Storm and Storm Systems Related Vocabulary and Definitions

Magnitude: this is an indication of the scale of an event, often synonymous with intensity or size. In natural systems, magnitude is also related to frequency, such that low magnitude events happen much more often than high magnitude events. Magnitude can also be about spatial extent and subjectively categorized as local, regional, synoptic (multiple regions) or planetary.

Magnitudes are measured differently for different hazard types:

- River flood magnitude is based on the water height needed to overtop a river bank and to flood, or inundate, particular areas (https://water.usgs.gov/osw/flood_inundation/science/index.html).

- Ocean floods and storm surges are rated by water height against coastal features, like coastal dunes or seawalls (https://coastal.er.usgs.gov/hurricanes/impact-scale/).

- Hurricane magnitudes are based on the speed of sustained winds near the storm's center and has Categories 1-5 (http://www.nhc.noaa.gov/aboutsshws.php).

- Snowstorms are rated by wind speed, snow accumulation rates and visibility but can also be rated by snow depths (https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis).

Air mass: any large volume of air that can be distinguished from surrounding air by temperature and humidity characteristics. Air masses typically develop over several days and may be transported by winds into other regions. Air masses are named according to their relative characteristics of temperature (tropical, polar, Arctic) and humidity (continental, maritime).

Wind shear: the junction of winds blowing in opposite directions. The friction of these opposing air masses causes rotation. On a small scale, this rotation can create tornadoes. On a much larger scale, such rotation can create frontal systems. Large areas of wind shear inhibit the development of thunderstorms and intensification of tropical systems. In the absence of wind shear, very large thunderstorm systems, called supercells, can develop over land areas. Over warm ocean areas, similar conditions allow tropical storms to form and intensify.

Front: the boundary between warm vs. cold air masses that develops as air masses are moved by winds out their region of origin. Fronts are typically associated with rapid changes in temperature and humidity, often accompanied by wind. When a cold front passes, warm air is replaced by cold air. When a warm from passes, cold air is replaced by warm air. Clouds and precipitation often develop along the boundary where the two air masses collide and mix.

Frontal systems: two or more distinct air masses and the fronts that separate them. A frontal system develops rotation around a central area of low pressure, so that there is a warm front leading the low and a cold front trailing the low. These systems are associated with storms, and thus are often called storm systems. It is common for a series of frontal systems to develop, with a new one every few days, when air masses and upper atmospheric winds set up in a stable pattern over several weeks. For this reason, it is not unusual for a region to experience several major storms in a row.

Precipitation: moisture that falls from the sky and reaches the ground (including rain, snow, sleet, and hail).

Air pressure: the relative weight of air over any one spot. More air piled onto one spot causes pressure to increase. Temperature also changes air pressure because cold air weighs more than warm air. As air leaves an area, the air pressure will decrease. Similarly, when air enters an area the air pressure increases. Compared to the air pressure around it, air pressure can be low or high. Winds develop in between areas of high and low pressure. The closer high and low pressure areas are to each other, and the greater the difference in the pressure gradient between them, the faster the winds are. Very high winds can develop if there is a strong enough pressure gradient. Mountains enhance this effect. Regions of high pressure often develop over mountains because of colder temperatures. This cold air flows off the mountains into lowland areas below, often at very high speeds. Regional weather conditions associated with high pressure are cool temperatures, strong winds, and sunny skies. Low pressure is associated with warmer temperatures, cloudy skies, light winds, and precipitation. Extreme low pressure brings storms.

Jet stream: a region of high winds in the uppermost level of the troposphere at the boundary of polar and sub-polar air masses. The high winds in the jet stream are created (in part) by Earth's rotation. Since polar air masses generally encircle both north and south polar regions, jet streams also circle the globe (one in each hemisphere). They mark the edge of polar air masses. Air masses are constantly moving, however, and so the jet stream varies from being relatively straight to curvy, depending on the shape of the polar air mass. Curved areas in the jet stream stimulate rotation in frontal and help generate continental-scale storms called mid-latitude cyclones. Because the jet stream follows the polar front, and polar air only extends over the United States in wintertime, most mid-latitude cyclones storms occur in winter and are commonly referred to as winter storms.

Storm (also called a *cyclone*): any organized low pressure system that typically includes clouds, precipitation and wind. Minor storms differ from major storms by their magnitude, both in the size of the area affected and the intensity of the storm effects. A major storm is one that affects a large area—often multiple states—with severe weather. Sometimes the conditions that generate storms become caught in a repeating pattern, so that a series of storms impact the same area week after week. The cumulative effect of these storms can be much more hazardous than just one storm. Changes in climate also change patterns in storm formation and the regions that are exposed to hazardous storm conditions.

Blizzard: a major winter storm that combines hurricane force winds, heavy snowfall (often over two feet), and cold temperatures. Dangerous conditions exist because of low visibility and severe windchill. Heavy snows and high winds increase the probability of power outages and road closures. Blizzard conditions develop when polar or Arctic air masses and tropical maritime air masses collide along a frontal boundary, in combination with a rapid change in air pressure across the region.

Storm surge: the rise in height of sea or lake water caused by a combination of very low atmospheric pressure and high waves. As air pressure at the center of the storm drops and winds respond by becoming stronger, the potential height of storm surge increases. Storm surge often increases sea level elevation by 5–10 feet above the tide height. This does not include wave

height, which can rise to an additional 10–15 feet above sea level. Storm surge is often the most damaging aspect of a coastal storm in terms of lives and infrastructure lost. The National Oceanic and Atmospheric Administration (NOAA) has an excellent compilation of major storm surge events at http://www.stormsurge.noaa.gov/event_history.html

Storm Types:

I. *Tropical storms* form over large bodies of warm water. They are created when a large mass of very warm (tropical), moist air from just above the water surface rises into the upper troposphere leaving a region of low pressure at the water surface. As more warm surface air rushes in to fill the gap left by the rising air, it begins to rotate. If there is little wind shear present to disrupt the rising column of warm, moist air, the system can strengthen. This type of storm needs a continuous supply of warm, very moist air in order to sustain itself. Therefore, when tropical storms move over land or cooler water, they rapidly lose energy, winds weaken, and central lows disappear. The warm, moist airmass can remain, however, for days after the storm has died. Significant flooding often occurs many days after a tropical storm passes through a region because fronts develop around the boundaries of the residual air mass. Tropical storms that remain over warm water have an abundant energy supply and can last several weeks if wind shear is low. The season for tropical storms is generally June–November.

Tropical storms are much larger than thunderstorms, with stormy weather often reaching 100 miles out from the center of the low. There are three categories of tropical storm, each distinguished by maximum sustained wind speed near the center of the storm:

A. *Tropical depression* (winds under 40 mph)

B. *Tropical storm* (winds of 40–75 mph)

C. *Hurricane or typhoon* (winds over 75 mph)

i. Category 1: winds 75–95 mph

ii. Category 2: winds 96–110 mph

iii. Category 3: winds 111–130 mph

iv. Category 4: winds 131–155 mph

v. Category 5: winds over 155 mph (also called Super Typhoon)

II. *Winter storms* form in mid-latitudes (generally between 30–45°) around frontal systems that involve cold continental and warm maritime air masses. Because these systems involve entire air masses, they can be massive in size, often reaching 1,000 to 2,000 thousand miles across. It is not unusual for a winter storm to extend from the U.S. border with Mexico to the U.S. border with Canada and to last up to a week. The energy for winter storms comes from the rotation of the two air masses around a low-pressure area, in combination with a bend—or partial "loop"—in the jet stream. This bend allows the central area's low pressure to become even lower, which adds energy to the entire system. As a result, the air masses move faster, wind speeds pick up, and the frontal boundaries extend to in length, becoming 1,000 miles long or more, mixing zones of moist warm air and cold dry air. Long lines of clouds, heavy precipitation, and high winds accompany these regions of mixing at the frontal boundaries, creating heavy rains along the warm front and blizzard conditions along the cold front. Snow accumulations can reach several feet. In regions not quite cold enough for snow, sleet and freezing rain create thick layers of ice

that knock down power lines and trees and create extremely hazardous driving conditions. The season for winter storms in the continental United States is generally October–April.