CLOUDS, THEIR ORIGIN AND TYPES

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Clouds are visible accumulations of water droplets or solid ice crystals that float in the Earth's troposphere moving with the wind.

From space, clouds are visible as a white blanket surrounding the planet. So in this session we are going to discuss the origin, types and also importance of clouds.

The topic is divided into following subheadings, they are….

- Origin of Clods
- Types of Clouds
- Atmospheric processes creating lift and clouds
- Colors of Clouds
- Importance of Clouds

1. Origin of clouds

- As defined by the World Meteorological Organization (WMO), it's primarily "a hydrometeor consisting of a visible aggregate of minute particles of liquid water or ice, or both, suspended in the free air and usually not touching the Earth's surface." Thus, clouds are the visible sign of ongoing atmospheric processes and as such they are a useful diagnostic tool.

- Clouds are made of tiny drops of water or ice crystals that settle on dust particles in the atmosphere. The droplets are so small – i.e., a diameter of about a hundredth of a millimeter – in which each cubic meter of air contain 100 million droplets.

Formation of clouds

Clouds form when the invisible water vapor in the air condenses into visible water droplets or ice crystals.

Clouds form when the air is saturated and cannot hold any more water vapour, this can happen in two ways:

- **The amount of water in the air has increased** - for example through evaporation - to the point that the air cannot hold any more water.
- **The air is cooled to its dew point** - the point where condensation occurs - and the air is unable to hold any more water.

- **Required elements for cloud formation:**

The first requirement for cloud formation is moisture.

This moisture is constantly recycled through the earth-atmosphere system by means of the hydrologic cycle.

Moisture in this cycle exists normally in the 3 states of water:

- solid,
- liquid, and
- vapor.

The primary way to cool the atmosphere is through upward vertical motion or lifting of air.

Thus the second requirement for cloud formation is a source of lift, through the following processes:

- Fronts associated with low pressure
- Systems Orographic or mountain barriers
- Convection
- Convergence (forced coming together of airflow)

2. TYPES OF CLOUDS

There are many kinds of clouds. The meteorologist classifies clouds mainly by their appearance.

1. **High clouds:** These clouds are high up in the sky, mean heights from 5 to 13 km, or 3 to 8 miles. The important high cloud types are,

   - Cirrus
   - Cirrocumulus
   - Cirrostratus

2. Middle clouds: Middle clouds are found between low and high clouds, mean heights 2 to 7 km, or 1 to 4 miles. The following are some important middle clouds

- Altocumulus
- Altostratus
- Nimbostratus

3.Low clouds: Low clouds form closer to Earth's surface. Low clouds can even touch the ground, mean heights 0 to 2 km, or 0 to 1.2 miles.. These clouds are called as fog. They are,

- Stratocumulus
- Stratus
- Cumulus
- Cumulonimbus

Another way the clouds are named is by their shape.

a) Cirrus clouds are high clouds - They look like feathers.

b) Cumulus clouds are middle clouds - These clouds look like giant cotton balls in the sky.

c) Stratus clouds are low clouds - They cover the sky like bed sheets.

Clouds of each genus are generally lower in the Polar Regions and higher in the tropics.

Four principal classes are recognized when clouds are classified according to the kind of air motions that produce them:

1. layer clouds formed by the widespread regular ascent of air.

2. layer clouds formed by widespread irregular stirring or turbulence.

3. cumuliform clouds formed by penetrative convection, and

4. orographic clouds formed by the ascent of air over hills and mountains.

What are the causes for cloud formation?

There are five factors which can lead to air rising, cooling and clouds formation.

- Surface heating
- Topography forcing
- Frontal
- Convergence
- Turbulence

The range of ways in which clouds can be formed and the variable nature of the atmosphere results in an enormous variety of shapes, sizes and textures of clouds.

3. Atmospheric processes creating lift and clouds

a. Clouds due to lift by fronts

b. Orograhic lift clouds

c. Lift due to convection

d. Convergence and lift

a. Clouds due to lift by fronts:

- In the case of a warm front, both the warm advancing air and the cold retreating air are moving in the same direction. As warm air glides up and over cold surface air (warm front), the clouds tend to be layered.
- In contrast, cold fronts cause more abrupt lifting with more intense localized vertical motion as the cold and warm air masses collide. This generally results in cumuliform clouds with showery conditions as the cold air undercuts and forces the warm air up.
- Frontal lift Clouds are generally of the stratiform layered type (stable) when associated with warm fronts. Cold fronts are generally associated with cumuliform clouds (unstable). Thunderstorms are most likely with cold fronts but can accompany warm fronts.

b) Orograhic lift clouds:

Orographic clouds are clouds that develop in response to the forced lifting of air by the earth's topography (mountains for example).

Orographic lift occurs when an air mass is forced from a low elevation to a higher elevation as it moves over rising terrain. As the air mass gains altitude it quickly cools down adiabatically, which can raise the relative humidity to 100% and create clouds and, under the right conditions, precipitation.

- **C. Lift due to convection:**

The earth's atmosphere is transparent to incoming solar radiation. Once this radiation hits the ground, it will convert to heat energy. As the ground warms, the air in contact with the ground is also warmed through conduction.

As the air is warmed, it becomes less dense, thus it rises (convection). However, as air rises it cools, with clouds ultimately forming over the updraft. The spacing of these up and down drafts results in the observed distribution of cumulus clouds. On the edges of the clouds, cool air sinks to replace the warm air rising, thereby completing the convection cell.

D. Convergence and lift:

Another source of lift, which is really a combination of the above processes, is convergence. When air is forced to converge or come together, it can only go upward (can't go into the ground). An example would be the air flowing inward toward the center of low pressure which is forced to rise.

4. **COLORS OF CLOUDS**

Clouds are white because the water droplets are bigger than the particles that scatter the blue light in the sky. The clouds scatter and reflect all the visible colors of light that strike them. Since the visible colors of the sun appear to be white, the clouds that reflect that light must be white too. So clouds are white because they reflect the white light from the sun.

- In some cases, if the cloud is super thick or filled with a lot of water molecules; sunlight cannot pass through the cloud. Therefore, clouds can appear very dark because of the lack of sunlight shining through.

- The white colors of clouds come from the condensed water vapor having a high reflective quality.

- The grey color comes from seeing clouds from beneath.

- On cloudy days most sunlight is blocked by the translucent and refractive quality of cloud cover. This makes clouds appear darker in color as part of the light has been uniformly absorbed.

- The color of a cloud also depends on the color of the light that illuminates it.
- When sunlight passes through thick layer of atmosphere and dust particles at sunset, blue color is scattered by Rayleigh scattering and only red-to-orange color remains.
- The clouds reflect these unscattered red/orange rays and appear in that color. The effect is much like shining a red spotlight on a white sheet.
- Since the Earth is spherical, the clouds at different heights turn red at different time when the sun crosses the horizon.

- Just before the sunset, the color of low clouds (e.g. stratus) will turn red first. Shortly after the sunset, the high clouds (e.g. cirrus) would be gradually stained in deep red and become apparent under the darken background.

- Thin clouds will generally appear white under the white moonlight.

- Finally, clouds have color. Some are white, some are grey, and in special circumstances such as major storms can have weird colors like green or red.

5. **Importance of clouds**

Clouds are essential to the earth-atmosphere system. Clouds complete the following functions:

- Clouds help to regulate Earth's energy balance by reflecting and scattering solar radiation and by absorbing Earth's infrared energy.
- They are required for precipitation to occur and, hence are an essential part of the hydrologic cycle.
- Clouds indicate what type of atmospheric processes are occurring (e.g., cumulus clouds indicate surface heating and atmospheric turbulence).

- Clouds help to redistribute the extra heat from the equator toward the poles.
- Clouds are important for many reasons. Rain and snow are two of those reasons. At night, clouds reflect heat and keep the ground warmer. During the day, clouds make shade that can keep us cooler.
- Clouds can have a cooling effect on the atmosphere, which counteract increases in temperature caused by climate change.

- Clouds affect the climate but changes in the climate, in turn, affect the clouds. This relationship creates a complicated system of climate feedbacks, in which clouds modulate Earth's radiation and water balances.

- Clouds are an important part of the water cycle. The water cycle is the movement of water from the Earth into the sky and then back down to Earth again.

- Clouds also have a major role in reflecting some of the Sun's short wavelength (visible light) radiation back into space. Thus clouds share a role with the greenhouse gases and also share a role with the ice and snow fields of the high latitudes.