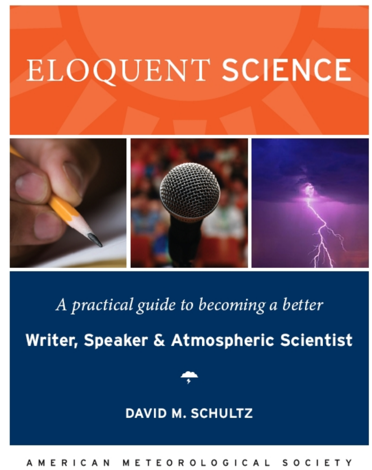
B

# COMMONLY MISUSED SCIENTIFIC WORDS AND EXPRESSIONS




*Just as Strunk and White have their list of commonly misused words and expressions, a list for the atmospheric sciences has long been needed. Some of the entries were written by others; many are my own irritations. Some people may agree with nearly all of these entries; others may agree with few, if any. Whatever your opinion, I invite you to at least think about how you are using these words and expressions.*

**Accuracy versus skill.** When describing the quality of forecasts, the notions of accuracy and skill often are treated as synonymous, but they are not. *Accuracy* refers to the correspondence between forecasts and observations, with increasing accuracy associated with increasing correspondence. *Skill*, on the other hand, is associated with the relative performance of the forecasting system in question, when compared to some baseline forecasting system. Baseline systems often used for measuring skill include climatology, persistence, and model output statistics (MOS) forecasts; the idea is to measure the improvement (or lack thereof) of the system in question compared to the baseline system. An accurate forecast is not necessarily skillful, and vice versa. —*Charles Doswell*

**Activity (convective, electrical, hurricane, lightning, thunderstorm).** "Activity" is an imprecise word in these contexts. Be specific about the measure: number of cloud-to-ground lightning flashes, total flash rate, number of supercells, frequency of hurricane passage, etc.

**Analysis of a vector quantity.** When creating a gridded analysis from or interpolating a vector quantity, perform the analysis on each vector component (e.g., *u* and *v* for a horizontal wind field) not on magnitude and direction (e.g., wind speed and direction) (Doswell and Caracena 1988).

**Causing.** Be careful using this phrase in some contexts. Usually we do not know the chain of cause and effect in the atmosphere, although we often infer it. "Associated with" is a better option. Similarly, read *Statistical association does not imply cause and effect* on page 363.

**Chaos/random.** These two terms have very specific scientific meanings, so casual use of these terms should be avoided (e.g., "chaotic or random cloud patterns"). Use "poorly organized" or "disorganized" instead.

**Cold-type occlusions, existence of.** The cross-frontal difference in static stability not near-surface temperature is what creates the three-dimensional structure of a cold- or warm-type occlusion (Stoelinga et al. 2002). Because warm fronts tend to be much more stable than cold fronts, the three-dimensional structure of a warm-type occlusion will be favored to develop, irrespective of the near-surface temperature difference across the occluded front. Thus, cold-type occlusions should be quite rare, if they exist at all (Schultz and Mass 1993).

**Collaboration versus coordination.** These two terms can be misused in either an operational-forecasting environment or a research-and-development environment. *Collaboration* refers to the intellectual process having a collective goal of producing the best possible forecast or forecast product by the interaction of two or more weather information sources. In contrast, *coordination* is the obligatory communication to ensure the forecasts and products from two or more sources meet a minimum standard of acceptance from users. —*Neil Stuart*

**Condensation occurs because cooler air cannot hold as much water as warmer air.** Condensation and evaporation are always occurring regardless of temperature—what matters is whether the rate of condensation exceeds the rate of evaporation. The Clausius–Clapeyron relation states that the saturation vapor pressure of the atmosphere increases with temperature. Thus, when everything else is held constant, as the temperature increases, the rate at which increasingly energetic water molecules evaporate is more likely to exceed the rate of condensation. When the air temperature drops below the dewpoint temperature, the rate of condensation exceeds the rate of evaporation, and water droplets form. These processes occur regardless of the volume or pressure of the air. Thus, water vapor is not "held" by the air.

**Convective initiation.** Use *convection initiation* instead.

**Convective temperature.** The convective temperature is the surface temperature that corresponds to the elimination of any convective inhibition associated with ascending low-level parcels, usually by insolation. Presumably, use of this term implies that deep convection initiation is delayed until the convective temperature is reached, after which deep convection begins. If this were a valid concept, then deep convection should begin by clouds flashing into existence over big chunks of real estate, all at the same time. Instead, deep convection usually commences as isolated convective clouds, perhaps at a few places along a line, usually well before the attainment of the convective temperature. Sometimes, the convective temperature is reached and nothing happens. The use of "convective temperature" seems to imply that deep convection is initiated solely by elimination of the inhibition through solar heating. Because the reality is quite different, the concept of the convective temperature is not valuable in forecasting, and perpetuates an improper understanding of deep convection initiation. Thus, this term should not be used. —*Charles Doswell*

**Correlate/correlation.** Often authors will refer to "correlation" when they really mean a relation, an association, or a correspondence between two phenomena. Reserve "correlate" when you mean it in a mathematical sense, as when you calculate a linear correlation coefficient. In general, use "relate," "relation," or "correspond" instead.

**Correlation, linear.** See the sidebar "Misuses of Linear Correlation" on page 121.

**Data.** "Data" is always plural. "Datum" is the singular form, but I think saying "data point" sounds better.

**Data, model output as.** Some scientists are uncomfortable with model output being called "data." Reserve the use of "data" for observations, not the output from models.

**Date/day.** Do not use the word "day" as a substitute for "date."

> **INCORRECT:** The day of the tornado in Lone Grove, Oklahoma, was 9 February 2009.
>
> **CORRECT:** The date of the tornado in Lone Grove, Oklahoma, was 9 February 2009.

**Dates and times.** Use the standard format for dates and times, wherever possible: 1200 UTC 10 December 1994. Avoid the 12/10/94 or 12.10.94 formats because of the ambiguity of whether the date is December 10 (U.S. format) or October 12 (European format). Do not use the syntax "1200 UTC on December 10th," which contains more characters than is needed.

**Difluence does not equal divergence.** In meteorology, $\alpha$ represents the angle of the wind direction with the convention that wind from the north is 0° and the angle increases in a clockwise direction. In a natural coordinate system ($s$, $n$) where $s$ is the direction along the flow and $n$ is the direction normal to the flow (and to the right of the wind), divergence $\nabla_h \cdot \mathbf{V}_h$ is given by:

$$\nabla_h \cdot \mathbf{V}_h = V\,\frac{\partial \alpha}{\partial n} + \frac{\partial V}{\partial s}$$

where $V$ is the wind speed. Difluence, the spread of streamlines downstream, is only the first term $V\, \partial\alpha/\partial n$ in the expression for divergence. Therefore, difluence cannot be equivalent to divergence, although they clearly are related. —*Charles Doswell*

**Divergence/convergence does not cause vertical velocity.** See also the entry for *causing*. Divergence of the horizontal wind $\nabla_h \cdot \mathbf{V}_h$ and vertical velocity $\omega$ are connected by the Law of Mass Continuity. In pressure ($p$) coordinates, this takes the form:

$$\frac{\partial \omega}{\partial p} = -\nabla_h \cdot \mathbf{V}_h$$

The simultaneous existence of ascent, with convergence at its base and divergence at its top, is a necessary consequence of mass continuity. Mass continuity is a diagnostic equation and contains no time derivative of vertical velocity. Hence, it cannot identify causes for vertical wind. —*Charles Doswell*

**INCORRECT:** Low-level convergence along the front caused strong ascent to occur.
**INCORRECT:** Deep moist convection resulted when a region of upper-level divergence became superimposed over a region of low-level convergence.
**CORRECT:** Ascent is associated with upper-level divergence and low-level convergence.

**Dynamics.** This term is often used to describe physical processes vaguely without actually stating what those processes are. Replace such expressions with a more physical description.

**DRAFT:** The strong dynamics of the rapidly developing extratropical cyclone . . .
**IMPROVED:** A strong short-wave trough in the jet stream was responsible for the rapid development of the extratropical cyclone.

**Equations, formulas, and theories (generality of).** Theories, equations, or empirical formulas are often developed for specific circumstances with a given set of assumptions, or based on limited datasets. As such, caution should be exercised if extending these theories, equations, or formulas to situations outside of their original intent.

**False alarm rate versus false alarm ratio.** Often people not being careful will refer to the false alarm ratio as the false alarm rate. Do not confuse the two! The *false alarm ratio* is the number of false alarms divided by the number of forecasted events, whereas the *false alarm rate* (also known as the *probability of false detection*) is the number of false alarms divided by the number of times the event did not happen (e.g., Wilks 2006, Section 7.2.1; Barnes et al. 2009).

**Fog burning off:** Popular as a colloquialism, this phrase misrepresents the physical processes involved in the elimination of fog and should not be used in a scientific context.

**Forcing:** Although an imprecise term at best, "forcing" is most troubling when used in connection with diagnostic equations, such as the omega equation, where the terms on the right-hand side are referred to as "forcing terms." Forcing is clearest in the context of an applied force resulting in an acceleration, where some process derives a time-dependent response. Thus, terms on the right-hand side of the horizontal momentum equation, such as the pressure gradient force, would be appropriately described as forcing. In the quasigeostrophic system, vertical velocity is not forced—it is merely required for consistency with the changes that are occurring to the geostrophic flow. —*Chris Davis*

*Ignoring the shades of gray that exist in the natural world is one hallmark of bad science; employing multiple definitions for the same term is another. —Corfidi et al. (2008. p. 1301)*

**Frequency.** When using this word, ensure that the units are in "per time," such as the number of events per unit time. Otherwise, the expression is just a "number of events," not a frequency.

**Front, definition of.** A front is characterized by a horizontal gradient in density (temperature). Therefore, analyzing fronts should be performed using temperature or potential temperature only. (Virtual temperature, which accounts for the effect of moisture on the density of air can also be employed.) Including moisture in the definition of fronts, even indirectly through variables such as equivalent potential temperature or wet-bulb potential temperature, runs the risk of weakening the definition of a front—analyzing features that may not be temperature gradients, but merely moisture gradients, and implying a frontogenetical circulation when none may exist. For more on proper frontal analysis, read Sanders and Doswell (1995) and Sanders (1999).

**Frontogenesis, as a measure of the intensity changes of a front.** Frontogenesis is the Lagrangian rate of change of the horizontal temperature gradient (Petterssen 1936; Keyser et al. 1988). Thus, air parcels approaching a front from the warm sector experience an increasing temperature gradient, or positive frontogenesis. Petterssen frontogenesis says little about what the temperature gradient along the front is doing in time because even fronts where the temperature gradient is weakening experience positive Petterssen frontogenesis. A proper analysis of frontogenesis to explain the strengthening or weakening of a front would require a new formulation, a quasi-Lagrangian, or front-following, form of the frontogenesis function (cf. Schultz 2007 vs Markowski and Stonitsch 2007). Thus, the value of Petterssen frontogenesis is to objectively determine where active frontogenesis is occurring, not whether a front is strengthening or weakening.

**Frontogenesis, use of the tilting term.** The Miller (1948) expression for frontogenesis to assess the physical processes acting to change the magnitude of the potential temperature gradient includes a tilting term. Some people have calculated the tilting term, then said that the complete frontogenesis expression can be used to assess the regions of vertical velocity. This approach is incorrect. Petterssen (1936) frontogenesis is the correct expression used to estimate the areas favorable for ascent (Keyser et al. 1988); the tilting term is not included.

**Frontogenesis, warm or cold.** Consider the term *warm frontogenesis* that some have tried to coin as an abbreviation for "frontogenesis along a warm front." This term does not make scientific sense because frontogenesis does not have a sign of cold or warm, only positive or negative (frontogenesis or frontolysis). To be precise, write out the phrase completely: "frontogenesis along a warm front."

**Froude number.** The Froude number $Fr$ is classically defined as the ratio of the flow speed $U$ to the phase speed of linear shallow-water waves, $\sqrt{gH}$, where $g$ is gravity and $H$ is the fluid depth. By comparison, in stratified flow over an obstacle, the quantity $Nh/U$ is often referred to as either the Froude number or its inverse, where $N$ is the Brunt–Väisälä frequency and $h$ is the obstacle height. (Because of the ambiguity about $Fr$ or its inverse, always define $Fr$ for the readers.) Scaling analysis shows that $Nh/U$ is the sole nondimensional parameter controlling two-dimensional hydrostatic flow forced by a steady wind $U$ in an atmosphere with constant $N$. In fact, $Nh/U$ is best referred to as a measure of nonlinearity because the perturbation wind $u'$ is proportional to $Nh$ in the linear limit. In contrast to the classically defined, shallow-water Froude number, associating $Nh$ with the phase speed of a significant internal gravity wave mode is difficult.

A third context in which the Froude number arises is when a strong inversion is present and a reduced-gravity shallow-water Froude number is computed as $U/\sqrt{g'H}$, where $H$ is the height of the inversion, $g' = g\Delta\theta/\theta_0$, $\Delta\theta$ is the potential temperature jump across the inversion, and $\theta_0$ is a potential temperature representative of that in the inversion layer. Empirical observational and modeling evidence suggests that when the inversion is sufficiently strong, and the static stability below and above the inversion is sufficiently weak, $U/\sqrt{g'H}$ governs nonlinear flows in a manner at least qualitatively similar to that played by the classically defined, shallow-water Froude number. Nevertheless, the precise numerical value of the reduced-gravity shallow-water Froude number should not be overemphasized, because vertical wind shear and the finite thickness of the inversion layer introduce considerable uncertainty in its evaluation. In addition, at least one example involving coastally trapped waves exists in which the phase speed of linear disturbances in the presence of a strong inversion does not agree with the reduced-gravity shallow-water phase speed (Durran 2000a, Fig. 9). —*Dale Durran*

**Gravity currents, cold fronts as.** Despite the widespread use in the literature of equations to calculate the theoretical speed of a gravity current, Smith and Reeder (1988) argue that any similarity between the theoretical speed and observed speed of cold fronts is superficial. Thus, a close correspondence between the two is not evidence for a front being a gravity current. See also *Morphological similarity does not equal dynamical similarity*.

**Greenhouse effect.** The name, greenhouse effect, is unfortunate, for a real greenhouse does not behave as the atmosphere does. The primary mechanism keeping the air warm in a real greenhouse is the suppression of convection (the exchange of air between the inside and outside). Thus, a real greenhouse does act like a blanket to prevent bubbles of warm air from being carried away from the surface. This is not how the atmosphere keeps the Earth's surface warm. Indeed, the atmosphere facilitates rather than suppresses convection. —*Alistair Fraser*

**Greenhouse gases behave as a blanket and trap radiation.** At best, the reference to a blanket is a bad metaphor. Blankets act primarily to suppress convection; the atmosphere acts to enable convection.

As rapidly as the atmosphere absorbs energy it loses it. Nothing is trapped. If energy were being trapped (i.e., retained), then the temperature would of necessity be steadily rising (a temperature increase unrelated to global warming). Rather, on average, the mean temperature is constant and the energy courses through the system without being trapped within it.

The correct explanation is remarkably simple and easy to understand; namely, the surface of the Earth is warmer than it would be in the absence of an atmosphere because it receives energy from two sources: the sun and the atmosphere. —*Alistair Fraser*

**Instability, conditional, convective, and potential.** *Conditional instability* occurs when the environmental lapse rate lies between the dry- and the moist-adiabatic lapse rates, or the saturated equivalent potential temperature ($\theta_e^*$ or $\theta_{es}$) decreases with height. *Potential* or *convective instability* occurs when the equivalent potential temperature ($\theta_e$) decreases with height. Conditional instability is one of the three ingredients of deep, moist convection, and is therefore the proper instability to be considered for such situations (e.g., Johns and Doswell 1992). Potential instability is usually considered as instability over a layer that is released when lifted in slab ascent (e.g., Bryan and Fritsch 2000). Schultz and Schumacher (1999), Sherwood (2000), and Schultz et al. (2000) discuss the differences between and the origins of these terms.

**Instability, presence of versus release of.** The presence of an instability does not imply that it will be released (e.g., Sherwood 2000). Therefore, conditional symmetric instability bands are not a proper term. It is more accurate to say, “bands associated with the release of conditional symmetric instability in the presence of frontogenesis,” acknowledging the presence of the instability and moisture, as well as the lifting mechanism.

**Jet streaks, locations of severe weather.** The four-quadrant model of a straight jet streak (e.g., midtropospheric ascent in the right-entrance and left-exit regions, descent in the left-entrance and right-exit regions) is often invoked as evidence of a preference for severe weather occurrence in the ascent regions, but Rose et al. (2004) and Clark et al. (2009) show that severe weather can occur in any quadrant of a straight jet streak, particularly in both quadrants of the jet-exit region and the right-entrance region. Curvature further accentuates the differences between expected locations of severe weather from the model alone and observed locations. That the four-quadrant model does not solely explain the formation and locations of convective storms is not surprising given that such storms are also influenced by low-level convergence (e.g., along surface fronts) and favorable environments of convective available potential energy and vertical shear of the horizontal wind, not just the synoptic-scale vertical velocities associated with the jet streak. This result is a reminder that convective storms result from the superposition of several ingredients, not just synoptic-scale ascent alone.

**Julian day.** The Julian day is the number of days since 1 January 4713 B.C. Thus, the Julian day corresponding to 22 August 2008 is 2,454,700, not 235. Use *day of the year* instead (also called *ordinal date*).

**Lightning (bolt, flash, strike, and stroke).** There is a hierarchy of terms from general to specific when referring to lightning or lightning processes. *Lightning* is the most general, and the entire phenomenon of lightning includes the processes involved in the formation of the channel itself, the associated light, and the acoustic properties of thunder, to the end of the time of the travel of the last thunder from the lighting channel. The more specific term *flash* refers to a single interconnected discharge. A *cloud-to-ground flash* is often defined by the point where the flash strikes the surface of the earth as located by a lightning mapping system. The colloquial terms *bolt* and *strike* have no specific scientific meanings.

There are two categories of lightning type: *intracloud lightning* (preferably called *cloud flashes*, because intracloud flashes technically mean a flash completely within a cloud, but are often used to mean any flash that fails to strike ground) and *cloud-to-ground lightning* (which are often called *ground flashes* for variety and brevity).

*Lightning stroke* is more specific still, but with two different usages. First, it can refer to the return stroke, which is the bright surge back up the channel after the downward propagating leader connects with the ground.

A cloud-to-ground flash contains one or more return strokes; the average is three or four return strokes per flash. When you see lightning, the light may seem to flicker. Those are return strokes running up and down the channel of the first stroke. Second, the word *stroke* by itself should mean the combination of downward leader and return stroke, several of these being possible in a given flash. *—Don MacGorman and Ron Holle*

**Low-level jet.** The definition of the term low-level jet is precise, but its usage is sloppy in the literature. *Low-level jet* simply means that a low-level maximum exists in the vertical profile of wind speed. Usually various criteria for the maximum value are given, along with criteria about the decrease in wind speed above the level of maximum wind. From this definition, it is not surprising that low-level jets are relatively common. However, some have used the term loosely, leading to a myriad of problems and confusion. In essence, more information is needed than "low-level jet" to know what kind of meteorological phenomena is being discussed because jets at low levels may be due to a variety of reasons. As argued by Reiter (1963), Stensrud (1996), and Doswell and Bosart (2001), a distinction should be made between *low-level jet streams* and *nocturnal low-level wind maxima*, where possible. Low-level jet streams have mesoscale or synoptic-scale horizontal extent with strong horizontal shears along their edges, are associated with synoptic-scale processes, and have little diurnal variability. They may be barrier jets related to orography. In contrast, the nocturnal low-level wind maxima possess a strong diurnal cycle that low-level jet streams do not possess. *—David Stensrud*

**Moisture flux convergence.** Although the term appears in the conservation of water vapor equation, the divergence of water vapor flux is not a useful expression for determining convection initiation (Banacos and Schultz 2005). Near-surface mass convergence is a more appropriate quantity to examine.

**Morphological similarity does not equal dynamical similarity.** Observations of the midtropospheric flow around convective storms often appear as though the storm is an obstacle, and there have been studies making extensive use of these observations to make statements about the vorticity source for the counterrotating vortices seen on the flanks of the updraft. Although an interesting analogy, the morphology of the flow does not necessarily mean that the flow dynamics are identical to those associated with solid obstacles embedded in a fluid flow (Davies-Jones et al. 1994, commenting on Brown 1992).

When there really is a solid obstacle in the flow, vorticity is generated in the viscous boundary layer associated with the solid obstacle. This vorticity is shed into the wake of the flow and is the source of the vorticity in the counterrotating vortices. Thus, even if the ambient flow is completely uniform with no ambient vorticity, obstacle flow will generate these vortices.

Severe thunderstorms are associated with environmental flows having considerable vertical shear and, therefore, considerable vorticity about a horizontal axis. The counterrotating vortices associated with severe thunderstorms arise from tilting of this substantial ambient vorticity. Thus, the similarity in appearance to flow around an obstacle is only coincidental. *—Charles Doswell*

**Normals, calculation of.** Every 30 years the international meteorological community produces a document of the "normal" climate for all of the nations of the world. The effort originated from the International Meteorological Committee in 1872 to assure comparability between data collected at various stations. Thirty years is used to calculate the average climate, most often on a monthly or annual basis, for the official normals as specified by the World Meteorological Organization, and these values are updated every ten years. Although averaging over 30 years will help to filter out short-term fluctuations, this number of years appears to be defined arbitrarily, perhaps because of the rule of thumb in sampling theory suggesting 30 independent samples can be used to arrive at a well-behaved sampling distribution through the Central Limit Theorem. Such an interpretation is incorrect, as the closeness of the parent distribution to normal is related to the required sample size. Moreover, independence of the adjacent years as well as stationarity and homoscedasticity in climate on the 30-year scale is assumed (e.g., stations' data records are assumed to be homogeneous). There is nothing special about 30 years in computing average weather conditions. In fact, averaging for periods less than 30 years can offer advantages (e.g., Huang et al. 1996; Scherrer et al. 2005). *—Michael Richman*

**Northward/southward.** To foster writing free of geographical bias, replace "northward" and "southward" with their hemispheric-neutral siblings, "poleward" and "equatorward" (page 102).

**Numerical prediction.** What people really mean when they use this term is "dynamical prediction," but statistical prediction methods are numerical, also. *—Dan Wilks*

**Objective versus subjective methods.** Because so-called "objective" methods involve subjective decisions, do not use the terms "subjective" and "objective" (page 210). Instead, use the terms "manual" and "automated."

**Observed/seen.** Unless you have direct measurements of the quantity, reword.

**DRAFT:** Cyclonic vorticity advection at 500-hPa was observed throughout Montana and Wyoming.

**IMPROVED:** Cyclonic vorticity advection at 500-hPa occurred throughout Montana and Wyoming.

**DRAFT:** Precipitation was not seen in the simulation.

**IMPROVED:** The simulation did not produce precipitation.

**Obstacle flow around a convective storm.** See *Morphological similarity does not equal dynamical similarity*.

**Overrunning.** This term is generally applied to the physical process responsible for precipitation falling on the cold side of a surface front. This term lacks any insight into the physical process responsible for the ascent, and so should be eliminated from scientific discussion.

**Percent/percentage.** *Percent* is the unit for a particular measure (%), whereas *percentage* is synonymous with "fraction" or "portion." Do not use "percent cloud cover," instead use "cloud cover in percent" or "percentage of cloud cover."

**Positive vorticity.** As with *northward/southward*, replace "positive vorticity" and "negative vorticity" with their hemispheric-neutral siblings, "cyclonic vorticity" and "anticyclonic vorticity."

**Propagate.** *Propagate* is often used in the meteorological literature as a technical-sounding word for *move*. Almost always use the word *move* instead. Movement is advection plus propagation. Consider a boat in a river. If the boat has no motor or sail, then the boat moves downstream at the speed of the river—the boat is advected by the river. If the boat has a motor or sail and moves against the river's flow, then the boat is propagating relative to the river. Similarly, consider a feature that is not an object, such as a squall line. The propagation of the feature may involve subsequent development of the convective cells in the warm air ahead of the squall line, or the propagation component. But the movement of the feature is the addition of the propagation component and the advection component. Therefore, writers should be precise about whether they mean the total motion of the squall line or the propagation component alone.

**Radar reflectivity factor.** Strictly speaking, *radar reflectivity* and *radar reflectivity factor* are two different parameters (e.g., Rinehart 2004, pp. 90–91). The parameter that nearly all meteorologists use (radar reflectivity factor, with units of dB*Z*) is independent of wavelength of the radar beam. Thus, 50 dB*Z* as measured by two different, yet identically calibrated, radars should characterize precipitation in the same way. In contrast, radar reflectivity depends on the radar wavelength and has different units ($cm^{-1}$). Furthermore, the radar equation assumes a spherical water drop and Rayleigh scattering. Should these conditions not be met (as in clear air where the scatterers may be birds, insects, or gradients in the index of refraction), the qualifier "equivalent" should be used.

**Random.** See *chaos/random*.

**Reradiation/reemission.** One often hears the claim that the atmosphere absorbs radiation emitted by the Earth (correct) and then reradiates or reemits it back to Earth (false). The atmosphere radiates because it has a finite temperature, not because it received radiation. When the atmosphere emits radiation, it is not the same radiation (which ceased to exist upon being absorbed) as it received. The radiation absorbed and that emitted do not even have the same spectrum and certainly are not made up of the same photons. The terms reradiate and reemit are nonsense. —*Alistair Fraser*

**Resolution.** When describing the *resolution* of a model, the grid intervals (in space and time) typically are cited. Strictly speaking, features on the scale of the grid intervals are not resolved by the model. The smallest features that can be said to be resolved in any meaningful sense of the term are those at twice the model's grid interval, and even at that scale, the amount of information about such small features is pretty limited (Doswell and Caracena 1988). Thus, this terminology should be discouraged. See also the published comments by Pielke (1991, 2001), Laprise (1992), and Grasso (2000a). —*Charles Doswell*

Yet another term is the *effective resolution*, defined by Walters (2000, p. 2475) as "the minimum wavelength the model can describe with some required level of accuracy (not defined)" (Laprise 1992; Walters 2000; Skamarock 2004). Therefore, because no precise definition of resolution exists (e.g., Durran 2000b; Grasso 2000b), choose "grid spacing," "grid increment," "grid separation," or "grid interval," instead of "resolution."

**Severe storms.** To be precise, refer to "severe convective storms." See also *thunderstorm*.

**Severe weather, definition of.** In the United States, "severe" weather has a specific definition as applied by the NOAA/Storm Prediction Center (Galway 1989): any tornado, hailstones with diameter greater than ¾ in. (1.9 cm), or convective wind gusts with speeds greater than 50 kt (25.7 m $s^{-1}$). A generic term to discuss weather that has a high impact on society is "hazardous weather" or "high-impact weather." The term "violent weather" is too colloquial.

**Short-wave.** "Short-wave" (waves in the jet stream) should always be followed by "trough" or "ridge."

**Significance/significant.** Only use "significant" in the context of statistical significance or *significant severe weather* (see entry). To do so otherwise may confuse the reader.

**Significant severe weather, definition of.** Significant severe weather is defined as hail 2 in. (5.1 cm) or larger in diameter, wind gusts of at least 65 kt (33.4 m $s^{-1}$), or tornadoes with F2 intensity or larger (Hales 1988).

**State.** "State" means "to declare definitively," which is a much stronger definition than the way that most people use "state," as a synonym for "say." Use "state" specifically for where a strong declaration is needed as in "to state a hypothesis" (Section 10.2.1).

**Statistical association does not imply cause and effect.** If event A is strongly associated with event B, it is tempting to presume that A explains B or vice versa. As a somewhat contrived (but still useful) example, it is easy to show that nearly every criminal has, at one time or another, eaten at least one pickle. If we did a statistical analysis of the data, there might well be a near-perfect correlation between crime and having eaten at least one pickle. Does it make sense to infer that pickles cause crime? Perhaps we could do a study that showed that nearly all noncriminals had eaten at least one pickle, as well, demonstrating that pickles are unlikely to be the source of criminal behavior (or we have a large number of unrecognized criminals). If an association can be shown, then it might be a clue to causality, but there should be a plausible causal connection before pursuing the issue in detail. Is there a plausible reason that explains why eating a pickle would lead to a life of lawlessness?—*Charles Doswell*

***t* test.** Formally known as *Student's* t *test*, not "the student *t* test." Student was the penname of author William Sealy Gosset, who published the test in 1908 (Student 1908).

**Temperatures, cold and warm.** Temperatures are not warm or cold—they are high or low. Air (the object) is warm or cold. See page 99. Other examples of inconsistencies between an adjective and its noun exist as well. For example, change broad/narrow spectral width to large/small spectral width, fast/slow velocity to large/small velocity, long/short wavelength to long/short waves or large/small wavelength, and deep/shallow boundary layer height to deep/shallow boundary layer or high/low boundary layer height. If the noun is a measurement or quantity, then adjectives such as "high," "low," "fewer," "more," etc. are preferred. Qualitative adjectives should be reserved for physical objects.

**Theory.** Reserve the word *theory* for a time-tested idea, framework, or conceptual model that has unified observations and theory, and makes testable predictions about the future (e.g., baroclinic instability theory, Milankovitch theory). Do not use the word to describe someone's results or speculation from a previous paper ("Smith's theory"); use "hypothesis" instead.

*Theories are good for the intellect, but are no more useful than a bit of practical experience. Perhaps the most significant thing about them is that they have been accorded quite unjustified status by engineers. —R. S. Scorer (2004)*

**Thunderstorm.** The term *thunderstorm* is not necessarily synonymous with *convective storm* or *severe convective storm*. Although thunder and lightning may be present in many convective storms, they are not requirements.

**Trigger.** Triggering is not a synonym for "lifting," especially when applied in the context of thunderstorms. Thunderstorm initiation requires moisture, instability, and lift. For a thunderstorm to form, somewhere within the atmosphere, a parcel exists that has buoyancy if lifted far enough to attain its Level of Free Convection (LFC; beyond which it is buoyant and can accelerate upward with no further lift required). For this to take place, three things are required: moisture, conditional instability, and some process to lift a nonbuoyant parcel to its LFC. Presumably, the notion of lifting as a trigger assumes the presence of moisture and instability sufficient to allow some parcel to have an LFC, and it is only awaiting the lift.

In the absence of any one ingredient of the necessary triad, no thunderstorms will occur. So which is the trigger? If any two are present, in the absence of the third, the thunderstorms await the missing ingredient as a trigger. For example, moisture and lift often occur in the absence of conditional instability—its arrival could then logically be considered a trigger! To avoid an incorrect impression of how convection works, we should forgo the idea of a trigger completely. —*Charles Doswell*

**TRMM rainfall.** Because the Tropical Rainfall Measuring Mission (TRMM) does not directly measure rainfall or hydrometeors, the term "TRMM rainfall" is misleading. The TRMM Microwave Imager measures upwelling microwave radiation in several bands, and then those measurements are input to algorithms from which estimates of instantaneous rain rates, hydrometeor profiles, and other geophysical variables are calculated. These variables are then mapped and issued as products labeled by the algorithm(s) used to produce them. The best terminology to use is the proper product names (1B11, 3B42, 3B43, etc.) when referring to specific products or "TRMM-based products" in a more general context. —*Karen Mohr*

**UTC.** For the convenience of the reader, define any local time conventions (e.g., LST or local standard time) in UTC: UTC = LST + $n$ hours.

**Vertical motion.** Use the term *vertical velocity* instead. Generally, we do not say "horizontal motion" when referring to the wind, so why would we say "vertical motion?"

**Vorticity, definition versus equation.** The vorticity vector $\vec{\omega}$ is defined by $\vec{\omega} \equiv \nabla \times \vec{v}$ where $\vec{v}$ is the three-dimensional velocity vector. This expression is merely a definition of a kinematic quantity of the flow. In contrast, a vorticity equation (there are many different versions of them) is derived from the equations of motion (i.e., Newton's second law as applied to fluids). A vorticity equation describes how the vorticity at a fixed point (or of a parcel, if a Lagrangian version of vorticity equation is being considered) changes with time in response to various dynamical processes (e.g., tilting, stretching, diffusion, baroclinic generation). Thus, to "analyze the vorticity equation" means to diagnose the time tendencies of vorticity through the various processes, not to perform the trivial calculation of $\nabla \times \vec{v}$. —*Alan Shapiro*

**Vorticity generation by shear.** Consider the boring scenario of an environment in which the $v$ and $w$ velocity components are zero, and the $u$

velocity component is positive (westerly wind) and increases with height, $\partial u/\partial z > 0$ such that the shear vector is westerly (points toward the east). In this case, the only nonzero component to the vorticity vector $\vec{\omega}$ is the $y$ component $\partial u/\partial z$. Thus, there is shear in this flow and there is also vorticity, and neither the shear nor the vorticity "generated" the other—they are both present in the environment and are associated with the same $u$ velocity field.

On the other hand, suppose that a thunderstorm begins to grow in the same environment considered above. In this case, the vertical velocity field associated with the developing updrafts can tilt the environmental vorticity ($y$ component of vorticity) into the vertical, thus generating vertical vorticity. Since the environmental vorticity is associated with the environmental wind shear, one can say that the shear does play a role in the generation of the vertical vorticity. —*Alan Shapiro*

**Why.** "Philosophy and theology explore the *why* of nature; science deals with *how*." (Lipton 1998, p. 25).

**DRAFT:** CDI does not explain why mammatus only appears locally on some regions of the anvil and not over the entire anvil.
**IMPROVED:** CDI is an inadequate explanation for mammatus that only appear locally on some regions of the anvil and not over the entire anvil.

**DRAFT:** Why the formation of the aerosol particles varies with solar radiation has not been determined.
**IMPROVED:** How the formation of the aerosol particles varies with solar radiation has not been determined.