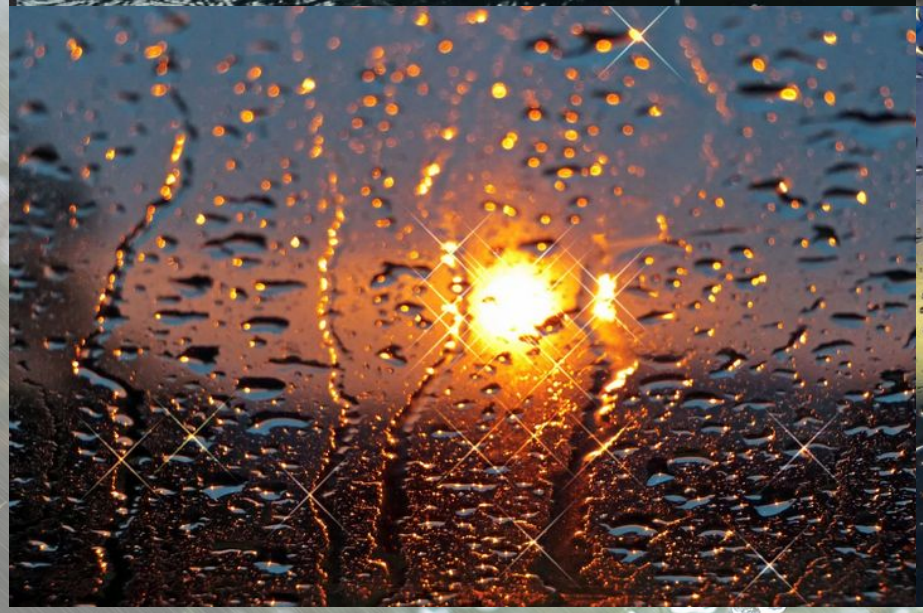
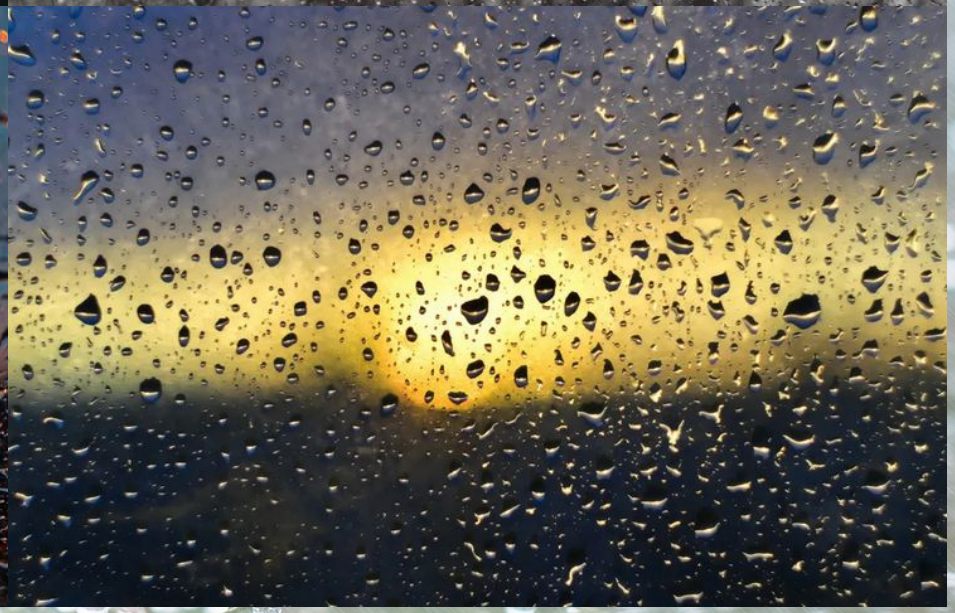
Rain



Rain is liquid water in the form of droplets that have condensed from atmospheric water vapor and then become heavy enough to fall under gravity. Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth. It provides suitable conditions for many types of ecosystems, as well as water for hydroelectric power plants and crop irrigation.

The major cause of rain production is moisture moving along three-dimensional zones of temperature and moisture contrasts known as weather fronts. If enough moisture and upward motion is present, precipitation falls from convective clouds (those with strong upward vertical motion) such as cumulonimbus (thunder clouds) which can organize into narrow rainbands. In mountainous areas, heavy precipitation is possible where upslope flow is maximized within windward sides of the terrain at elevation which forces moist air to condense and fall out as rainfall along the sides of mountains. On the leeward side of mountains, desert climates can exist due to the dry air caused by downslope flow which causes heating and drying of the air mass. The movement of the monsoon trough, or intertropical convergence zone, brings rainy seasons to savannah climes.

The urban heat island effect leads to increased rainfall, both in amounts and intensity, downwind of cities. Global warming is also causing changes in the precipitation pattern globally, including wetter conditions across eastern North America and drier conditions in the tropics. Antarctica is the driest continent. The globally averaged annual precipitation over land is 715 mm, but over the whole Earth it is much higher at 990 mm.

Climate classification systems such as the Köppen classification system use average annual rainfall to help differentiate between differing climate regimes. Rainfall is measured using rain gauges. Rainfall amounts can be estimated by weather radar.

Air contains water vapor, and the amount of water in a given mass of dry air, known as the mixing ratio, is measured in grams of water per kilogram of dry air. The amount of moisture in air is also commonly reported as relative humidity; which is the percentage of the total water vapor air can hold at a particular air temperature. How much water vapor a parcel of air can contain before it becomes saturated (100% relative humidity) and forms into a cloud (a group of visible and tiny water and ice particles suspended above the Earth's surface) depends on its temperature. Warmer air can contain more water vapor than cooler air before becoming saturated. Therefore, one way to saturate a parcel of air is to cool it. The dew point is the temperature to which a parcel must be cooled in order to become saturated.

There are four main mechanisms for cooling the air to its dew point: adiabatic cooling, conductive cooling, radiational cooling, and evaporative cooling. Adiabatic cooling occurs when air rises and expands. The air can rise due to convection, large-scale atmospheric motions, or a physical barrier such as a mountain (orographic lift).

Conductive cooling occurs when the air comes into contact with a colder surface, usually by being blown from one surface to another, for example from a liquid water surface to colder land. Radiational cooling occurs due to the emission of infrared radiation, either by the air or by the surface underneath. Evaporative cooling occurs when moisture is added to the air through evaporation, which forces the air temperature to cool to its wet-bulb temperature, or until it reaches saturation.

The main ways water vapor is added to the air are: wind convergence into areas of upward motion, precipitation or virga falling from above, daytime heating evaporating water from the surface of oceans, water bodies or wet land, transpiration from plants, cool or dry air moving over warmer water, and lifting air over mountains. Water vapor normally begins to condense on condensation nuclei such as dust, ice, and salt in order to form clouds. Elevated portions of weather fronts (which are three-dimensional in nature) force broad areas of upward motion within the Earth's atmosphere which form clouds decks such as altostratus or cirrostratus. Stratus is a stable cloud deck which tends to form when a cool, stable air mass is trapped underneath a warm air mass. It can also form due to the lifting of advection fog during breezy conditions.

Coalescence occurs when water droplets fuse to create larger water droplets. Air resistance typically causes the water droplets in a cloud to remain stationary. When air turbulence occurs, water droplets collide, producing larger droplets.
Black Rain Clouds

As these larger water droplets descend, coalescence continues, so that drops become heavy enough to overcome air resistance and fall as rain. Coalescence generally happens most often in clouds above freezing, and is also known as the warm rain process. In clouds below freezing, when ice crystals gain enough mass they begin to fall. This generally requires more mass than coalescence when occurring between the crystal and neighboring water droplets. This process is temperature dependent, as supercooled water droplets only exist in a cloud that is below freezing. In addition, because of the great temperature difference between cloud and ground level, these ice crystals may melt as they fall and become rain.

Raindrops have sizes ranging from 0.1 to 9 mm mean diameter but develop a tendency to break up at larger sizes. Smaller drops are called cloud droplets, and their shape is spherical. As a raindrop increases in size, its shape becomes more oblate, with its largest cross-section facing the oncoming airflow. Large rain drops become increasingly flattened on the bottom, like hamburger buns; very large ones are shaped like parachutes.

Contrary to popular belief, their shape does not resemble a teardrop. The biggest raindrops on Earth were recorded over Brazil and the Marshall Islands in 2004 — some of them were as large as 10 mm. The large size is explained by condensation on large smoke particles or by collisions between drops in small regions with particularly high content of liquid water.

Rain drops associated with melting hail tend to be larger than other rain drops.

Intensity and duration of rainfall are usually inversely related, i.e., high intensity storms are likely to be of short duration and low intensity storms can have a long duration.