CVEN3501 Notes

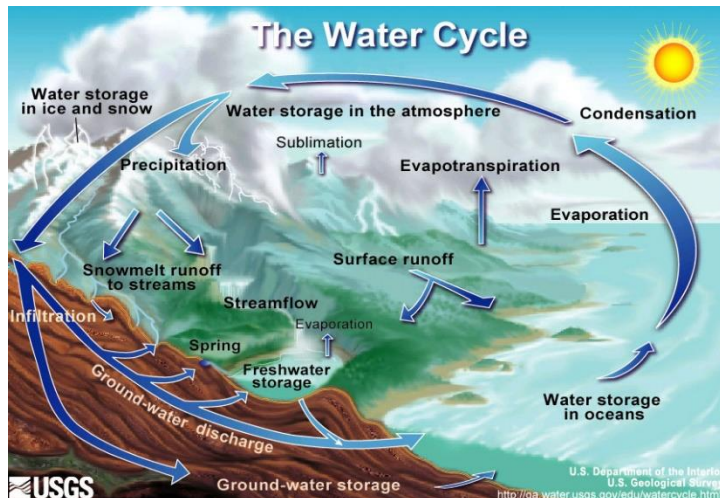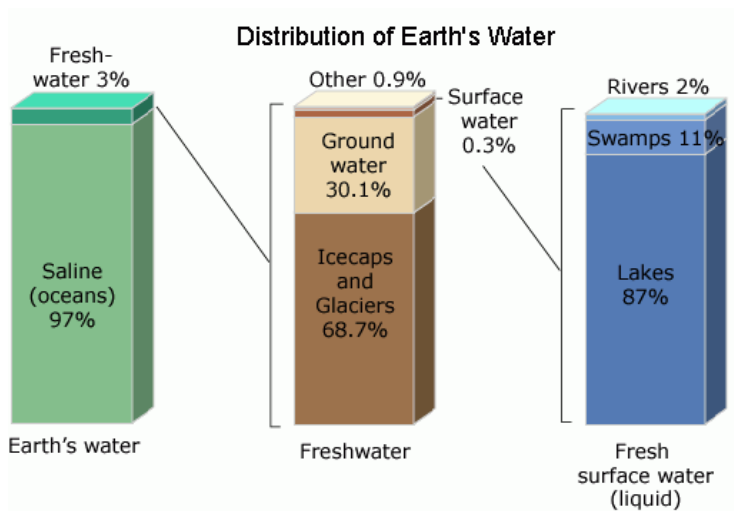**Hydrological Cycle**

- More than 70% of the Earth is covered by water.
- The **hydrosphere** contains about 1.36×10^9 km^3 of water
- Only substance (on Earth) that can exist in all states
- Maximum density in liquid form (not solid).
- Conducts heat & has a high **specific heat**.

Distribution

- Oceans make up ~ 70% of the Earth's surface.
- Solar radiation powers the global evaporation process.
- 86% of the Earth's evaporation occurs over the oceans; 14% occurs over land
- Of the total amount evaporated, P returns > 80% to the oceans and < 20% to land.
- Runoff sends 7% of the land based P back to the ocean to balance the processes of ET and P.

$$\Delta V / \Delta t = ET_{ocean} + ET_{land} - P$$

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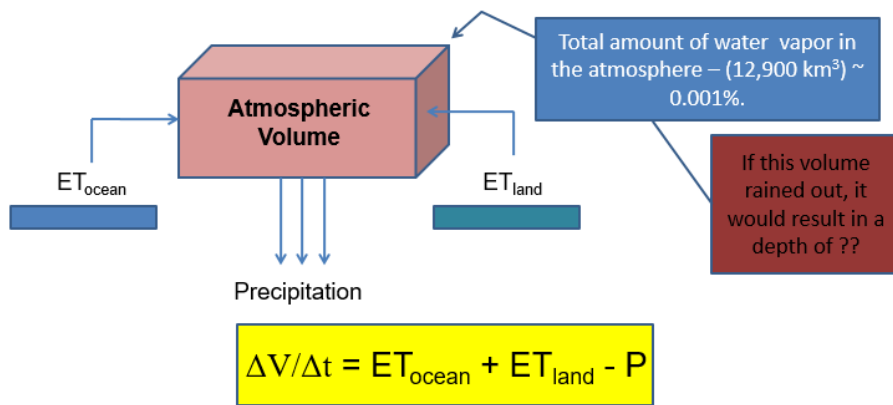
Residence times

- Amount of time that water 'stays' in a storage component can be calculated by dividing the **total volume (m^3) by the flux rate ($m^3.s^{-1}$)**.
- Water is renewed in rivers once every 16 days. Water in the atmosphere is <u>completely</u> replaced every 8 days, much longer in lakes, glaciers etc.

Stefan-Boltzmann Law

- Perfect emitter
  - $E = \sigma T^4$
- Relationship says that a small increase in temperature results in a large amount of radiation being emitted.

Wein's Law

- There is an inverse relationship between the wavelength of the peak emission of a blackbody and its temperature, wavelength shorter as temperature increases
- **$\lambda_m T = 2877 \ \mu m \ K$**
- Light from the sun: temp ~ 6000K, λ ~ 0.5 μm
- Light from a campfire: temp ~ 1500K, λ ~ 2 μm

Units

- Joule – basic unit of energy
  - 1 Joule work done to move 1 Newton by 1 metre
  - (lift a small apple by one metre)
- Power – energy per time
  - 1 Watt = 1 Joule per second
- Flux – power per area

Radiation Balance

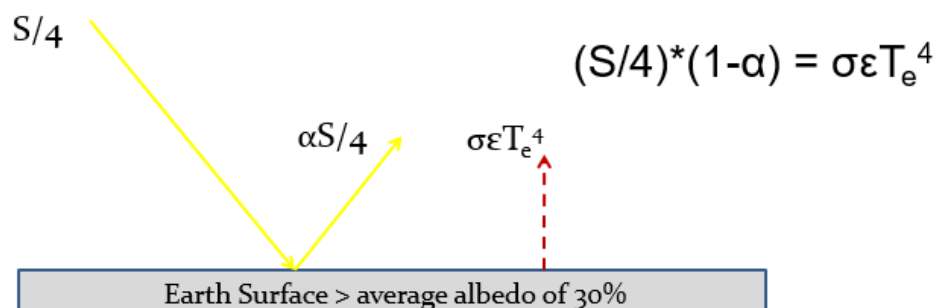$$S = S_o \left(\frac{r_o}{D} \right)^2$$

- S is the radiation at Earth, S_o is the radiation leaving the sun, r_o is the radius of the sun, D is the distance from the earth to the sun
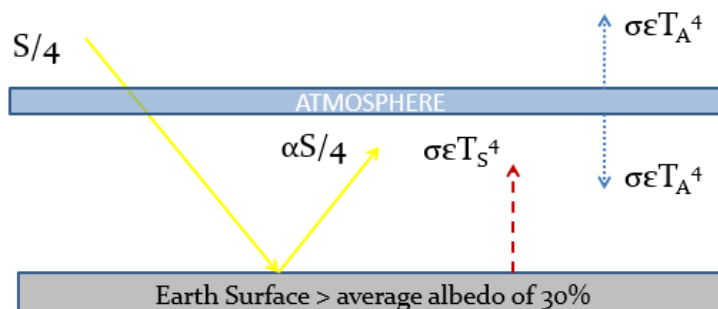
Albedo

- Albedo = reflected solar radiation/incoming solar radiation
- On Earth, albedo = 30%
- Stefan Boltzmann relationship
- **$E = \sigma\varepsilon T_e^4$**
    - E is the energy flux in W/m^2
    - e is the emissivity of the surface, 1 for a blackbody
    - σ is constant
    - T is temp in Kelvin

Global radiation balance

Energy absorbed by Earth = Energy emitted by Earth

$$(S/4)*(1-\alpha) = \sigma\varepsilon T_e^4$$

S/4

$\alpha S/4$ $\sigma\varepsilon T_e^4$

Earth Surface > average albedo of 30%

Energy absorbed by Earth = Energy emitted by Earth

$\sigma\varepsilon T_A^4$

S/4

ATMOSPHERE

$\alpha S/4$ $\sigma\varepsilon T_S^4$ $\sigma\varepsilon T_A^4$

Earth Surface > average albedo of 30%

This is the **radiation balance** at the Earth's surface

$$(S/4)*(1-\alpha) + \sigma\varepsilon T_A^4 = \sigma\varepsilon T_S^4$$

Seasonal Variation

- Changes in the position of the Earth's axis cause the location of the Sun to wander 47° across our skies.
- These changes have a direct effect on the **intensity** of solar radiation incident upon the surface.

Energy Distribution