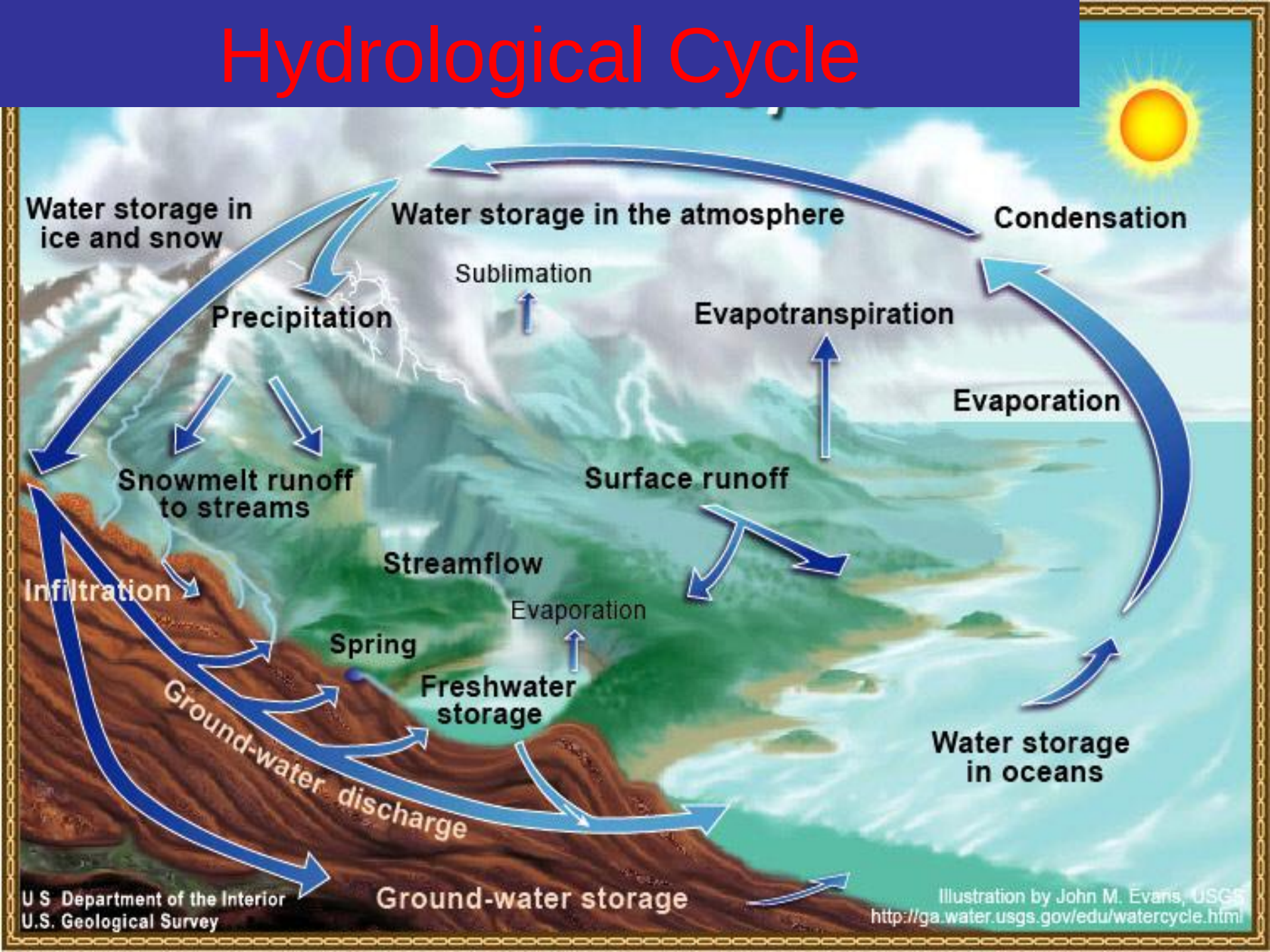
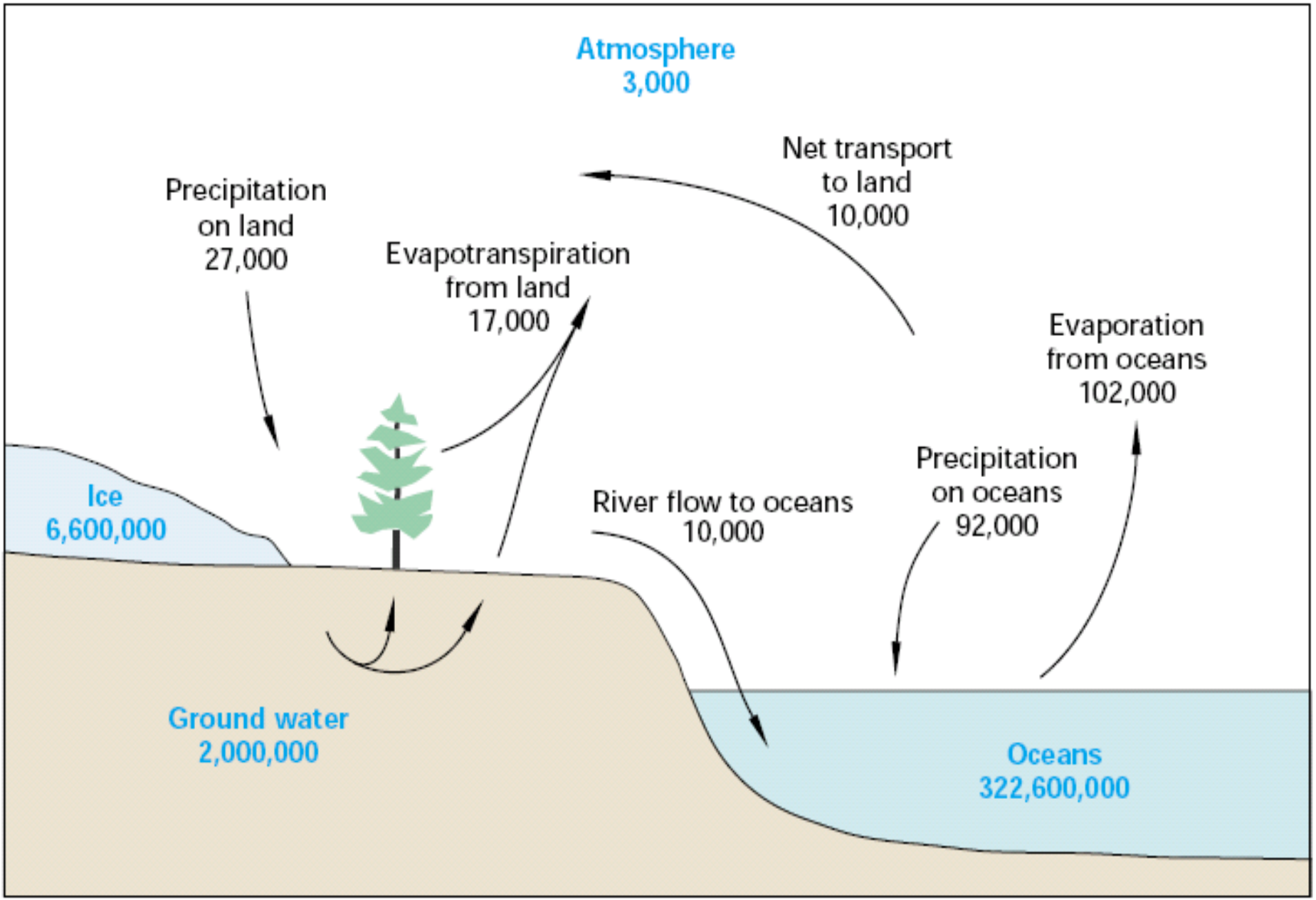
Hydrological Cycle





Pools are in cubic miles

Fluxes are in cubic miles per year

Hydrologic Equation

I – O = Delta S

Where

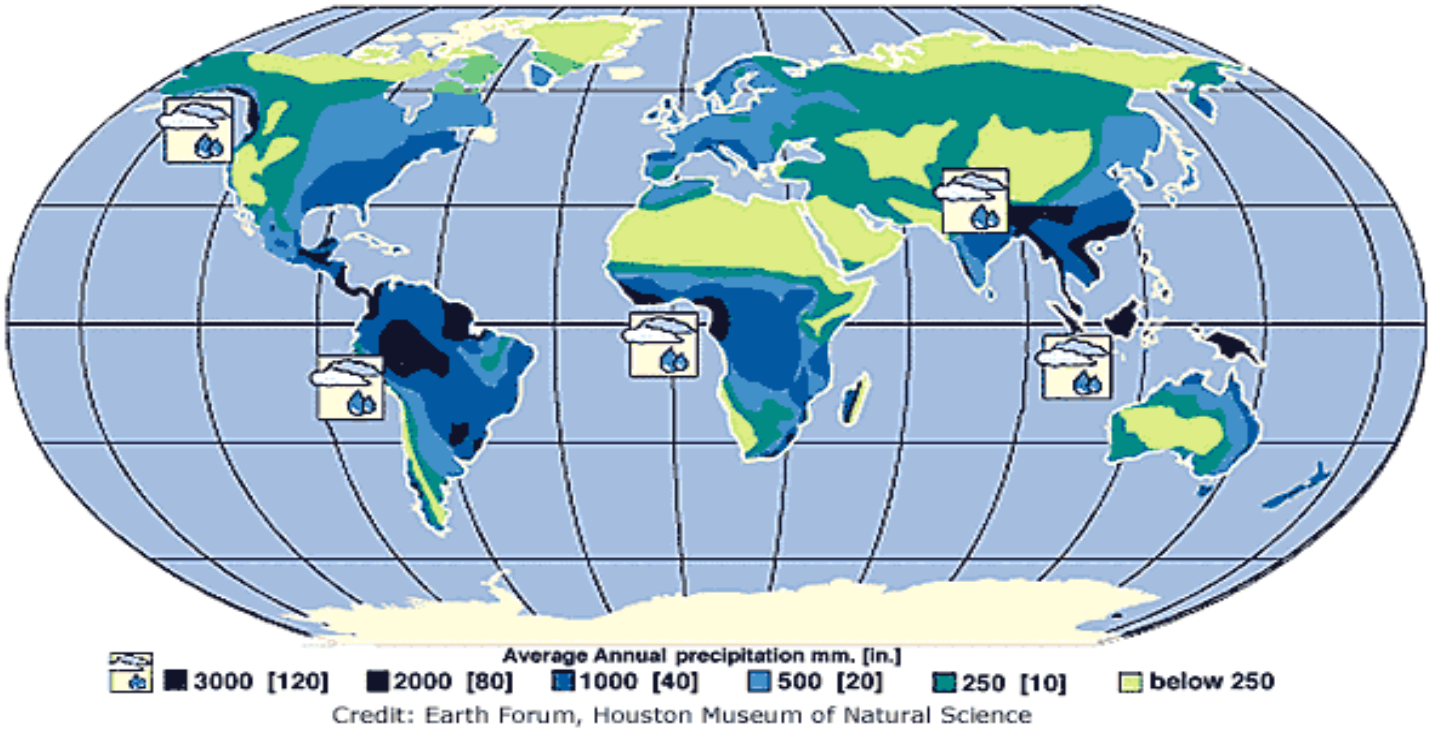
I = Precipitation, Surface inflow, Ground water inflow, Intra basin transfer into the basin

O= Surface out flow, Ground water out flow, Evaporation, Transpiration, Interception, intra basin transfer out of the basin

Delta S = Change in water storage (Including, change in storage of groundwater, snow cover, surface reservoirs, Channel storage

Climatic factors
Precipitation

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth. Most precipitation falls as rain.

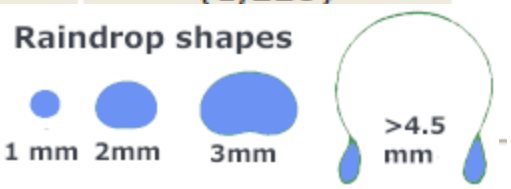


Credit: Earth Forum, Houston Museum of Natural Science

Rainfall intensity and types

	Intensity inches/hour (cm/hour)	Median diameter (millimeters)	Velocity of fall feet/second (meters/second)	Drops per second per square foot (square meter)
Fog	0.005 (0.013)	0.01	0.01 (0.003)	6,264,000 (67,425,000)
Mist	.002 (.005)	.1	.7 (.21)	2,510 (27,000)
Drizzle	.01 (.025)	.96	13.5 (4.1)	14(151)
Light rain	.04 (1.02)	1.24	15.7 (4.8)	26 (280)
Moderate rain	.15 (.38)	1.60	18.7 (5.7)	46 (495)
Heavy rain	.60 (1.52)	2.05	22.0 (76.)	46 (495)
Excessive rain	1.60 (4.06)	2.40	24.0 (7.3)	76 (818)
Cloudburst	4.00 (10.2)	2.85	25.9 (7.9)	113 (1,220)

Source: Lull, H.W., 1959, Soil Compaction on Forest and Range Lands, U
Forestry Service, Misc. Publication No.768



Evaporation

Evaporation is the process by which water changes from a liquid to a gas or vapor.

Evaporation cools hot water produced by power plants.

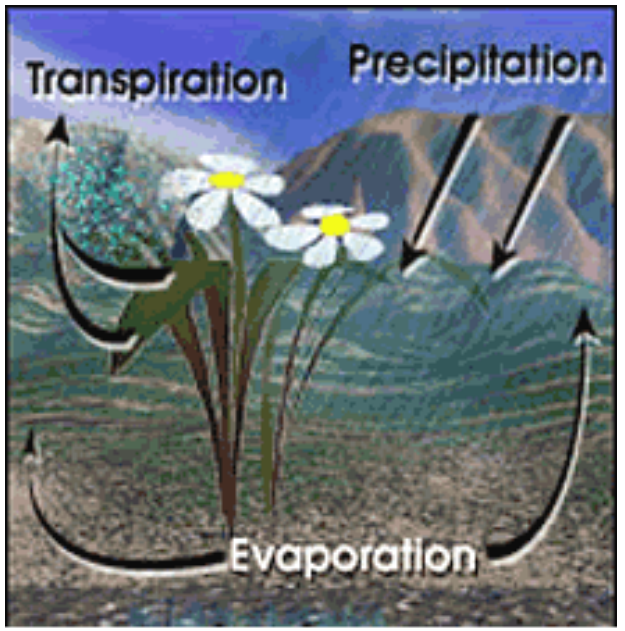
- 90 percent of the moisture in the atmosphere via evaporation from Oceans, seas, lakes, and rivers provide

- 10 percent being contributed by plant transpiration

Evapotranspiration

evapotranspiration is defined as

1. the water lost to the atmosphere from the ground surface,
2. evaporation from the capillary fringe of the groundwater table,
3. transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwater table



Hailey King, NASA, GFSC

The transpiration aspect of evapotranspiration is essentially evaporation of water from plant leaves

During a growing season, a leaf will transpire many times more water than its own weight.

- An acre of corn gives off about (11,400-15,100 liters) of water each day,
- A large oak tree can transpire (151,000 liters) per year.

Surface Runoff

Precipitation - Losses = Runoff

Hetch-Hetchy basin near Yosemite, California. Photo by David Gay

- Meteorological factors affecting runoff
  - Type of precipitation (rain, snow, sleet, etc.)
  - Rainfall intensity
  - Rainfall amount
  - Rainfall duration
  - Distribution of rainfall over the drainage basin
  - Direction of storm movement
  - Precipitation that occurred earlier and resulting soil moisture
  - Other meteorological and climatic conditions that affect evapotranspiration, such as temperature, wind, relative humidity, and season

Surface Runoff (Cont)

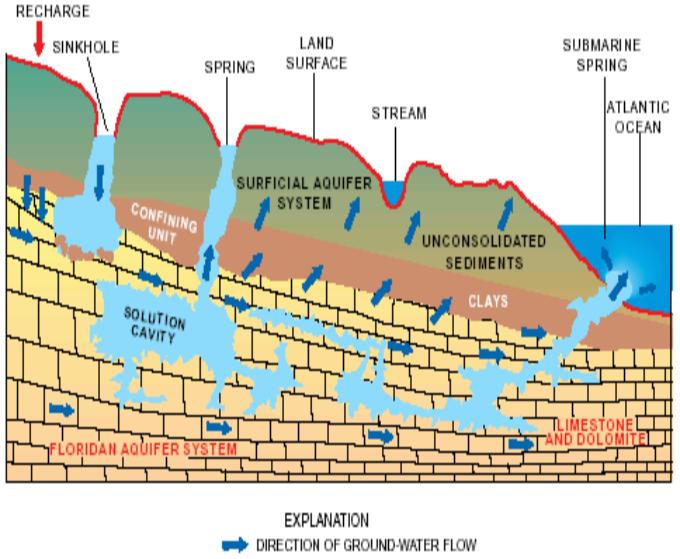
- Physical characteristics affecting runoff
  - Land use
  - Vegetation
  - Soil type
  - Drainage area
  - Basin shape
  - Elevation
  - Topography, especially the slope of the land
  - Drainage network patterns
  - Ponds, lakes, reservoirs, sinks, etc. in the basin, which prevent or delay runoff from continuing downstream
- Human activities can affect runoff
- Urban development

Springs

A spring is a water resource formed when the side of a hill, a valley bottom or other excavation intersects a flowing body of ground water at or below the local water table, below which the subsurface material is saturated with water

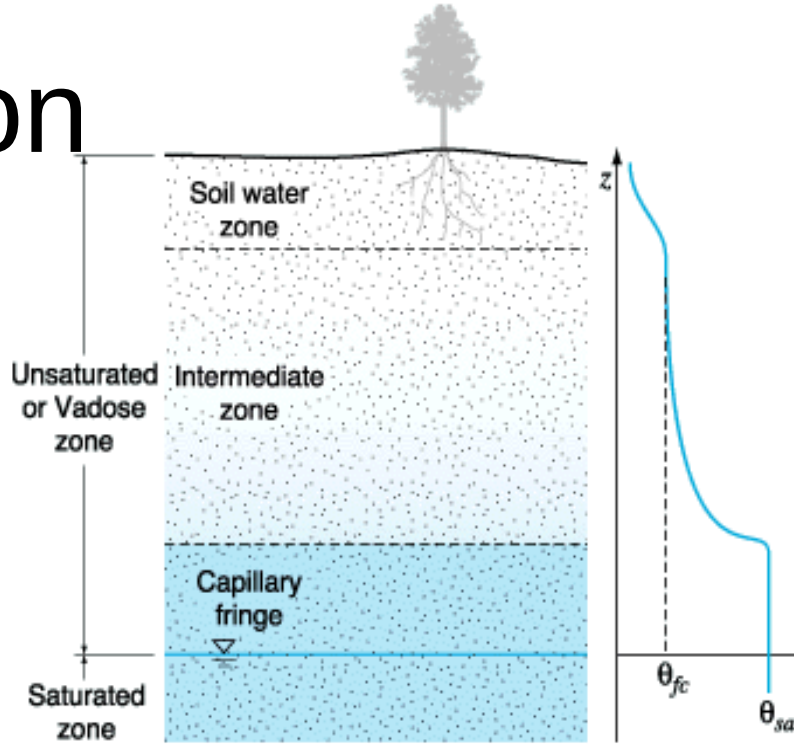
Ground water discharges from springs in the Grand Canyon.
Credit: R.D. MacNish, USGS

A spring is the result of an aquifer being filled to the point that the water overflows onto the land surface. They range in size from intermittent seeps, which flow only after much rain, to huge pools flowing hundreds of millions of gallons daily.



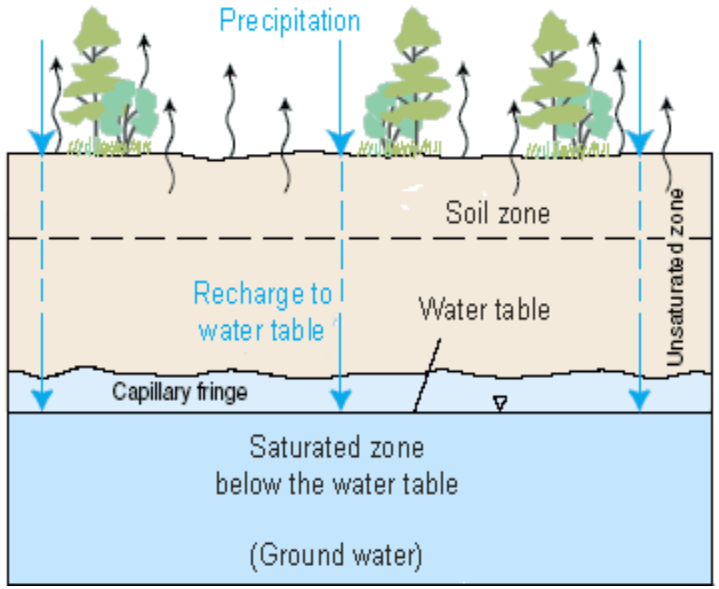
Infiltration

A portion of the water that falls as rain infiltrates into the subsurface soil and rock.



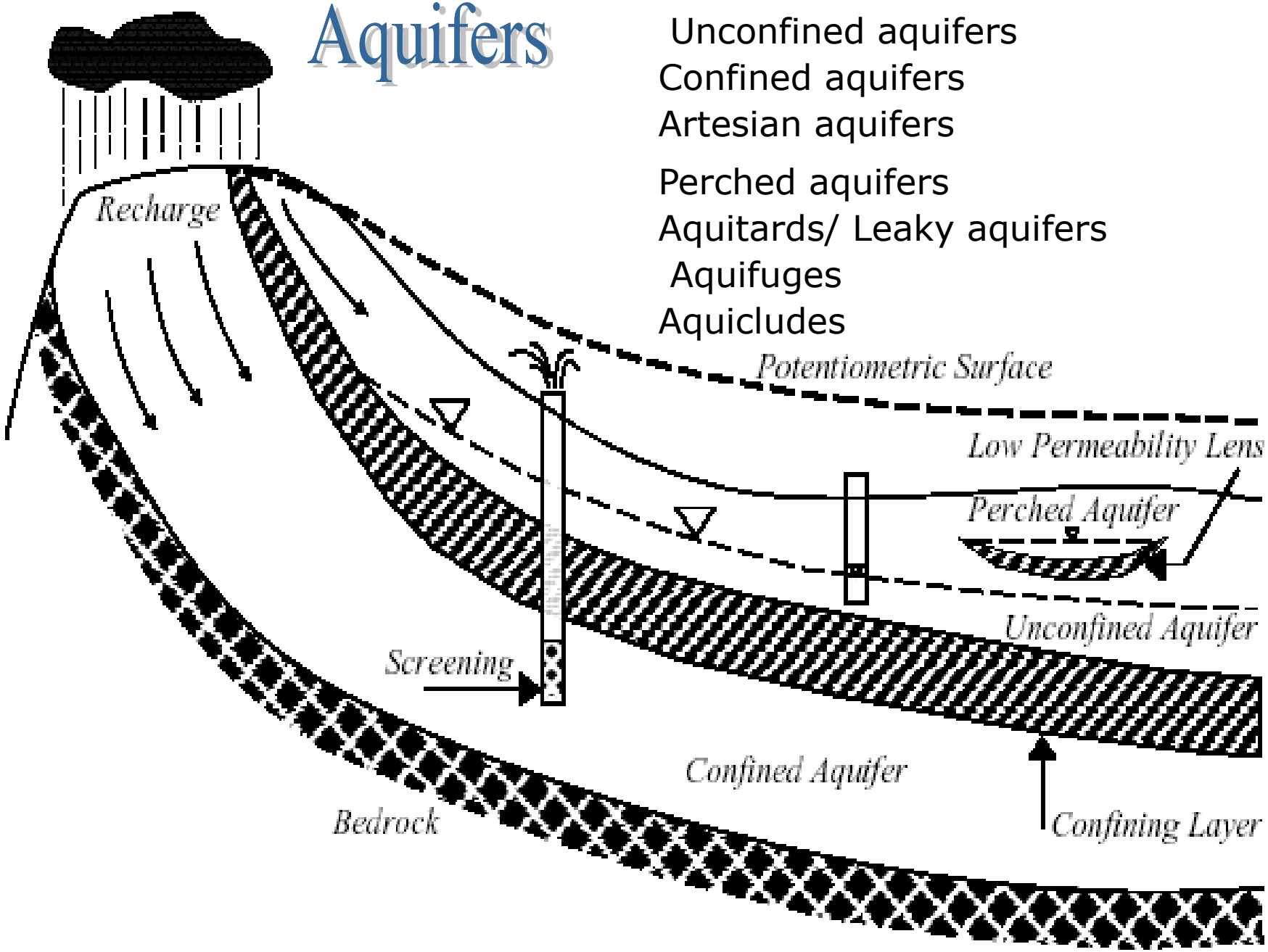
Factors affecting infiltration

- Precipitation
- Soil characteristics
- Soil saturation
- Land cover
- Slope of the land
- Evapotranspiration and interception



Aquifers

Unconfined aquifers
Confined aquifers
Artesian aquifers
Perched aquifers
Aquitards/ Leaky aquifers
Aquifuges
Aquicludes



Other Important Climatic Factors

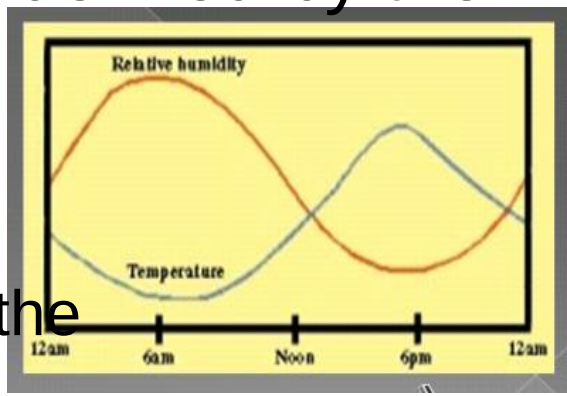
Temperature
Relative Humidity
Wind Velocity

- ***Air temperature*** is a measure of the heat content of the air.
  - The temperature of our atmosphere is controlled by a complex set of interactions between the biosphere, lithosphere and atmosphere.
  - Energy is constantly being exchanged between the surface and the air above a place, as well as circulating around the globe

Air Humidity

- The humidity of air is a measure of the amount of moisture present in it. The usual term used to express humidity is relative humidity (RH), which gives a direct indication of the evaporation potential. Relative Humidity, a function of temperature, is defined by the expression:

$$RH = AH / SH * 100\%$$

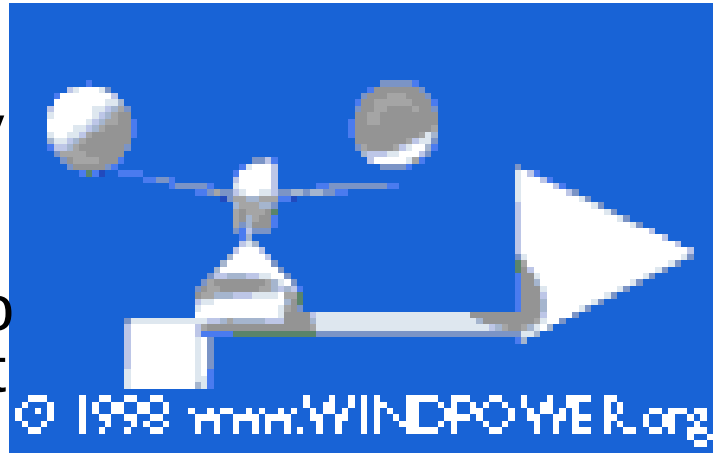


Where

AH is the Absolute Humidity, defined as the amount of moisture present in unit mass or unit volume of air, in terms of grams per kilogram (g/kg) or grams per cubic meter (g/m3),

SH Saturation Point Humidity) is the maximum amount of moisture that a unit mass or volume of air can hold at that temperature.

Wind Velocity



- **wind,** flow of air relative to the earth's surface. A wind is named according to the point of the compass from which it blows, e.g., a wind blowing from the north is a north wind.

The direction of wind is usually indicated by a thin strip of wood, metal, or plastic (often in the shape of an arrow or a rooster) called a weather vane or weathercock (but more appropriately called a wind vane) that is free to rotate in a horizontal plane. When mounted on an elevated shaft or spire, the vane rotates under the influence of the wind such that its center of pressure rotates to leeward and the vane points into the direction of wind flow

Vz / V(0.3) = log(z)+1.5

Where Vz= Velocity at a given height (m)/sec)
V(0.3) = Velocity at 0.3 m above ground in m/sec

END