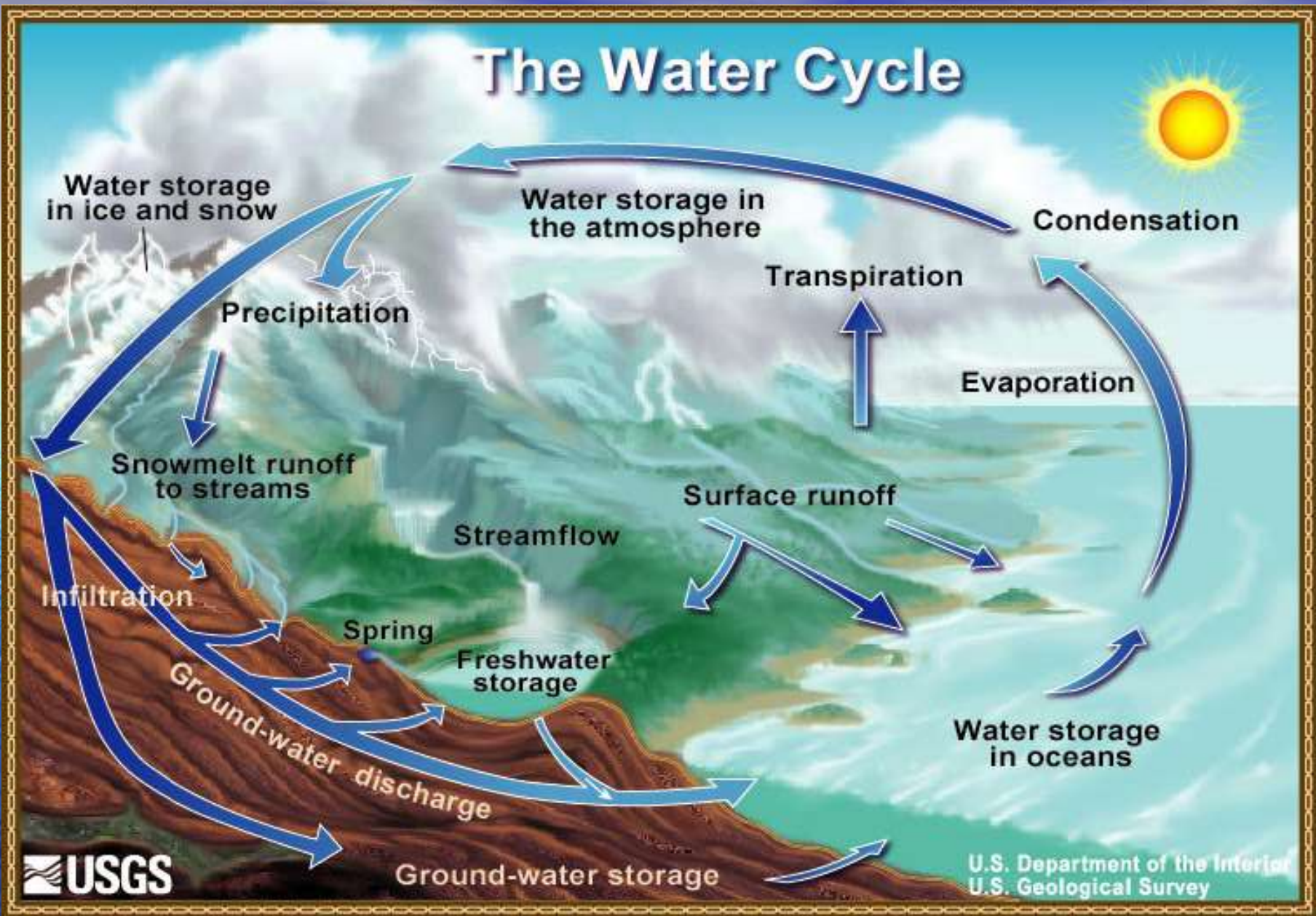




Water never leaves the Earth. It is constantly being cycled through the atmosphere, ocean, and land. This process, known as the **water cycle**, is driven by energy from the sun. The water cycle is crucial to the existence of life on our planet.

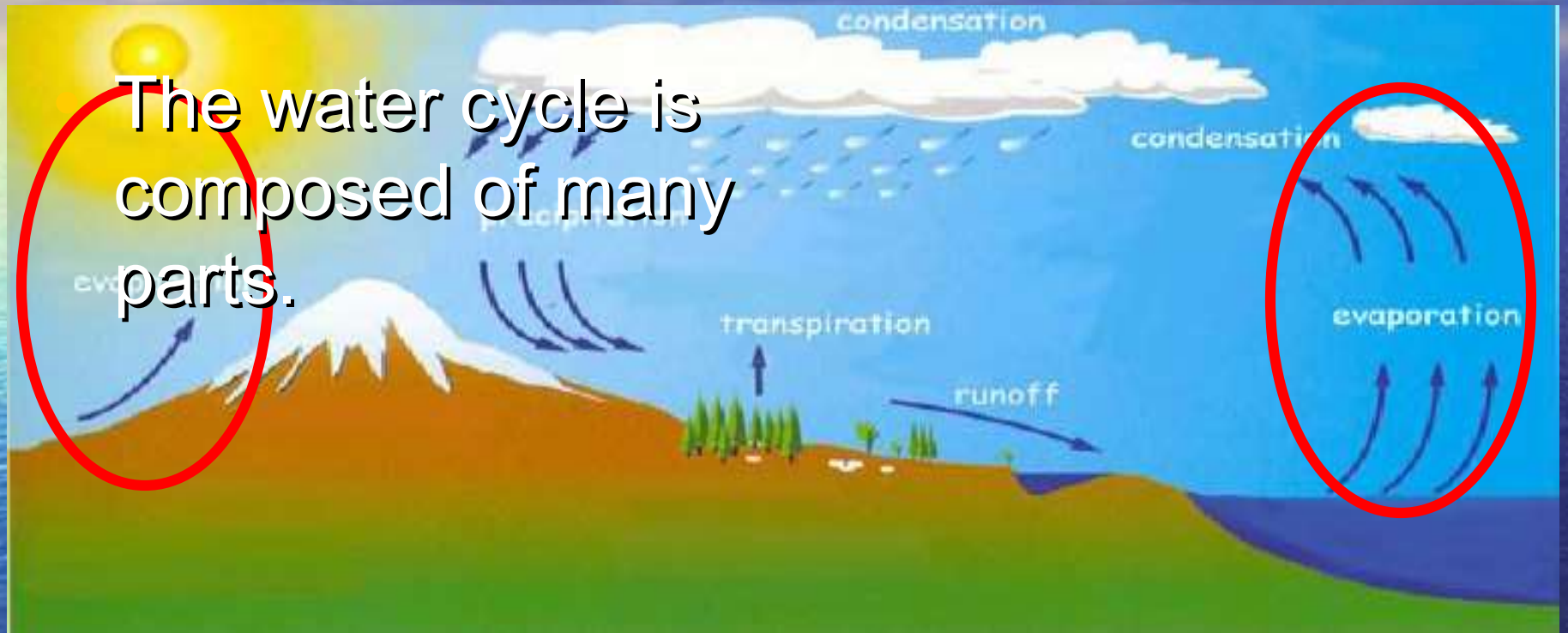


The Water Cycle



U.S. Department of the Interior
U.S. Geological Survey

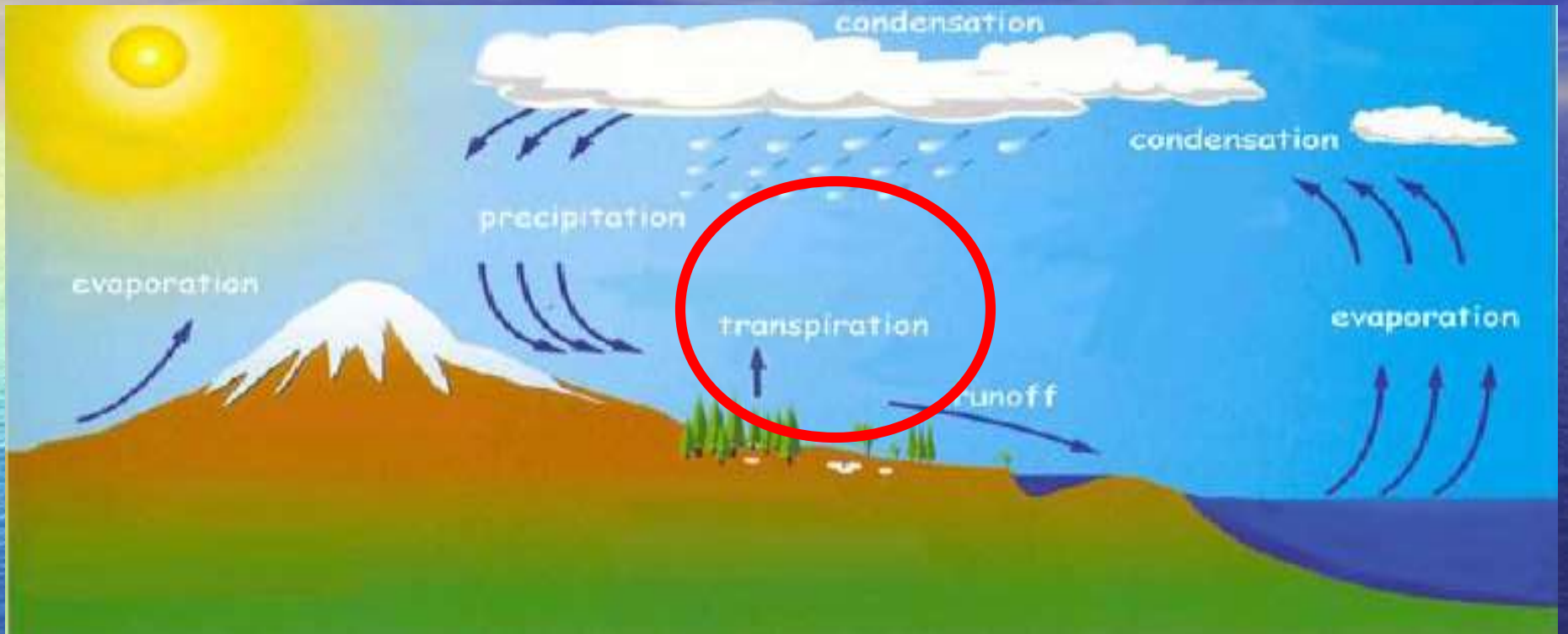
The Water Cycle



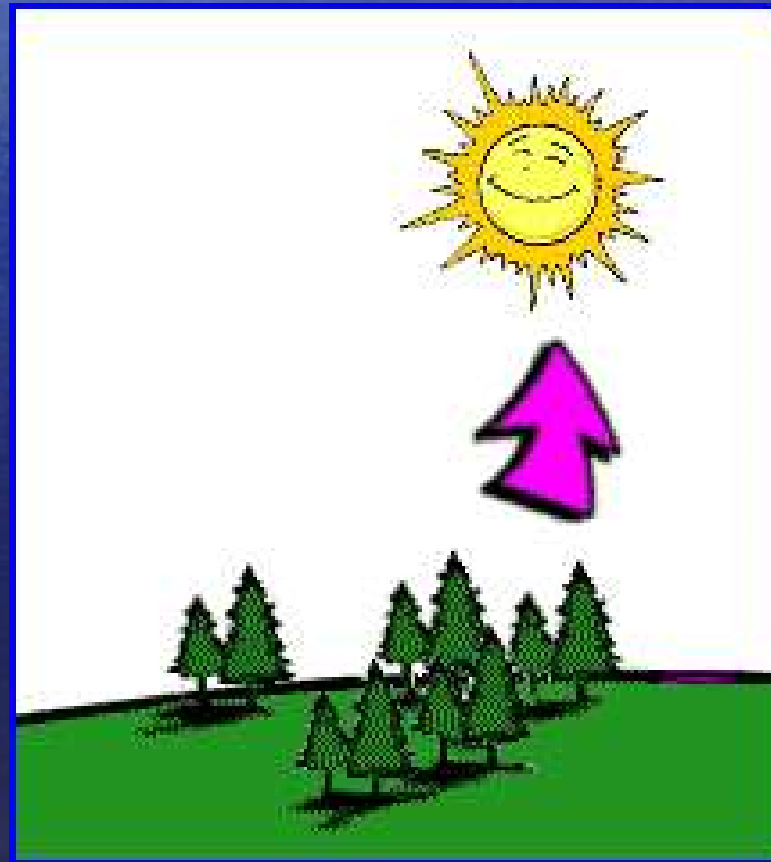
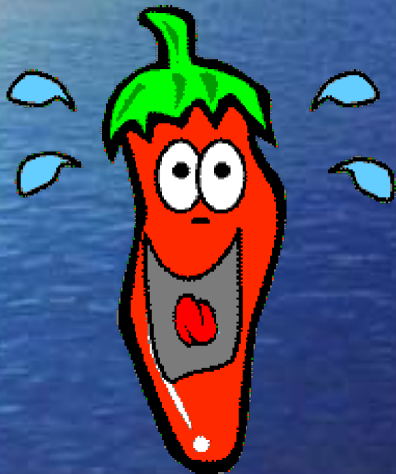
The water cycle is composed of many parts.

During part of the water cycle, the sun heats up liquid water and changes it to a gas by the process of **evaporation**. Water that evaporates from Earth's oceans, lakes, rivers, and moist soil rises up into the atmosphere.

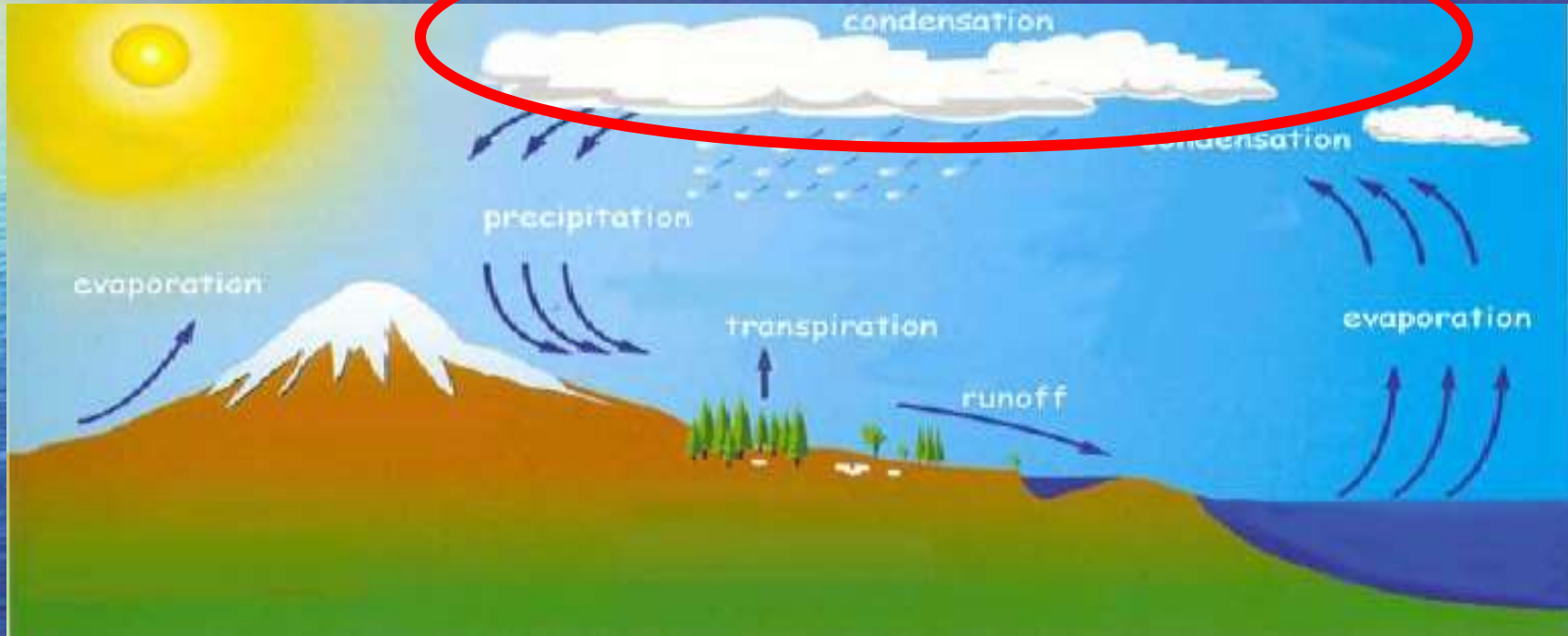




The process of evaporation from plants is called **transpiration**. (In other words, it's like plants are sweating or perhaps exhaling.) When humans exhale, we release water vapor as well.



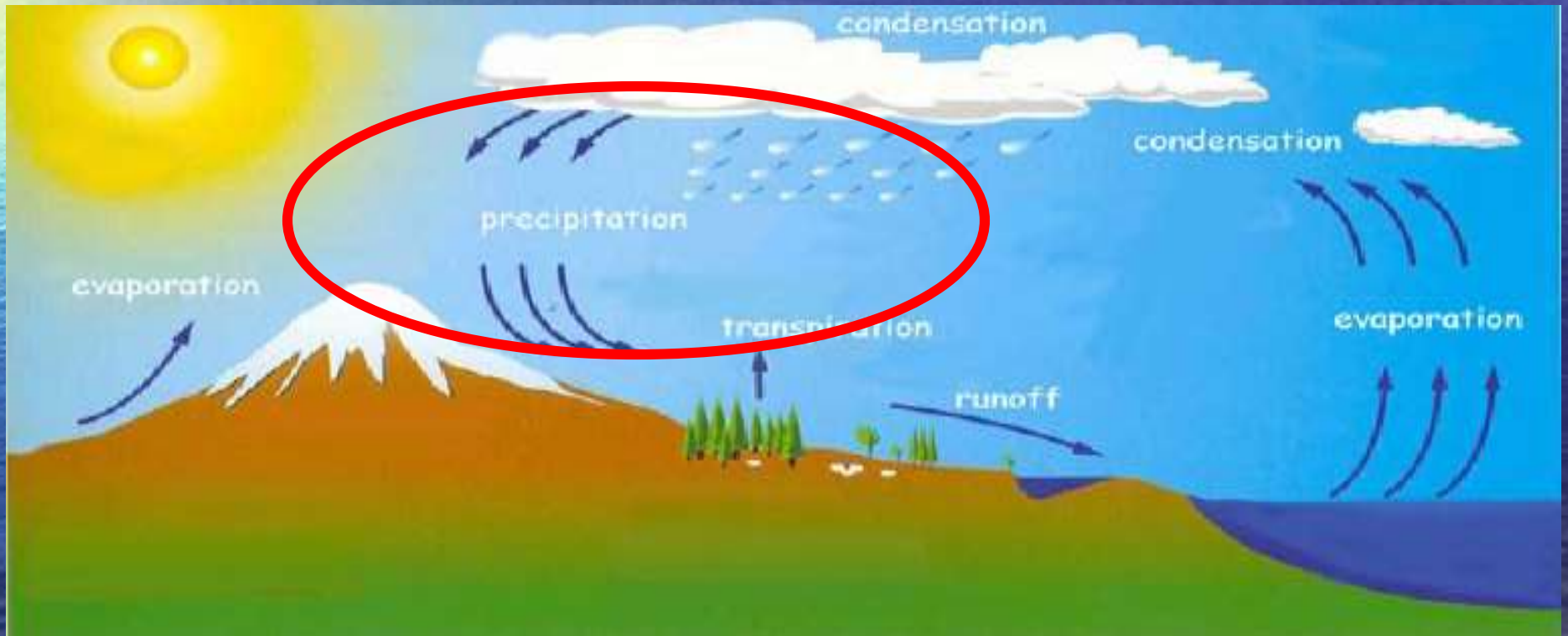
Condensation



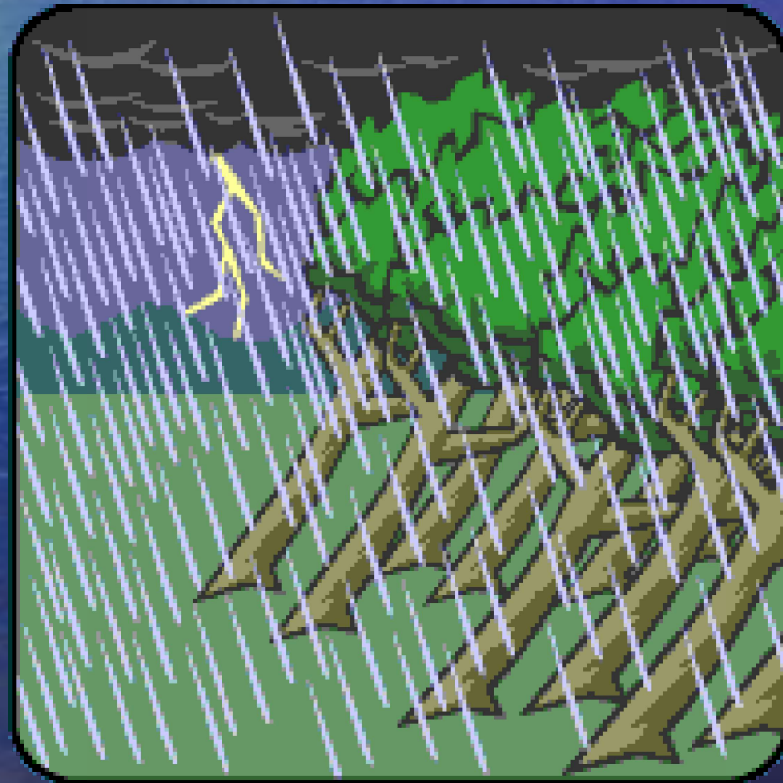
As water (in the form of gas) rises higher in the atmosphere, it starts to cool and become a liquid again. This process is called **condensation**. When a large amount of water vapor condenses, it results in the formation of clouds.



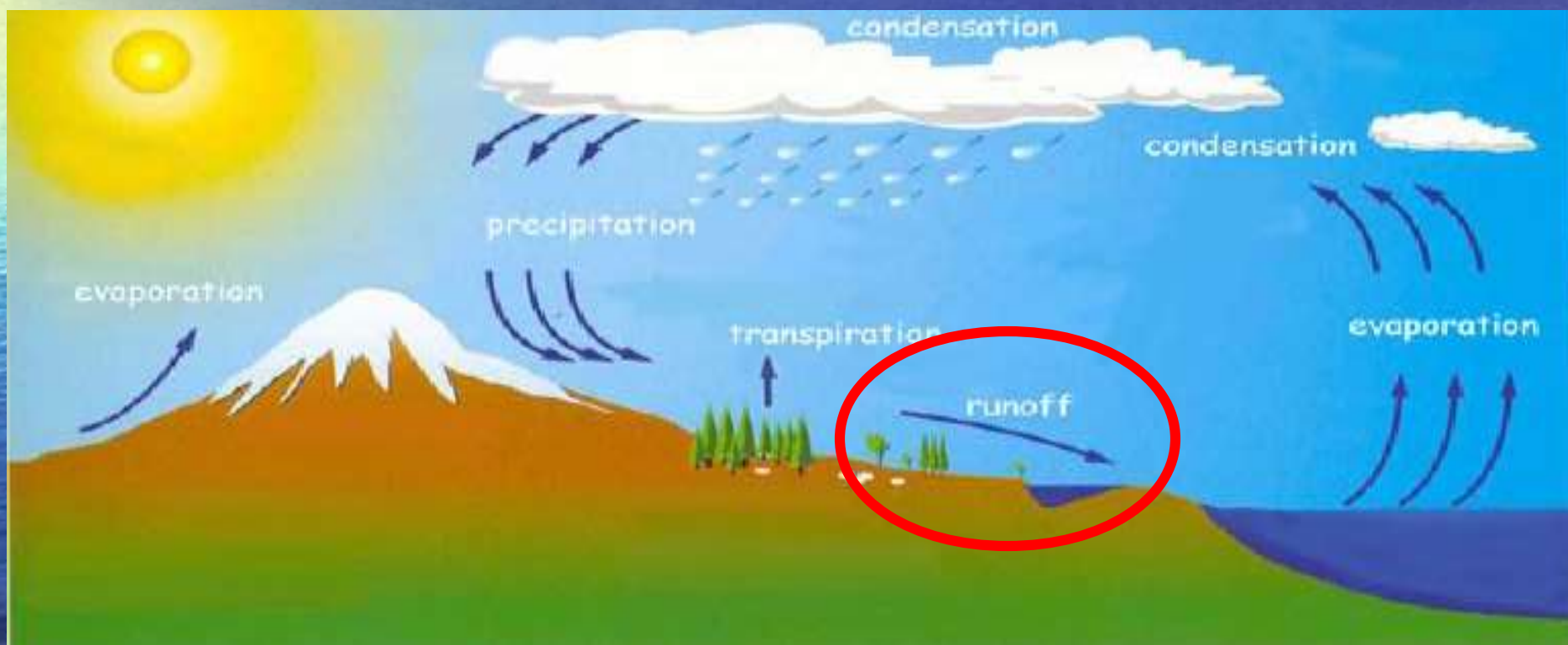
Precipitation



When the water in the clouds gets too heavy, the water falls back to the earth. This is called **precipitation**.

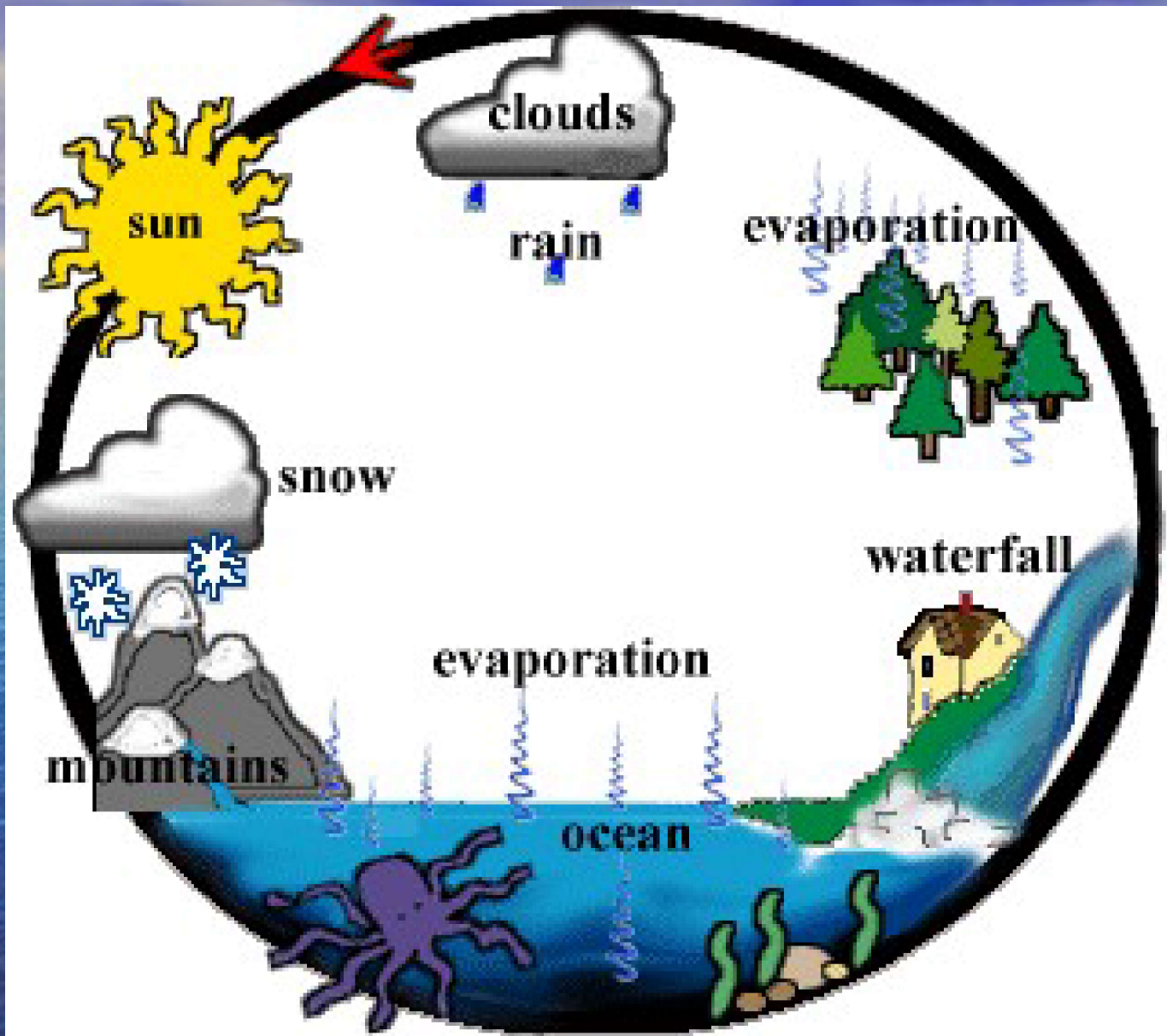


Runoff



When rain falls on the land, some of the water is absorbed into the ground forming pockets of water called groundwater. Most groundwater eventually returns to the ocean. Other precipitation runs directly into streams or rivers. Water that collects in rivers, streams, and oceans is called **runoff**.





Video: Water Cycle:



Link: <https://www.youtube.com/watch?v=al-do-HGulk>

Quantity and quality:

- **On an average, each person in a developed country uses about 260 litres of water a day in the home.**
- **The Quality of water is equally important than quantity.**
- **Even if present in huge amounts, we can not use salt water in many life support activities.**

Characteristics of Water:

- **Water is a good solvent**
- **Water never occurs in its pure form**
- **All waters contain some dissolved substances**
- **The quality of water is determined by these substances.**
- **It has the ability to dissolve many inorganic and organic substances.**

Water Quality Parameters:

Water has its own

- **Physical properties**
- **Chemical composition and**
- **Biological Properties**

Physical Properties:

- **Temperature**
- **Colour**
- **Odor**
- **Turbidity**
- **Electrical Conductivity**

Temperature (T) of Water:

- **Essential for all environmental studies**
- **Controls many ecological processes including chemical reactions.**
- **T of surface water varies from space and time**
- **T of groundwater varies not only with reference to space and time but also with reference to depth.**

Temperature of Water:

- **Measured using Thermometers**
- **It ranges from 0 to 100 degree Celsius**
- **Unit of measurement is degree Celsius**
- **The temperature of Surface water is influenced by the atmospheric conditions**
- **The temperature of groundwater is controlled by the thermal characteristics of bedrocks and the depth.**

Color of water:

- **The color of water is due to the suspended particles and organic matter**
- **Ranges form light to dark brown**
- **Brownish color in water comes due to the presence of iron**
- **Greenish color in pond water is seen due to the presence of organic substances including algae**

Odor:

- Pure water is odorless
- When water dissolves other substances, the odor is determined by them
- Mostly decayed organic substances give fouling smell
- Inorganic substances give earthy smell

Turbidity:

- **Muddiness in water**
- **Comes due to suspended particles from clay, silt and organic matter**
- **Controls the transparency of water**
- **Transparency is measured using Secchi Disc**
- **Water Turbidity is measured using Nephelometer**

Electrical Conductivity(EC):

- **Ability of a substance to conduct an electrical current.**
- **The presence of charged ionic species makes water conductive.**
- **It is measured using EC meters.**
- **Directly related to temperature of water.**
- **Unit of measurement is mmhos/cm at std temperatures. Ranges from 100-1,00,000**
- **Pure water is less conductive**

Chemical properties:

- **pH**
- **Total Dissolved Solids(TDS)**
- **Major ions**
- **Minor or trace elements**
- **Hardness**
- **Salinity**
- **Alkalinity**

pH of water:

- **Refers to the effective concentration of hydrogen ions in water**
- **It ranges from 0 to 14. Measured using pH meters**
- **Water is said to be acidic(less than 7)**
or alkaline (above 7) depending on the relative concentration of hydrogen ions from the neutral value which is 7.

Total Dissolved Solids(TDS):

- **Concentration of non-volatile substances present in colloidal or molecular state**
- **Total of all ions present in water, expressed in ppm or mg/L**
- **Increases due to dissolution of more mineral substances by water on its path**
- **TDS determines the suitability of water for our use and consumption.**

Quality of Water :

- Total dissolved solids(ppm)
- < 1000 fresh water
- 1000-10,000 brackish water
- 10,000 to 1,00,000 saline
- > 1,00,000 hypersaline or brine

Classification of Dissolved constituents:

- **Basis of concentrations- mg/L**
- **Charges(positive or negative)**
- **Level of Toxicity (toxic or non-toxic)**

Based on Concentrations:

- **Major ions(> 10 mg/L)**
 - **Mostly Bicarbonate, calcium, Magnesium, Chloride, sodium, sulphate and silicon**
- **Minor ions (0.1-10 mg/L)**
 - **Mostly Carbonate, fluoride, nitrate, potassium, iron, strontium, boron.**
- **Trace elements(< 0.1 mg/L)**
 - **Mostly Aluminium, Arsenic, Barium, Bromide, Cadmium, Chromium, Cobalt, Copper, Lead, Zinc, Nickel, Phosphate, Silver, Tin and Vanadium.**

Based on ionic Charges:

- **Major ions**
- **Positively charged = Cations**
- **Negatively charged = anions**

Major Cations in water:

- Calcium
- Magnesium
- Sodium
- Potassium

(Source: lithosphere)

Major Anions in Water:

- **Bicarbonate**
- **Carbonate**
- **Chloride**
- **Sulphate**
- **Nitrate**
- **Phosphate**

Trace elements in water:

- **Play a significant role in the use of water**
- **Some are essential elements for health & growth**
- **Some are injurious to health and toxic also.**
- **Deficiency or excess intake of some of these elements may cause serious health problems to life.**

Hardness:

- **Hardness of water is defined as its content of metallic ions which react with sodium soaps to produce a residue**
- **Expressed as total concentration of Calcium and Magnesium in ppm.**
- **Total hardness= $2.5 \text{ Ca} + 4.1 \text{ Mg}$.**
- **Softwater (Temporary)**
- **Hardwater (permanent).**

Salinity of Water:

- **Comes due to sodium and chloride**
- **Sea water contains 35,000 ppm or mg/L of dissolved salts**

Alkalinity of water:

- Combined effect of Bicarbonates and Carbonates with calcium ions
- It has a direct relationships with pH.
- Carbonates will be noticeable for water having a pH of more than 8.2

Biological Properties:

- **Dissolved Oxygen (DO)**
- **Biochemical Oxygen Demand(BOD)**
- **Chemical oxygen Demand(COD)**
- **Microorganisms-Bacterial counts**

Dissolved Oxygen(DO):

- **Is related to the solubility of air in water at 0 deg. C**
- **Solubility of oxygen in water decreases with high temperatures**
- **Important property for aquatic organisms**
- **Surface water bodies should have enough DO**
- **If DO depletes, it will be difficult to many aquatic organisms for their survival.**

Biochemical Oxygen Demand (BOD):

- Is a measure of the biodegradable material
- It is determined by incubating a water sample and measuring the decrease in dissolved oxygen as bacteria decompose these materials.

Chemical Oxygen Demand(COD):

- Is determined by chemical oxidation of water with dichromate

Water Quality Parameters:

- **Limits the suitability of water for different purposes**
- **Drinking**
- **Domestic consumption**
- **Agriculture**
- **Industrial Processes**
- **Cleaning and Recreation.**