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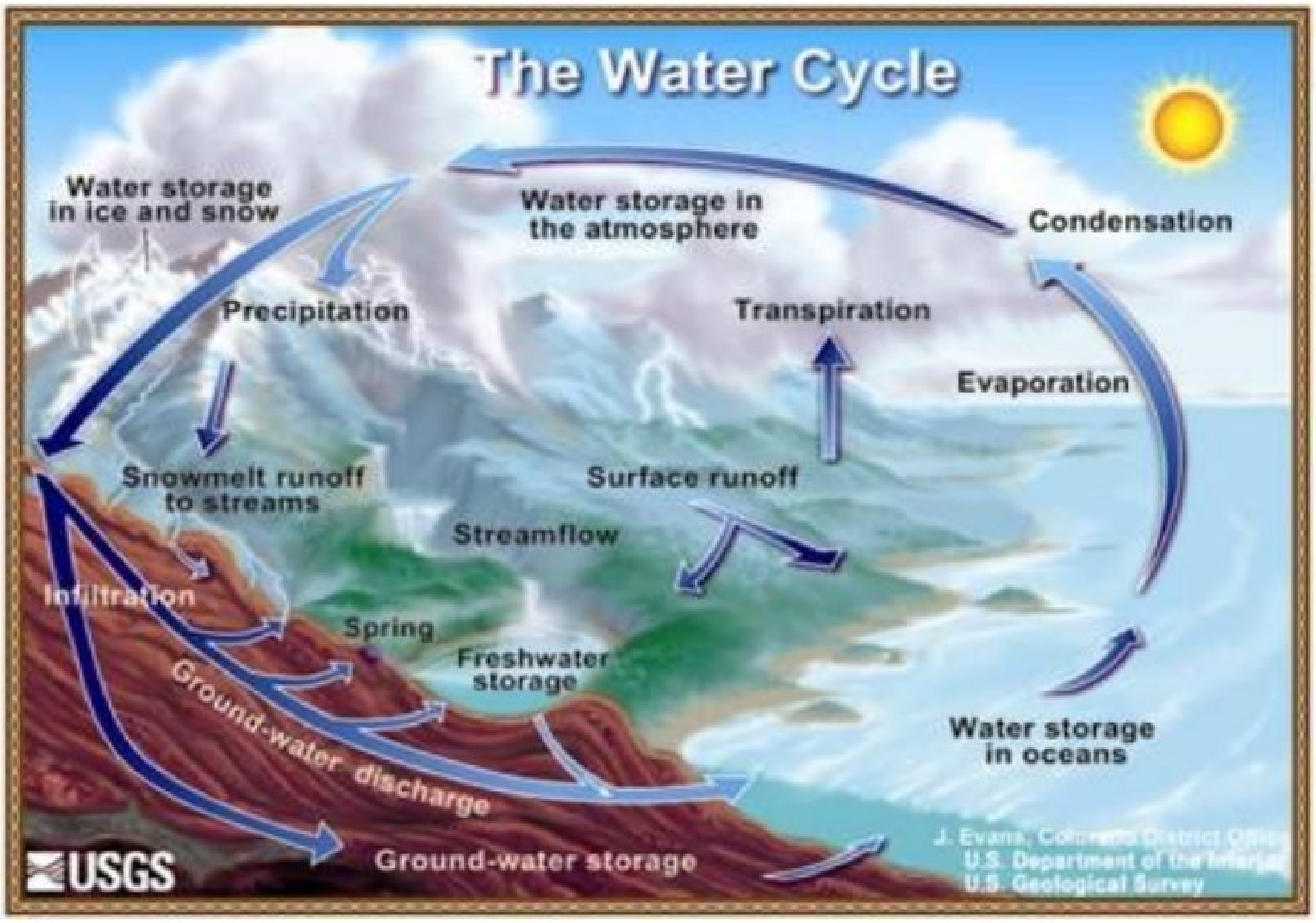
Water Cycle – Hydrological cycle

- There is a continuous exchange of water between the atmosphere, the oceans and the continents through the processes of **evaporation, transpiration, condensation and precipitation.**
- The moisture in the atmosphere is derived from water bodies through **evaporation** and from plants through **transpiration (evapotranspiration)**.
- Evaporated water undergoes **condensation** and forms clouds.
- When saturation is reached, clouds give away water in the form of precipitation.
- Since the total amount of moisture in the entire system remains constant, a balance is required between evapotranspiration and precipitation. The hydrological cycle maintains this balance.



Water Vapour in Atmosphere

- Water vapour in air varies from **zero to four per cent** by volume of the atmosphere (averaging around **2%** in the atmosphere). Amount of water vapour (Humidity) is measured by, an instrument called **Hygrometer.**

Significance of Atmospheric Moisture

1. Water vapour absorbs radiation—**both incoming and terrestrial**. It thus plays a crucial role in the **earth's heat budget**.
2. The amount of water vapour present decides the **quantity of latent energy stored** up in the atmosphere for development of storms and cyclones.
3. The atmospheric moisture affects the human body's rate of cooling by influencing the sensible temperature.

Evaporation

- The oceans covering 71% of the earth's surface hold 97% of all the earth's water reserves.
- Evapotranspiration may be taken as the starting point in the hydrological cycle. The oceans contribute **84%** of the annual total and the continents **16%.**

- The highest annual evaporation occur in the **sub-tropics of the western North Atlantic** and **North Pacific** because of the influence of the **Gulf Stream** and the **Kurishino Current**, and in the **trade wind zone of the southern oceans**.
- The land maximum occurs in equatorial region because of **high insolation** and luxuriant

Humidity

- Water vapour present in the air is known as Humidity.

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 absolute humidity **differs** from place to place on the surface of the earth.
- The ability of the air to hold water vapour depends entirely on its temperature **(Warm air can hold more moisture than cold air)**.

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.

Relative Humidity = [Actual amount of water vapor in air (absolute humidity)/humidity at saturation point (the maximum water vapor air can hold at a given temperature)] X 100

- With the change of air temperature, the capacity to retain moisture increases or decreases and the relative humidity is also affected.
- **Relative humidity is greater over the oceans and least over the continents** (absolute humidity is greater over oceans because of greater availability of water for evaporation).
- The **relative humidity** determines the **amount and rate of evaporation** and hence it is an **important climatic factor.**
- Air containing moisture to its full capacity at a given temperature is said to be **'saturated'.** At this temperature, the air **cannot** hold any additional amount of moisture. Thus, relative humidity of the saturated air is **100%.**

- If the air has half the amount of moisture that it can carry, then it is unsaturated and its relative humidity is only **50%.**

Relative humidity can be changed in either of the two ways—

1. **By adding moisture through evaporation (by increasing absolute humidity)**: if moisture is added by evaporation, the relative humidity will increase and vice versa.
2. **By changing temperature of air (by changing the saturation point)**: a decrease in temperature (hence, decrease in moisture-holding capacity/decrease in saturation point) will cause an increase in relative humidity and vice versa.

Consider 1 m^3 of air at a temperature 'T'.

Let us assume that saturation occurs when 0.5 kg of water vapor is present in 1 m^3 of air.

That is, relative humidity will be 100% if 1 m^3 of air contains 0.5 kg of water vapor at temperature T (saturation temperature or saturation point).

Assume that 1 m^3 of air at a given time consists of 0.2 kg of water vapor at a temperature 'T'.

Now the relative humidity = 40 % ===> 0.2 kg of water vapor per 1 m^3 of air ===> the air can still hold 0.3 kg of water vapor since saturation occurs at 0.5 kg.

Here,

Absolute Humidity = 0.2 kg/ m^3 and

Relative Humidity = 40 %

So, relative humidity is expressed as % whereas absolute humidity is expressed in absolute terms.

Now to make the air saturated (100 % relative humidity),

1. we can add that additional 0.3 kg of water vapor by evaporation. **OR**
2. we can decrease the temperature.

If we decrease the temperature, the saturation point will come down.

Let us assume that the temperature of 1 m^3 of air is decreased by 2 °C. The water holding capacity will fall due to decrease in temperature. Let us assume that the water holding capacity decreases by 0.1 kg per m^3 of air per 1 °C fall in temperature.

So, for 2 °C fall in temperature, the fall in water holding capacity is 0.2 kg/m^3 of air (0.1 kg/m^3 x 2).

Hence the new saturation point occurs at 0.3 kg/m^3 of air [0.5 kg/m^3 – 0.2 kg/m^3].

That is, the 'new saturation point' (relative humidity = 100%)" occurs when the water vapor content is 0.3 kg per 1 m^3 of air.

So now we can saturate 1 m^3 of air by adding just 0.1 kg instead of 0.3 kg as in the earlier case.

[because, initially, we assumed that 1 m^3 of air at a given time consists of 0.2 kg of water vapor at a temperature 'T'.]

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 in a given sample of air is known as **dew point.**
- **Dew point occurs when Relative Humidity = 100%.**

Specific Humidity

- It is expressed as the **weight of water vapour per unit weight of air**.
- Since it is measured in units of weight (usually grams per kilogram), the specific humidity is **not affected by changes in pressure or temperature**.

Absolute Humidity and Relative Humidity are Variable whereas Specific Humidity is a constant.