

# Meteorology

- is the scientific study of the atmosphere that focuses on weather processes and forecasting.

- **Earth's atmosphere** is a layer of gases surrounding the planet Earth and retained by the Earth's gravity. It contains 78% nitrogen and 21% oxygen, with trace amounts of other gases. The atmosphere protects life on Earth by absorbing ultraviolet solar radiation and reducing temperature extremes between day and night.

## Temperature and the atmospheric layers

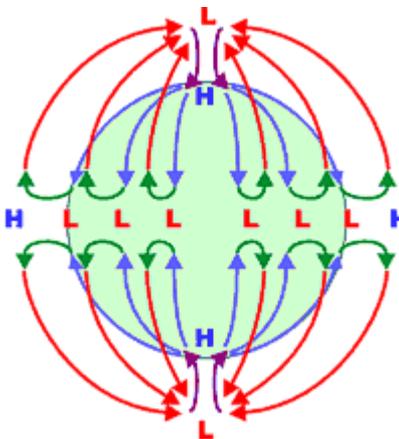
The temperature of the Earth's atmosphere varies with altitude; the mathematical relationship between temperature and altitude varies between the different atmospheric layers:

- **troposphere** is the lowest layer of the atmosphere starting at the surface going up to between 7 km at the poles and 17 km at the equator with some variation due to weather factors. The troposphere has a great deal of vertical mixing due to solar heating at the surface. This heating warms air masses, which then rise to release latent heat (describes the amount of energy in the form of heat that is required for a material to undergo a change of phase). This process continues until all water vapor is removed. In the troposphere, on average, temperature decreases with height due to expansive cooling.
- **stratosphere**: from that 7–17 km range to about 50 km, temperature increasing with height.
- **mesosphere**: from about 50 km to the range of 80 km to 85 km, temperature decreasing with height.
- **thermosphere**: from 80–85 km to 640+ km, temperature increasing with height.

## Various atmospheric regions

Atmospheric regions are also named in other ways:

- **ionosphere** – the region containing ions: approximately the mesosphere and thermosphere up to 550 km.
- **Exosphere** – above the ionosphere, where the atmosphere thins out into space.
- **ozone layer** – or ozonosphere, approximately 10 - 50 km, where stratospheric ozone is found. Note that even within this region, ozone is a minor constituent by volume.



**Atmospheric circulation** – At the equator warm air rises forming an area of low pressure. It moves towards the poles and at the sub-tropics (20-30 North and South) this air sinks because it is colder and denser. This forms high pressure at the sub-tropics. From here, air returns to the equator its rising air. On the other hand cold and dense air sinks at the poles and move outwards to the mid-latitudes

## Weather and climate

- **Weather** - describes whatever is happening outdoors in a given place at a given time. Weather is what happens from minute to minute. The weather can change a lot within a very short time. For example, it may rain for an hour and then become sunny and clear.
- **Climate** - describes the total of all weather occurring over a period of years in a given place. This includes average weather conditions, regular weather sequences like winter, spring, summer, and fall, and special weather events like tornadoes and floods.
- An **air mass** is a large body of air of relatively similar temperature and humidity characteristics covering thousands of square kilometers. Typically, air masses are classified according to the characteristics of their **source region** or area of formation. A source region can have one of four temperature attributes: *equatorial*, *tropical*, *polar* or *arctic*. Air masses are also classified as being either *continental* or *maritime* in terms of moisture characteristics
- A **depression** is an area of low pressure caused by rising air. This is opposite to an **anti-cyclone** which is an area of high pressure. Water vapour in the rising air cools and condenses to form clouds and precipitation. For this reason depressions normally bring cloudy, wet and windy weather.
- A **hurricane** is an intense cyclonic storm consisting of an organized mass of thunderstorms that develops over the warm oceans of the tropics. To be classified as a hurricane, winds speeds in the storm must be greater than 118 kilometers per hour.
- A **tornado** is a violent spinning storm typically shaped like a funnel with the narrow end on the ground. Tornadoes are developed from thunderstorms. They are believed to be produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. (Boston, New York, Philadelphia, Washington). Air masses, all moving different directions, set up shearing conditions and create spin in a thundercloud.
- A **cloud** is a visible mass of condensed droplets or ice crystals suspended in the atmosphere above the surface of the Earth or another planetary body. The branch of meteorology that studies clouds is nephology.
- **Cloud formation** - clouds form when the invisible water vapor in the air condenses into visible water droplets or ice crystals. This can happen in three ways.

1. The air is cooled below its saturation point. This happens when the air comes in contact with a cold surface or a surface that is cooling by radiation.

2. Clouds can be formed when two air masses below saturation point mix. Examples are breath on a cold day.

3. The air stays the same temperature but absorbs more water vapor into it until it reaches saturation.

- **Classification of clouds: altitude and appearance**
  1. **High - Level Clouds** - form above 6,000 meters and since the temperatures are so cold at such high elevations, these clouds are primarily composed of ice crystals. **altitude**
  2. **Mid-Level Clouds** The bases of mid-level clouds typically appear between 2,000 to 6,000 meters. Because of their lower altitudes, they are composed primarily of water droplets, however, they can also be composed of ice crystals when temperatures are cold enough. **Altitude**

3. **Low clouds** are of mostly composed of water droplets since their bases generally lie below 2,000 meters. However, when temperatures are cold enough, these clouds may also contain ice particles and snow. **altitude**
  4. **Vertically Developed Clouds** - these clouds can grow to heights in excess of 12,000 meters, releasing incredible amounts of energy through the condensation of water vapor within the cloud itself. **appearance**
- **Rain** is a form of precipitation, other forms of which include snow, sleet, hail, and dew. Rain forms when separate drops of water fall to the Earth's surface from clouds. Not all rain reaches the surface, however; some evaporates while falling through dry air. Measured by **rain gauge**.

#### **Types of rain:**

1. **Relief (orographic) rain** – air from a sea is forced to cool when it rises over relief features in the landscape(hills or mountains). As it rises it cools, condenses and forms **rain**.
  2. **Convection rain** – Under conditions of low pressure, the heated air will continue to rise, as it rises it cools.Low pressure leads to unstable air conditions => heated air = rising warm air = condensation = **rain**
  3. **Frontal rain** - it is caused when two air masses meet. For example when warm air mass meets a cold air mass. The warm air being less dense, will slide over the cold air. As it rises, it will cool and condense into cloud and **rain**.( New Zealand, Western Europe)
  4. **Monsoon rain** –Monsoons are caused by the fact that land heats up and cools down more quickly than water. In summer, land reaches a higher temperature than the ocean. The hot air over the land tends to rise, creating an area of low pressure. This creates an extremely constant wind blowing toward the land. Associated rainfall is caused by the moist ocean air being diverted upward by mountains, which causes cooling, and in turn, condensation.
- **A Fog** – cloud that is in contact with ground, saturated air by cooled or evaporated water.
  - **A Mist** – similar to fog but located in higher altitudes and thinner, typical for mornings in mountain areas.
  - **A Haze** – very thin and large mist. Haze can be seen from the top of a mountain in further distances.
  - Measuring the **temperature**. Temperature of the air is recorded by **Thermometer** in a **Stevenson Screen** (box painted white to reflect sunshine, stands 1 m above ground level, away from trees)
  - **Humidity** is the concentration of water vapor in the air. The concentration can be expressed as *absolute* humidity, *specific* humidity, or *relative* humidity. A device used to measure humidity is called a **hygrometer**.
  - **Atmospheric pressure** is the pressure above any area in the Earth's atmosphere caused by the weight of air. Air masses are affected by the general atmospheric pressure within the mass, creating areas of high pressure (anti-cyclones) and low pressure (depressions). Measured by **barometer**.
  - **Wind** – wind direction measured by a wind vane  
- wind speed recorded by an anemometer(kph, mps)