisphere, these easterlies exist to an appreciable extent only north of the Aleutian low and Icelandic low.

**POLAR FRONT**—According to the polar-front theory, the semi permanent, semi continuous front separating air masses of tropical and polar origin. This is the major front in terms of air mass contrast and susceptibility to cyclonic disturbance.

**POLAR-FRONT THEORY**—A theory originated by the Scandinavian school of meteorologists whereby a polar front, separating air masses of polar and tropical origin, gives rise to cyclonic disturbances, which intensify and travel along the front, passing through various phases of a characteristic life history.

**POLAR OUTBREAK**—The movement of a cold air mass from its source region; almost invariably applied to a vigorous equatorward thrust of cold polar air, a rapid equatorward movement of the polar front.

**POLAR TROUGH**—In tropical meteorology, a wave trough in the westerlies having sufficient amplitude to reach the tropics in the upper air. At the surface it is reflected as a trough in the tropical easterlies, but at moderate elevations it is characterized by westerly winds. It moves generally from west to east and is accompanied by considerable cloudiness at all levels. Cumulus congestus and cumulonimbus clouds are usually found in and around the trough lines. The early and late season hurricanes of the western Caribbean frequently form in polar troughs.

**POTENTIAL ENERGY**—The energy that a body possesses as a consequence of its position in the field of gravity; numerically equal to the work required to bring the body from an arbitrary standard level, usually taken as mean sea level, to its given position.

**PRE-FRONTAL SQUALL LINE**—A squall line or instability line located in the warm sector of a wave cyclone, about 50 to 300 miles in advance of the cold front, usually oriented roughly parallel to the cold front and moving in about the same manner as the cold front.

**PRESSURE CENTER**—On a synoptic chart, a point of local minimum or maximum pressure; the center of a low or high. It is also a center of cyclonic or anticyclonic circulation.

**PRESSURE GRADIENT**—The rate of decrease (gradient) of pressure in space at a fixed time. The term is sometimes loosely used to denote simply the magnitude of the gradient of the pressure field.

**PRESSURE GRADIENT FORCE**—The force due to differences of pressure within a fluid mass. In meteorological literature the term usually refers only to horizontal pressure force.

**PRESSURE PATTERN**—The general geo-metric characteristics of atmospheric pressure distribution as revealed by isobars on a constant-height chart, usually the surface chart.

**PRESSURE SYSTEM**—An individual cyclonic scale feature of atmospheric circulation; commonly used to denote either a high or low, less frequently a ridge or trough.

**PRIMARY CIRCULATION**—The prevailing fundamental atmospheric circulation on a planetary scale that must exist in response to (a) radiation differences with latitude, (b) the rotation of Earth, and (c) the particular distribution of land and oceans; and which is required from the viewpoint of conservation of energy.

**PROMINENCE**—A filament-like Protuberance from the chromosphere of the Sun.

**QUASI-STATIONARY FRONT**—(Commonly called stationary front) A front that is stationary or nearly so. Conventionally, a front that is moving at a speed less than about 5 knots is generally considered to be quasi-stationary. In synoptic chart analysis, a quasi-stationary front is one that has not moved appreciably from its position on the last (previous) synoptic chart (3 or 6 hours before).

**RADIATION**—(1) The process by which electromagnetic radiation is propagated through free space by virtue of joint undulatory variations in the electric and magnetic fields in space. This concept is to be distinguished from convection and conduction. (2) The process by which energy is propagated through any medium by virtue of the wave motion of that medium, as in the propagation of sound waves through the atmosphere, or ocean waves along the water surface.

**RADIATIONAL COOLING**—The cooling of Earth's surface and adjacent air, accomplished (mainly at night) whenever Earth's surface suffers a net loss of heat due to terrestrial radiation.

**RADIATION FOG**—A major type of fog, produced over a land area when radiational cooling reduces the air temperature to or below its dew point.

**RAINBOW**—Any one of a family of circular arcs consisting of concentric colored bands, arranged from red on the inside to blue on the outside, which may be seen on a "sheet" of water drops (rain, fog, or spray).

**REDUCTION**—In general, the transformation of data from a "raw" form to some usable form. In meteorology, this often refers to the conversion of the observed value of an element to the value that it theoretically would have at some selected or standard level, usually mean sea level. The most common reduction in observing is that of station pressure to sea level pressure.

**REFLECTION**—The process whereby a surface of discontinuity turns back a portion of the incident radiation into the medium through which the radiation approached.

**REFLECTIVITY**—A measure of the fraction of radiation reflected by a given surface; defined as the ratio of the radiant energy reflected to the total that is incident upon that surface. The reflectivity of a given surface for a specified broad spectral range, such as the visible spectrum or the solar spectrum, is referred to as albedo.

**REFRACTION**—The process in which the direction of energy propagation is changed as the result of a change in density within the propagating medium, or as the energy passes through the interface representing a density discontinuity between two media.

**RESULTANT WIND**—In climatology, the vectorial average of all wind directions and speeds for a given level at a given place for a certain period, as a month. It is obtained by resolving each wind observation into components from north and east, summing over the given period, obtaining the averages, and reconvertng the average components into a single vector.

**SCATTERING**—The process by which small particles suspended in a medium of a different index of refraction diffuse a portion of the incident radiation in all directions.

**SEA BREEZE**—A coastal local wind that blows from sea to land, caused by the temperature difference when the sea surface is colder than the adjacent land. Therefore, it usually blows on relatively calm, sunny, summer days; and alternates with the oppositely directed, usually weaker, night land breeze.

**SEA-BREEZE FRONT**—A sea breeze that forms out over the water, moves slowly toward the coast and then moves inland quite suddenly. Often associated with the passage of this type of sea breeze are showers, a sharp wind shift from seaward to landward, and a sudden drop in temperature. The leading edge of such a sea breeze is sometimes called the sea breeze front.

**SEA LEVEL**—The height or level of the sea surface.

**SEASON**—A division of the year according to some regularly recurrent phenomena, usually astronomical or climatic. Astronomical seasons extend from an equinox to the next solstice (or vice versa). Climatic seasons are often based on precipitation (rainy and dry seasons).

**SECONDARY CIRCULATION**—Atmospheric circulation features of synoptic scale.

**SECONDARY FRONT**—A front that forms within a baroclinic cold air mass that itself is separated from a warm air mass by a primary frontal system. The most common type is the secondary cold front.

**SHEAR**—The variation (usually the directional derivative) of a vector field along a given direction in space. The most frequent context for this concept is wind shear.

**SHEAR LINE**—A line or narrow zone across which there is an abrupt change in the horizontal wind component parallel to this line; a line of maximum horizontal wind shear.

**SHORT-WAVE RADIATION**—A term used loosely to distinguish radiation in the visible and near-visible portions of the electromagnetic spectrum (roughly 0.4 to 1.0 micron in wavelength) from long-wave radiation.

**SIBERIAN HIGH**—A cold-core high-pressure area that forms over Siberia in winter, and which is particularly apparent on mean charts of sea-level pressure.

**SINGULAR POINT**—In a flow field, a point at which the direction of flow is not uniquely determined, hence a point of zero speed, e.g., a col.

**SMOOTHING**—An averaging of data in space or time, designed to compensate for random errors or fluctuations of a scale smaller than that presumed significant to the problem at hand; the analysis of a sea-level weather map smoothes the pressure field on a space-scale more or less systematically determined by the analyst by taking each pressure as representative not of a point but of an area about the point.

**SOLAR CONSTANT**—The rate at which solar radiation is received outside Earth's atmosphere on a surface normal to the incident radiation, and at Earth's mean distance from the Sun.

**SOLSTICE**—(1) Either of two points on the Sun's apparent annual path where it is displaced farthest, north or south, from Earth's equator. The Tropic of Cancer (north) and Tropic of Capricorn (south) are defined as the parallels of latitude that lie directly beneath a solstice. (2) Popularly, the time at which the Sun is farthest north or south; the "time of the solstice." In the Northern Hemisphere, the summer solstice falls on or about 21 June, and the winter solstice on or about 22 December. The reverse is true in the southern latitudes.

**SPECIFIC HEAT**—The heat capacity of a system per unit mass. That is, the ratio of the heat absorbed (or released) by unit mass of the system to the corresponding temperature rise (or fall).

**SPECIFIC HUMIDITY**—In moist air, the ratio of the mass of water vapor to the total mass of the system. For many purposes it may be approximated by the mixing ratio.

**SQUALL LINE**—Any non-frontal line or narrow band of active thunderstorms.

**STANDARD ATMOSPHERE**—A hypothetical vertical distribution of atmospheric temperature, pressure, and density which, by international agreement, is taken to be representative of the atmosphere for purposes of pressure altimeter calibrations, aircraft performance calculations, aircraft and missile design, ballistic tables, etc. The air is assumed to obey the perfect gas law and the hydrostatic equation, which, taken together, relate temperature, pressure, and density variations in the vertical. It is further assumed that the air contains no water vapor and that the acceleration of gravity does not change with height.

**STRATOSPHERE**—The atmospheric shell above the troposphere and below the mesosphere. It extends, therefore, from the tropopause to the height where the temperature begins to increase in the 20- to 25-km region.

**SUBLIMATION**—The transition of a substance from the solid phase directly to the vapor phase, or vice versa, without passing through an intermediate liquid phase.

**SUBSIDENCE**—A descending motion of air in the atmosphere, usually with the implication that the condition extends over a rather broad area.

**SUBSIDENCE INVERSION**—A temperature inversion produced by the adiabatic warming of a layer of subsiding air. Vertical mixing of the air layer below the inversion enhances this inversion.

**SUBTROPICAL HIGH**—One of the semi-permanent highs of the subtropical high-pressure belt. They appear as centers of action on mean charts of surface pressure. They lie over oceans and are best developed in summer.

**SUBTROPICAL HIGH-PRESSURE BELT**—One of the two belts of high atmospheric pressure that are centered, in the mean, near 30°N and 30°S latitudes.

**SUNSPOT**—A relatively dark area on the surface of the Sun, consisting of a dark central umbra surrounded by a penumbra, which is intermediate in brightness between the umbra and the surrounding photosphere.

**SUPERADIABATIC LAPSE RATE**—An environmental lapse rate greater than the dry-adiabatic lapse rate, such that potential temperature decreases with height.

**SUPERCOOLING**—The reduction of temperature of any liquid below the melting point of that substance's solid phase, that is, cooling beyond its nominal freezing point.

**SUPERIOR AIR**—An exceptionally dry mass of air formed by subsidence and usually found aloft but occasionally reaching Earth's surface during extreme subsidence processes.

**SUPERIOR MIRAGE**—A spurious image of an object formed above its true position by abnormal refractive conditions; opposite of *inferior mirage*.

**SUPERSATURATION**—The condition existing in a given portion of the atmosphere (or other space) when the relative humidity is greater than 100 percent, that is, when it contains more water vapor than is needed to produce saturation with respect to a plane surface of pure water or pure ice.

**SURFACE BOUNDARY LAYER**—That thin layer of air adjacent to Earth's surface, extending up to the so-called anemometer level (the height above the ground at which an anemometer is exposed; usually 10 meters to 100 meters).

**SURFACE CHART**—(also called surface map, sea-level chart, sea-level pressure chart) An analyzed synoptic chart of surface weather observations. It shows the distribution of sea level pressure (positions of highs, lows, ridges, and troughs) and the location and nature of fronts and air masses. Often added to this are symbols of occurring weather phenomena, analysis of pressure tendency (isallobars), indications of the movement of pressure systems and fronts, and perhaps others, depending on the use of the chart.

**SURFACE INVERSION**—A temperature in-version based at Earth's surface; that is, an in-crease of temperature with height beginning at ground level.

**SURFACE OF DISCONTINUITY**—A surface separating two fluids across which there is a discontinuity of some fluid property, such as density, velocity, etc., or of some derivative of one of these properties in a direction normal to the interface. An atmospheric front is represented ideally by a surface of discontinuity of velocity, density, temperature, and pressure gradient; the tropopause is represented ideally by a surface of discontinuity of, for example, the derivatives: lapse rate and wind shear.

**SYNOPTIC**—In general, pertaining to or affording an overall view. In meteorology, this term has become somewhat specialized in referring to the use of meteorological data obtained simultaneously over a wide area for the purpose of presenting a comprehensive and nearly instantaneous picture of the state of the atmosphere.

**SYNOPTIC CHART**—In meteorology, any chart or map on which data and analyses are presented that describe the state of the atmosphere over a large area at a given moment in time.

**SYNOPTIC SCALE**—The scale of the migratory high- and low-pressure systems (or cyclonic

waves) of the lower troposphere, with wavelengths of 1,000 to 2,500 km.

**SYNOPTIC SITUATION**—The general state of the atmosphere as described by the major features of synoptic charts.

**TEMPERATURE INVERSION**—A layer in which temperature increases with altitude.

**TERTIARY CIRCULATION**—The generally small, localized atmospheric circulations. They are represented by such phenomena as the local winds, thunderstorms, and tornadoes.

**THERMAL**—(1) Pertaining to temperature or heat. (2) A relatively-small-scale rising current of air produced when the atmosphere is heated enough locally by Earth's surface to produce absolute instability in its lower layers. The use of this term is usually reserved to denote those currents either too small and/or too dry to produce convective clouds; thus, thermals are a common source of low-level clear-air turbulence.

**THERMAL GRADIENT**—The rate of variation of temperature either horizontally or vertically.

**THERMAL HIGH**—An area of high pressure resulting from the cooling of air by a cold underlying surface, and remaining relatively stationary over the cold surface.

**THERMAL LOW**—An area of low atmospheric pressure resulting from high temperatures caused by intense surface heating. They are stationary with a generally weak and diffuse cyclonic circulation. They are non-frontal.

**THERMOSPHERE**—The atmospheric shell extending from the top of the mesosphere to outer space. It is a region of more or less steadily increasing temperature with height, starting at 70 or 80 km.

**TORNADO**—A violently rotating column of air, pendant from a cumulonimbus cloud, and nearly always observable as a "funnel cloud" or tuba.

**TRIPLE POINT**—Term commonly used to denote the apex of an occlusion.

**TROPICAL AIR**—A type of air whose characteristics are developed over low latitudes. Maritime tropical air (mT) is produced over the tropical and subtropical seas, while continental tropical air is produced over subtropical arid regions.

**TROPOPAUSE**—The boundary between the troposphere and stratosphere, usually characterized by an abrupt change of lapse rate.

**TROPOSPHERE**—That portion of Earth's atmosphere extending from the surface to the tropopause; that is, the lowest 10 to 20 km of the atmosphere.

**TROUGH**—An elongated area of low atmospheric pressure; the opposite of a ridge.

**TRUE NORTH**—The direction from any point on Earth's surface toward the geographic North Pole; the northerly direction along any projection of Earth's axis upon Earth's surface, for example, along a longitude line. Except for much of navigational practice (which uses magnetic north), true north is the universal 0° (or 360°, mapping reference).

**UPSTREAM**—In the direction from which a fluid is flowing.

**UPWIND**—In the direction from which the wind is blowing.

**VECTOR**—Any quantity, such as force, velocity, or acceleration, that has both magnitude and direction at each point in space, as opposed to a scalar, which has magnitude only. Geometrically, it is represented by an arrow of length proportional to its magnitude, pointing in the assigned direction.

**VEERING**—A change in wind direction in a clockwise sense in the Northern Hemisphere and counterclockwise direction in the Southern Hemisphere.

**VERNAL EQUINOX**—For either hemisphere, the equinox at which the Sun's most direct rays approach from the opposite hemisphere. In northern latitudes, this occurs approximately on 21 March; the Sun's most direct rays are centered over the equator and moving north.

**VIRTUAL TEMPERATURE**—In a system of moist air, the temperature of dry air having the same density and pressure as the moist air. It is always greater than the actual temperature.

**WARM-CORE HIGH**—At a given level in the atmosphere, any high that is warmer at its center than at its periphery.

**WARM-CORE LOW**—At a given level in the atmosphere, any low that is warmer at its center than at its periphery.

**WARM FRONT**—Any non-occluded front or portion thereof that moves in such a way that warmer air replaces colder air.

**WARM SECTOR**—That area within the circulation of a wave cyclone where the warm air is found. It lies between the cold front and the warm front of the storm; and, in the typical case, the warm sector continually diminishes in size and ultimately disappears (at the surface) as the result of occlusion.

**WAVE CYCLONE**—A cyclone that forms and moves along a front.

**WAVE THEORY OF CYCLONES**—A theory of cyclone development based upon the principles of wave formation on an interface between two fluids. In the atmosphere, a front is taken as such an interface.

**WEATHER**—The state of the atmosphere, mainly with respect to its effect upon life and human activities.

**WESTERLIES**—(also known as circumpolar westerlies, counter-trades, middle-latitude westerlies, midlatitude westerlies, polar westerlies, subpolar westlies, subtropical westerlies, temperate westerlies, zonal westerlies, and zonal winds) Specifically, the dominant west-to-east motion of the atmosphere, centered over the middle latitudes of both hemispheres. At the surface, the westerly belt extends, on the average, from about 35° to 65° latitude. At upper levels, the westerlies extend farther equatorward and poleward. The equatorward boundary is fairly well defined by the subtropical high-pressure belt; the poleward boundary is quite diffuse and variable.

**WIND-CHILL FACTOR**—The cooling effect of any combination of temperature and wind, expressed as the loss of body heat, in kilogram calories per hour per square meter of skin surface. The wind-chill factor is based on the cooling rate of a nude body in the shade; It is only an approximation, because of individual body variations in shape, size, and metabolic rate.

**WIND ROSE**—Any one of a class of diagrams designed to show the distribution of wind direction experienced at a given location over a considerable period; it thus shows the prevailing wind direction. The most common form consists of a circle from which 8 or 16 lines emanate, one for each compass point. The length of each line is proportional to the

frequency of wind from that direction, and the frequency of calm conditions is entered in the center.

**WINTER SOLSTICE**—For either hemisphere, the solstice at which the Sun is above the opposite hemisphere. In northern latitudes, the time of this occurrence is approximately 22 December.



## APPENDIX II

# ANSWERS TO REVIEW QUESTIONS

## CHAPTERS 1 THROUGH 6

### CHAPTER 1

- A1-1. The metric (CGS centimeter-gram-second) system measures length, weight and time respectively.*
- A1-2. Weight is a function of gravitational force. Mass is a function inertia/acceleration.*
- A1-3. A dyne is a measure of force.*
- A1-4. Sunspots are regions of strong localized magnetic fields and indicate relatively cool areas in the photosphere.*
- A1-5. The Southern Hemisphere receives the greatest amount of incoming solar radiation around December 22.*
- A1-6. Land and water surfaces absorb 51 percent of the earth's insolation.*
- A1-7. An air column over the poles is thinner than an air column over the equator.*
- A1-8. Pressure is the force per unit area.*
- A1-9. With a sea level pressure reading of 1000 MB, the approximate pressure at 18,000 ft will be 500 MB.*
- A1-10. Temperature change has the biggest effect on pressure change.*
- A1-11. Temperature is the measure of molecular motion.*
- A1-12. 20 degrees C converted to Fahrenheit is 68 degrees.*
- A1-13. The earth's meteorological atmospheric zones in ascending order are the troposphere, tropopause, stratosphere, stratopause, mesosphere, mesopause, thermosphere, and the exosphere.*
- A1-14. The four methods of heat transfer are conduction, advection, convection, and radiation.*
- A1-15. Advection is the horizontal transport of heat.*
- A1-16. The three states in which moisture in the atmosphere is found are solid, liquid and gaseous.*
- A1-17. The primary sources of atmospheric moisture are the oceans.*
- A1-18. The difference between relative humidity and absolute humidity is that relative humidity is the ratio (in percent) between the water vapor actually present and the water vapor necessary for saturation at a given temperature. Absolute humidity is the amount of water vapor present per unit volume of space.*
- A1-19. The mixing ratio is defined as the ratio of the mass of water vapor to the mass of dry air.*
- A1-20. The dew point is the temperature that the air must be cooled, at a constant pressure and constant water vapor content, in order for saturation to occur.*

## CHAPTER 2

- A2-1. *Speed is the rate at which something moves in a given amount of time.*
- A2-2. *The amount of work done is the product of the magnitude of the force and the distance moved.  $W=F \cdot d$ .*
- A2-3. *The two types of forces that AGs deal with are contact force and action at a distance forces.*
- A2-4. *The two basic particles that make up the composition of matter are the atom and the molecule.*
- A2-5. *The correct formula for density is  $D = \frac{M}{V}$  (or  $D = M \div V$ ), whereas the density equals the mass divided by its volume.*
- A2-6. *Fusion is the change of state from a solid to a liquid at the same temperature.*
- A2-7. *The behavior of gases depend on the variations in temperature, pressure, and density.*
- A2-8. *According to Boyle's Law, the volume of a gas is inversely proportional to its pressure, provided the temperature remains constant.*
- A2-9. *According to Charles' Law, if the volume of an enclosed gas remains constant, the absolute temperature is directly proportional to the pressure.*
- A2-10. *The universal gas law states that the product of the initial pressure, initial volume, and new temperature (absolute scale) of an enclosed gas is equal to the product of the new pressure, the new volume and the initial temperature.  $PVT' = P'V'T$*
- A2-11. *The two basic kinds of atmospheric energy important to AGs are kinetic energy and potential energy.*
- A2-12. *The definition of lapse rate is the rate of decrease in the value of any meteorological element with elevation.*
- A2-13. *The dry adiabatic lapse rate is 5 1/2°F per 1,000 feet, or 1°C per 100 meters.*
- A2-14. *The two types of conditional instability are real latent and pseudol latent.*

## CHAPTER 3

- A3-1. *The length of day and the angle of the Sun's rays influences the Earth's temperature.*
- A3-2. *The unequal heating of Earth's surface due to its tilt, rotation, and differential insolation, results in the wide distribution of pressure over Earth's surface.*
- A3-3. *The rotation of Earth causes a force that affects thermal circulation, causing it to be deflected to the right of the direction of movement in the northern hemisphere.*
- A3-4. *According to the 3-cell theory, Earth is divided into six circulation belts.*
- A3-5. *According to the 3-cell theory, subsidence or high pressure is usually found at 30 degrees north latitude.*
- A3-6. *The trade winds are the predominant winds in the tropics.*
- A3-7. *Two types of pressure gradients are horizontal and vertical.*
- A3-8. *The difference between centripetal force and centrifugal force is that centripetal force is directed toward the center of rotation, and centrifugal force is directed outward from the center of rotation.*

- A3-9. *The difference between gradient wind and geostrophic wind is that gradient wind flow is parallel to the curved portion of the analysis. Geostrophic wind is the windflow that is parallel to that portion of the analysis showing straight flow.*
- A3-10. *The relationship between centrifugal force and pressure gradient force around anticyclones is that the centrifugal force acts with the pressure gradient force.*
- A3-11. *Anticyclogenesis is the term defined as the formation of an anticyclone or the intensification of an existing one.*
- A3-12. *The direction of windflow around a cyclone is counterclockwise in the northern hemisphere.*
- A3-13. *The temperatures in a cold core low decrease toward the center.*
- A3-14. *Low pressure due to intense heating in the southwestern United States is an example of a warm core low.*
- A3-15. *Monsoon winds are caused by the unequal heating and cooling of land and water surfaces.*
- A3-16. *Land and sea breezes are caused by the diurnal (daily) contrast in the heating of local water and land areas.*
- A3-17. *Bernoulli's theorem states that pressures are least where velocities are greatest, and pressures are greatest where velocities are least.*
- A3-18. *A valley breeze usually reaches it's maximum strength in the early afternoon.*
- A3-19. *An eddy is caused when the wind flows over or adjacent to rough terrain, buildings, mountains or other obstructions.*
- A3-20. *Foehn winds are caused by adiabatic heating of descending air on the lee sides of mountains.*

#### **CHAPTER 4**

- A4-1. *An air mass is a body of air extending over a large area (usually 1,000 miles or more across).*
- A4-2. *The two primary factors necessary to produce an air mass are a surface whose properties are relatively uniform and a large divergent flow.*
- A4-3. *Maritime tropical air that is colder than the surface over which it is moving is written as mTk.*
- A4-4. *The modifying factors on air mass stability are thermodynamic and mechanical.*
- A4-5. *Superior air is the warmest air mass observed in the United States at its altitude.*
- A4-6. *A frontal surface is the surface that separates the air masses.*
- A4-7. *The frontal zone is located between the air masses of different densities.*
- A4-8. *The difference between a stable wave and an unstable wave is that a stable wave neither develops nor occludes. An unstable wave develops along the polar front and usually occludes.*
- A4-9. *Frontogenesis occurs where there is a concentration of isotherms with the circulation to sustain that concentration.*
- A4-10. *The polar front in winter is usually found off east coasts of continents between 30 and 60 degrees latitude.*

- A4-11. *The pressure tendency with the passage of a slow moving cold front is indicated by a steady or unsteady fall prior to frontal passage, followed by weak rises after passage.*
- A4-12. *The slope of a fast moving cold front is usually 1:40 to 1:80 miles.*
- A4-13. *Prefrontal squall lines form about 50 to 300 miles in advance of fast-moving cold fronts.*
- A4-14. *The average speed of a warm front is usually between 10 and 20 knots.*
- A4-15. *The cloud types in advance of a warm front, in order, are cirrus, cirrostratus, altostratus, nimbostratus, and stratus.*
- A4-16. *The difference between warm and cold occlusions is that warm occlusions form when the air in advance of the warm front is colder than the air to the rear of the cold front. A cold occlusion forms when the cold air in advance of a warm front is warmer than the cold air to the rear of the cold front.*
- A4-17. *The most violent weather associated with an occlusion occurs near the apex or tip of the occlusion.*
- A4-18. *When a stationary front moves, the speed is normally less than 5 knots.*
- A4-19. *The weather associated with an unstable stationary front depends on the frontal slope. Severe thunderstorms and heavy rain showers usually occur with steep slopes. Broad or extensive areas of showers, fog, and reduced visibility occur with shallow slopes.*
- A4-20. *The modifications of fronts are caused by movement and orographic effects.*
- A4-21. *When a cold front moves off the eastern coast of the United States, it intensifies and waves develop along the frontal boundary.*

## **CHAPTER 5**

- A5-1. *Rain is precipitation that reaches the ground as water droplets and the droplet size measures .5 mm or greater. Drizzle is very small and appears to float with the air currents and the droplet size measures less than .5 mm.*
- A5-2. *The altitude range of cloud occurrence in the tropics is from sea level to 60,000 feet.*
- A5-3. *The altitude range of middle clouds, in the temperate regions, is from 6,500 to 25,000 feet.*
- A5-4. *Sea fog occurs when the wind brings moist, warm air over a colder ocean current. Steam fog is caused by saturation of the air through the evaporation of water, when cold air moves over warm water.*
- A5-5. *Blowing spray occurs when the water droplets are lifted in such quantities that they reduce visibility to six miles or less at eye level.*
- A5-6. *Haze appears as a bluish tinge when viewed against a dark background and a dirty yellow or orange tinge when viewed against a bright background. Smoke appears as a reddish tinge when viewed against the solar disk during sunrise and sunset.*
- A5-7. *Dust devils are usually observed on clear, hot afternoons in desert regions.*
- A5-8. *The two sources of light are natural and artificial.*

- A5-9. *Natural light is received from the sun and electric lamps, fire, or fluorescent tubes produce artificial light.*
- A5-10. *Reflection occurs when light waves that are neither transmitted nor absorbed, but are thrown back from the surface of the medium they encounter. Refraction occurs when a ray of light passes at an oblique angle from one transparent substance into another substance of different density.*
- A5-11. *Mirages are images of objects that are made to appear displaced from their normal positions because of refraction.*
- A5-12. *The diameter range of a mature thunderstorm cell is 1 to 6 miles.*
- A5-13. *Rain is observed at the surface during the mature stage.*
- A5-14. *A macroburst is a larger scale downburst with winds that can last 5 to 20 minutes with speeds that reach 130 knots. Microbursts are smaller scale downbursts with winds that last 2 to 5 minutes with speeds that may reach 130 knots.*
- A5-15. *Two types of thunderstorms are air mass and frontal.*

## **CHAPTER 6**

- A6-1. *Climate is the average or collective state of Earth's atmosphere at any given location or area over a long period of time.*
- A6-2. *Descriptive climatology is typically oriented in terms of geographic regions.*
- A6-3. *Microclimatology is measured in small-scale areas such as golf courses or plowed fields.*
- A6-4. *The most important climatic element is temperature.*
- A6-5. *Wind is the climatic element that transports heat and moisture into a region.*
- A6-6. *The mean or average is the climatological parameter that is determined by adding all values together and dividing by the number of values calculated.*
- A6-7. *Absolute is the term that is usually applied to the extreme highest or lowest value ever recorded at a location.*
- A6-8. *A degree day is the number of degrees the mean daily temperature is above or below a standard temperature base.*
- A6-9. *The climatic belts or zones are the torrid or tropical zone, the two temperate zones, and the two polar zones.*
- A6-10. *The three climatic classification types are C.W. Thornthwaite, W. Köppen, and G.T. Trewartha.*
- A6-11. *The five climatic types according to Köppen are tropical rain, dry, warm temperate rainy, cool snow forest (Boreal), and polar.*
- A6-12. *Latitude is the climatic control that has the biggest effect on climatic elements.*
- A6-13. *Coastal areas assume the temperature characteristics of the land or water that is on their windward side. Therefore, in the middle latitudes, the western coast of the United States will normally receive maritime temperature characteristics from the Pacific Ocean, and the eastern coast will normally receive continental temperature characteristics from the mainland.*
- A6-14. *Ocean currents transport heat by moving cold polar water equatorward into warmer waters and moving warm equatorial water poleward into cooler waters.*

- A6-15. *Requests for climatic support should be made to the Oceanography Facility or Center in your chain of command. Requests that cannot be fulfilled are forwarded to FMOD Asheville, N.C.*
- A6-16. *The Local Area Forecaster's Handbook contains climatic information for a particular weather station.*
- A6-17. *The two climatic extremes that relate to water and land distribution are over Earth are maritime and continental.*
- A6-18. *The southwest pacific coastal area experiences a Mediterranean-type climate.*
- A6-19. *The cause of the summer monsoon is the major warm low-pressure center over Asia (Asiatic Low) during the summer, and the cause of the winter monsoon is the major cold high-pressure center over Asia during the winter (Siberian High).*
- A6-20. *South America lacks the severe weather of its North American counterpart because of the absence of continental polar air. This is due to the tapering of the continent toward Antarctica.*

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