Present Day Global Cycles- Hydrologic Cycle

I. Hydrologic Cycle **Fig. 4-24a**
- A. cycles of water between oceans, atmos. & land (streams, rivers)
  1. driven by solar energy
- B. most water found in the oceans **Fig. 4-24b**
  1. very small percentage in atmos. or ice
  2. freshwater phase of cycle strongly dependent on atmos. as a conduit
- C. evaporation removes water from the ocean
  1. most simply returns as rainfall
     a. the rest is transported to land via advection and precip.
     b. eventually returned as river flow
- D. leads to a water residence time in the oceans of ~4000 yrs
  1. slightly longer than the mixing time of the ocean
- E. large exchanges between land/oceans and atmos (evap/precip)
  1. river run-off ~10x smaller

II. Properties or water
- A. High heat capacity and high dissolving power
  1. important for the storage and transport of heat in the aqueous phase
  2. important for the transport of mass
- B. water can exist in all 3 phases under the range of Earth sfc conditions
  1. water is involved in a wide range of biogeochemical processes
- C. hydrogen bonding
  1. temp of max density is at 4°C
- D. ice is less dense than water
- E. water is the most important medium for transporting energy and matter among Earth system components

III. Hydrologic cycle and heat transport **Figs. 5-15 and 16**
- A. along with atmospheric circulation, this cycle allows for redistribution of heat on the Earth
  1. sensible heat vs. latent heat
- B. weather and climate are the response of the atmosphere to an unequal latitudinal distribution of energy

IV. Important regional differences in the water cycle
- A. evaporation much higher in tropical oceans than at the poles due to radiation imbalance
  1. evap. exceeds precip. in the tropics
- B. this radiation imbalance leads to water vapor and heat transport from equator to polar regions
- C. energy transport driven by several factors
- D. ocean currents move sensible heat
  1. oceans represent an important heat "reservoir"
  2. warm sfc currents that flow towards the poles (e.g., the Gulf Stream) carry heat
     a. release of heat in N Atl when surface waters flow north and then form bottom waters
- E. atmos moves latent heat and sensible heat
  1. water phase changes require heat - evaporation takes up heat
  2. transport of this latent heat is a significant way heat is transported from equator to poles
  3. energy required to drive the annual evaporation cycle is equivalent to 23% of the annual solar input

V. Sources of water for precipitation also vary regionally
- A. nearly all rainfall over the oceans comes from the oceans

1. in regions close to the coast much of the rainfall is derived from the oceans

B. not so in other places **Fig. 9.7**
   1. Amazon Basin - ~75% of rainfall derived from evapotranspiration
      a. loss of water through plants
      b. the rest comes from long range transport
   2. this regional evapotranspiration is important

C. deforestation decreases this regional water cycle
   1. decrease regional evaporation and precipitation
   2. increase loss of soil moisture
      a. increase regional temperatures

VI. Hydrologic cycle can change with time

A. primarily driven by changes in sea level

B. can occur several ways

C. glacial cycles increase the amount of water stored in continental glaciers

D. changes in tectonic activity
   1. increase/decrease the activity of mid-ocean ridge systems
   2. change to volume of the oceans
      a. changes in the cooling rate of oceanic crust
   3. increase CO_2 flux from tectonic systems
   4. change in greenhouse warming/cooling and global temperatures

E. global warming may also impact hydrologic cycle
   1. may lead to a more vigorous hydrologic cycle
   2. freshening of N Atl
   3. increase in salinity of the tropics

F. may impact thermohaline circulation – shut down the conveyor belt
      a. more later