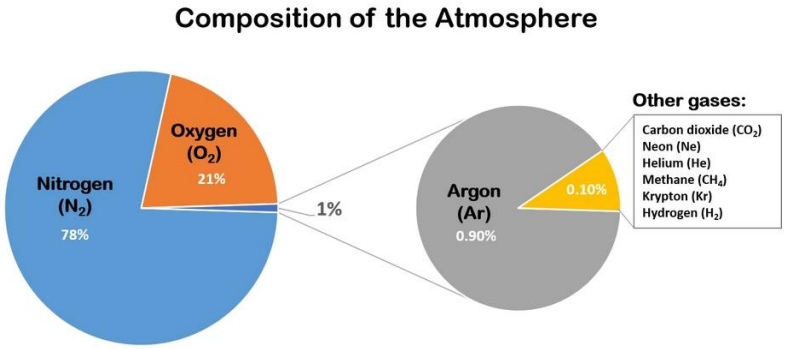
As previously discussed, the atmosphere is a collective layer of gas. The air that fills our atmosphere is composed of many different gases

Components of the Atmosphere



Besides these gases, the atmosphere is also composed of minor and variable components such as water vapor, aerosols, and ozone that vary in abundance depending on time, location, and other factors.

Despite occurring in relatively small amounts, these components are still very important and can have significant effects on the atmosphere.

1. Water Vapor.

Water vapor is the primary source of precipitation and cloud formation in the atmosphere and thus, a very important factor when predicting the weather.

Water vapor is also one of the most important greenhouse gases because it helps absorb heat that radiates from the Earth, heating the atmosphere.

Greenhouse gases (GHG) are gases that trap heat in the Earth's atmosphere and include other gases such as carbon dioxide, methane, nitrous oxide, and ozone. **Humidity** refers to the amount of water vapor or moisture in the atmosphere.

2. Aerosols

These are minuscule solid and liquid particles that are suspended in the air. Common examples of aerosols are smoke, pollen, sea salt, dust, airborne microorganisms, and other natural or man-made sources.

Because of their size and weight, aerosols can remain suspended in the air for long periods of time (even years!). Aerosols have two important functions in the atmosphere: (1) They can be "cloud seeds" or **cloud condensation nuclei** upon which clouds form and (2) they can also **absorb, reflect, and scatter incoming solar radiation from the Sun**, preventing harsh amounts of UV rays that can be damaging to Earth's inhabitants.

3. Ozone

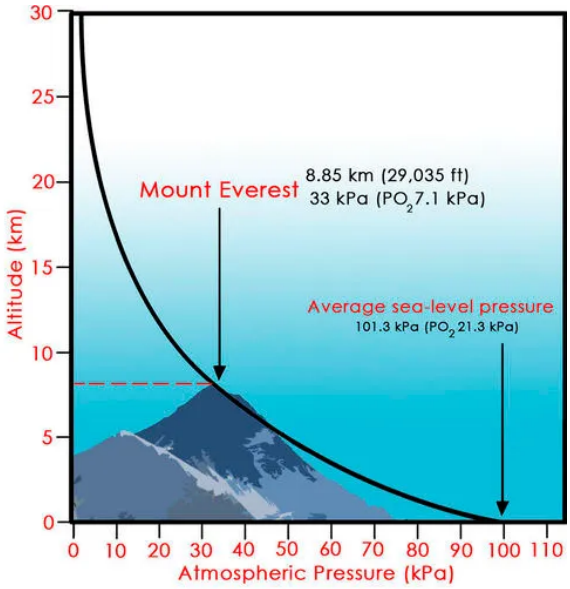
As previously discussed, ozone is one of the primary GHG (greenhouse gases) in the atmosphere. It is a form of oxygen with three oxygen atoms in each molecule (O_3).

Like aerosols, ozone plays an important part in absorbing potentially harmful UV radiation from the Sun. Ozone depletion became a global issue in the 20th century primarily due to the overuse of chlorofluorocarbons (CFCs) that entered the atmosphere and broke down the ozone. This problem was addressed with the implementation of the **Montreal Protocol** by the United Nations in order to ban the production and use of CFCs starting in 1987.

Parts of the Atmosphere

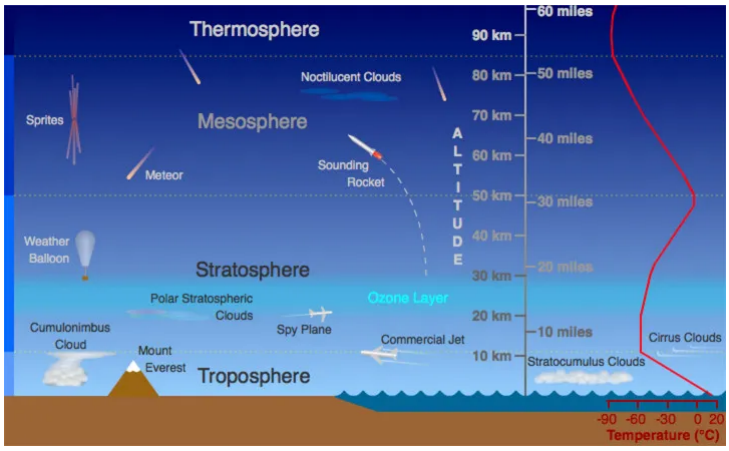
The atmosphere is not uniform all throughout. In fact, as you go from the bottom (Earth's surface) to the top (towards space), you will observe changes in temperature and pressure.

As you go up the atmosphere, the **pressure decreases** due to fewer air molecules "pressing down" on you. Most of the air molecules are heavy and are concentrated near the surface of the Earth.



Credit: CK-12 Foundation2020

On the other hand, temperature changes differently as you go from one atmospheric layer to another. Let's take a look at the different layers of the atmosphere.



Credit: UCAR-NCAR

1. Troposphere

This is the lowest layer of the atmosphere. In this layer, temperature decreases with increasing altitude. The troposphere is the most important layer for meteorologists because **all of the weather phenomena occur here**.

The outermost boundary of the troposphere is called **tropopause**.

2. Stratosphere

The temperature in this region increases with altitude because **the ozone layer is located here**.

As discussed earlier, the ozone layer becomes hot due to the absorption and trapping of UV rays from the Sun. Commercial airplanes fly in the lower portions of the stratosphere because of the less frequent turbulence experienced, unlike in the troposphere.

The end of the stratosphere is marked by **stratopause**.

3. Mesosphere

The coldest temperatures in the atmosphere (around -90°C) can be found at the end of this layer at the **mesopause**. The mesosphere **protects us from meteors** by burning up most meteors and asteroids before they reach the Earth's surface.

4. Thermosphere

Temperatures start to rise again in this layer due to the constant absorption of high-energy radiation from the Sun by atoms of oxygen and nitrogen. It is in this layer **where satellites orbit around the Earth**.

At the end of the thermosphere is a very thin layer of air called the **exosphere** which is considered the "final frontier" of the atmosphere.

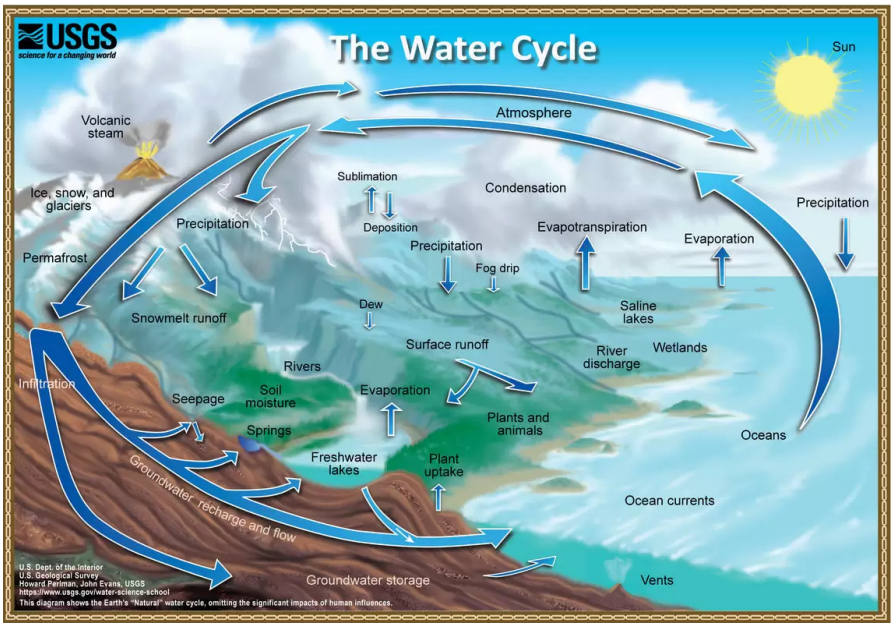
Weather versus Climate

As mentioned above, the troposphere is the layer in which all weather phenomena occur. The study of weather phenomena is called meteorology.

Weather refers to the conditions of the atmosphere in a region over a short period of time. **Climate**, on the other hand, is the long-term behavior of the atmosphere over a region.

Meteorologists use humidity, air pressure, temperature, wind, and other factors in order to gain a better understanding of weather and climate in a region.

The Hydrological Cycle



Credit: USGS

Water is inexplicably tied to a lot of Earth processes, including processes in the atmosphere.

Water goes through a constant journey of evaporation and condensation called the hydrological cycle or water cycle that is primarily driven by the radiation from the Sun. Regardless of what we can observe on the Earth's surface, the hydrological cycle occurs continuously for millions of years above, on, and below the ground.

Although the water cycle does not have a starting point, we can start in the ocean, where the heat from the Sun evaporates water into vapor. These water vapors are then transported into the atmosphere due to rising air currents where they form clouds.

Colder temperatures in the atmosphere encourage clouds to condense and precipitate. Precipitation reaches the surface of the Earth and flows down slopes as **runoff**. Some of the water seeps into the ground and replenishes the groundwater in **aquifers** (underground freshwater reservoirs).

Eventually, all rivers and streams arrive at their ultimate destination, the ocean, and the cycle repeats.

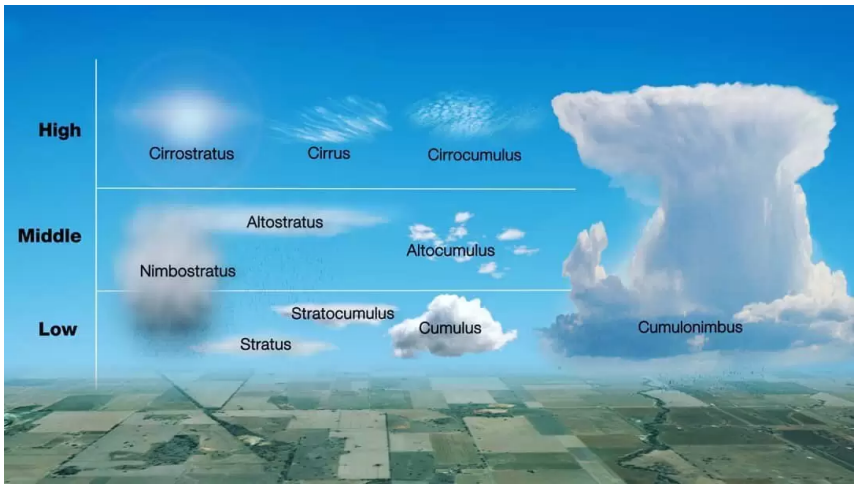
Indeed, the hydrological cycle is an important system upon which all of the Earth's residents depend on.

Cloud Formation.

Clouds are one of the easily observable indicators of weather conditions.

Clouds start out when water vapor in the air changes to liquid in a process called **condensation** and forms around a "cloud seed" or condensation nuclei (aerosols). Soon, a cloud is formed from millions of tiny cloud droplets.

There are different types of clouds that are classified according to form and height. Based on height, there are **low clouds** (0-2000 m), **middle clouds** (2000-6000 m), and **high clouds** (over 6000 m).



Credit: GeeTheCurious

There are three main types of clouds based on form:

1. **Cirrus clouds** (From Latin word *cirrus* meaning “lock of hair”). These are thin, wispy, and white clouds that resemble hair.
2. **Stratus clouds** (From Latin word *stratum* meaning “layer”). These are thin layers of clouds that cover extensive portions of the sky.
3. **Cumulus clouds** (From Latin word *cumulo* meaning “a heap”). These are big, cotton candy-looking clouds that can stack vertically in a tower-like manner.

Combinations of these basic forms result in the formation of different cloud types.

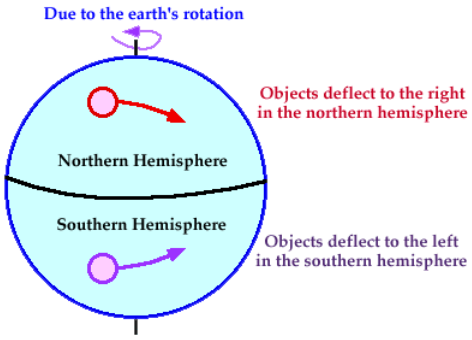
Wind Formation

The wind is generated when air flows from regions of high pressure to regions of low pressure caused by the unequal heating of the Earth’s surface. It is controlled by the following factors:

1. Pressure Gradient Force

Physics tells us that when an object encounters an unbalanced force in one direction, it will accelerate in the same direction. This is what happens when there are horizontal pressure differences in the air. This variation in air pressure is the driving force of the wind.

2. Coriolis Effect



Credit: University of Illinois

When the wind moves, it does not go in a straight line. It is deflected from its original path due to the Earth's rotation in a phenomenon called the **Coriolis Effect**.

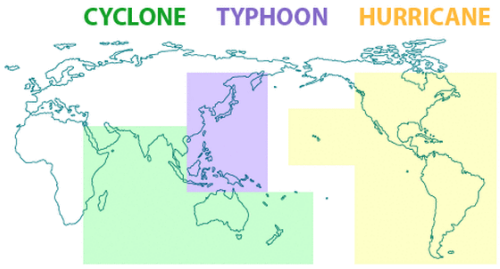
The Earth spins in a **counterclockwise** direction and so, all free-moving objects (including the wind) are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

3. Friction.

Friction with the Earth's surface is caused by the terrain the winds encounter. This could include mountains, hills, forests, and even man-made structures that hinder the flow of wind.

Other types of weather phenomena.

1. Typhoons, hurricanes, and cyclones



Credit: GE16-B/Weebly

These refer to the same thing: areas of low pressure that form over oceans that are characterized by a spiral movement of viral winds. The only difference between them is where they formed.

Typhoons are storms that form in the Western Pacific. **Hurricanes** are storms that form in the Atlantic Ocean and Eastern Pacific, while **cyclones** form over the South Pacific and the Indian Ocean.

2. Thunderstorms.

These are associated with cumulonimbus clouds, heavy rainfall, thunder, lightning, and sometimes tornadoes. They are caused by the upward movement of air that is moist and warm. **Lightning** is caused by the electric charge that results from the collision of ice crystals (cloud droplets) in the air.

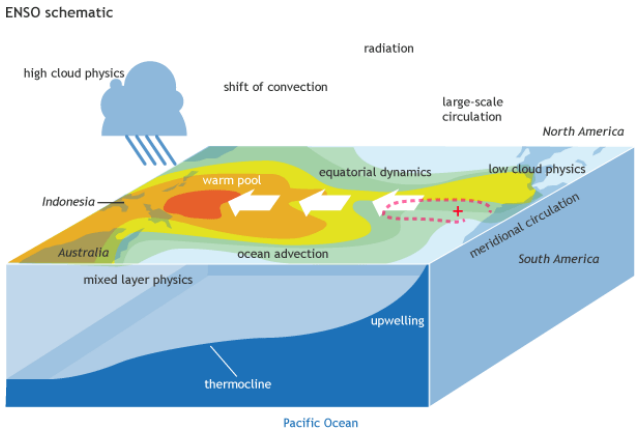
3. Tornadoes.

These are columns of violently spinning air that extend downwards from cumulonimbus clouds. Most tornadoes are short-lived but can still cause extensive damage to property, nature, and life along their path.

4. Precipitation.

Precipitation occurs when any form of water particles descend from the atmosphere towards the Earth's surface. The most common form of precipitation is **rain** (water droplets). Other types of precipitation can include **sleet** (pellets of ice), **hail** (lumps of ice), **snow** (ice crystals), and **drizzle** (very fine water droplets).

5. El Niño.



Credit: Eric Guilyardi/NOAA – Climate.gov

This is a weather pattern that affects countries near the Southern Pacific Ocean.

During normal conditions, wind along the equator pushes warm surface water near South America towards the Western Pacific countries (such as Indonesia, Philippines, etc.). The warm surface water is soon replaced by cooler water from underneath.

However, during El Niño, warm water from the Western Pacific flows instead towards South America and up north towards the western portion of North America. This phenomenon induces changes in weather patterns, marine fisheries, and ocean conditions.

El Niño is part of a weather cycle called **El Niño-Southern Oscillation (ENSO)** and is known as the warm phase of ENSO. **La Niña**, the cold phase, can be considered as the opposite of El Niño.

The **Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA)** is the authority on all meteorological, climatological, and astronomical phenomena related to the Philippines. As seen on the news, PAGASA is responsible for monitoring tropical cyclone activity within the **Philippine Area of Responsibility (PAR)**.