Atmospheric Humidity and Precipitation

Mohd. Akram
Assistant Professor and Programme Coordinator
Department of Geography and Natural Resource Management
School of Earth and Environmental Science (SoEES)
Uttarakhand Open University, Haldwani (Nainital) Uttarakhand, India

Humidity

- The quantity of water present in the atmosphere in the form of water vapour is called humidity.
- **Hygrometry:** The scientific study of atmospheric humidity.
- **Measurement tool:** Humidity is measured by **Hygrometer** ((1) Hair hygrometer (2) Dew point hygrometer).
- **Hygrograph**: Humidity writer.

Humidity is expressed/measured in three ways

(1) Absolute Humidity (2) Specific Humidity (3) Relative Humidity

(4) Mixing Ratio

(1) Absolute Humidity

- A.H. is the total amount of water contained in a parcel/volume of air. In other word, A.H. is the mass of water vapor divided by the mass of dry air in a certain volume of air at a specific temperature.
- The warmer the air is, the more water it can absorb.
- Absolute humidity is the measure of water vapor or moisture in the air, regardless of temperature. It's expressed as grams of moisture per cubic meter of air (g/m^3).

(2) Specific Humidity

- **Specific humidity is** mass of water vapour in a unit mass of moist air, usually expressed as grams of vapour per kilogram of air. It is the actual amount of water vapour present per kg of mass of air.
- For instance- if 1 kg air holds 10 grams of water vapour, the specific humidity will be 10 grams per kg of air i.e. **10 g/kg**.
- The specific humidity of saturated air increases rapidly with increasing temperature.

(3) Relative Humidity

- **Relative humidity** is the ratio of the absolute humidity at a given time to the maximum moisture holding capacity, which depends on current air temperature. It is expressed in percentage (%).
- Relative humidity doesn't tell us how much water vapor is in the air, but what percentage of the maximum vapor pressure has been reached.
- For example, say the maximum vapor holding capacity of a certain volume of air is 100 kilograms of water. Supposed this volume of air is actually holding only 40 kilograms of water. The relative humidity would be 40 kilograms out of 100 kilograms, or 40%, because only 40% of the maximum vapor pressure/weight holding capacity is being used.

Mixing Ratio

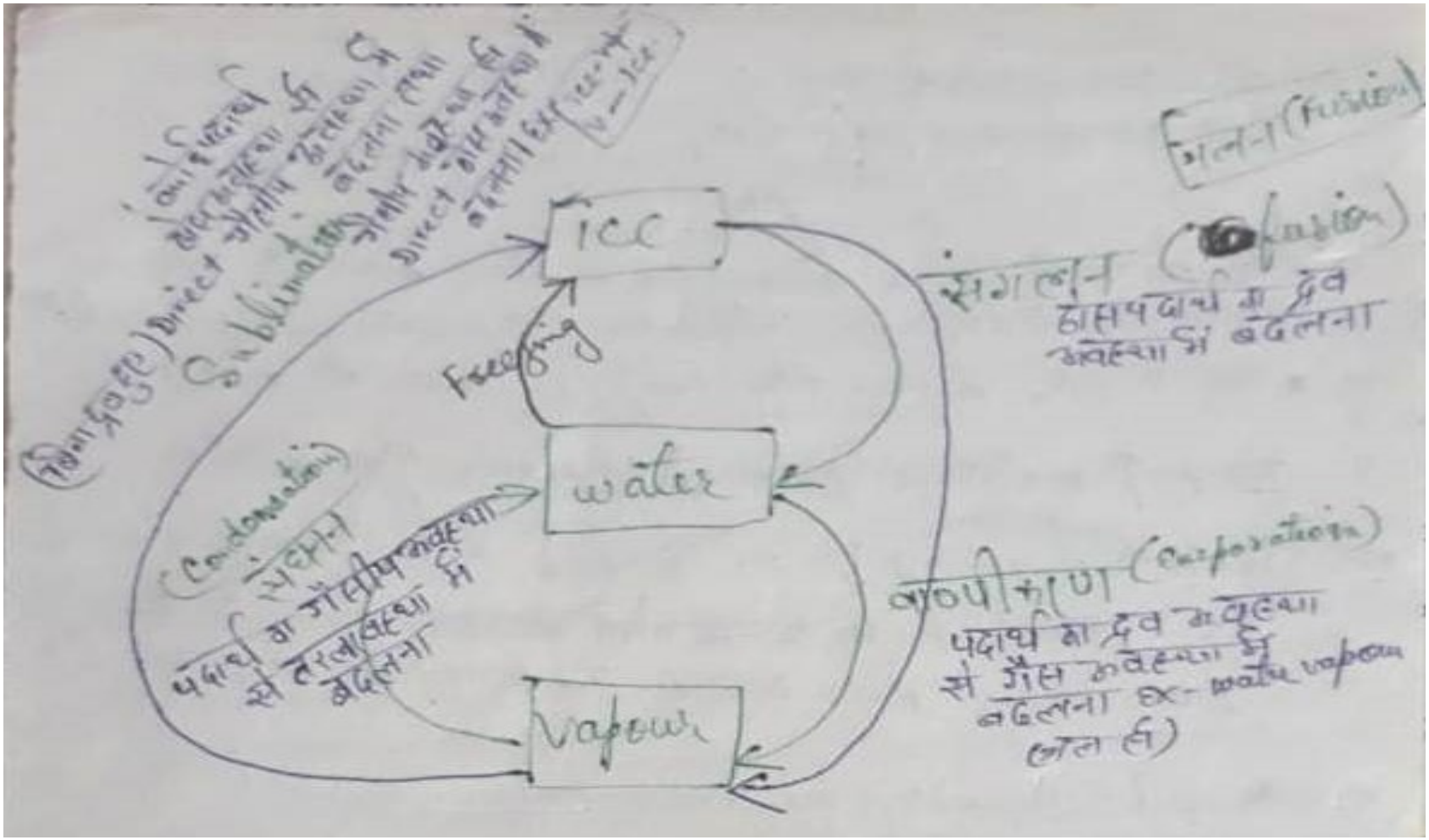
- The **mixing ratio is** defined as the **ratio** of the mass of water vapor in an air parcel to the mass of dry air for the same parcel.
- The **mixing ratio** is approximately equal to Specific **humidity.**
- As temperature decreases, the amount of water vapor needed to reach saturation also decreases.

Important Process and Terms

- **Latent heat**: the heat required to convert a solid into a liquid or vapour, or a liquid into a vapour, without change of temperature.
- **Fusion**: the process of causing a solid material to melt with intense heat. Example- changing of ice into liquid water.
- **Evaporation**: it happens when a liquid turns into a gas. When water is heated, it evaporates. The molecules move and vibrate so quickly that they escape into the atmosphere as molecules of water vapor. Evaporation is a very important part of the water cycle.
- **Sublimation**: **Sublimation** is the conversion between the solid and the gaseous phases of matter, with no intermediate liquid stage. It happens when ice or snow directly becomes vapour and water vapour directly becomes ice or snow.

  For example-sublimation is the process of snow and ice changing into water vapor in the air without first melting into water.

Freezing: it is a phase transition where a liquid turns into a solid when its temperature is lowered below its freezing point.



Condensation of Water Vapour

- **Condensation**: It is the process in which water vapour becomes liquid. It is the opposite of evaporation. This process can happen in two ways:

(1) When the air is cooled to its dew point.

(2) When the air becomes so saturated with water vapor that it cannot hold any more water.

Hygroscopic nuclei: are "water seeking" **nuclei**. Water vapor condenses on **hygroscopic** surfaces readily even when the relative humidity is considerably lower than 100 percent. Salt is an example of a **hygroscopic** particle.

Normal dust particles can not become hygroscopic nuclei.

Forms of Condensation

(1) Dew: The moisture that forms as a result of condensation. **Dew** forms as temperatures (due to terrestrial radiation) drop and objects cool down.

Dew point: temperature at which water in the air condenses to form water droplets on objects near the ground.

Condition for dew formation:

- Dew forms when night sky is clear and long.
- Calm air
- Temperature is above 0^0C.
- Relative Humidity must be 100%

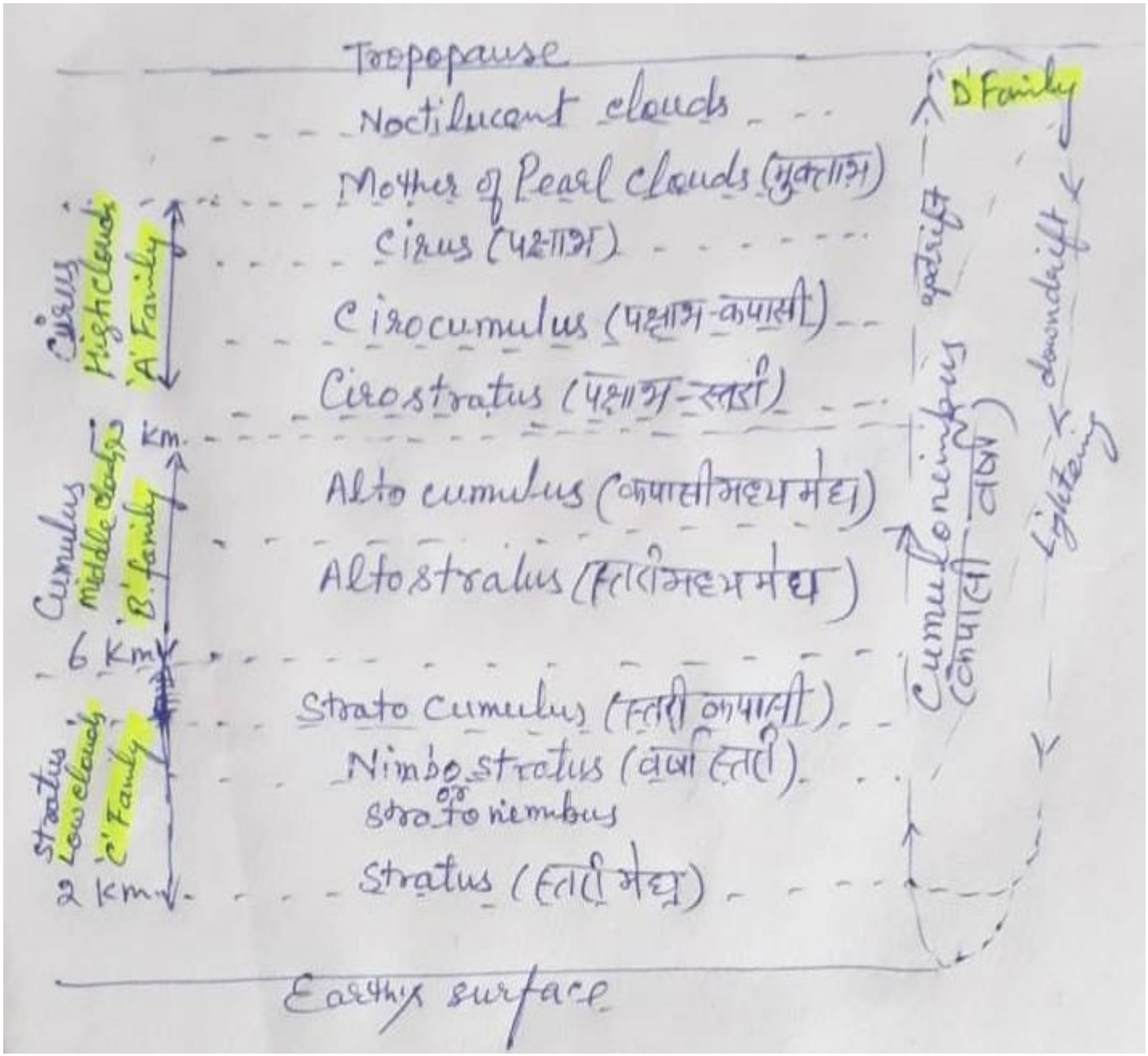
(2) Frost: **It** is water vapor that becomes solid due to temperature below 0^0C. **Frost** usually forms on objects like cars, windows, and plants that are outside in air that is saturated, or filled, with moisture. Areas that have a lot of fog often have heavy **frosts**. **Frost** forms when an outside surface cools past the dew point.

(3) Fog: fog is the stratus cloud that does not produce rain. Fog is found close the surface and causes haziness and sometimes invisibility.

(4) Clouds: clouds are visible aggregates/mass of water droplets, ice particles, or a mixture of both along with varying amounts of dust particles.

- A normal cloud contains billions of water droplets having diameters between 0.01 mm to 0.02 mm. Liquid and solid water accounts for less than 10 parts per million (ppm) of the cloud volume.
- Most of the clouds are formed due to lifting of air.
- Descending order of families of clouds causing heavy rainfall: D>B>C>A

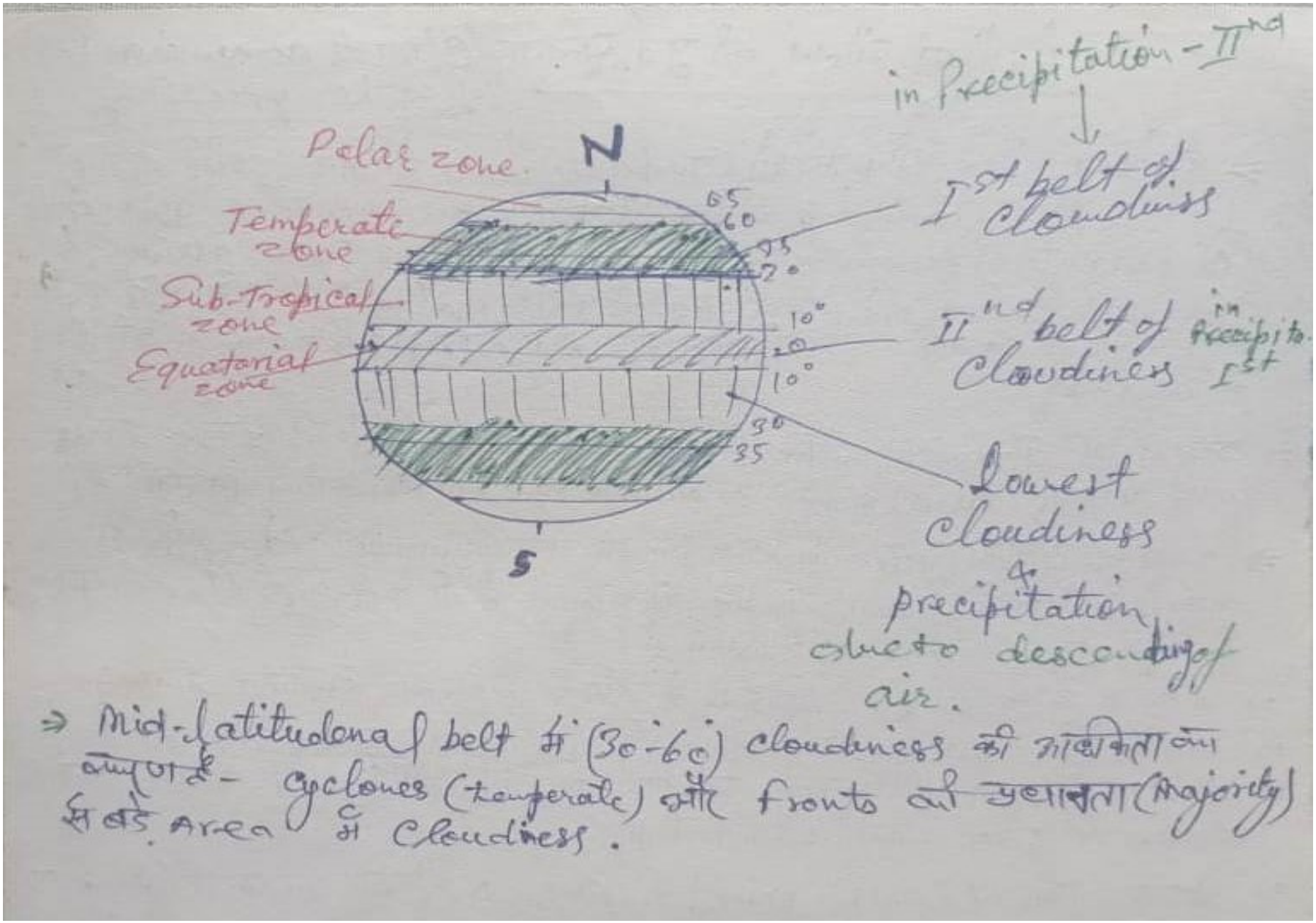
Types of Clouds



Some facts about clouds

- Almost 50% of earth is overcasted at any time. However rainfall occurs over only 3% of that overcasted area.
- Clouds are important in climate.
- Clouds reflect 23% of solar radiation.
- Clouds are found upto tropopause (due to convectional currents).
- The colour of clouds are based on height.
- Lightening.

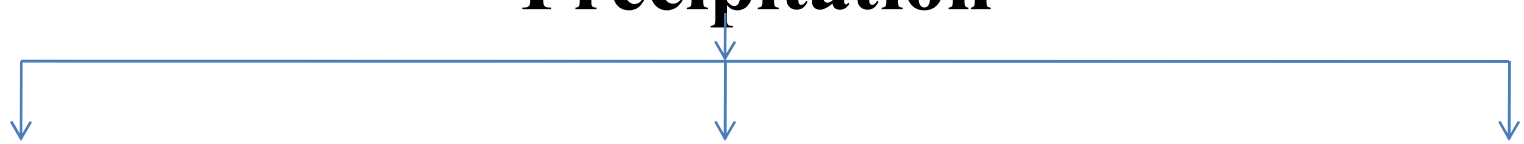
World distribution of cloudiness



Precipitation

- Precipitation is any liquid or frozen water that forms in the atmosphere and falls to the Earth.
- Precipitation is one of the three major parts of the global water cycle after *evaporation* and *condensation*.
- Precipitation forms in the clouds when water vapor condenses into bigger and bigger droplets of water. When the drops are heavy enough, they fall to the Earth.

Precipitation



Gaseous

1. Dew
2. Fog
3. Smog

Liquid

1. Drizzle
2. Mizzle
3. Rainfall
    1. Orographic rain
    2. Cyclonic rain
    3. Convectional rain
    4. Advectional rain

Solid

1. Snowfall
2. Hailstorm
3. Sleet

Orographic Rainfall

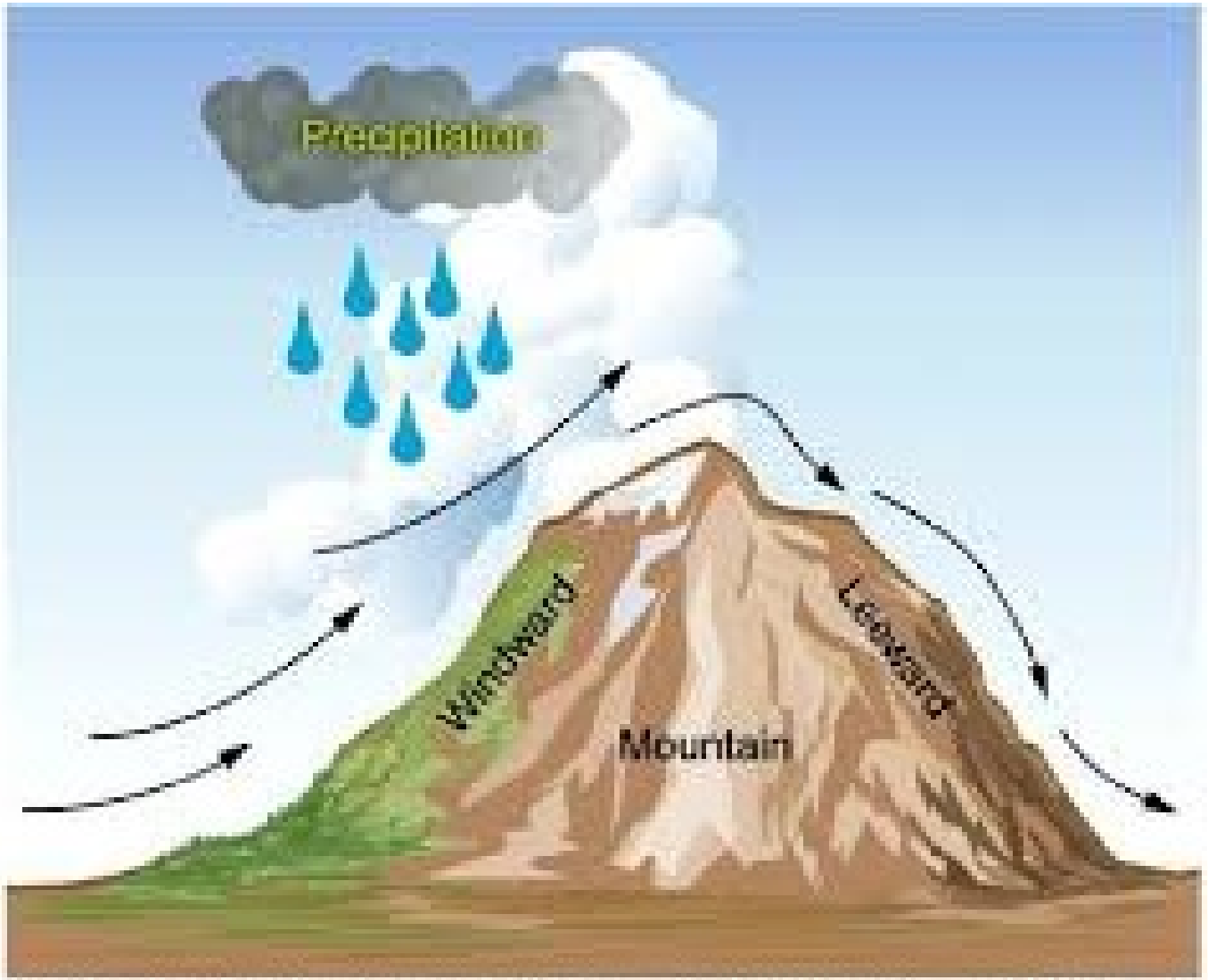
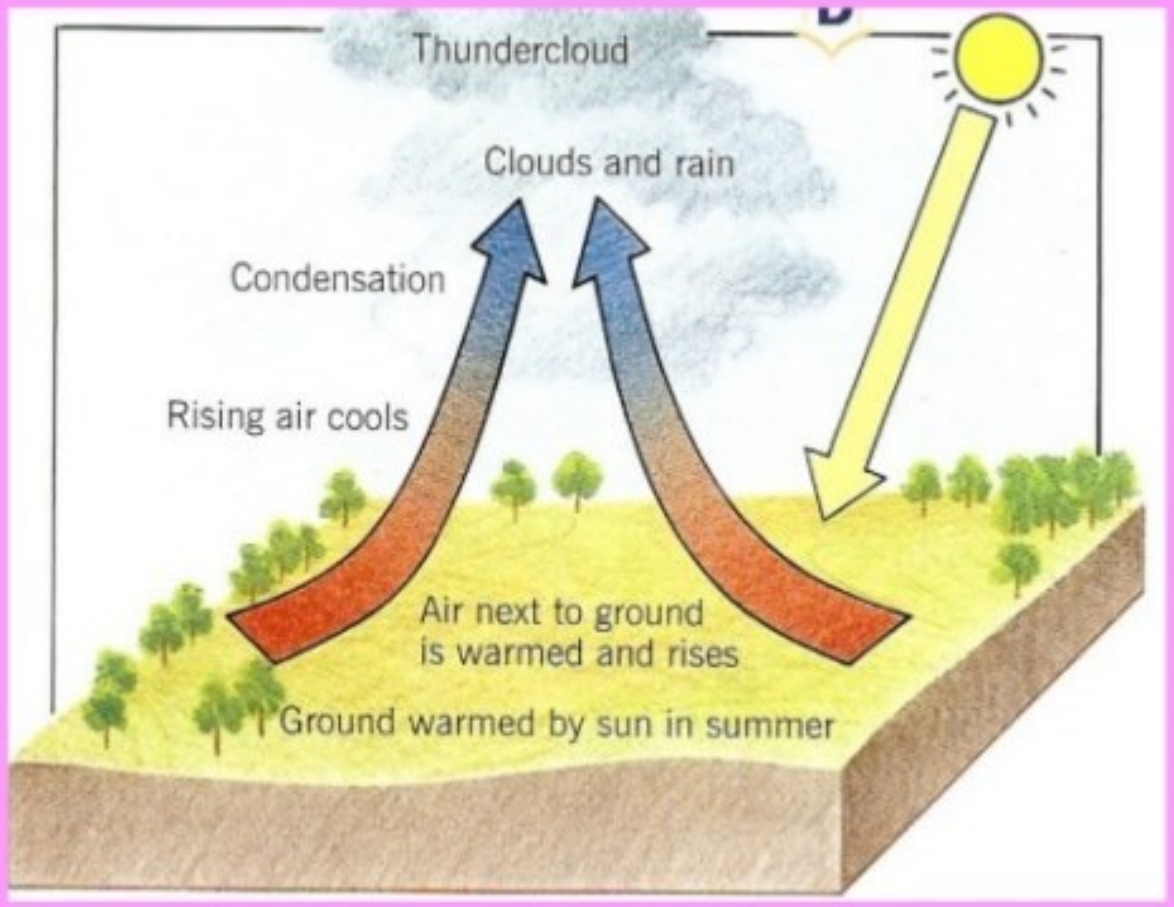
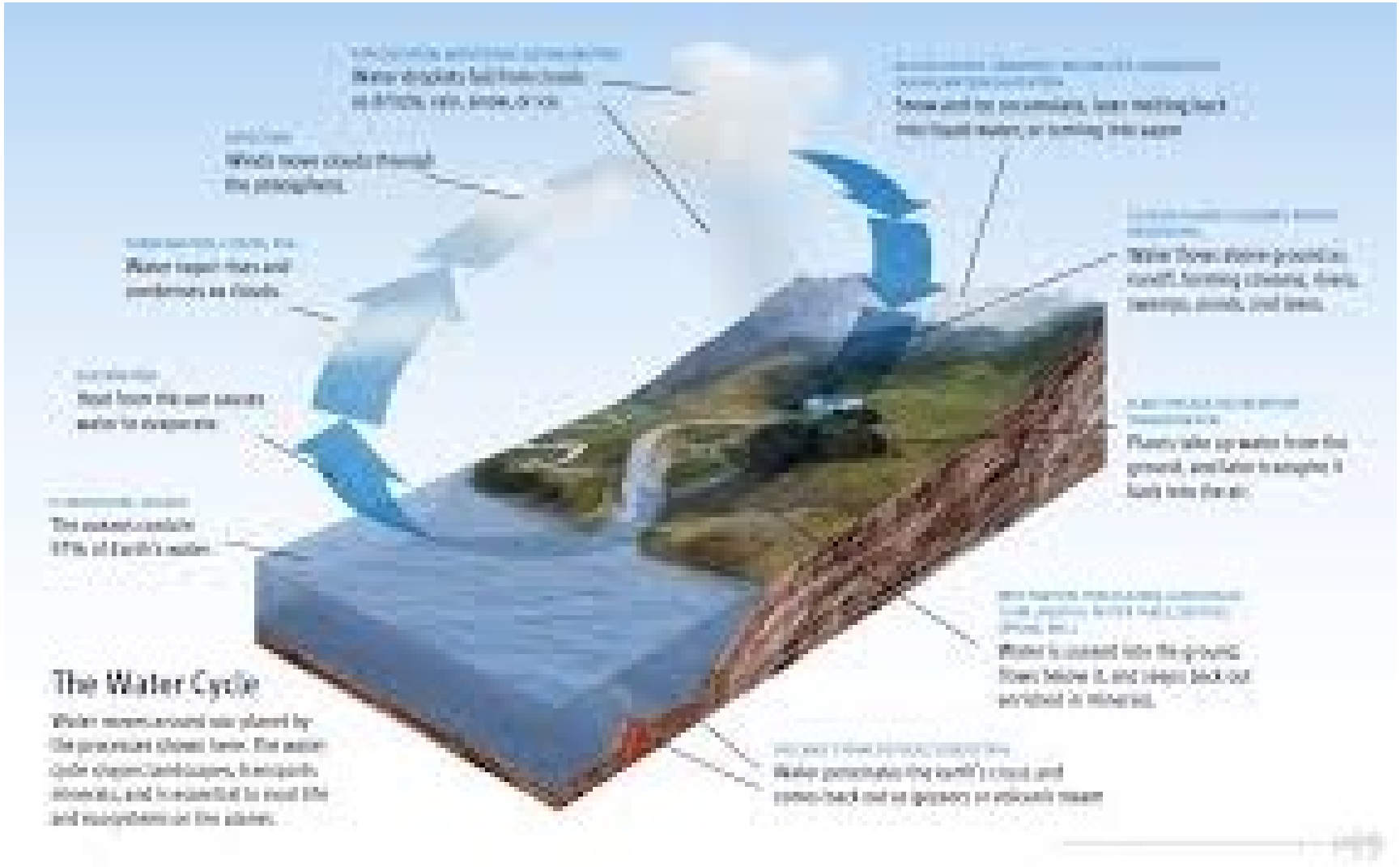


Fig. 2 showing the formation orographic or relief rainfall. (Source: Google search)

Convectional rainfall

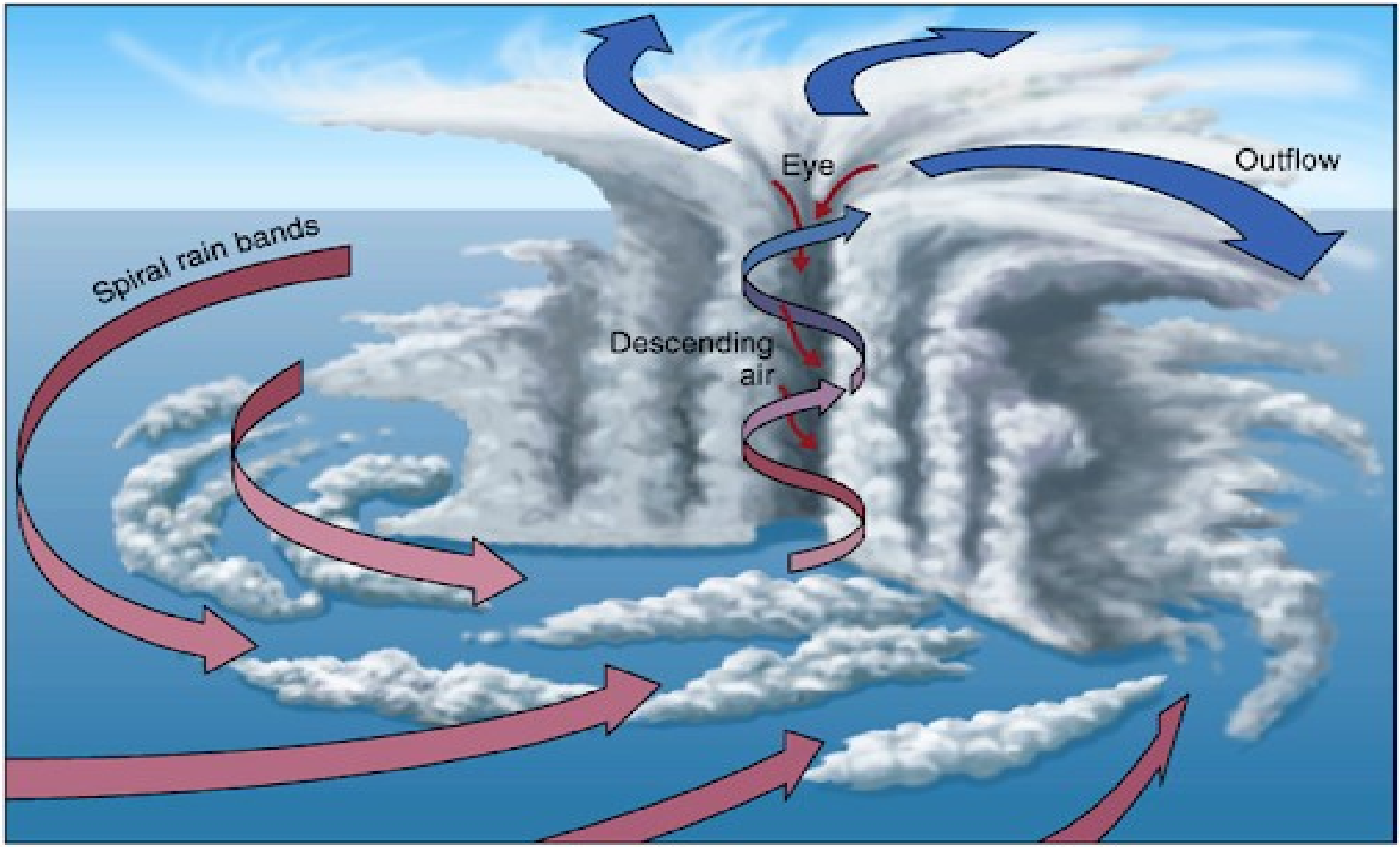


Advectionl Rainfall



Cyclonic Rainfall

Tropical Cyclonic Rainfall



Temperate Cyclonic Rainfall