

The Hydrologic Cycle

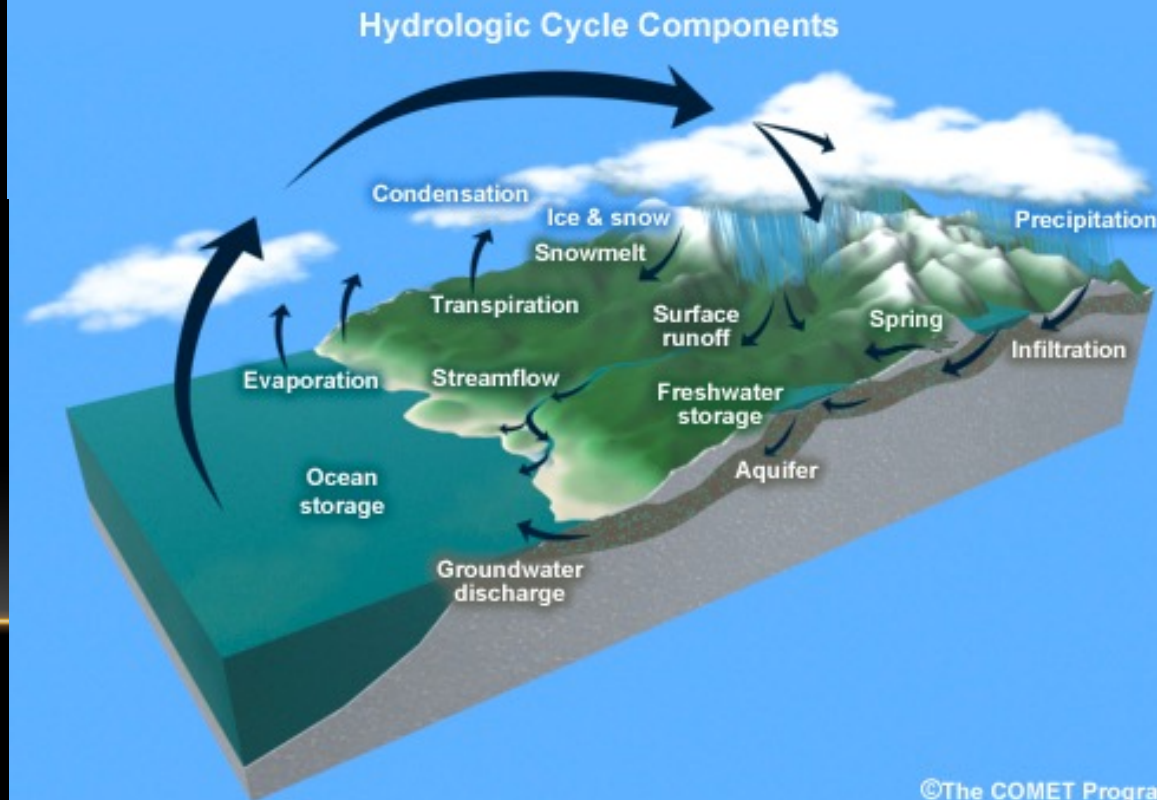
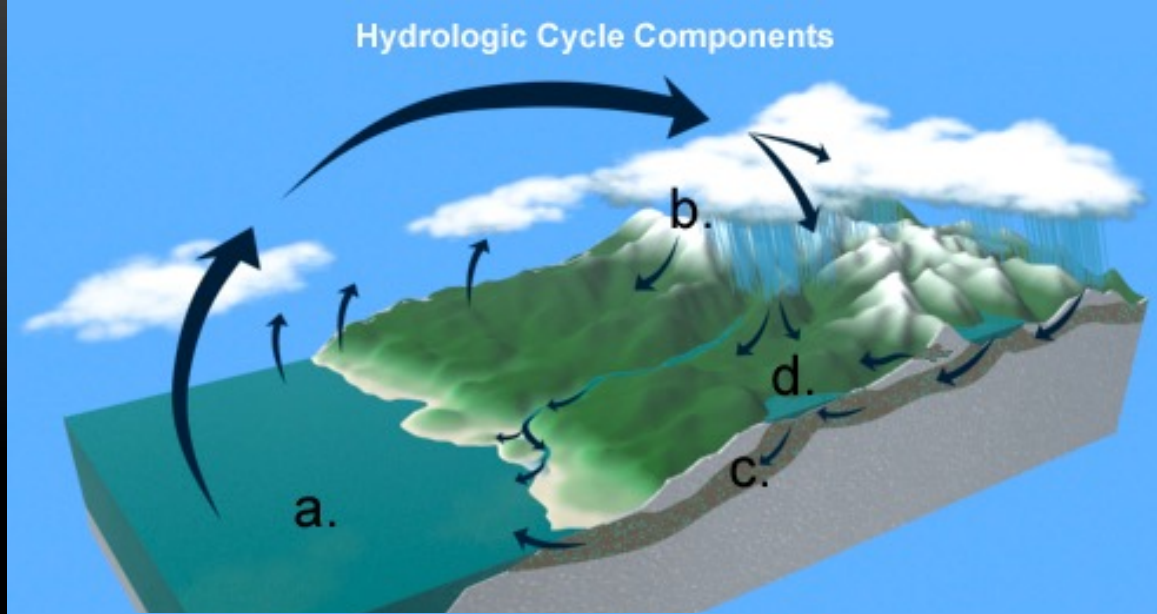
What is the hydrologic cycle?

- Hydrology is the scientific study of the waters of the earth. Hydrology examines the properties of water as well as its planetary occurrence, distribution, and movement.
- The hydrologic cycle is often called the water cycle. It is the vertical and horizontal movement of water as either vapor, liquid, or solid between the earth's surface, subsurface, atmosphere, and oceans.

Components of the Hydrologic Cycle

Could you describe the major components of the water cycle?

- a. Oceans
- b. Water storage in ice and snow (this is also part of cryosphere)
- c. Water storage as groundwater in aquifers
- d. Water storage as freshwater in lakes, ponds and reservoirs



Distribution

- Mountain snowpacks are an **important source of water**, especially in arid and semi-arid regions. In some areas, snow makes up a significant part of the annual precipitation.
- Predicting **snowmelt runoff** is a complicated process that involves estimating changes to the snow water equivalent, or SWE, of the snowpack over time, energy budgets, and groundwater/snowpack interface properties.
- Surface water storage and distribution occurs in lakes, ponds, rivers, and streams and accounts for **less than 0.01 percent** for the earth's water.
- Groundwater typically occurs in the **aquifer**, a region beneath the earth's surface composed of unconsolidated rock and soil particles. This region is able to transmit and store water for extraction.
- **Less than 1 percent** of the earth's total water supply is stored as groundwater or soil moisture.

Atmospheric Water

- Atmospheric water is the result of the distribution and transportation of water vapor by **transpiration, evaporation and sublimation**.
- Key processes in atmospheric water include condensation, precipitation, evaporation, and transpiration.
- **Condensation** is the movement of water from a vapor state to a liquid state. This process releases energy as latent heat and is needed to create precipitation. For most of the earth, precipitation is the single most important factor controlling the local hydrologic cycle.
- **Evaporation** is the movement of water from a liquid to a vapor state, the opposite of condensation. Evaporation can occur any time liquid water is in contact with the atmosphere. In arid regions, evaporation from a water surface may be as great as 2,000 mm per year.
- **Transpiration** is the process by which the soil moisture is taken up by a plant root system and eventually evaporated. The combined effect of evaporation and transpiration is often termed **evapotranspiration**, or ET, and it generally constitutes the largest loss component from the soil water system.

Surface Water

- Surface water storage and distribution occurs in lakes, ponds, rivers, and streams and accounts for less than 0.01 percent for the earth's water.
- Soil moisture: Soil is composed of mineral particles, organic matter, and "pore space," the void or empty space between soil particles. The degree to which the pore spaces in soil are filled with water determines the soil moisture conditions.
- Infiltration amount is limited by the available empty space within the soil.
- Runoff is that portion of rainfall that does not infiltrate into the soil. It is very important to know the soil moisture conditions when trying to model runoff from a storm.

Groundwater

- Groundwater is an important source of water. It is not subject to the same evaporation rates as a lake on the surface.
- Recharge is the introduction of surface water to groundwater storage such as an aquifer.
- Natural recharge consists of precipitation, snow, or other natural surface flows infiltrating and percolating into groundwater supplies.
- Artificial or induced recharge includes ways to increase groundwater supplies beyond what would occur naturally.
- Withdrawal is the artificial extraction of groundwater through a well or network of wells. When groundwater withdrawal rates are greater than the recharge of water into the ground, a lowering of the local water table occurs. This may cause various problems such as related land subsidence.

Accounting Budget

- The amount of water in a particular location can be calculated in a general sense by using an accounting budget approach:

$$\text{Inflow (I)} - \text{Outflow (O)} = \pm \text{Change in storage (S)}$$

or $I - O = \pm \Delta S$

- The volume of water at any point in a hydrologic system can be viewed simply as the difference between the inflow and outflow of the system and the resulting change of storage. In other words, inflow minus outflow equals change in storage.
- Hydrologists also call this the **continuity equation or the conservation of mass**. Other more complex formulae are also used in hydrology. These include methods for estimating water velocity, movement of water through a stream channel network, and movement of water through the soil, among other physical processes.

References

- UCAR COMET: Understanding the Hydrologic Cycle,
<https://www.meted.ucar.edu/hydro/basic/HydrologicCycle/navmenu.php>
- Understanding Assimilation Systems: How Models Create Their Initial Conditions - version 2. The source of this material is the COMET® Website at <http://meted.ucar.edu/> of the University Corporation for Atmospheric Research (UCAR), sponsored in part through cooperative agreement(s) with the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (DOC) ©1997-2010 University Corporation for Atmospheric Research. All Rights Reserved.