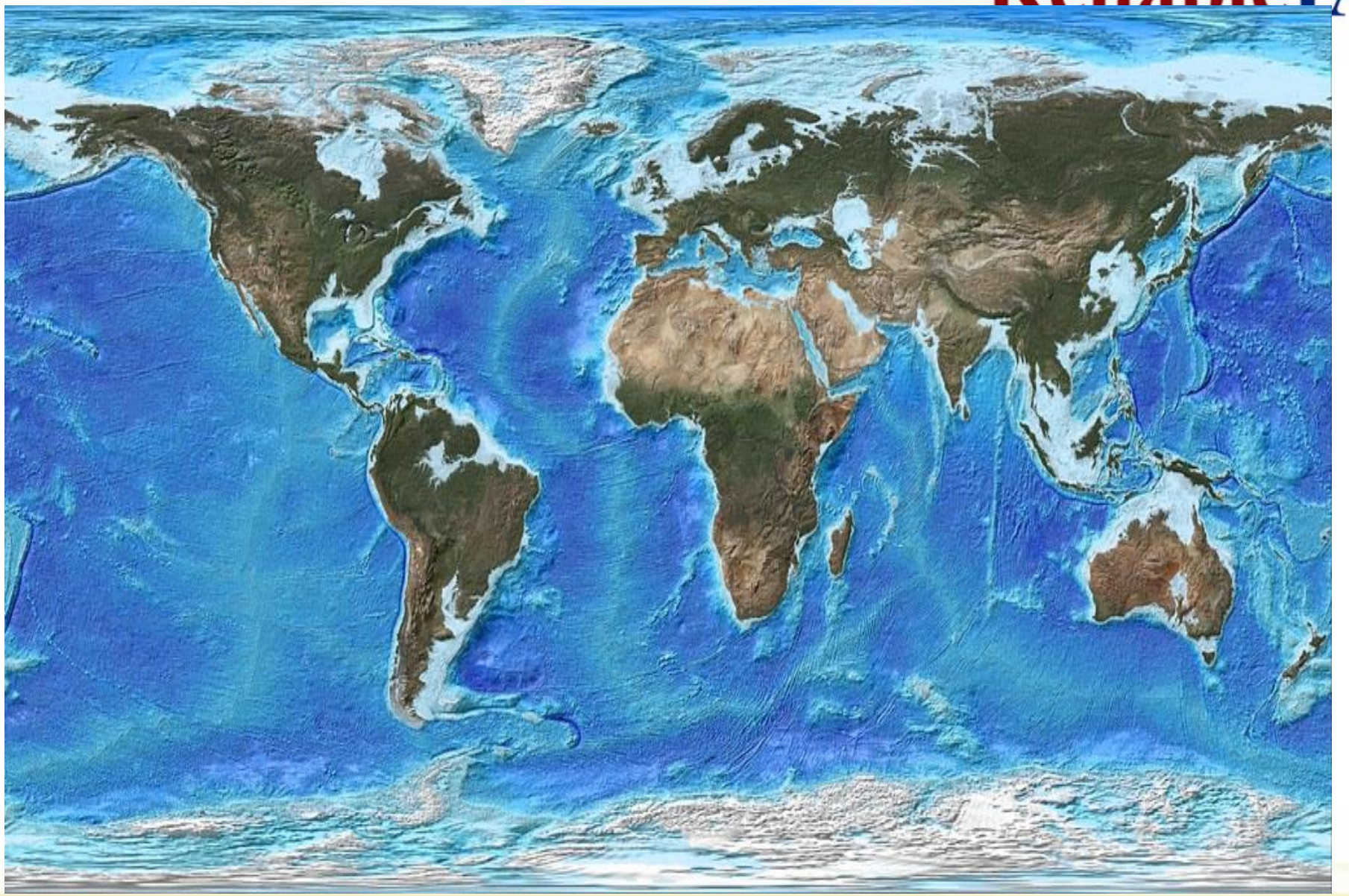
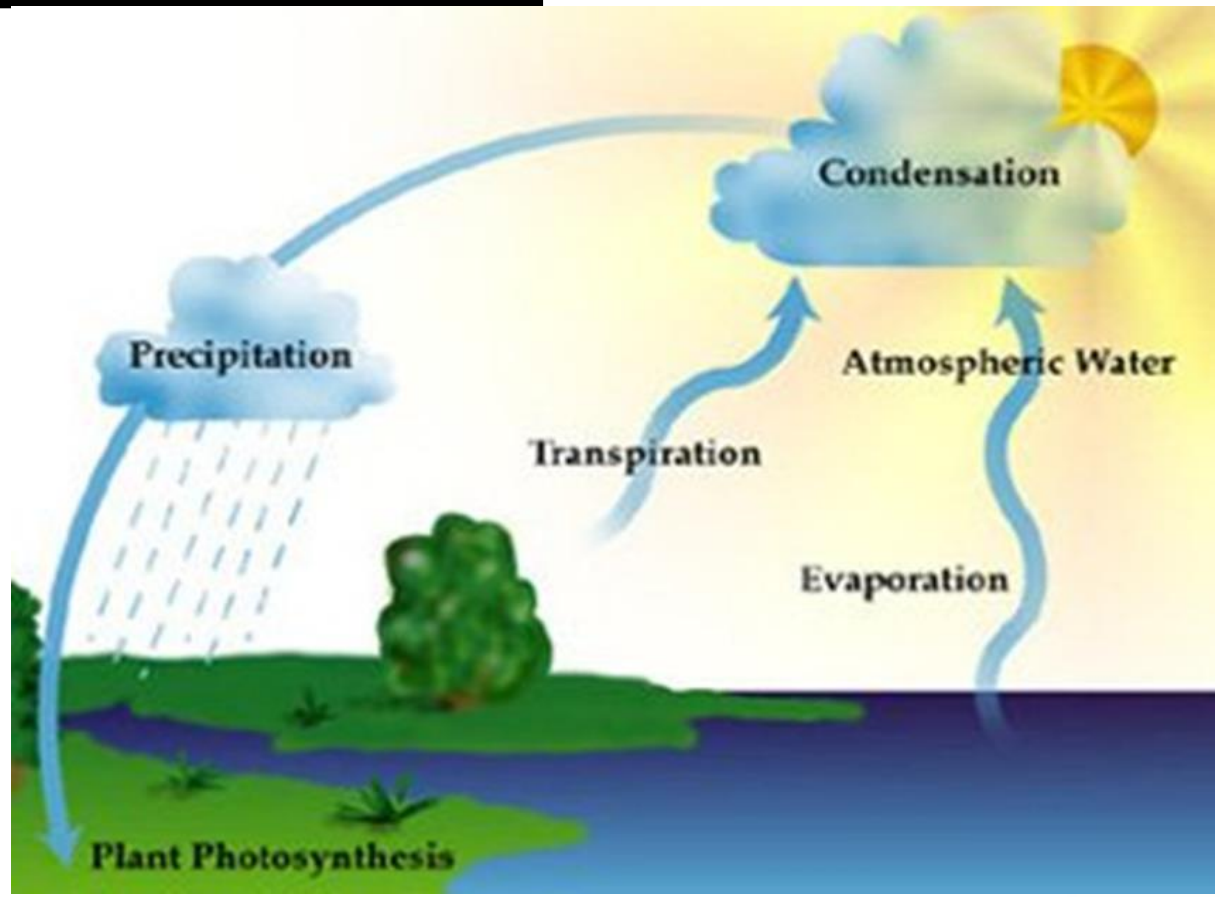
- FACULTY NAME:
  - KANHAIYA JHA
- SUBJECT:
  - GEOGRAPHY
- TOPIC NAME:
  - WATER IN ATMOSPHERE

WATER IN ATMOSHPHARE



DISTRIBUTION OF WATER

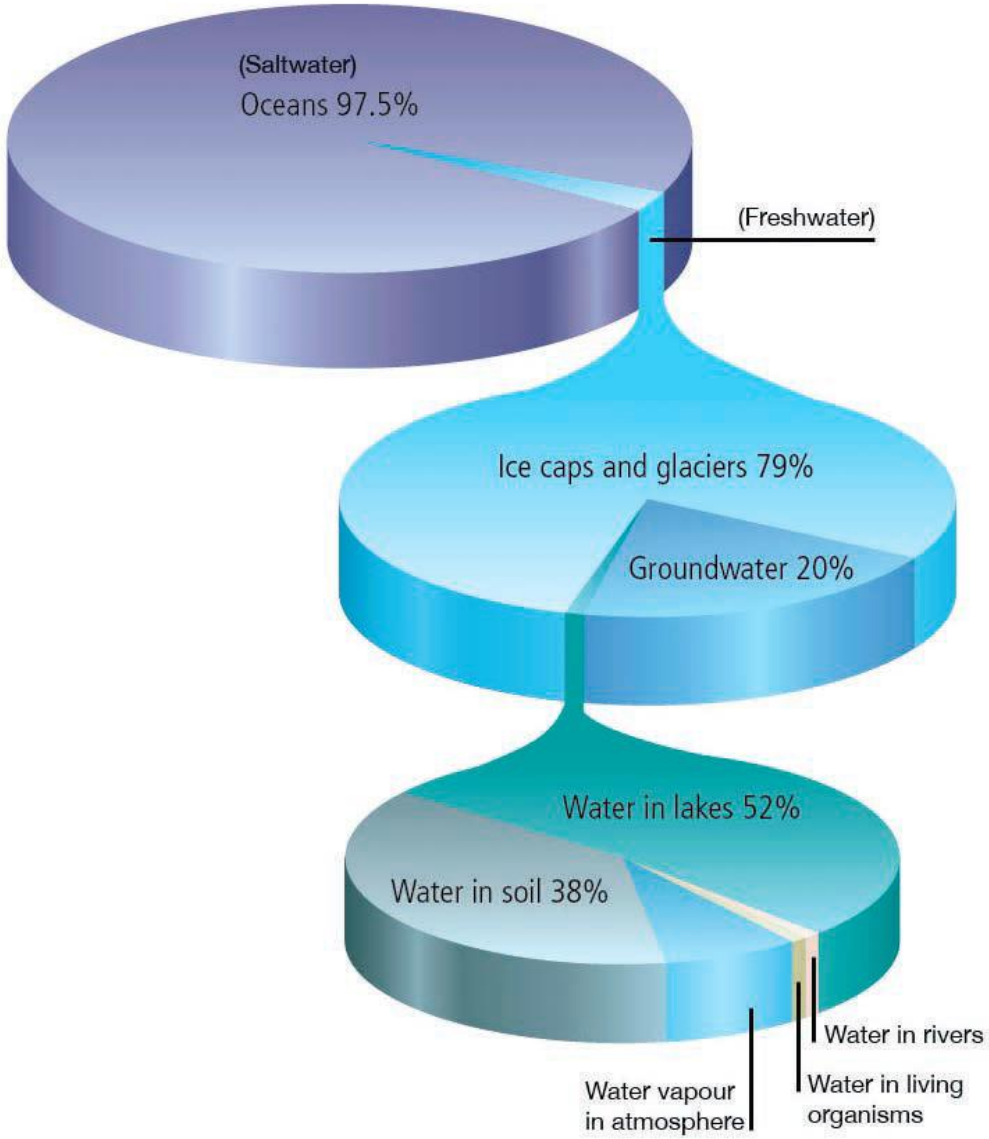
- Water is the precious nature resource and absolutely essential for survival.
- It found in the **atmosphere in three forms** – gaseous, liquid and solid.
- It support life on Earth and also determines **meteorological, economic and socio-political situation.**
- ***March 22*** is celebrated as **World Water Day**.



DISTRIBUTION OF WATER

- Liquid water covers about 71% of the earth's surface.
  - Out of which **97%** of the earth's water is found in the oceans however it is too salty for drinking, growing crops, and most industrial uses except cooling.
  - Only **3% of the earth's water is fresh**.
    - **2.5% of the earth's fresh water is unavailable for human since** locked up in glaciers, polar ice caps, atmosphere, and soil.
    - Trapped fresh water are highly polluted or lies too far under the earth's surface to be extracted at unaffordable cost.
  - Remaining merely 0.5% of the earth’s fresh water is available for human.
  - In actuality, that amounts to an average of **8.4 million liters (2.2 million gallons) for each person** on earth

DISTRIBUTION OF WATER IN BODIES



Oceans	:	97.3	Saline Water
Ice-caps	:	02.0	Fresh Water
Ground water	:	0.68	
Fresh water lakes	:	0.009	
Inland seas and salt lakes	:	0.009	
Atmosphere	:	0.0019	
Rivers	:	0.0001	
		100.00	

Water vapour

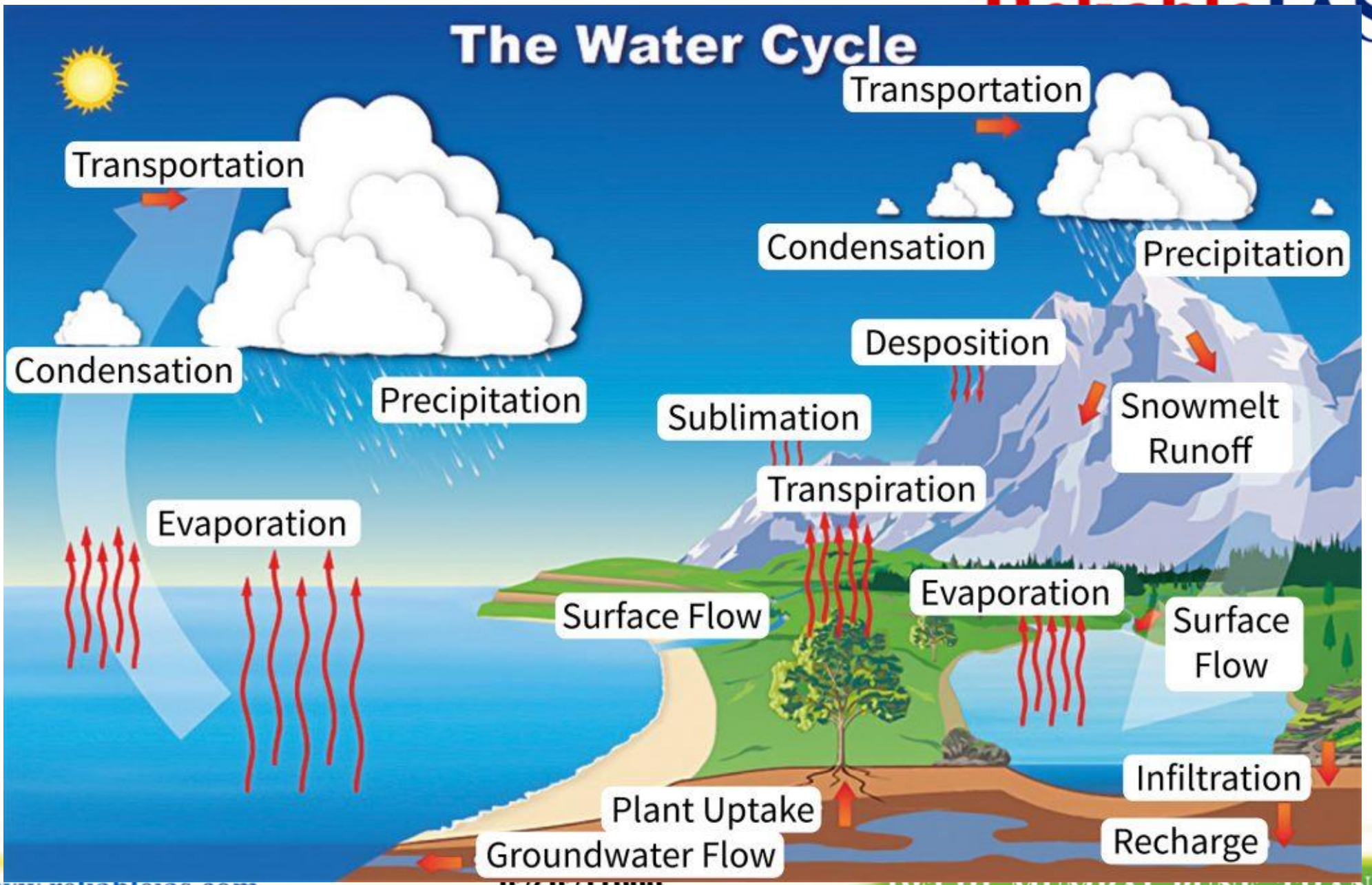
- Water vapour constitute **about 2 per cent** of the total composition of the atmosphere.
- This percentage varies from zero per cent in cold dry air of the Arctic regions during the winter season to as much as 5 per cent of the volume in warm humid equatorial regions.

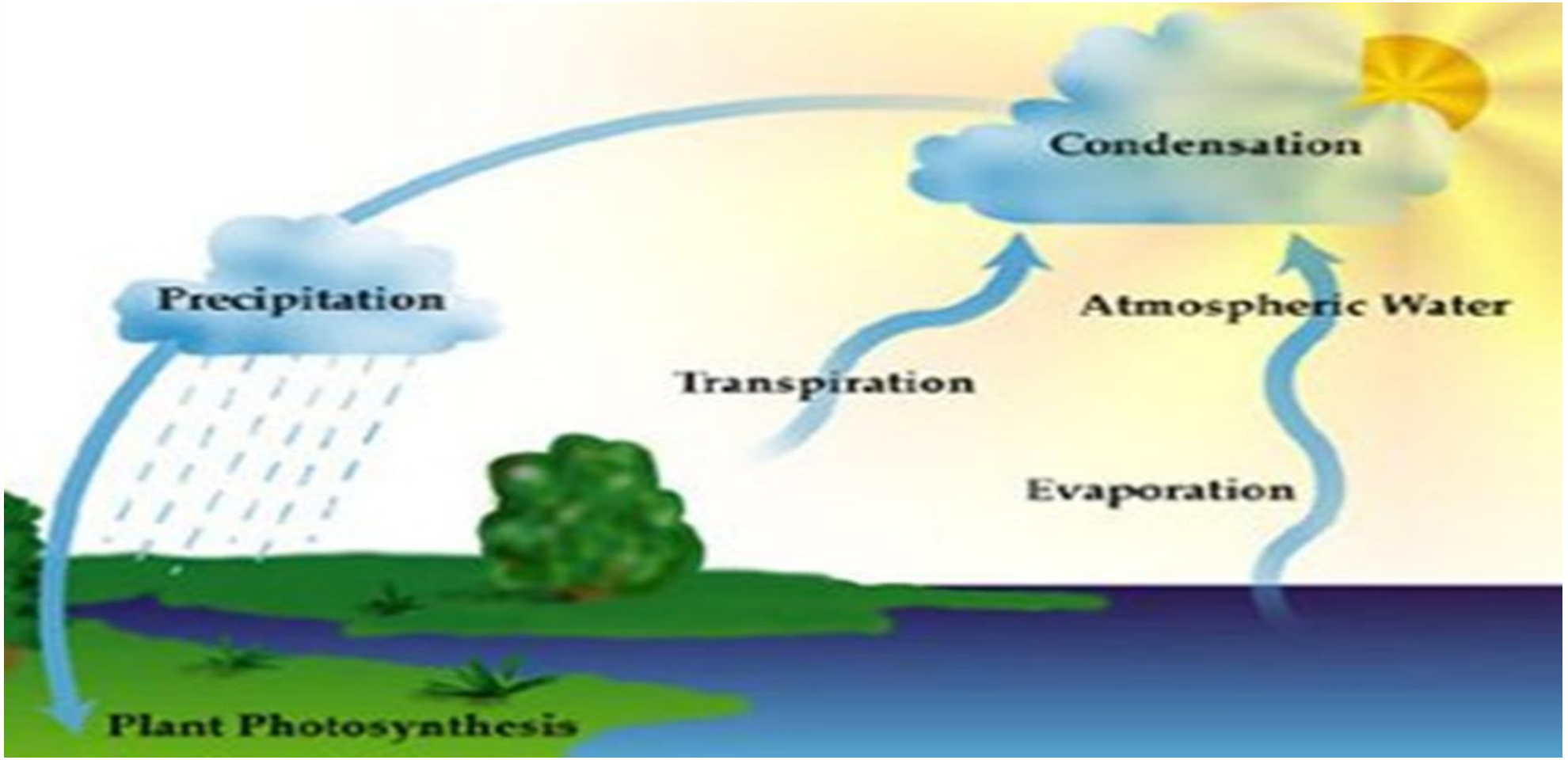
- The amount of water vapour present in the atmosphere influences the **nature and amount of precipitation, the amount of loss of heat through radiation from the earth's surface, the surface temperature, the latent heat of the atmosphere, the stability and instability of the air masses.**
- **Necessary energy for the development of storms (cyclones, hurricanes etc.) is provided by the water vapour in the form of latent h**eat energy.

Hydrological cycle

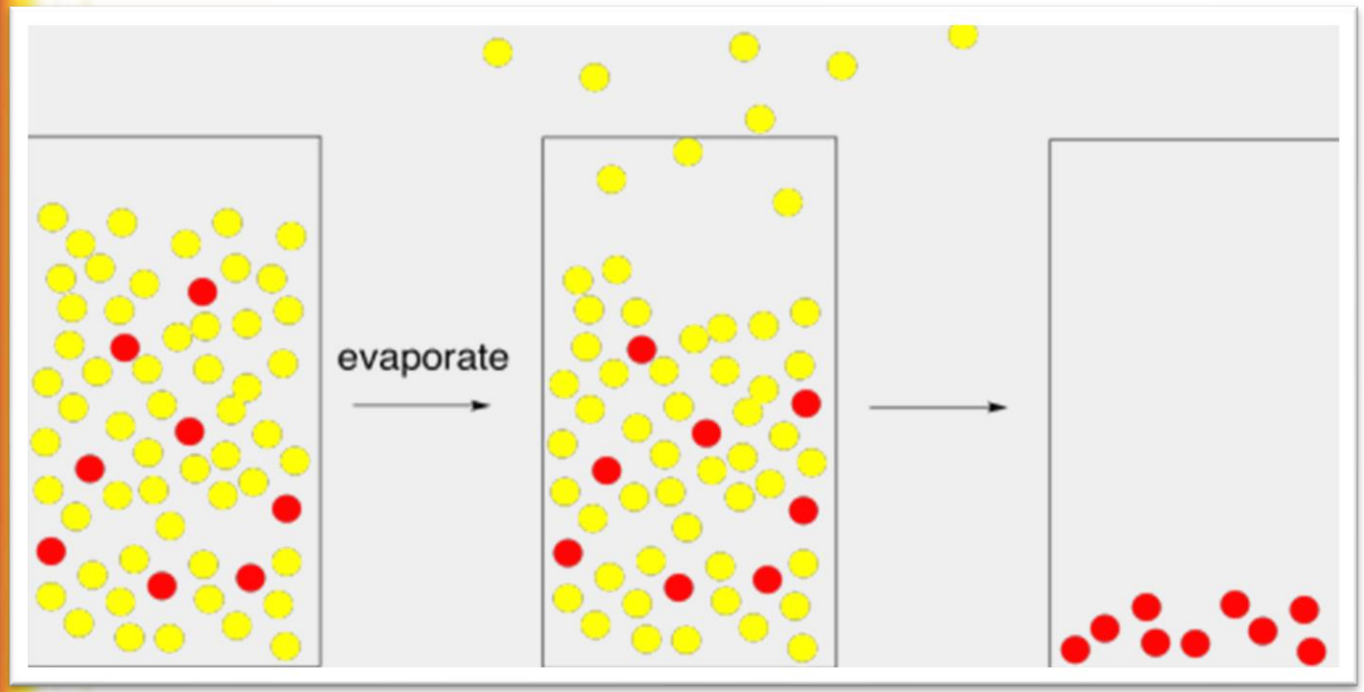
- Given that earth is like a terrarium. The same water that existed centuries ago still exists today.
- Supply of water is **continually collected, purified, and distributed** in the natural cycle. The circulation of water is called the w**ater cycle or the hydrological cycle.**
- The water cycle has no beginning or end, rather it is an intricate combination of **evaporation, transpiration, air mass movement, condensation, precipitation, run-off and groundwater movement.**

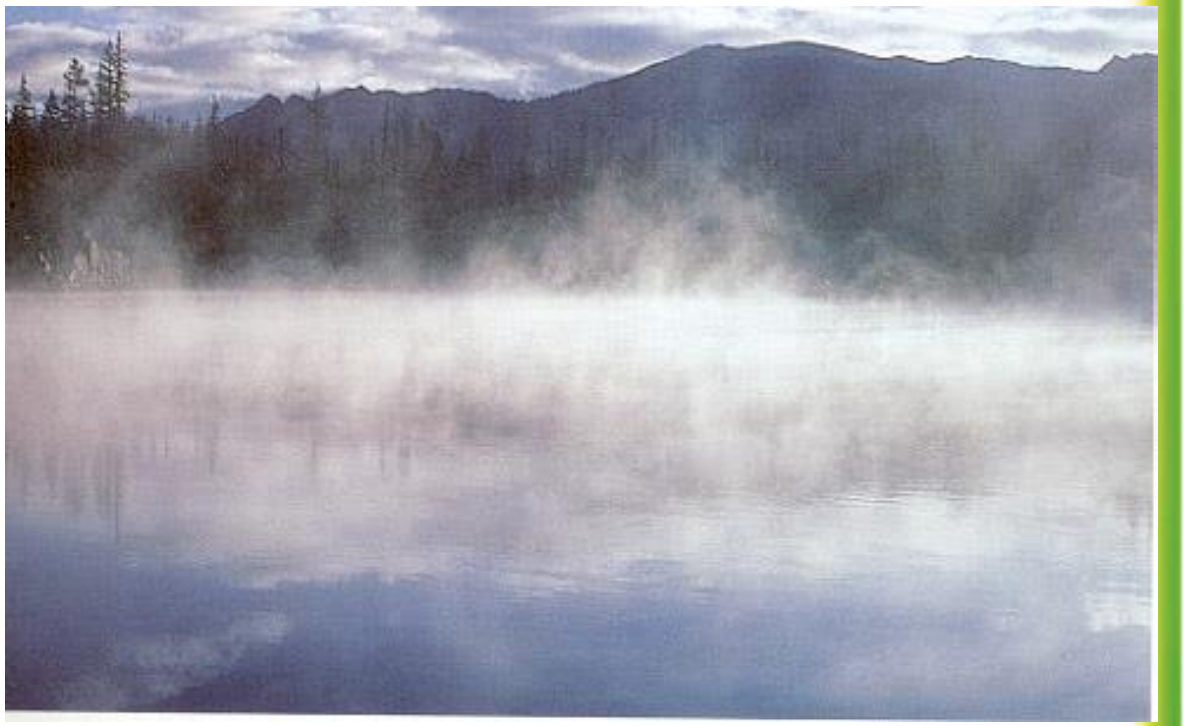
Terrarium: An artificial enclosure for keeping small house Plants.


The Water Cycle
Transportation
Condensation
Precipitation
Transportation
Condensation
Precipitation
Desposition
Snowmelt Runoff
Sublimation
Transpiration
Evaporation
Surface Flow
Evaporation
Surface Flow
Infiltration
Plant Uptake
Recharge
Groundwater Flow


Condensation
Precipitation
Atmospheric Water
Transpiration
Evaporation
Plant Photosynthesis

A.EVAPORATION



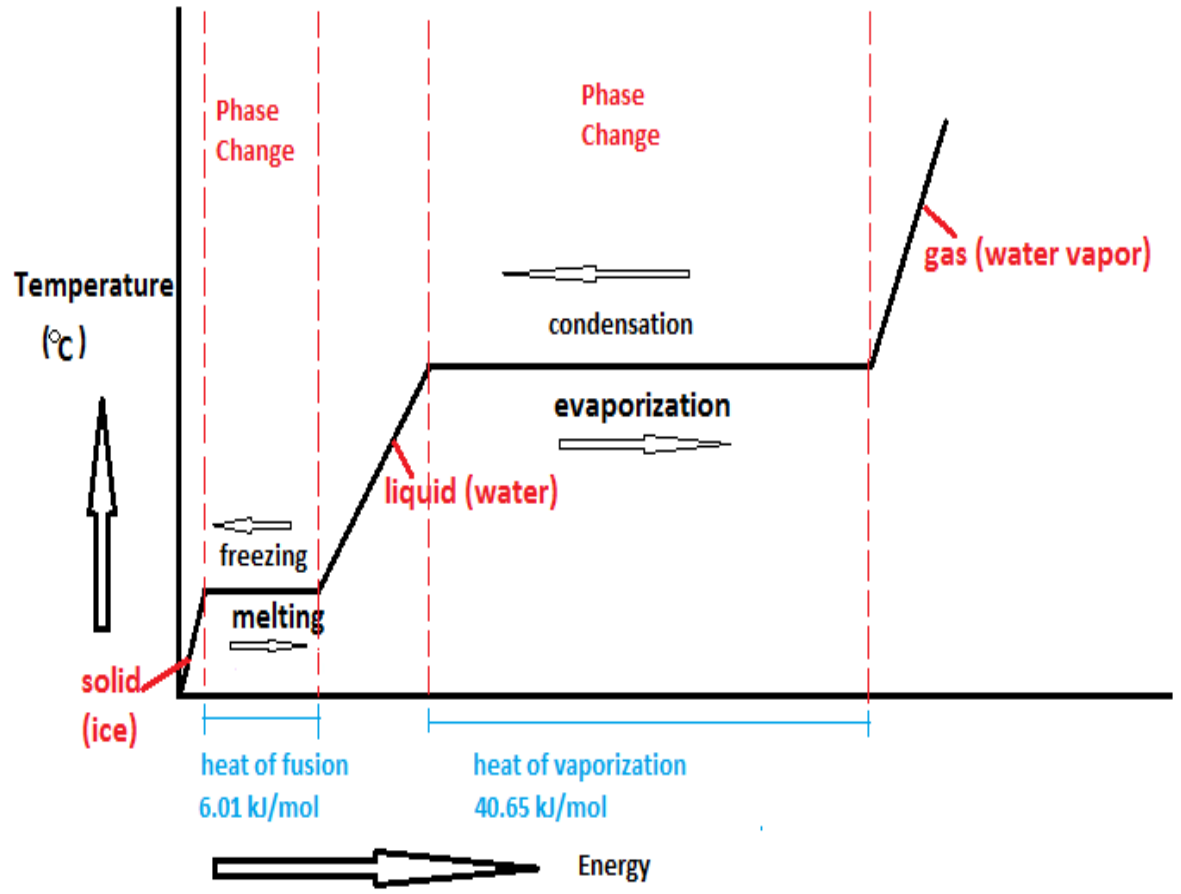


- Evaporation is a process by **which water is transformed from liquid to gaseous state.**
- Heat is the main cause for evaporation.
- Evaporation is **faster in dry air than in the wet air.**
- There is more evaporation from the ocean than from the land.
- A special case of evaporation is transpiration which entails loss of water from the leaves and stems of the plants.
- The temperature at which the water starts evaporating is referred to as the **latent heat of vaporization**.

- **Increase in temperature** increases water absorption and retention capacity of the given parcel of air.
- If the moisture content is low, air has a **potentiality** of absorbing and retaining moisture.
- **Movement of air replaces** the saturated layer with the unsaturated layer. Hence, the **greater the movement of air**, the greater is the evaporation

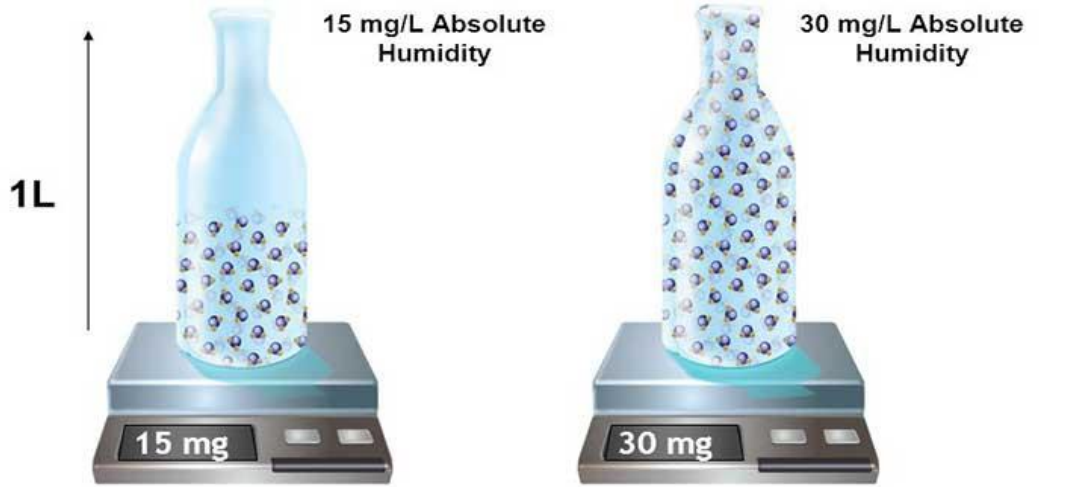
Latent heat

- At the time of evaporation, heat is absorbed and conserved in water vapour. It is known as **latent heat**.
- It is this same heat which is released when water vapour again changes into water through the process of **condensation.**
- Latent heat is essential for development of typhoons (storms, cyclones).

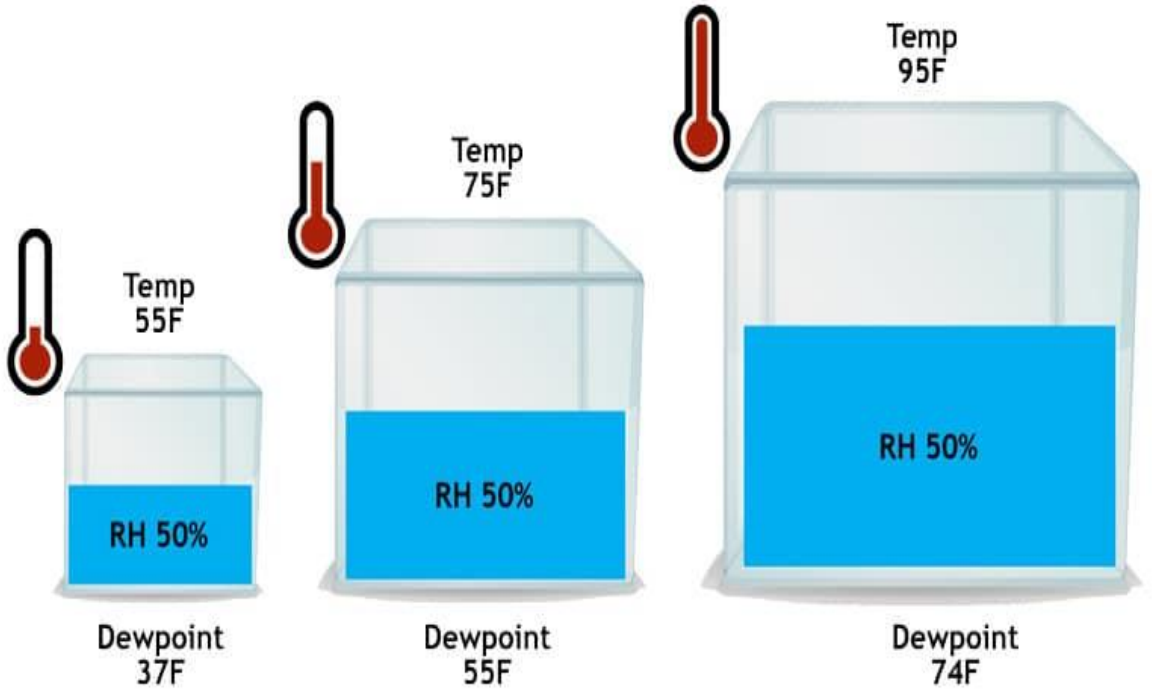


Humidity

Absolute Humidity (AH)



• mgH_2O/L is usually referred to as mg/L



Absolute air humidity

$$f_{abs} = \frac{\text{mass water [g]}}{\text{mass humid air [m}^3\text{]}}$$

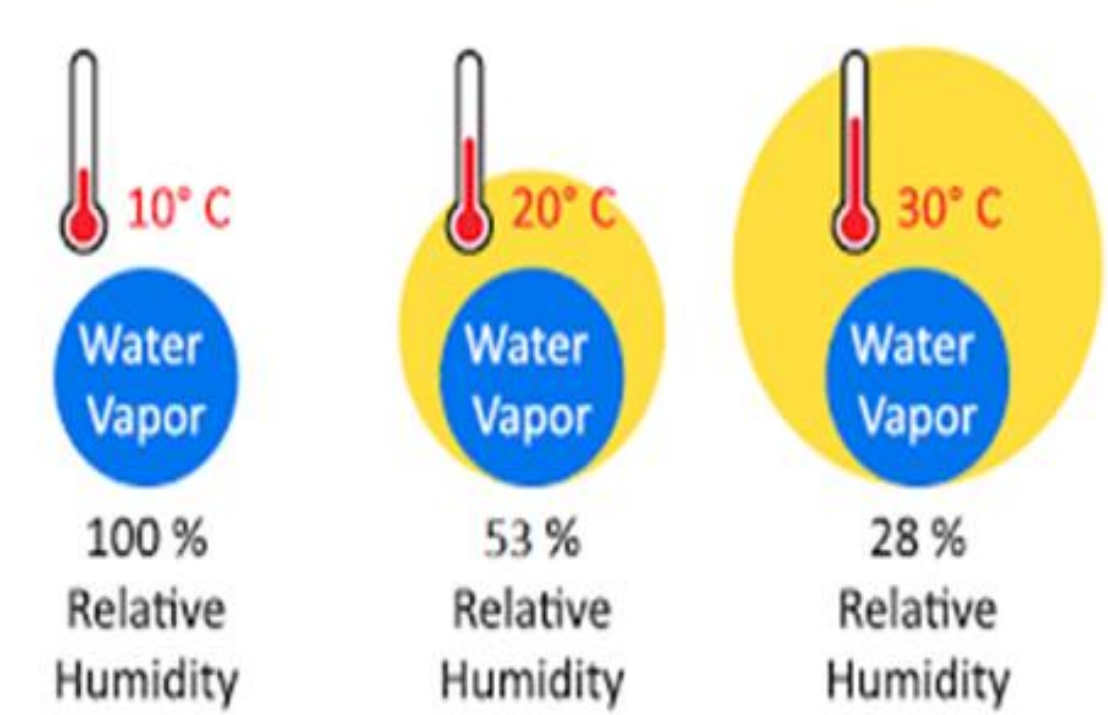
Relative Humidity

$$= \frac{\textit{Absolute Humidity}\ (\textit{Actual amount of water vapour present in the air at a given temperature})}{\textit{Humidity Retentive capacity}\ (\textit{Amount of water vapour that can be held by the same at the same temperature})}$$

- Water vapour present in the air is known as **humidity.**
- It decreases from the equator towards the poles.

- **1. Absolute humidity**
  - The actual amount of the water vapour present in the atmosphere is known as the **absolute humidity**.
  - **It is the weight of water vapour per unit volume of air and is expressed in terms of grams per cubic metre.**
  - The ability of the air to hold water vapour depends entirely on its temperature.
  - **Generally, the absolute humidity changes as air temperature or pressure changes.**

- **2. Relative Humidity**
- The **percentage of moisture** present in the atmosphere as compared to its full capacity at a given temperature is known as the **relative humidity**.
- With the change of air temperature, the capacity to retain moisture increases or decreases and the relative humidity is also affected.
- **It is greater over the oceans and least over the continents.**
- **Relative humidity is a better way of expressing the level of humidity in the air**.
- The Relative Humidity is expressed in **percentages**



- **Changes in Relative Humidity** can occur in the following three ways:
  - I. The temperature remaining the same and **amount of water vapour in air increases.** Its relative humidity will also increase.
  - II. **When the temperature of air rises** its humidity retentive capacity also rises correspondingly and the Relative Humidity decreases.
  - III. If the **temperature of air decreases** its humidity retentive capacity also decreases and Relative Humidity increases.

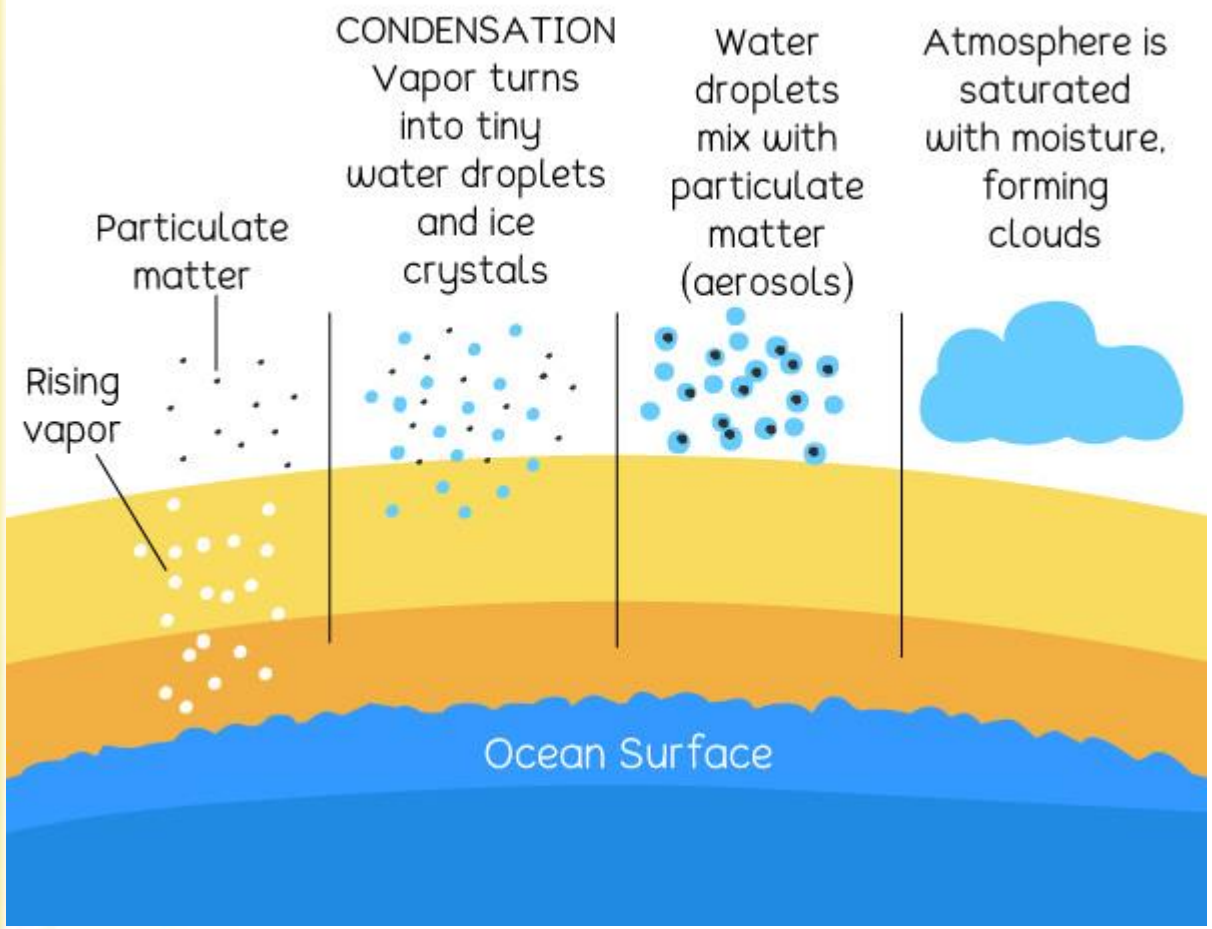
- **The absolute humidity determines the amount of precipitation while the relative humidity tells us about the possibility of precipitation.**
- The high and low relative humidity indicates the possibility of wet and dry conditions respectively.
- Evaporation decreases when there is high relative humidity and vice versa.
- Relative humidity is directly related to human health. That is why, the equatorial region with high temperature and high relative humidity, and the tropical hot deserts with very low relative humidity are unfavorable for human health.
- **Relative humidity is maximum in the mornings and minimum in the evenings.**

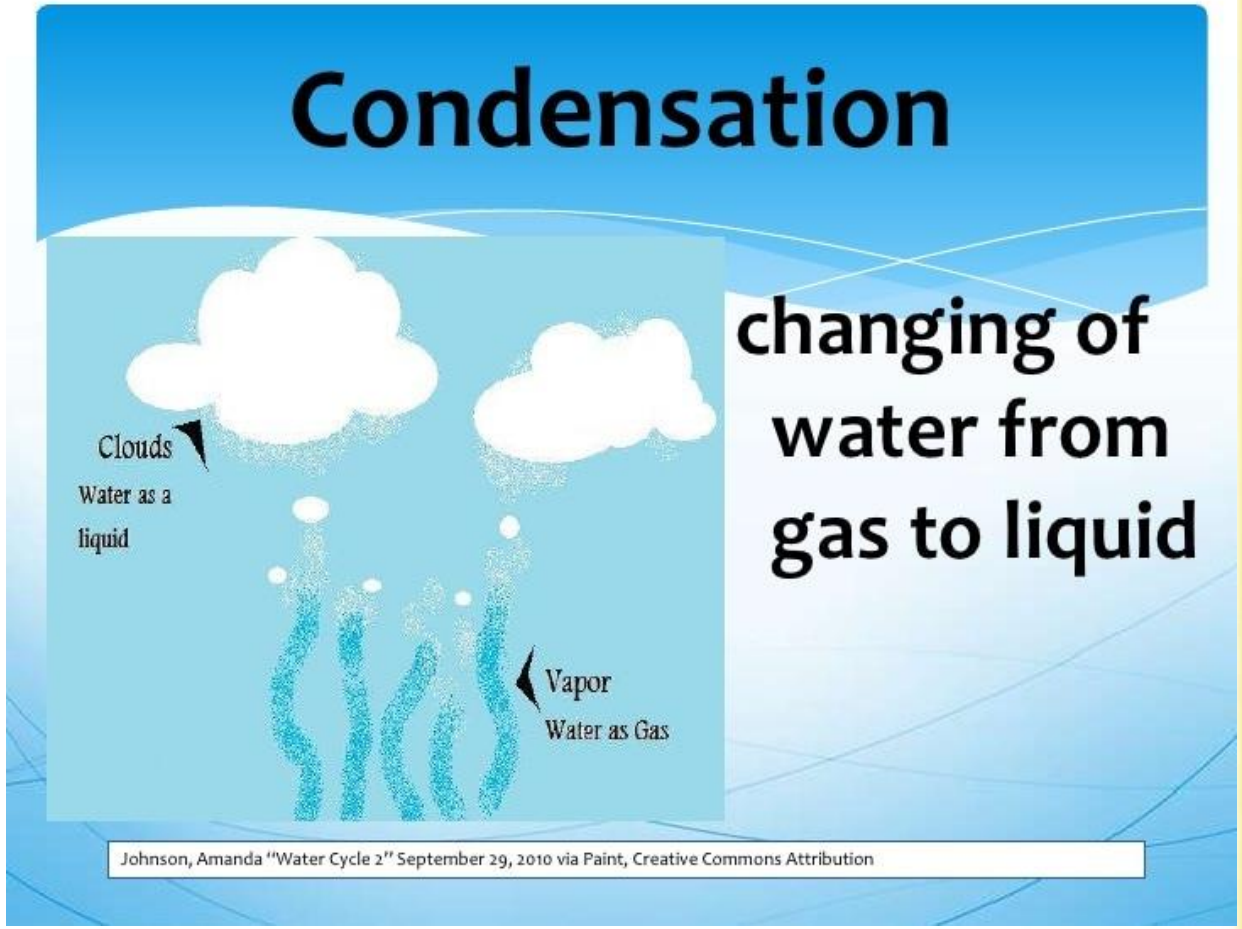

HUMIDITY

Saturation & dew point

- The air containing moisture to its full capacity at a given temperature is said to be **saturated.**
- It means that the air at the given temperature is incapable of holding any additional amount of moisture at that stage.
- The **temperature** at which saturation occurs is known as **dew point.**

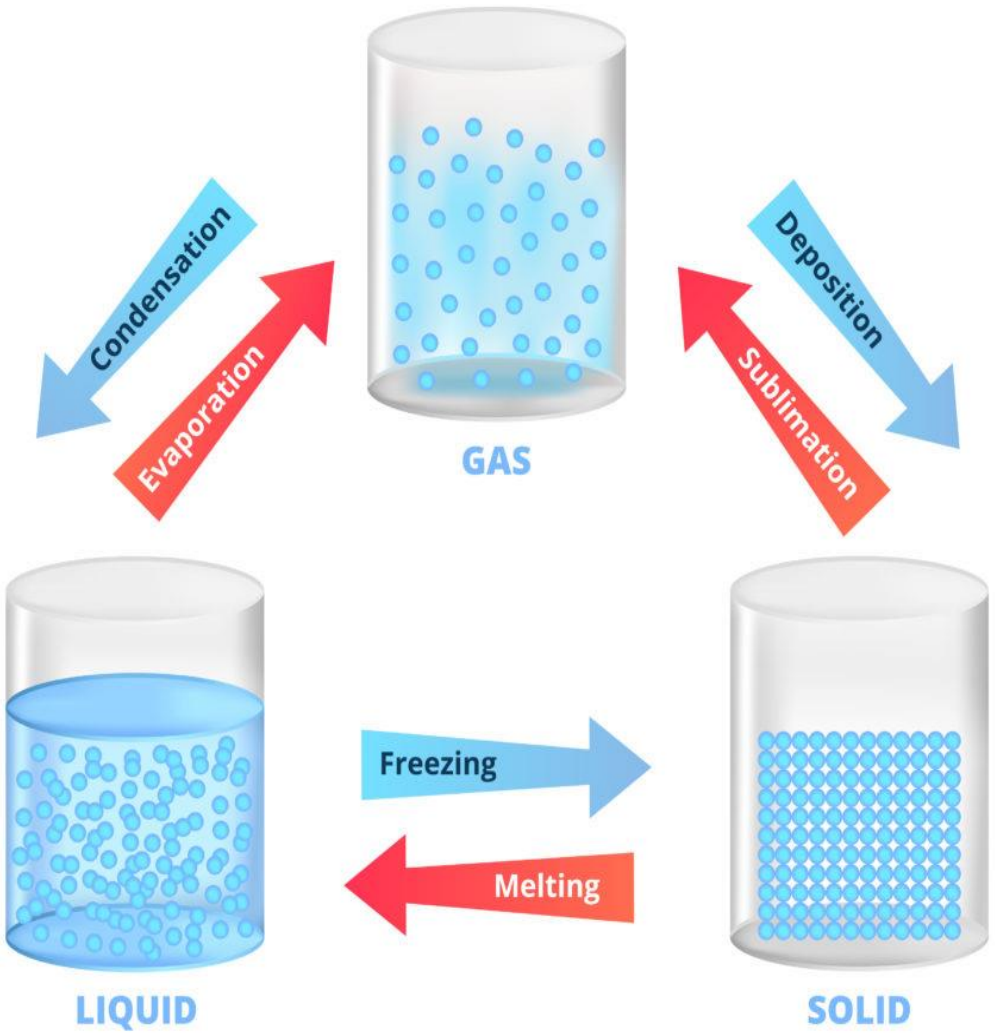
Condensation

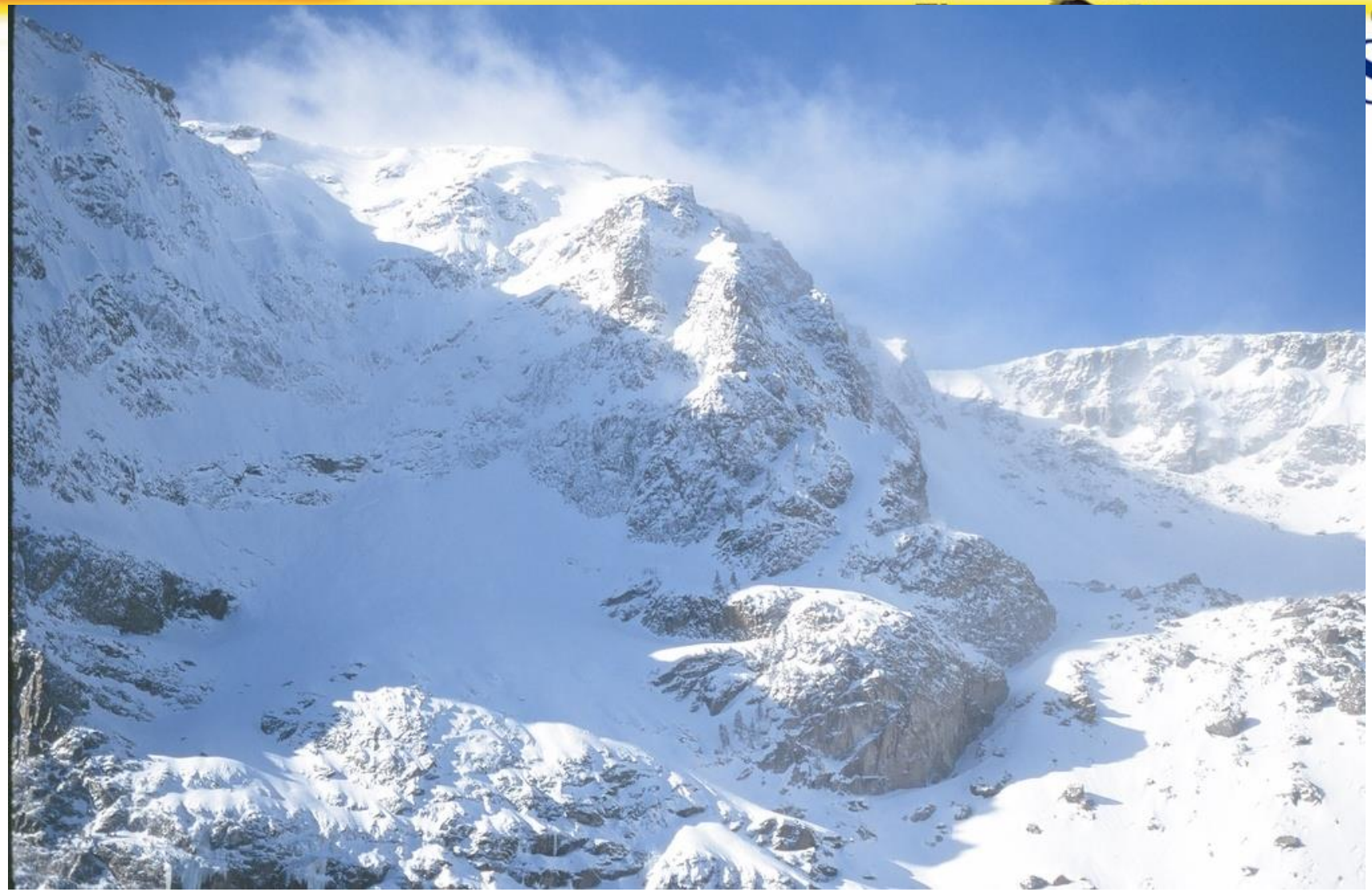




- The **transformation of water vapour into water is called condensation**. It is demonstration of the loss of latent heat of water vapour.
- Condensation also takes places when -
  - the moist air **comes in contact** with some colder object
  - the temperature reaches **close to the dew point**.
- In free air, condensation starts around very small particles termed as **hygroscopic condensation nuclei viz.** Particles of dust, smoke and salt.
- Condensation depends upon-
  - **Degree of cooling**
  - **Relative humidity** of the air
  - **Volume of air**,
  - **Temperature**
  - **Pressure**

- **Sublimation** is the transition of a substance directly from the solid phase to the gas phase without passing through the intermediate liquid phase.
- Without the addition of energy (heat) to the process, ice would not sublimate into vapor.
- **Deposition/ de-sublimation** is the phase transition in which gas transforms into solid without passing through the liquid phase. Deposition is a thermodynamic process.
- Ex- **Frost**





Chinook, or "snow eater," vaporizes snow before it even has a chance to melt

Forms of condensation

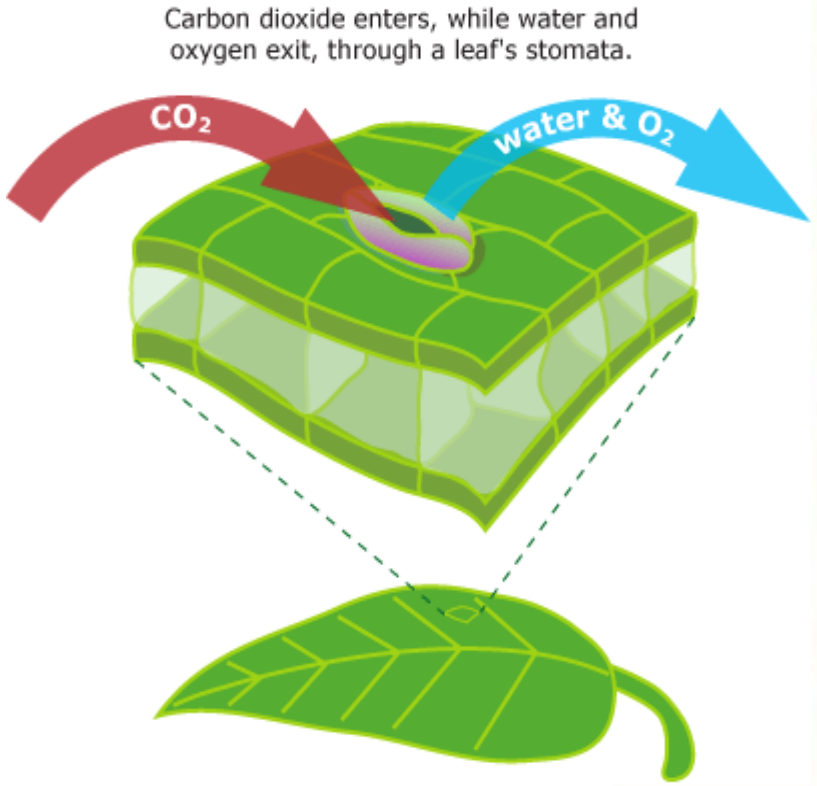
- Condensation can be classified on the basis of temperature and location.

Dew

- When the moisture is **deposited in the form of water droplets on cooler surfaces of solid objects** such as stones, grass blades and plant leaves, it is known as dew.
- The ideal conditions for its formation are **clear sky, calm air, high relative humidity, and cold and long nights**.
- For the formation of dew, it is necessary **that the dew point is above the freezing point.**
- It can be seen as droplets of water on leaves of small plants or blades of grass.
- It is useful for plants.

Frost

- Frost is actually **frozen dew.** Frost forms on cold surfaces.
- When condensation takes place below freezing point results into frost.
- The excess moisture is deposited in the form of minute ice crystals instead of water droplets.
- The ideal conditions for the formation of **white frost** are the same as those for the formation of dew, except that the air temperature must be at or below the freezing point.
- It can be found on solid surfaces of earth's crust as ice or snow crystal.
- **It is harmful for plant growth since it blocked plant stomata.**



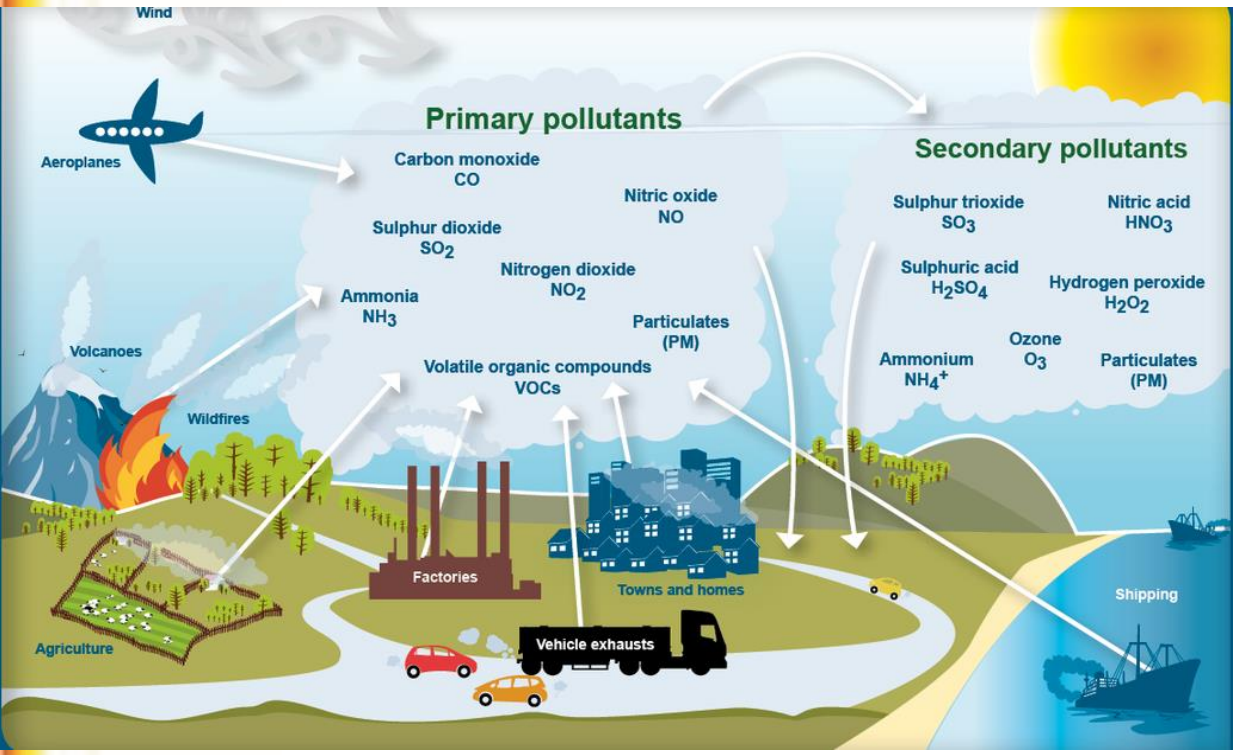
Fog

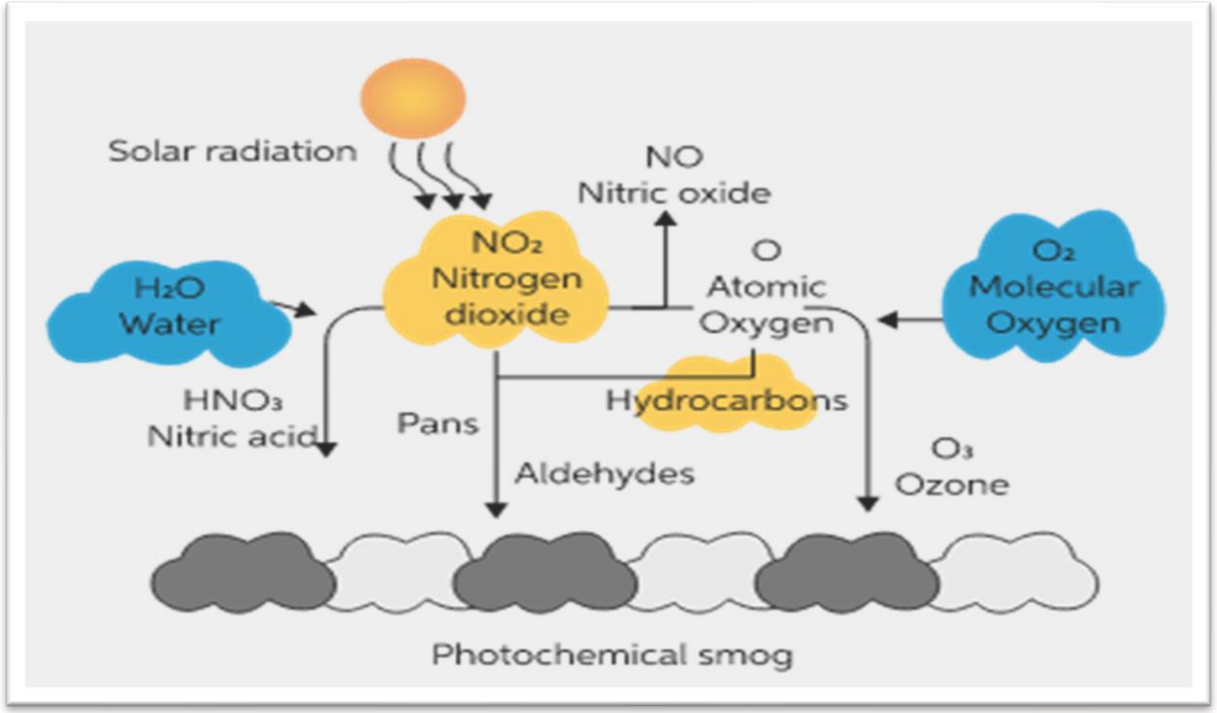
- Fog is a visible aerosol consisting of tiny water droplets or ice crystals suspended in the air at or near the Earth's surface.
- Fog can be considered a type **of low-lying cloud**
- Fog is formed due to condensation of water droplets suspended in the atmosphere in the vicinity of the earth’s surface .
- During the winter season, excessive radiation at night results in the fall of air temperature.
- The visibility is greatly reduced by fog (less than one km). Hence it hinders travel by land, air and sea.
- If there's too much fog, **photosynthesis is significantly reduced.** Periods of fog often cause discoloration, stunting, and even wilting in crops such as wheat.
- Agriculture sector is also affected since fog adversely hits late sowing crops tea and coffee plants
- Fog is beneficial to the as it protects them from the scorching sunlight on the hill slopes.
- When the fog is polluted becomes poisonous.

Mist

- It is also a type of fog but is relatively less dense.
- The only difference between mist and fog is density and its effect on visibility.
- **A cloud that reduces visibility to less than 1 km is called fog, whereas it's called mist if visibility range is between 1 and 2 km.**
- Mists are frequent over mountains as the rising warm air up the slopes meets a cold surface.

Smog





- SMOG is a mixture of smoke and fog.
- The photochemical smog is a **mixture of primary and secondary pollutants**.
- The **primary pollutants** are hydrocarbons and nitrogen oxides and their main source is the motor vehicles. secondary pollutants are formed when sunlight acts upon motor vehicle exhaust gases to form harmful substances such as ozone (O3), aldehydes and peroxyacetyl nitrate (PAN).
- While **industrial smog** is a mixture of **sulphur dioxide** and a variety of solid and liquid particles suspended in air.

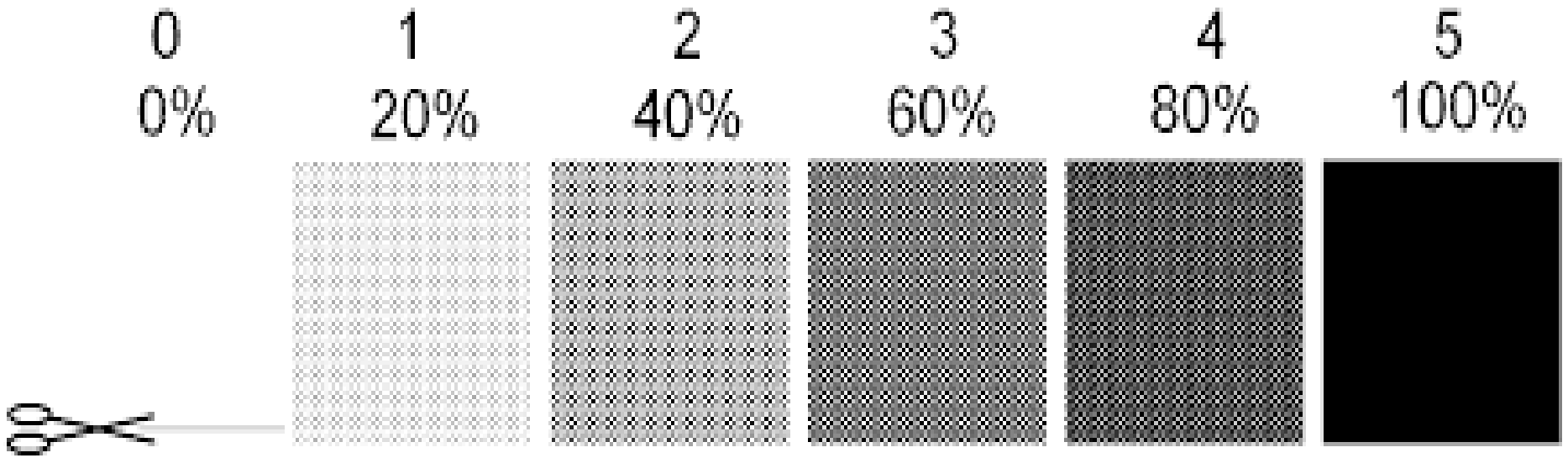
- Photochemical smog formation requires
  - sunny day and
  - temperature inversion
  - pollutants accumulate in the lower inversion layer.
- The photochemical smog directly affect lungs and eyes, causing irritation in these organs.
- **Sulphur dioxide** in combination with water and oxygen can turn into **sulphuric acid** in the atmosphere and falls on the earth as **acid rain**. It can dissolve marble and eat away iron and steel.
- In human it can affect the respiratory system

Haze

- **Haze** is traditionally an atmospheric phenomenon where dust, smoke and other dry particles obscure the clarity of the sky.
- Sources for haze particles include farming (ploughing in dry weather), traffic, industry, and wildfires.
- **Natural haze is typically white, gray or even blue. While Smog is almost always yellowish or brown in color.**

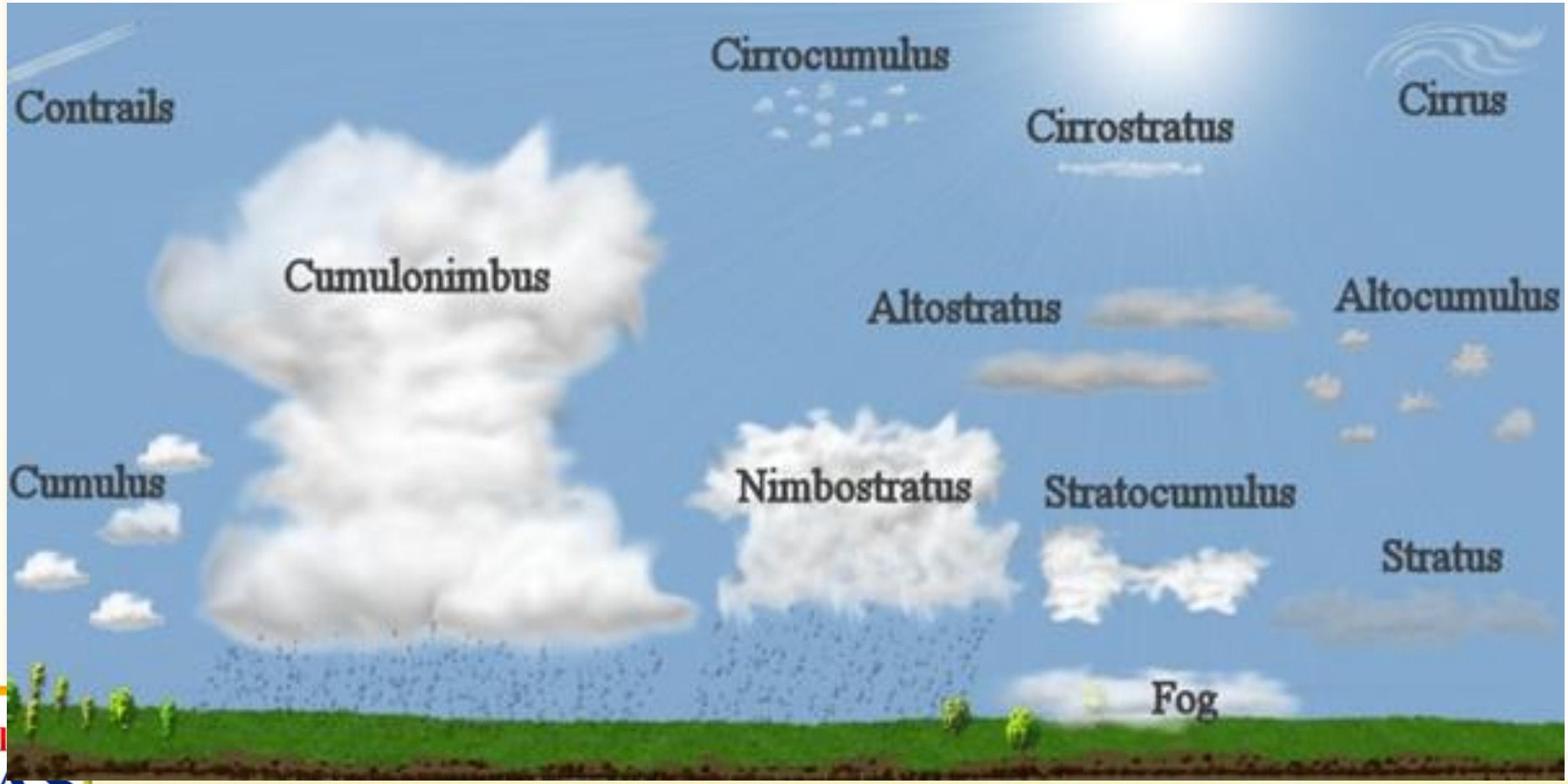
The Ringelmann scale

- is a scale for measuring the **apparent density or opacity of smoke.**
- Was developed by a French professor of agricultural engineering **Maximilien Ringelmann in 1888**.



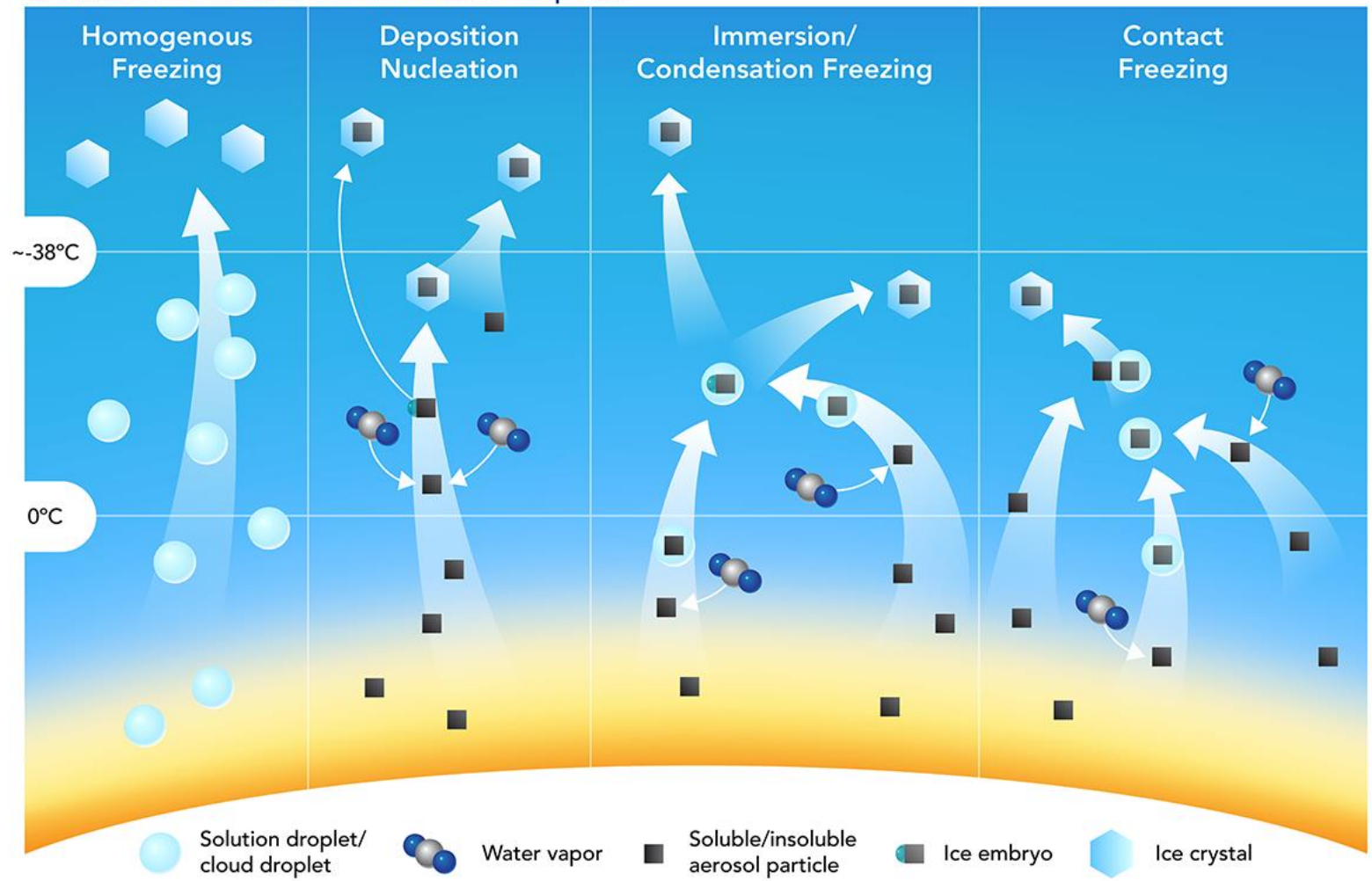
- The **international definition-**
  - Fog - visibility of less than 1 kilometres
  - Mist - visibility between 1 - 2 kilometres
  - Haze - from 2 kilometres to 5 kilometres .

CLOUDS

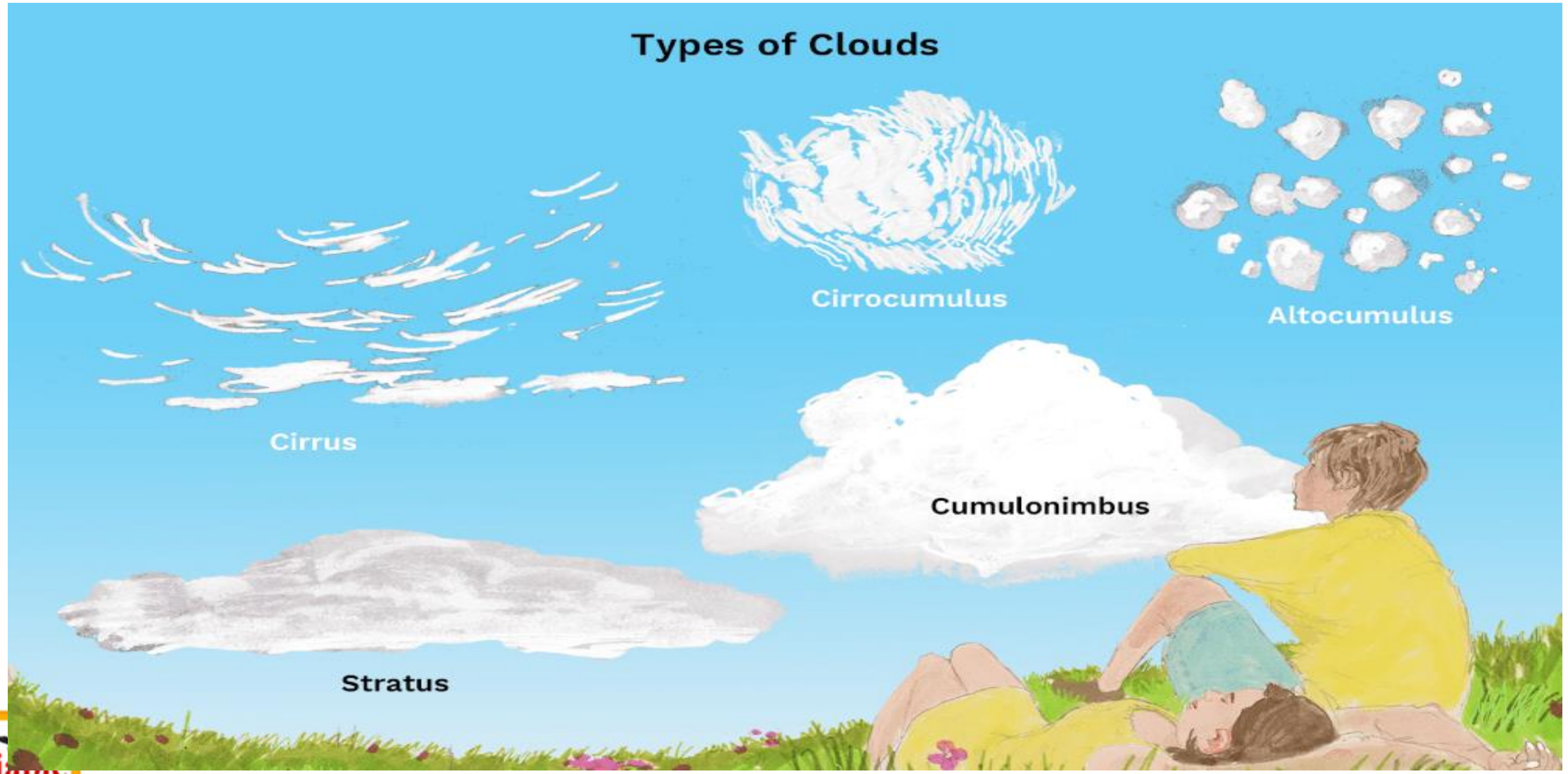

Cirrocumulus
Contrails
Cirrostratus
Cirrus
Cumulonimbus
Altostratus
Altocumulus
Cumulus
Nimbostratus
Stratocumulus
Stratus
Fog

- Cloud is a **mass of minute water droplets or tiny crystals of ice formed** by the **condensation of the water vapour** in free air at considerable elevations.
- As the clouds are formed **at some height** over the surface of the earth, they take various shapes.
- When the **moist air ascends, it expands, loses temperature, becomes cool, and gets saturated**. With further decrease in **temperature beyond the dew point,** condensation of the moisture takes place high up in the air and it results in the formation of clouds.
- All forms of **precipitation occur from the clouds**. It should be noted that not all clouds yield precipitation but no precipitation is possible without the clouds.

Ice Nucleation Mechanisms in the Atmosphere



Classification of Clouds



- Clouds are usually classified on the basis of **altitude, shape, expanse, density, colour, transparency, opaqueness, moisture content, etc**.
- There are three basic groups depending upon the height and shape of clouds.
- 1. cirrus clouds,
- 2. the cumulus clouds
- 3. the stratus clouds.

(1) Cirrus (curl of hair) Clouds:

- Cirrus clouds are formed at high altitudes (8,000 - 12,000m). Being at considerable height these
- clouds are formed of ice crystals and therefore are **white and thin**. They are detached, fibrous,
- feathery, often with silky sheen in direct sunlight.

(2) Cumulus (heap) Clouds:

- Cumulus clouds **look like cotton wool**. They are generally formed at a height of 4,000 -7,000 m.
- They exist in patches and can be seen scattered here and there. With a flat base on rising they
- appear like domes at the top. Their appearance and structure is like that of a Cauliflower.

(3) Stratus (layer) Clouds:

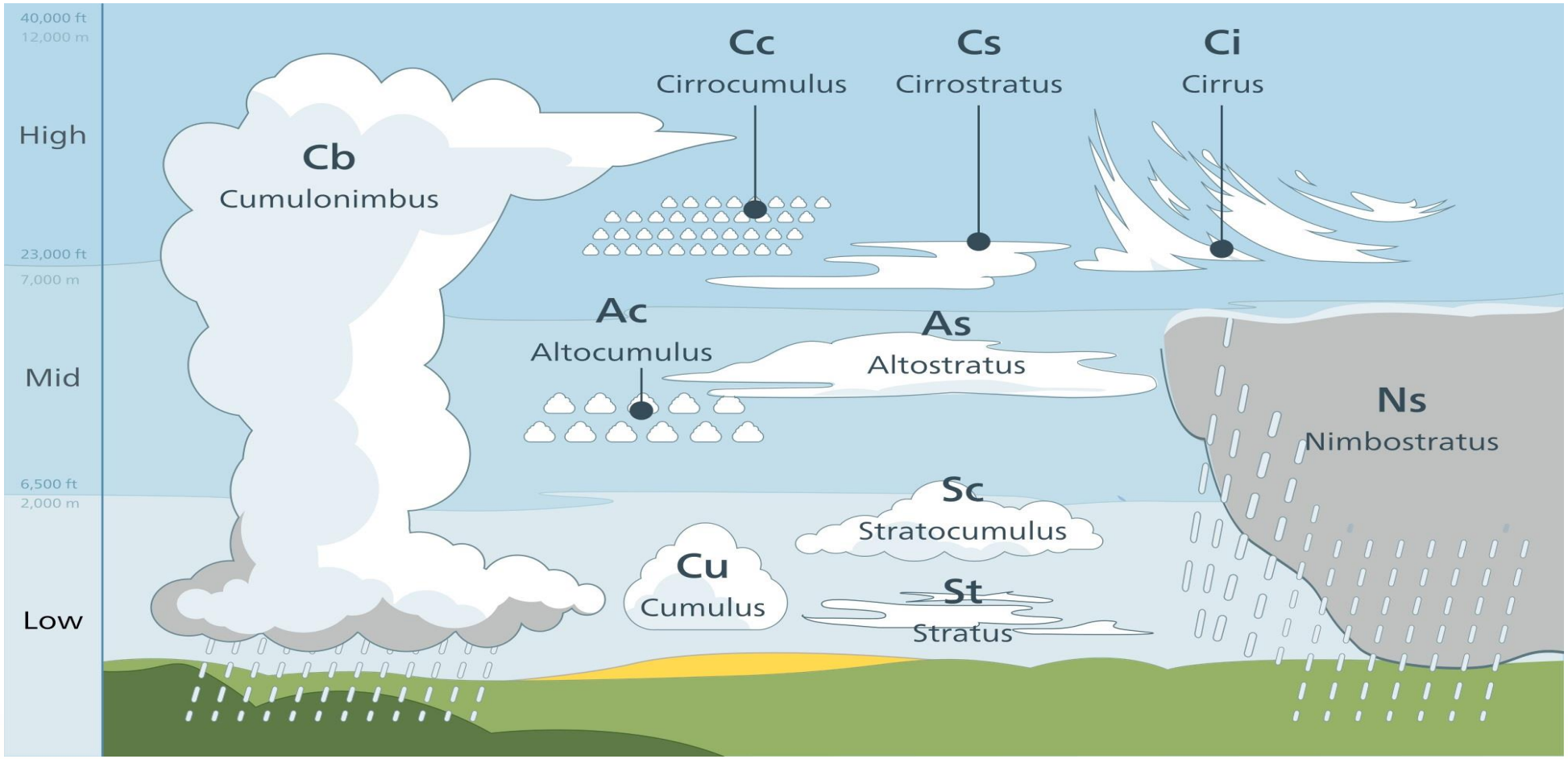
- These are layered clouds covering large portions of the sky. These clouds are generally formed either due to loss of heat or the mixing of air masses with differenttemperatures.

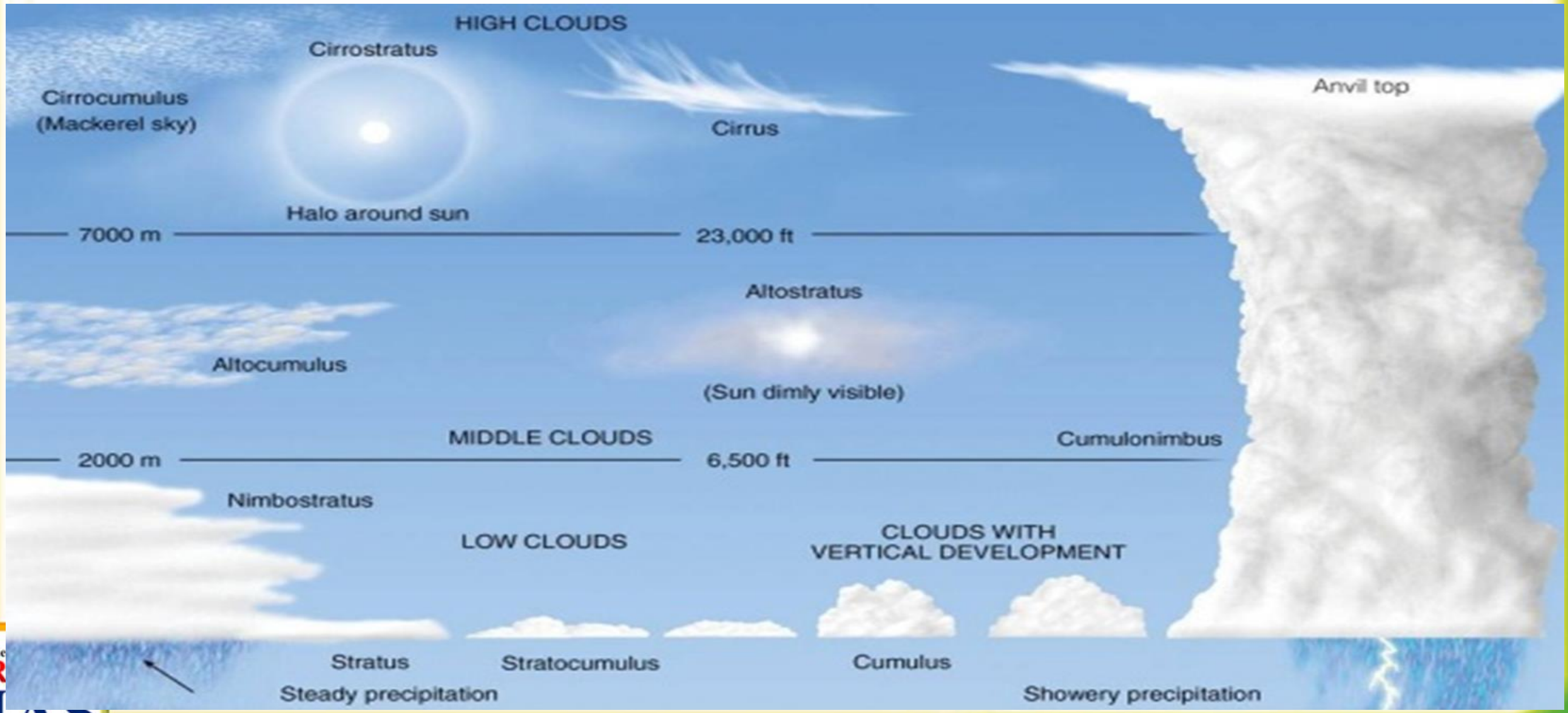
(4)Nimbus cloud

- The rain bearing clouds are generally the low level clouds and are given the prefix or suffix- ‘nimbus’, a Latin word meaning a rainy cloud.

International Classification of Clouds

The World Meteorological Organization presented a detailed International Atlas of Clouds mentioning **three main groups and ten main types of clouds**.




HIGH CLOUDS
Cirrostratus
Cirrocumulus
(Mackerel sky)
Cirrus
Anvil top
Halo around sun
7000 m
23,000 ft
Altostratus
Altocumulus
(Sun dimly visible)
MIDDLE CLOUDS
Cumulonimbus
2000 m
6,500 ft
Nimbostratus
LOW CLOUDS
CLOUDS WITH
VERTICAL DEVELOPMENT
Stratus
Stratocumulus
Cumulus
Steady precipitation
Showery precipitation

1. High Clouds

- **Cirrus family**
- **Height - 6-12 km**
- Type of clouds
  - 1. Cirrus (Ci)
  - 2. Cirrostratus (Cs)
  - 3. Cirrocumulus (Cc)

➢ High-level clouds form above 6,000 meters since the temperatures are so cold at such high elevations.

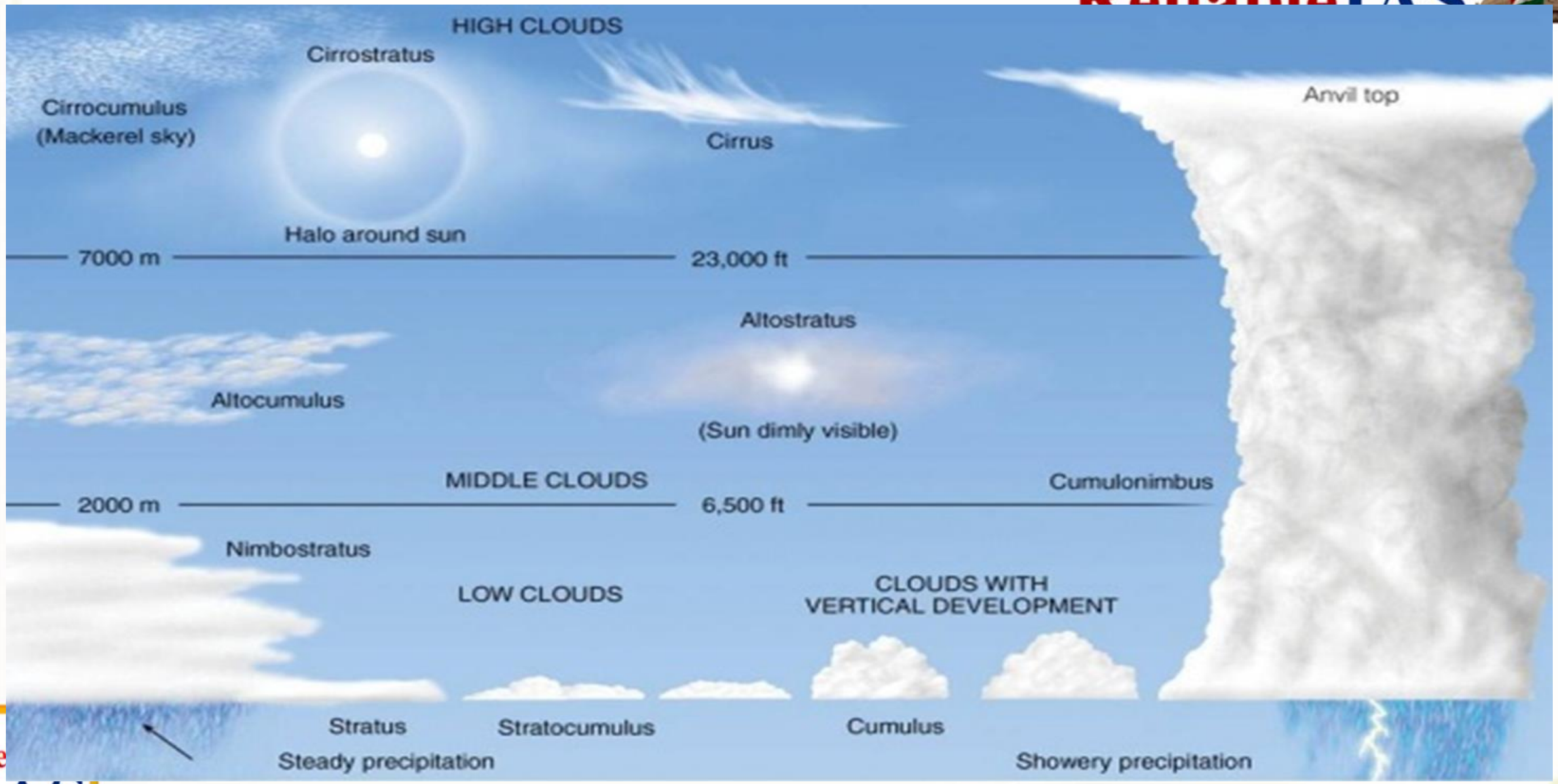
➢ These clouds are primarily composed of ice crystals.

➢ High-level clouds are typically thin and white in appearance, but can appear in a magnificent array of colors when the sun is low on the horizon.


CONSUELO SUAREZ

2. Middle Clouds

- Alto family
- Height - 2-6 km
- Type :-
    4. Altostratus
    5. Altocumulus
- 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.


HIGH CLOUDS
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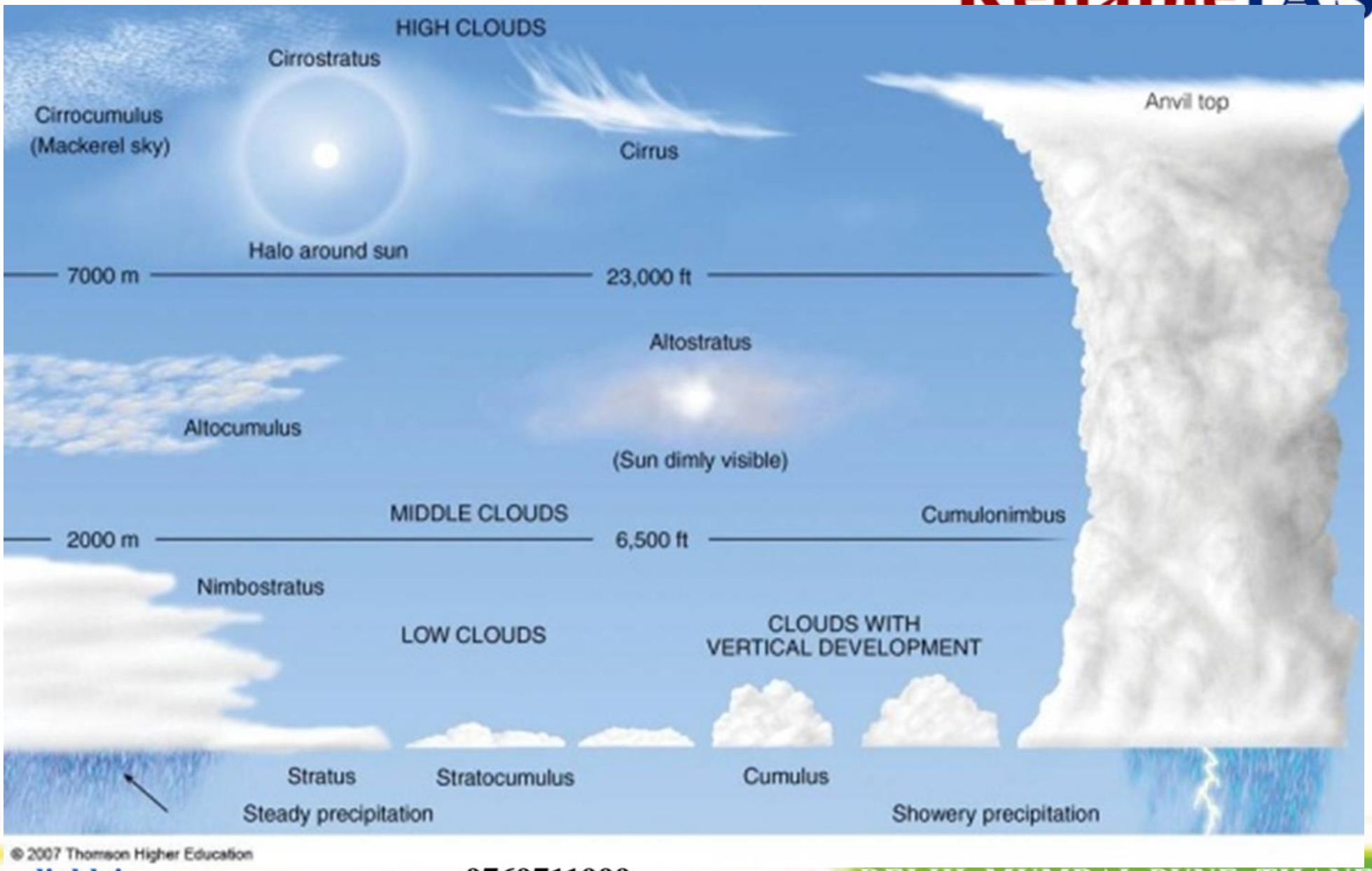
LOW CLOUDS
CLOUDS WITH
VERTICAL DEVELOPMENT
Stratus
Stratocumulus
Cumulus
Steady precipitation
Showery precipitation

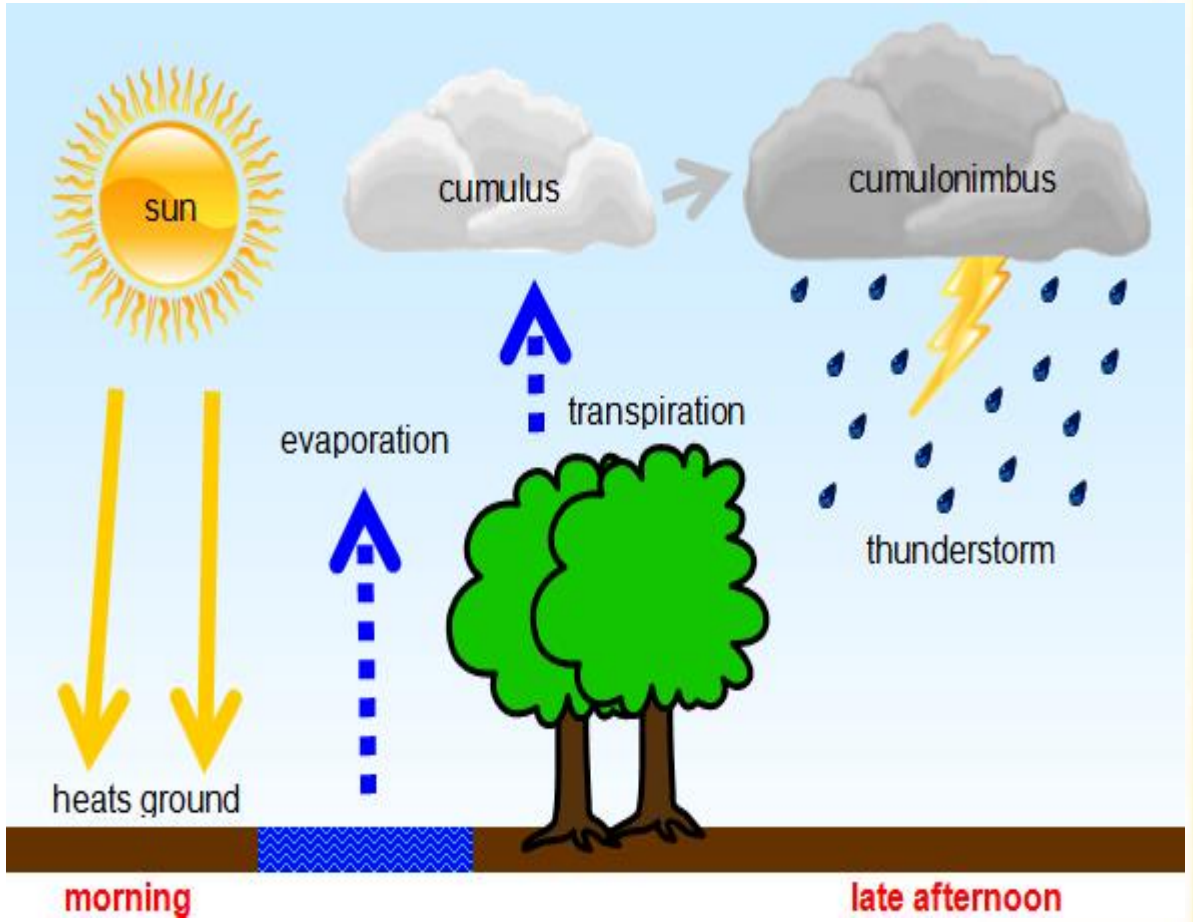
Low Clouds

- Stratus family
- Height – 0- 2 km
- Type
    6. Stratus
    7. Stratocumulus
    8. Nimbostratus
- 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.

Clouds with Vertical Growth



- Height – 0- 12 km
- Type -
  - **9. Cumulus**
  - **10. Cumulonimbus**
- Probably the most familiar of the classified clouds is the cumulus cloud.
- Generated through either thermal **convection** or frontal lifting.
- These clouds can grow up to the heights of 12 km.



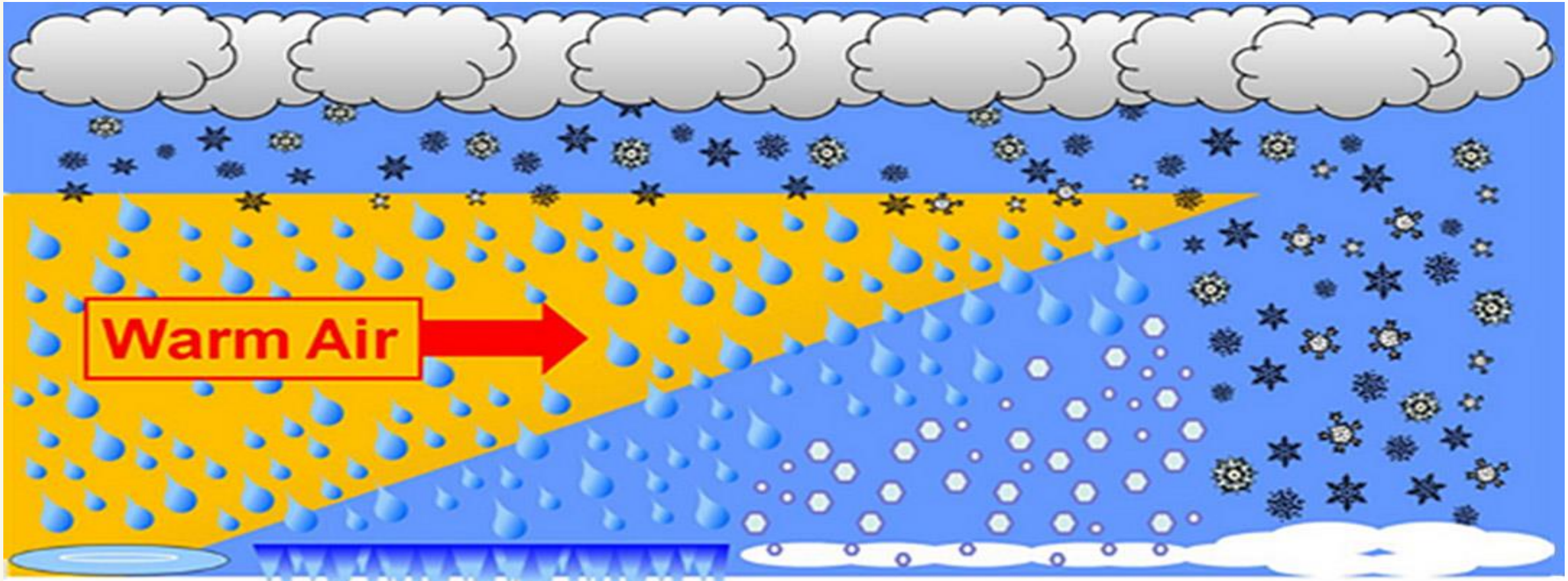
OTHER CLOUDS

- **Mammatus clouds**
- Also called mamma or mammatocumulus clouds
- Meaning "mammary cloud“
- Is a **cellular pattern of pouches hanging underneath the base of a cloud, typically a cumulonimbus raincloud**
- They often extend from the base of a cumulonimbus, but may also be found under altostratus, and cirrus clouds, as well as volcanic ash clouds.
- These are most often associated with severe thunderstorms.

- **Lenticular clouds**
- Are stationary clouds that form mostly in the troposphere,
- typically in parallel alignment to the wind direction.
- They are often comparable in appearance to a lens or saucer.
- Appearance: lens-like, Saucer-shaped
- Altitude: up to 12,000 m;

- **Noctilucent clouds**
- Noctilucent clouds are **the highest clouds in the Earth's atmosphere**, 83 km (50 miles) and are observed slightly below the **mesopause** in the polar summertime.
- **Are also called polar mesospheric clouds or night shining clouds**

PRECIPITATION



Rain

Frozen precipitation melts and reaches the ground as rain.

Freezing Rain

Frozen precipitation melts in warm air. Rail falls and freezes on cold surfaces.

Sleet

Frozen precipitation melts in shallow warm air. Then refreezes into sleet before reaching the surface.

Snow

Snow falls through cold air and reaches the surface.

- Precipitation is any **liquid or frozen water** that forms in the atmosphere and falls back to the earth.
- It comes in many forms, like **rain, sleet, and snow**.
- Along with evaporation and condensation, precipitation is one of the three major parts of the global water cycle.
- Precipitation condenses, or forms, around these tiny pieces of material, called **cloud condensation nuclei (CCN).**

- 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**. If a cloud is colder, like it would be at higher altitudes, the water droplets may freeze to form ice.
- Most rain **actually begins as snow** high in the clouds. As the snowflakes fall through warmer air, they become raindrops.

Form of Precipitation

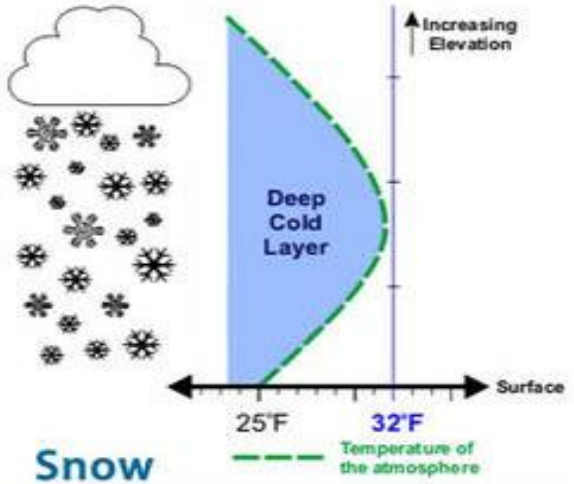
Types of Precipitation

Rain

Sleet

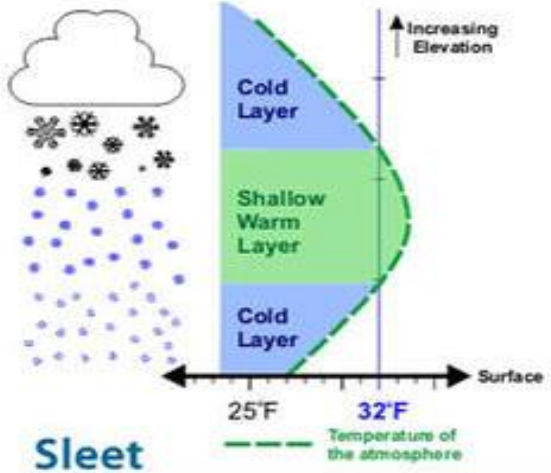
Snow

Hail



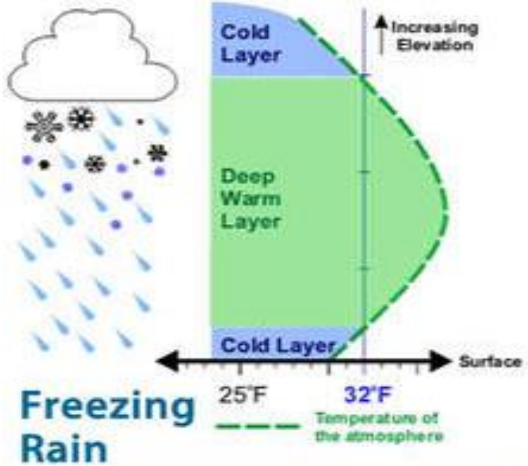
Snow

Snow falls when water vapor condenses as ice crystals. The air temperature is below freezing all the way to the ground, so the ice crystals remain frozen. They fall as flakes.



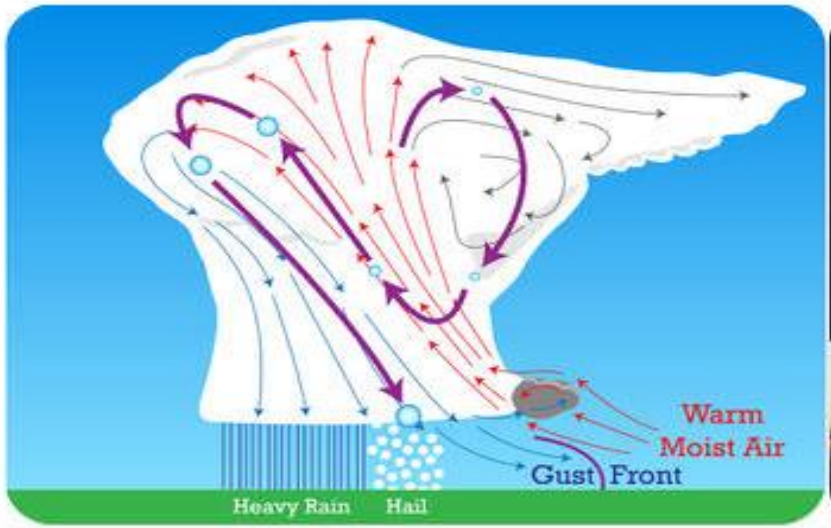
Sleet

Sleet forms when snow melts as it falls through a layer of warm air and then refreezes. It turns into small, clear ice pellets as it passes through a cold layer near the ground.



Freezing Rain

Freezing rain falls as liquid water. It freezes on contact with cold surfaces near the ground. It may cover everything with a glaze of ice. If the ice is thick, its weight may break tree branches and pull down power lines.



Hail

Hail forms when strong updrafts carry rain high into the tropo-sphere. The rain freezes into balls of ice called hailstones. This may happen over and over again until the hailstones are as big as baseballs. Hail forms only in cu-mulonimbus clouds.

- The most common types of precipitation are **rain, hail, and snow.**
- The precipitation **in the form of water is called rainfall.** It occurs when the temperature of underlying air is over than freezing point. Raindrops are actually spherical in shape.
- If the rain that falls from clouds but freezes before it reaches the ground is called **sleet or ice pellets**. Therefore, **Sleet is frozen raindrops and refrozen** melted snow-water.

- Hail forms in **cold storm clouds**.
- It forms when **very cold water droplets freeze**, or turn solid, as soon as they touch things like dust or dirt.
- The storm blows the hailstones into the upper part of the cloud. More frozen water droplets are added to the hailstone before it falls.
- Unlike sleet, which is liquid when it forms and freezes as it falls to Earth, hail falls as a stone of solid ice.
- Hailstones are usually the size of small rocks, but they can get as large as 15 centimeters (6 inches) across and weigh more than a pound.

- Snow is precipitation that falls in the form of ice crystals. Hail is also ice, but hailstones are just collections of frozen water droplets.
- Snow has a complex structure. The ice crystals are formed individually in clouds, but when they fall, they stick together in clusters of snowflakes.
- Snowfall happens when many individual snowflakes fall from the clouds. Unlike a hail storm, snowfall is usually calm. Hailstones are hard, while snowflakes are soft.

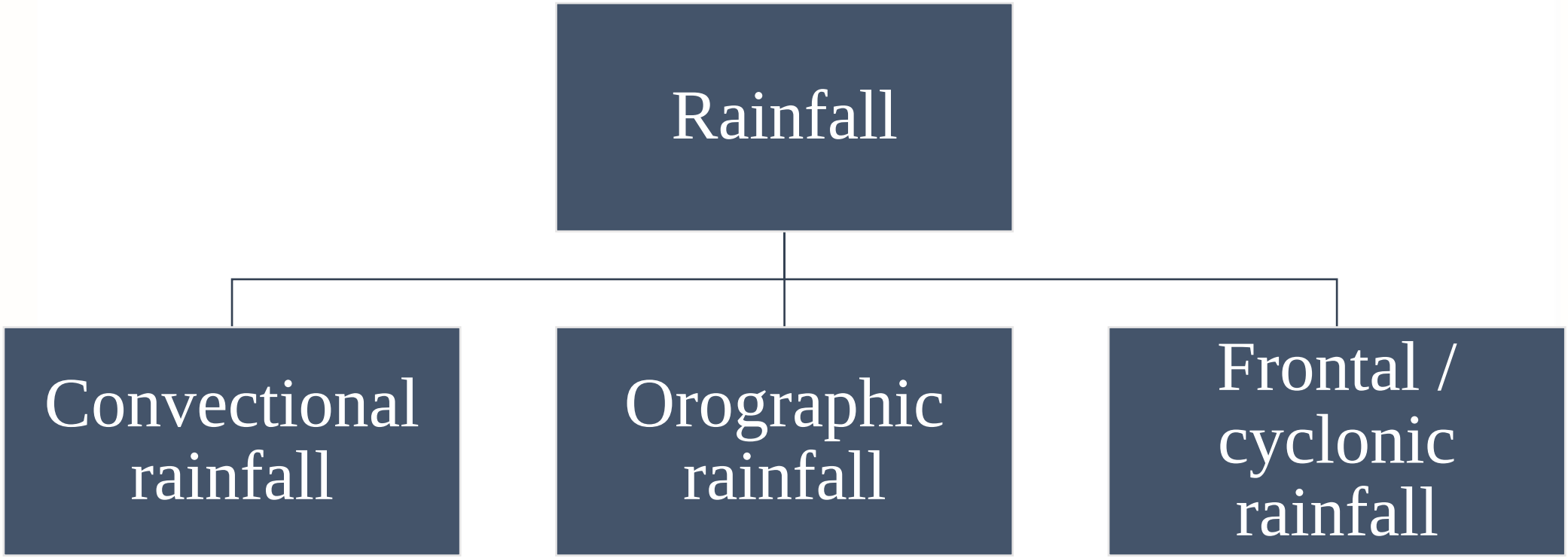

GRAUPEL
Snowflakes that collect supercooled water droplets on its surface
HAIL
Frozen raindrops of ice from thunderstorms
SLEET
Liquid precipitation that freezes before reaching the ground

- When snow falls in the form of a ball instead of soft flakes, it is called graupel. This happens when snow is melted and precipitation forms around the snow crystal.

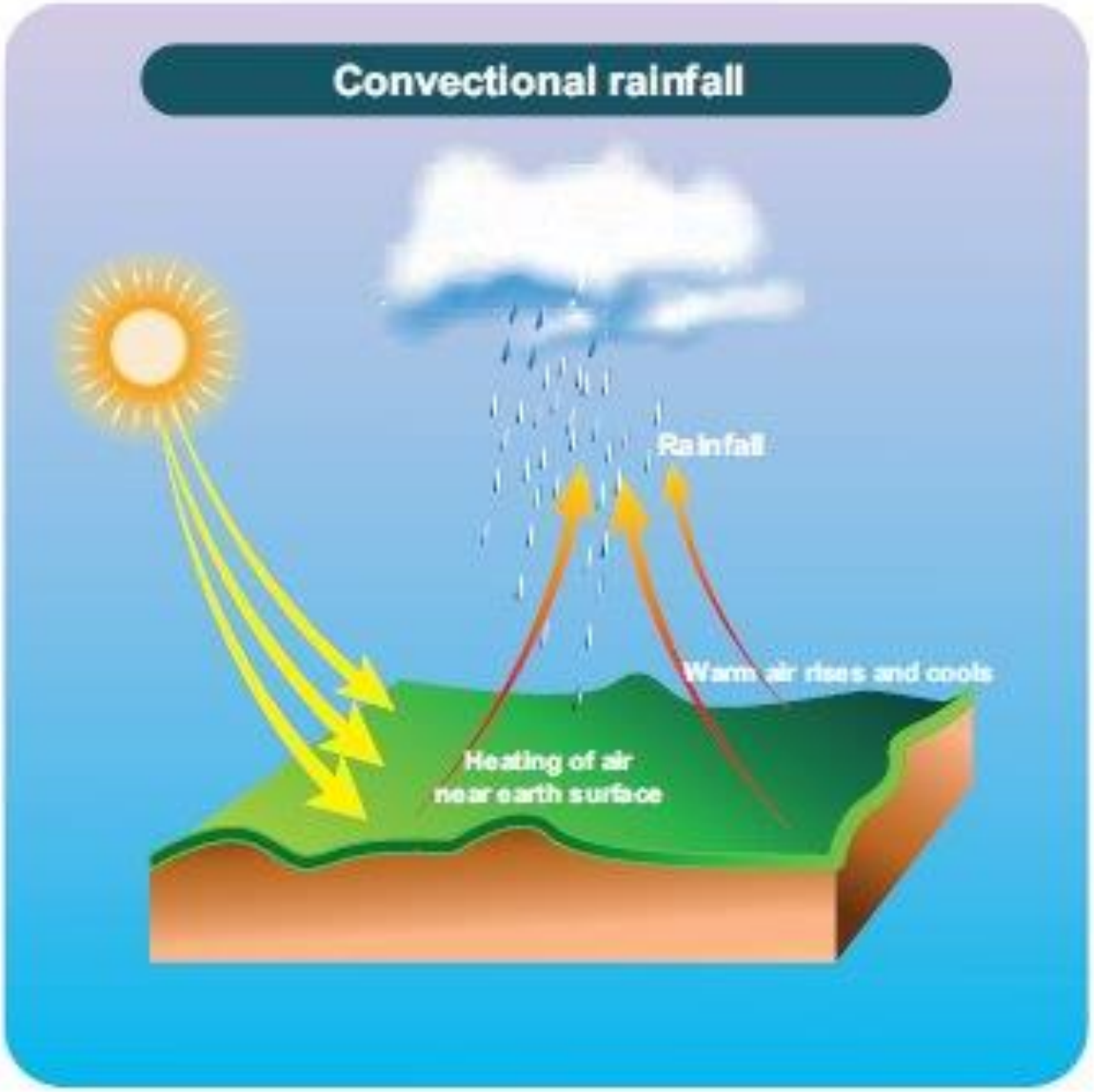
- Snow requires temperatures at the ground to be near or below freezing—less than 0 degrees Celsius (32-degrees Fahrenheit). Snow that falls on warmer ground melts on contact.

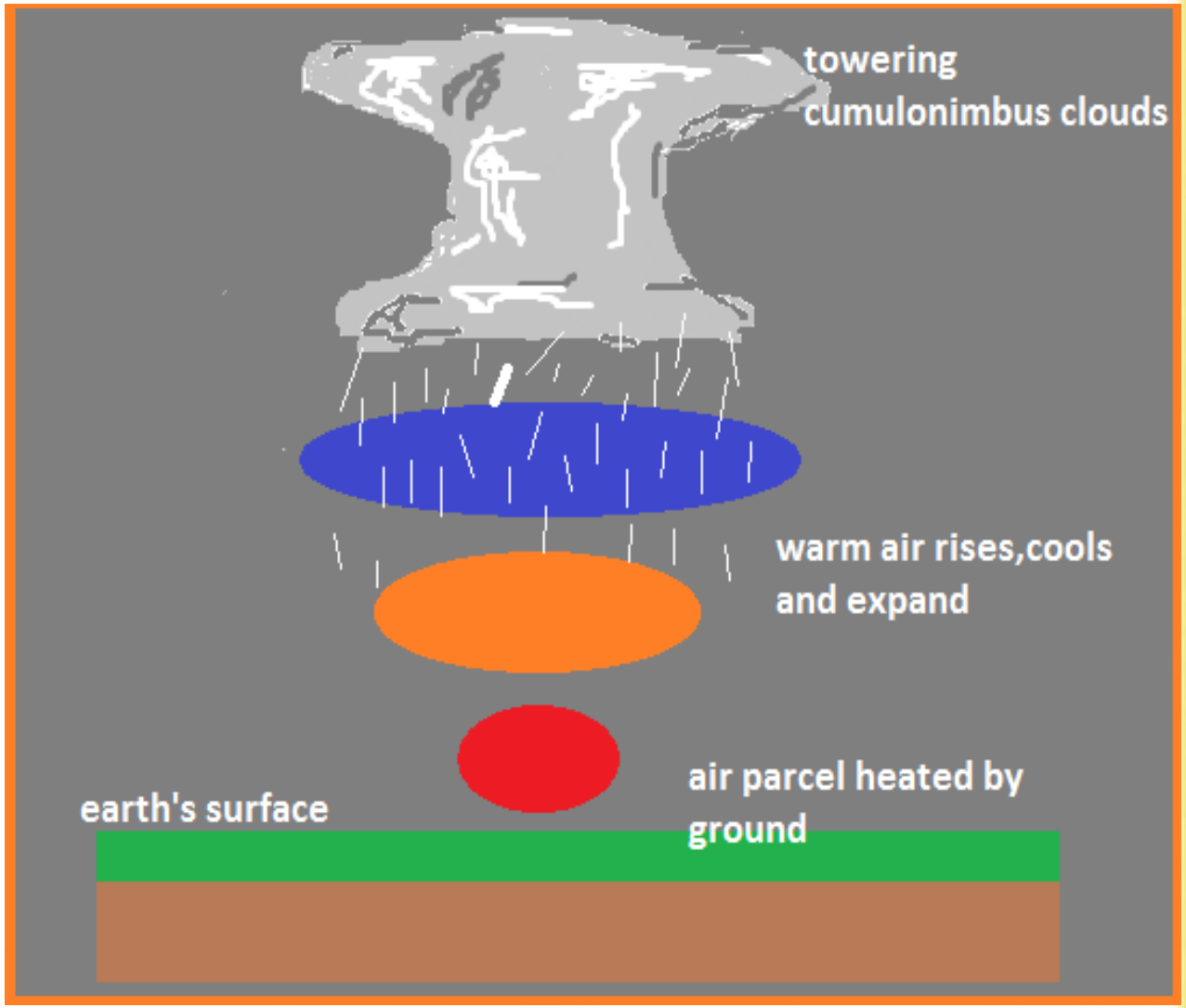
Virga is a type of precipitation that begins to fall from a cloud, but evaporates before it reaches the surface of the Earth.

Types of Rainfall



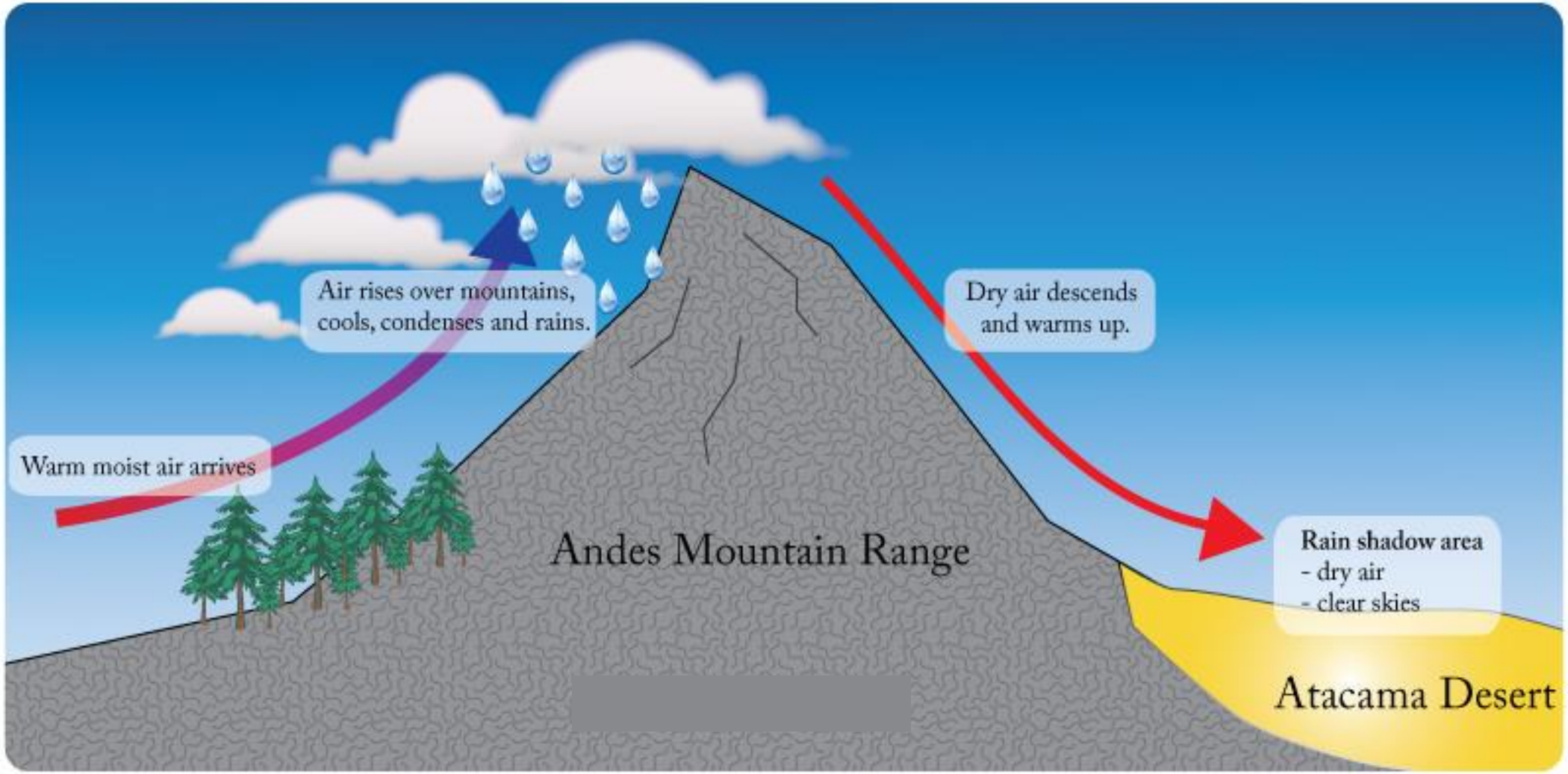
Convectional Rainfall



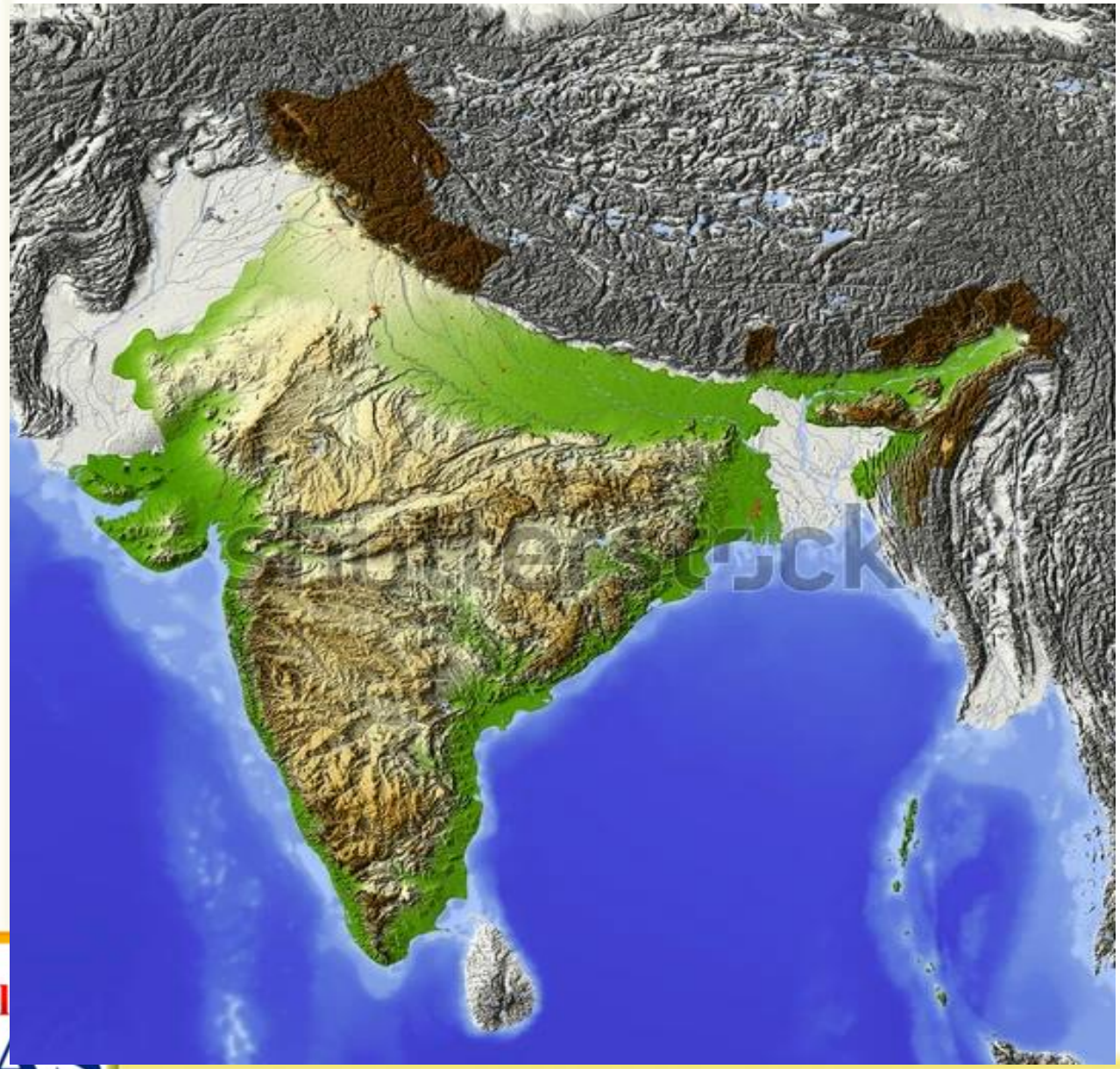


- Convectional rainfall is the typical form of rainfall triggered by vertical ascend of moist air (ascending convectional currents).
- Due to scorching sunlight air rises upward and expands. After reaching some height it loses heat and consequently, condensation takes place and cumulous clouds are formed.
- With thunder and lightening, heavy rainfall occurs but this does not last long.
- It is very common in **the equatorial regions** and interior parts of the continents during summer, particularly in the northern hemisphere.
- In the equatorial regions convectional rainfall is received almost daily in the afternoons. It generally happens regularly at 4 P.M. throughout the year. For this reason it is also called 4'O clock rainfall.

Orographic Rain



- Orographic rainfall is also known as the relief rain or mountain rainfall.
- When the saturated air mass approaches toward a mountain, it ascends and expands. Further, the temperature falls, and the moisture is condensed.
- The **windward slopes receives greater rainfall** due to it but leeward slopes remain rainless and dry.
- The area situated on the leeward side, which gets less rainfall is known as the **rain-shadow area.**
- The windward slope of a mountain, at the time of rainfall, **has cumulus clouds** while the leeward slope has stratus clouds.

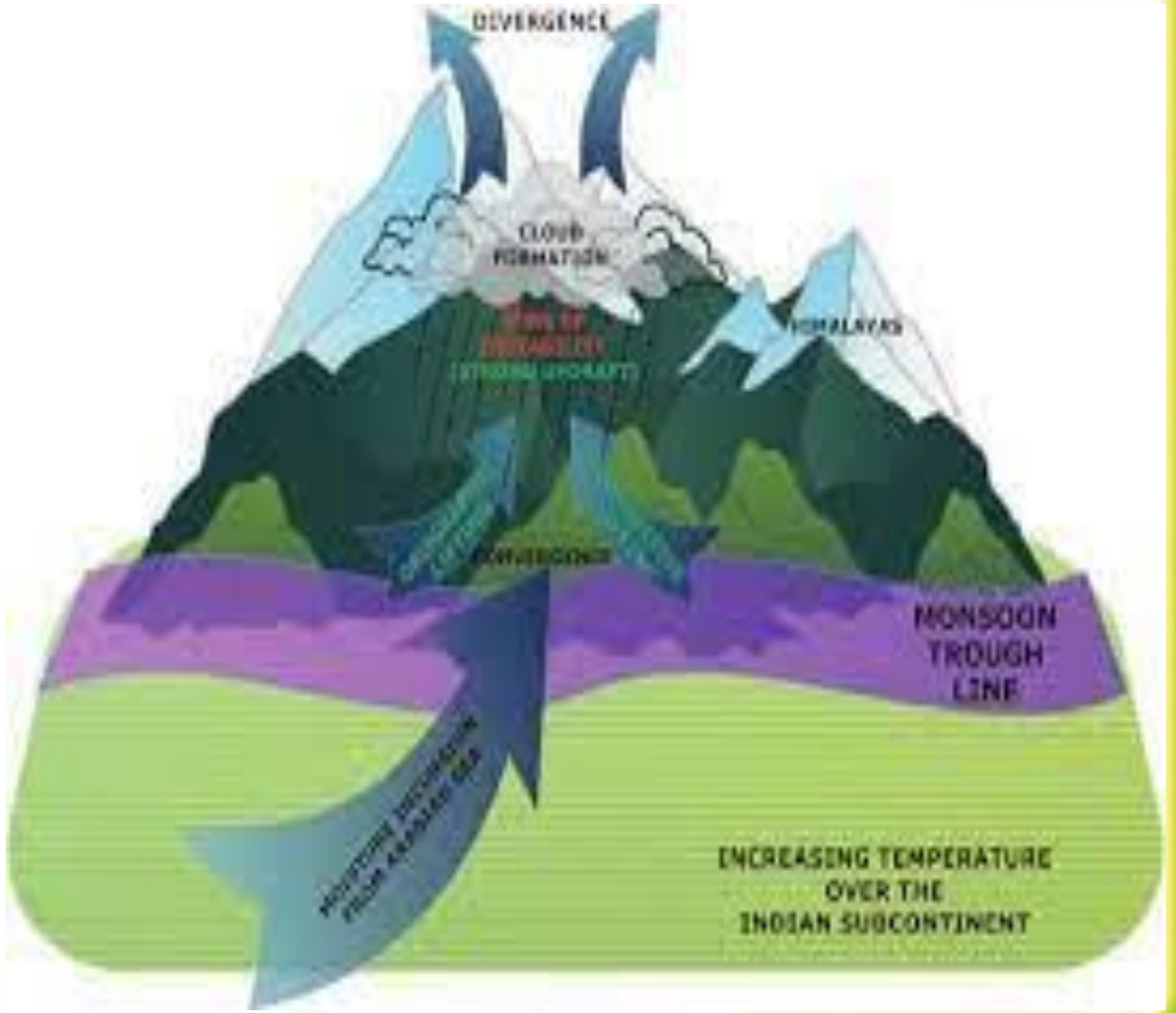


- Mahabaleshwar lying on the wind-ward side of Western Ghats receives annual rainfall of about 622 cm as against Pune on the leeward side only 70 km away from Mahabaleshwar receives only 66 cm annual rainfall.
- Cherrapunji in Meghalaya plateau, the Western Ghats and the entire Himalayan region receive Orographic Rainfall

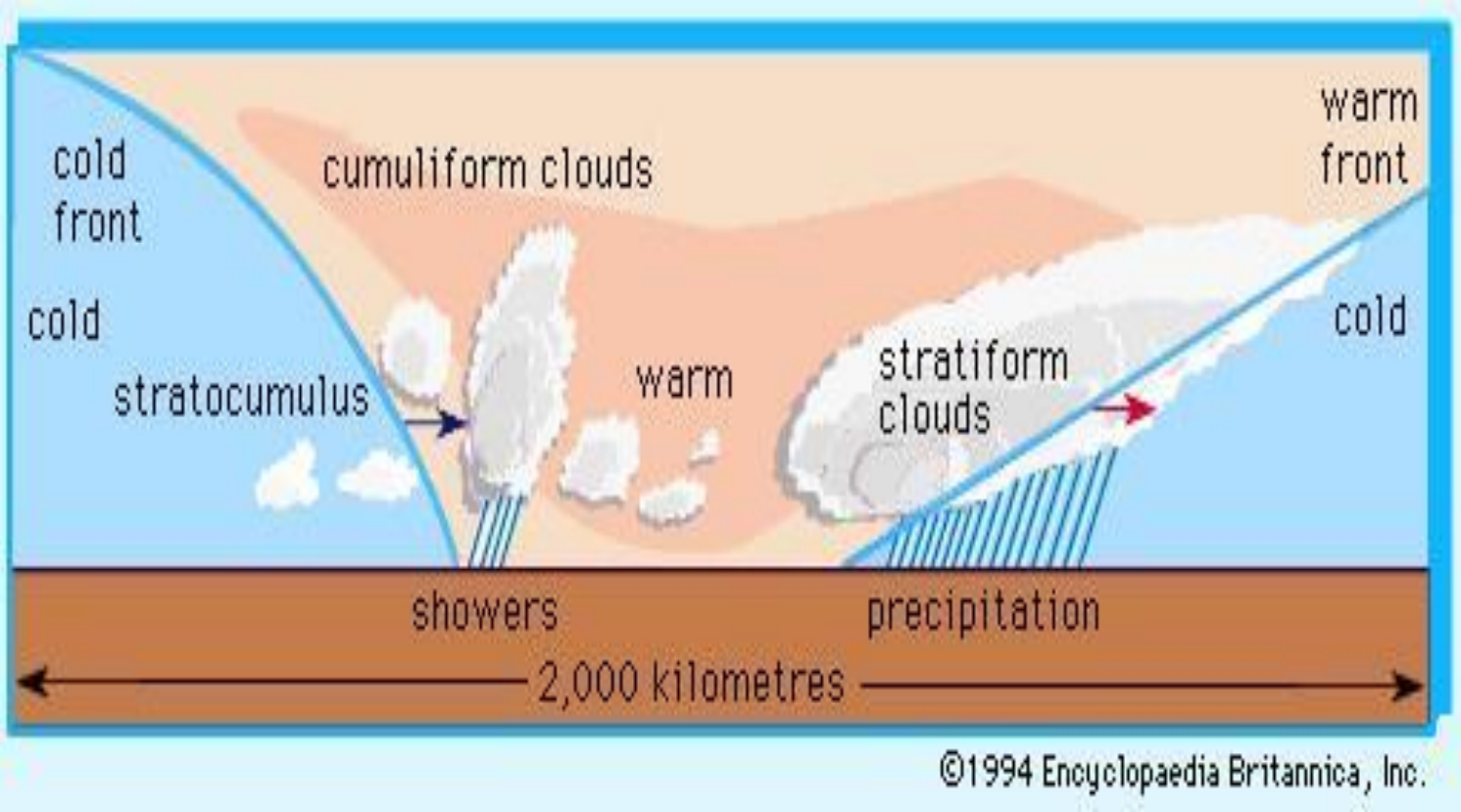
- The orographic rainfall may occur in any season. It is longer duration.
- The orographic rainfall is supported by convectional and cyclonic processes of condensation.
- Most of the precipitation in the world is orographic in nature.

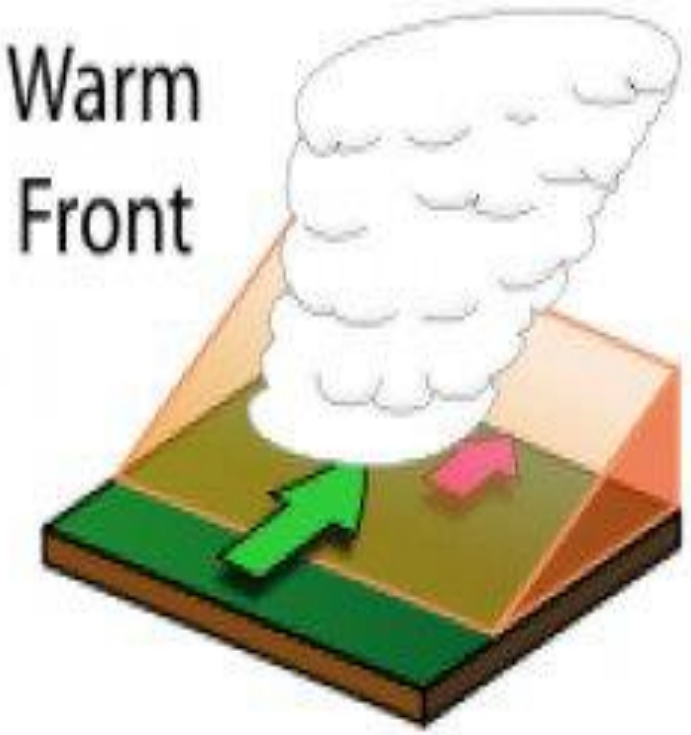
Cloudburst

- A cloudburst is an extreme amount of precipitation in a short period of time.
- sometimes accompanied by hail and thunder, which is capable of creating flood conditions.
- Cloudbursts can quickly dump large amounts of water, e.g. 25 mm of precipitation corresponds to **25,000 metric tons per square kilometer.**
- They usually occur via orographic lift or occasionally when a warm air parcel mixes with cooler air, resulting in sudden condensation.

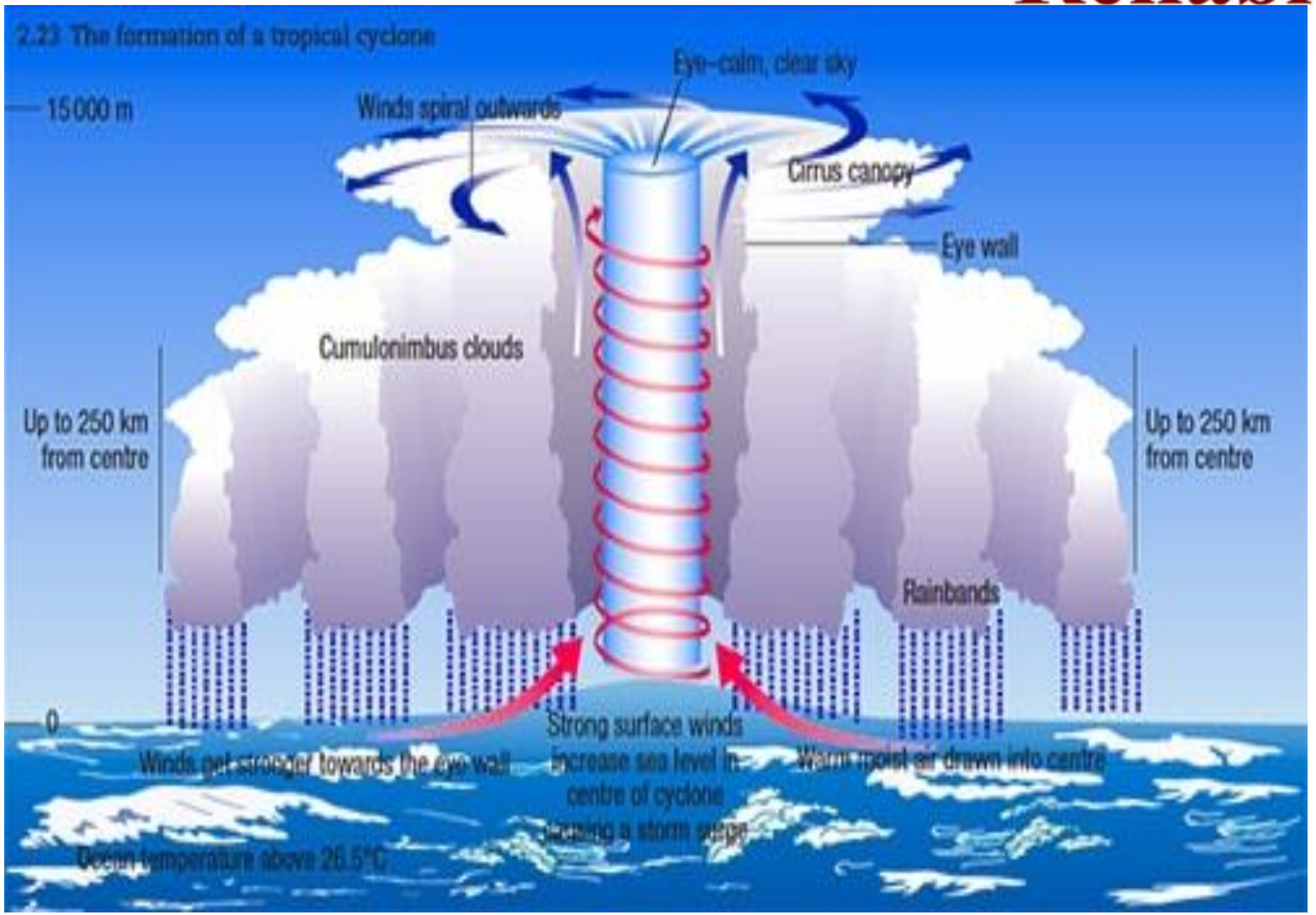


Cyclonic or Frontal Rainfall





- **Cyclones is the system of rotating wind around a low pressure at the centre**.
- The warm air being the lighter, rises above the cold air. The rising warm air cools and condensation takes place, causing rainfall.
- This type of rainfall is associated with **temperate and tropical cyclones**.
- Most of the rainfall in the temperate region is received through frontal or cyclonic rains.
- The tropical cyclone, regionally known as typhoons, hurricanes, tornadoes, etc., yield heavy downpour in China, Japan, Southeast Asia, India, USA, etc.


2.23 The formation of a tropical cyclone
15 000 m
Winds spiral outwards
Eye–calm, clear sky
Cirrus canopy
Eye wall
Cumulonimbus clouds
Up to 250 km from centre
Up to 250 km from centre
Rainbands
0
Strong surface winds increase sea level in centre of cyclone causing a storm surge
Winds get stronger towards the eye wall
Ocean temperature above 26.5°C

ARTIFICIAL RAIN COMETH!

WHAT IS ARTIFICIAL RAIN?

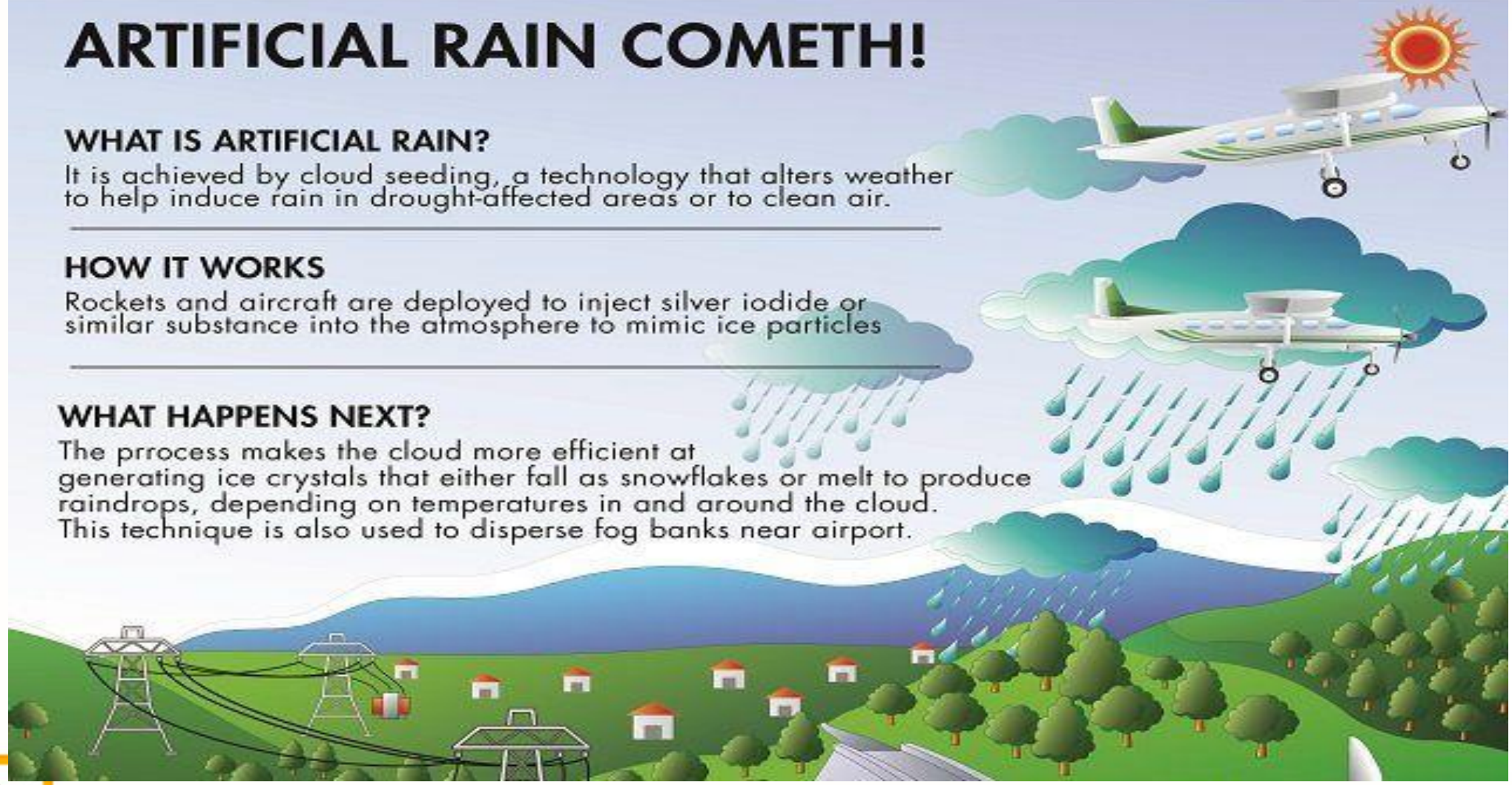
It is achieved by cloud seeding, a technology that alters weather to help induce rain in drought-affected areas or to clean air.

HOW IT WORKS

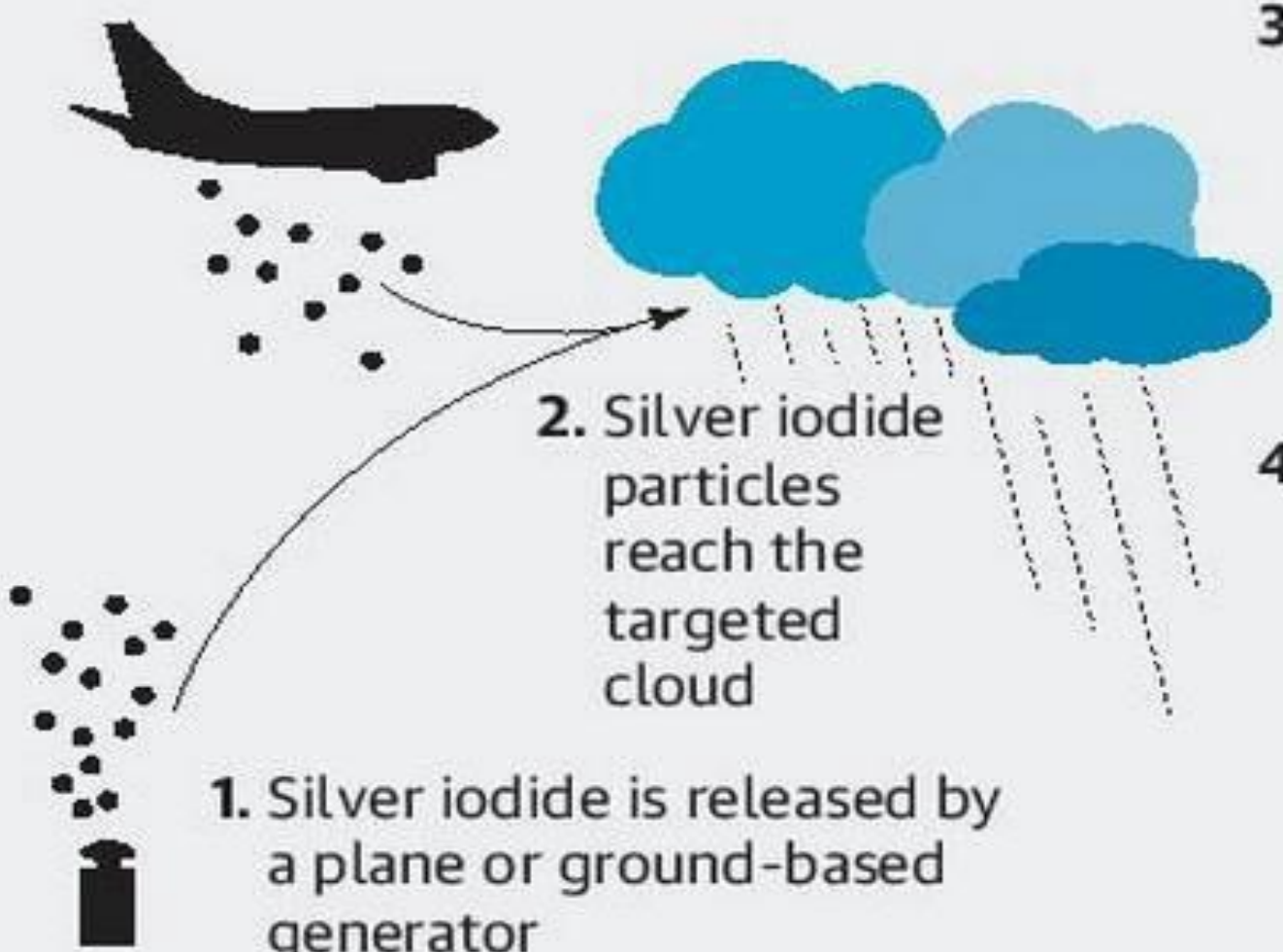
Rockets and aircraft are deployed to inject silver iodide or similar substance into the atmosphere to mimic ice particles

WHAT HAPPENS NEXT?

The prrocess makes the cloud more efficient at generating ice crystals that either fall as snowflakes or melt to produce raindrops, depending on temperatures in and around the cloud. This technique is also used to disperse fog banks near airport.

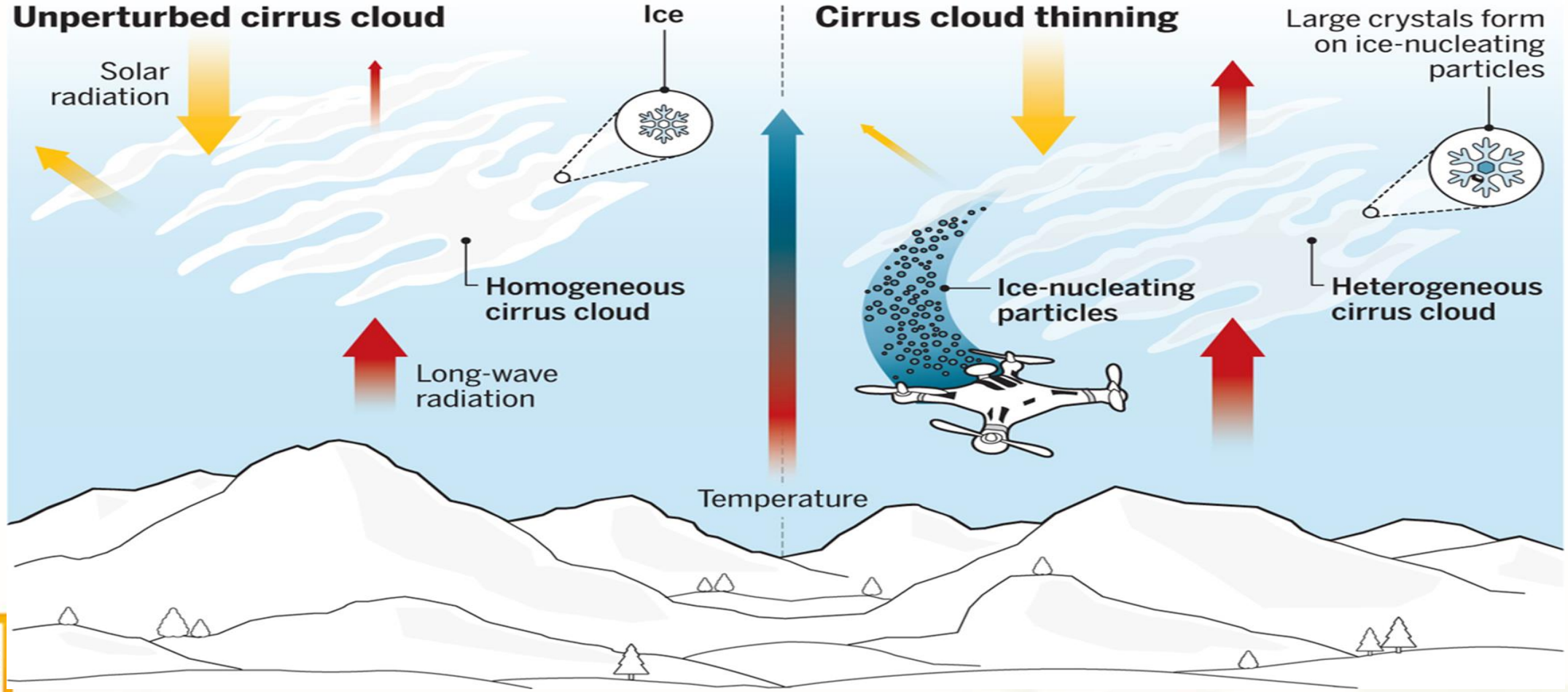


How cloud seeding works

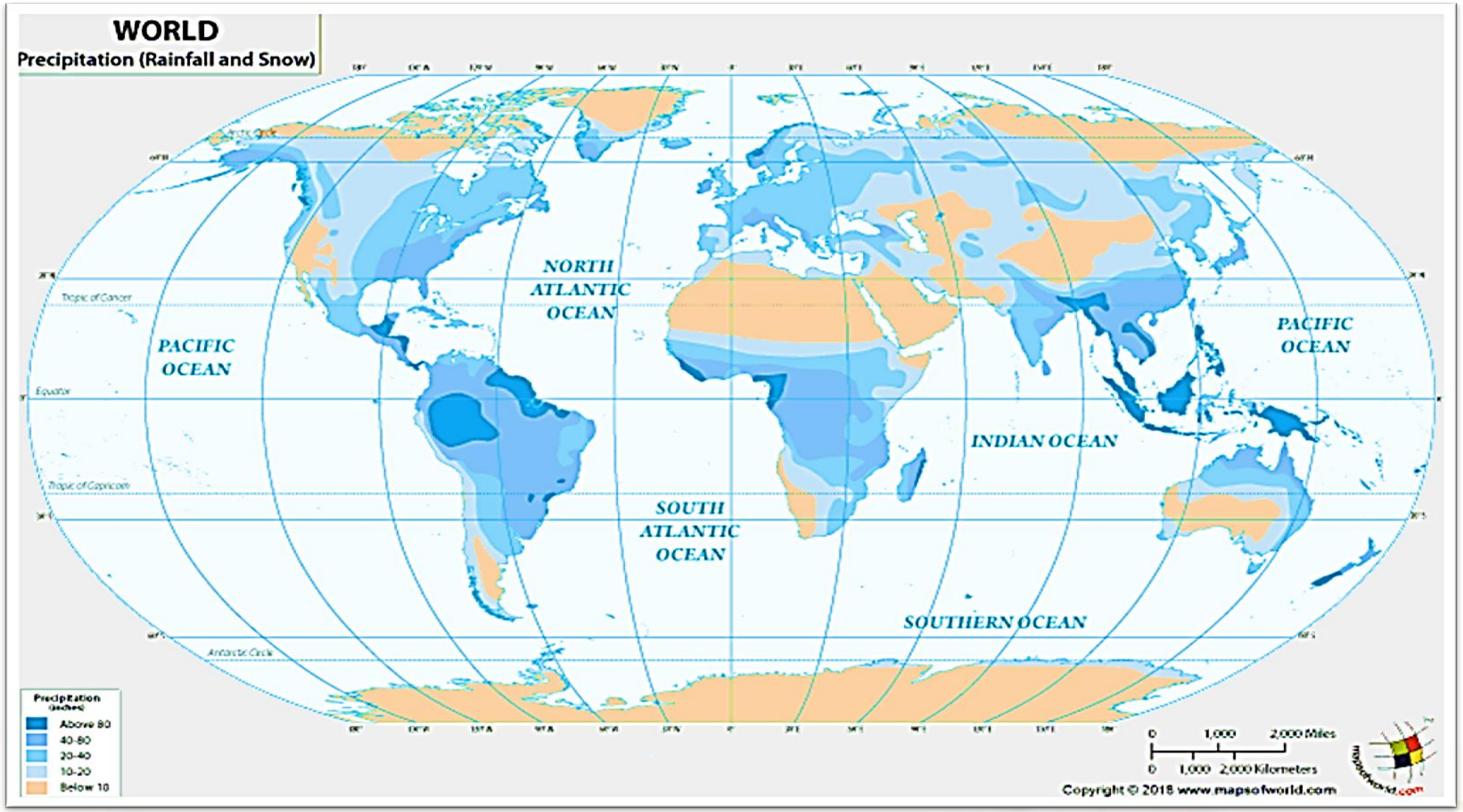


How seeded cirrus clouds could cool the climate

Cirrus clouds reflect some sunlight and absorb long-wave radiation; on balance, they warm the climate. Cirrus cloud thinning aims to change the radiative properties of cirrus clouds by reducing their lifetime and the altitude at which they form.

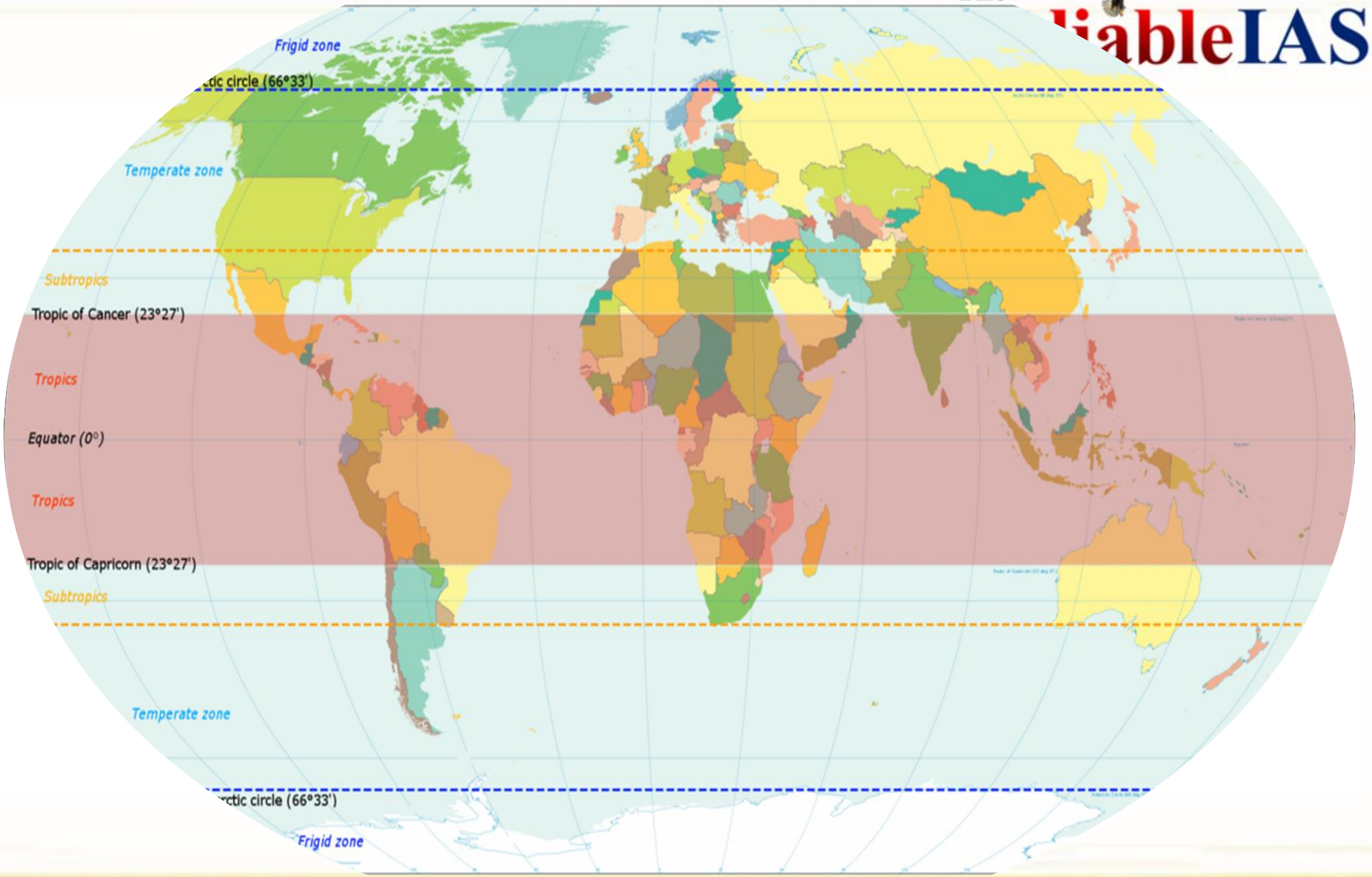


GLOBAL PATTERN OF RAINFALL



- In general, from the equator towards the poles, rainfall goes on decreasing steadily.
- The **coastal areas, in average, receive greater** amounts of rainfall than the interior of the continents.
- The rainfall is **more over the oceans** than on the continents.
- B/w **35 and 40 N and S LAT** of the equator, the rain is heavier on the **eastern coasts** and goes on decreasing towards the west.
- But, **between 45 and 65 N and S** of equator, due to the westerlies, the rainfall is first received on the western margins of the continents and it goes on decreasing towards the east.

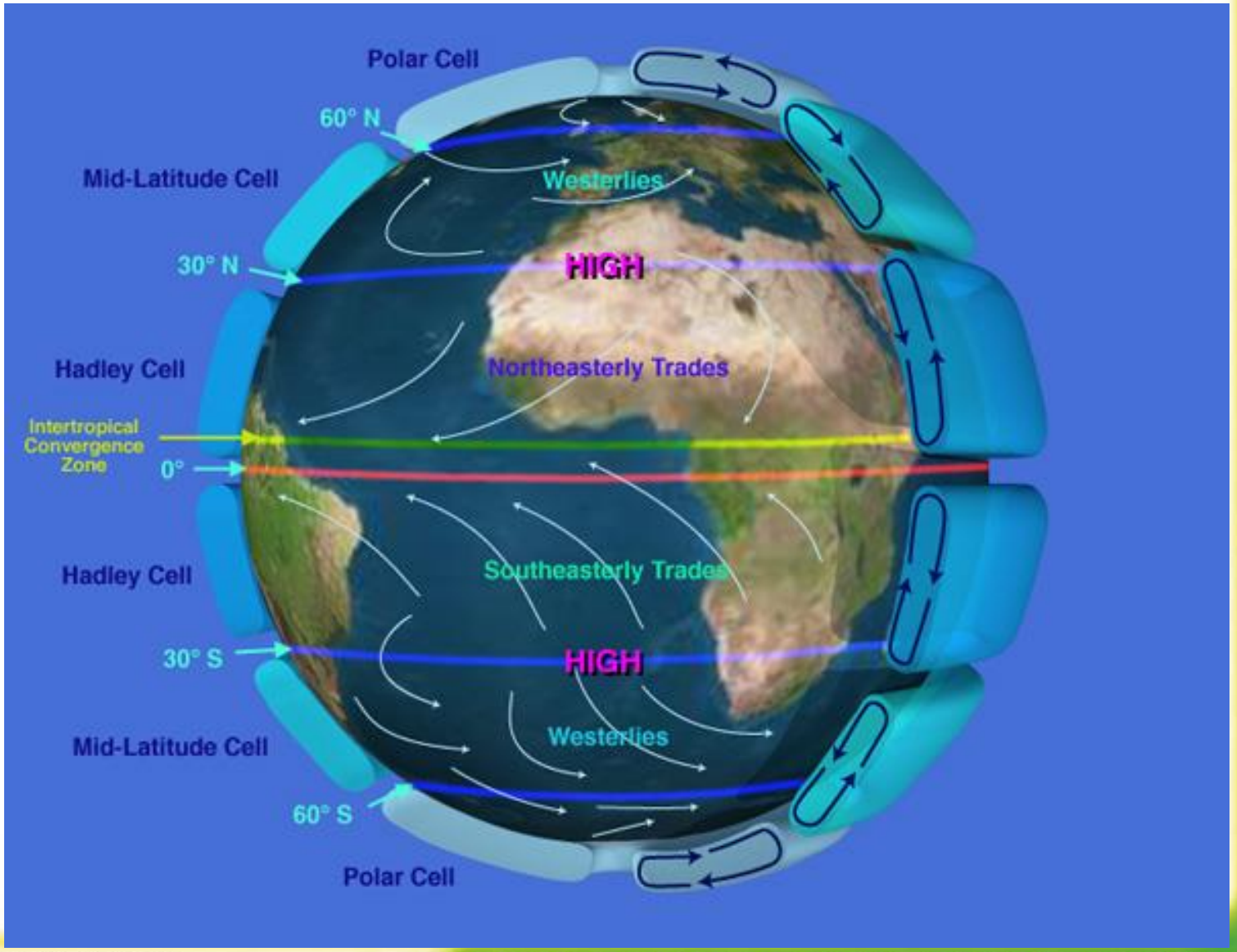
- Most of the **western coastal areas in the mid- latitudes** have **dry summers and wet winters** due to the presence of the sub-tropical high pressure belts.
- In the temperate region the precipitation is cyclonic in nature and the cyclones are more common in the winter season. Thus heavy rainfall occurs in winters and not in summers.
- However, most of the areas in the world receive a major part of the precipitation during the summer season.


Frigid zone
tic circle (66°33')
Temperate zone
Subtropics
Tropic of Cancer (23°27')
Tropics
Equator (0°)
Tropics
Tropic of Capricorn (23°27')
Subtropics
Temperate zone
rctic circle (66°33')
Frigid zone


MEDITERRANEAN BASIN
CALIFORNIA AND
NORTHERN BAJA
CALIFORNIA
CENTRAL CHILE
WESTERN CAPE,
SOUTH AFRICA
SOUTHWEST AND
SOUTH AUSTRALIA

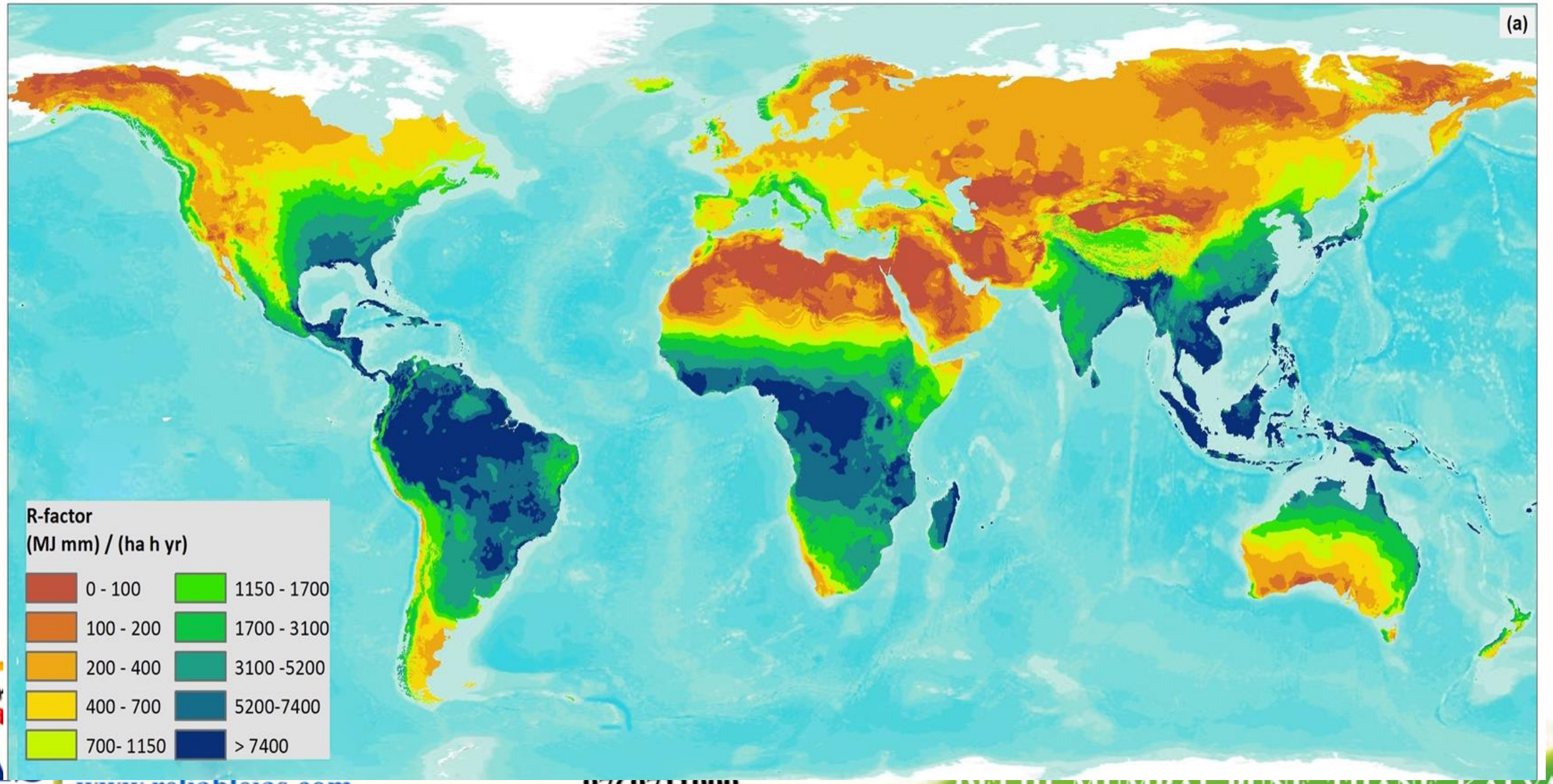
World- Distribution of Precipitation

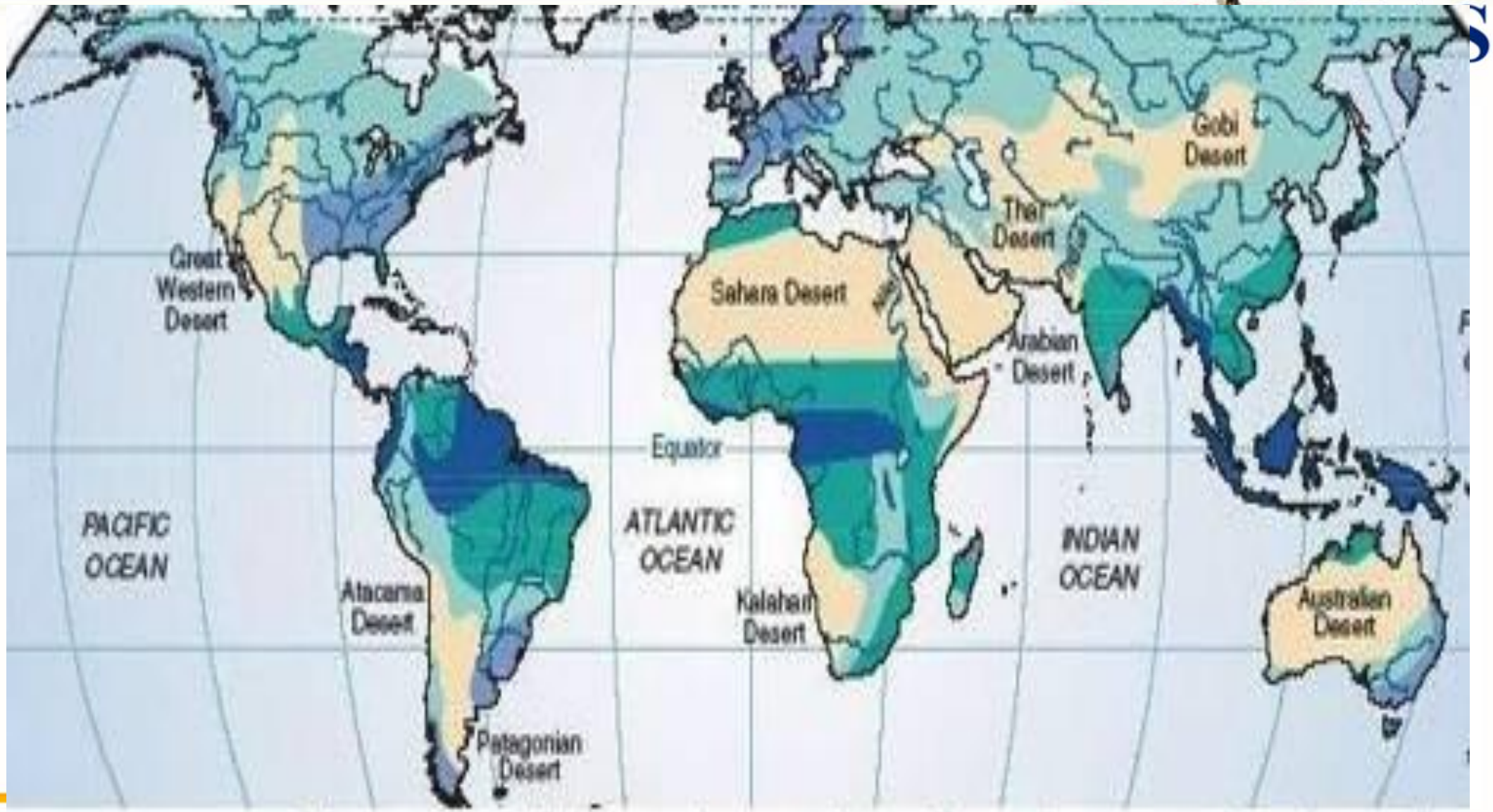
- The mean **annual rainfall on Earth is about 100 cm** but different places on the earth's surface receive different amounts of rainfall in a year and that too in different seasons.



FACTORS CONTROLLING THE DISTRIBUTION OF RAINFALL

- Distribution & Shifting of pressure belt
- Air temperature
- Moisture-bearing winds,
- Ocean currents,
- Distance inland from the coast
- Mountain ranges.


(a)
R-factor
(MJ mm) / (ha h yr)
0 - 100
100 - 200
200 - 400
400 - 700
700- 1150
1150 - 1700
1700 - 3100
3100 -5200
5200-7400
> 7400


Great Western Desert
Sahara Desert
Gobi Desert
Thar Desert
Arabian Desert
Equator
PACIFIC OCEAN
ATLANTIC OCEAN
INDIAN OCEAN
Atacama Desert
Kalahari Desert
Australian Desert
Patagonian Desert
snow
infrequent rain
light seasonal rain
moderate rain every month
heavy seasonal rain
heavy rain every month

- On the basis of the total amount of annual precipitation, major precipitation regimes of the world are identified as follows.
- **Areas of Heavy Rainfall**: The regions receiving more **than 200 cm of annual** precipitation are included in this belt. The main areas are the **equatorial belt, the mountain slopes along the western coasts in the cool temperate zone** and the **coastal areas of the monsoon lands**.

- **Areas of Moderate Rainfall:** The regions receiving **100 cm to 200 cm** of annual precipitation are included in this belt. The main areas **lie adjacent to the regions of heavy rainfall.** The coastal areas in the warm temperate zone also receive moderate precipitation.

- **Areas of Low Rainfall:** The **regions receiving 50 cm to 100 cm of annual precipitation are** included in this belt. The main **areas lie in the central part of the tropical lands and in the** eastern and the **interior parts of the temperate** lands.

- **Areas of Scanty Rainfall:** The regions receiving less than 50 cm of annual precipitation are included in this belt. The main areas are **the rain shadow areas on the** leeward slopes of the mountain ranges, the interior of the continents, the lands in the high latitudes, western margins of the continents in the tropical areas and the arid deserts.