Unit 10: Oceans and Climate

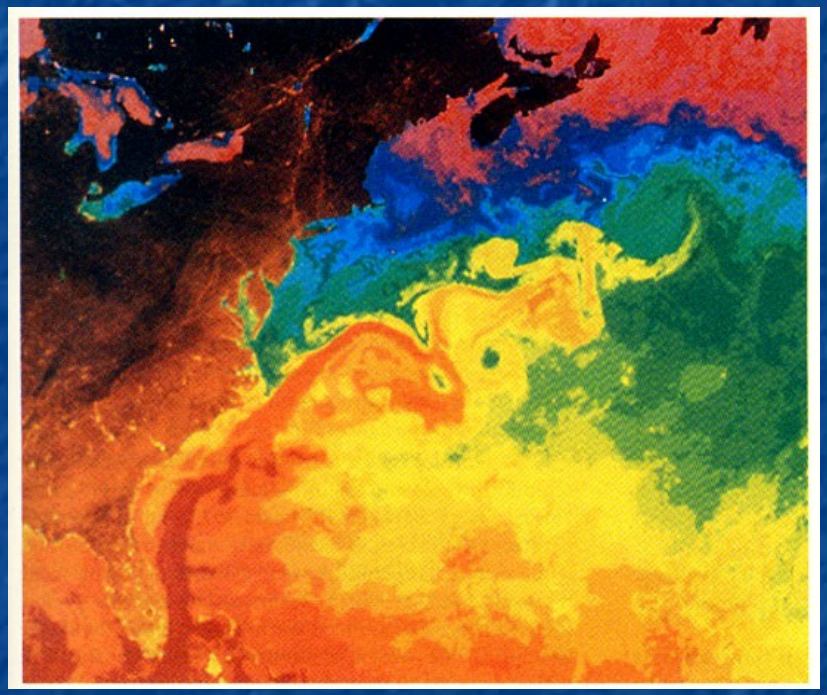
Lecture 2

Objective:

E4.2B - Explain how the interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climatic zones, and the ocean as a major CO_2 reservoir.

E4.2C - Explain the dynamics (including ocean-atmosphere interactions) of the El Nino-Southern Oscillation (ENSO) and its effect on continental climates.

Ocean-Atmosphere Connection

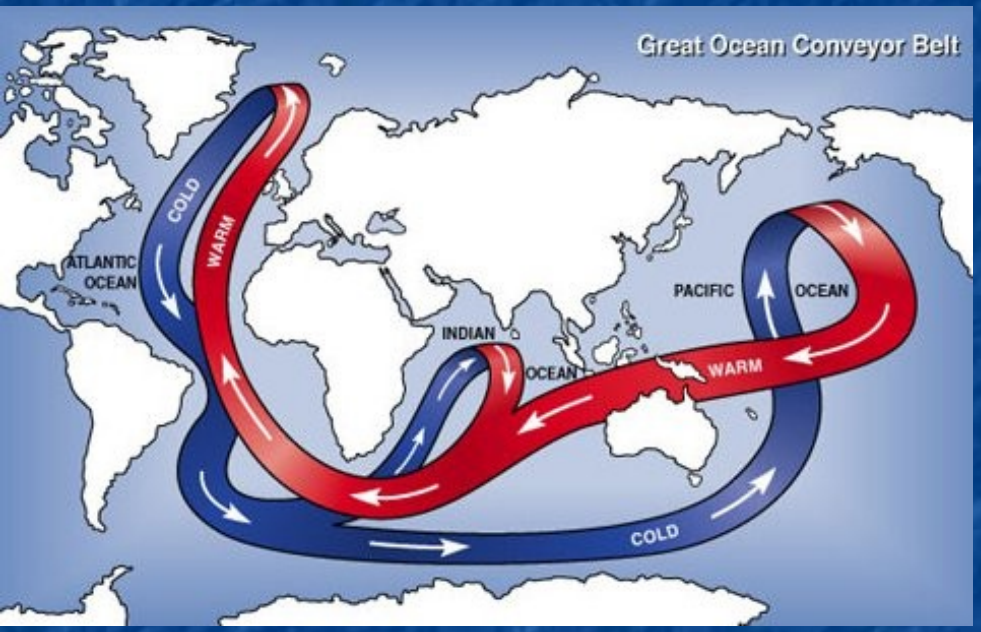


- To maintain an approximate steady state climate the ocean and atmosphere must move excess heat from the tropics to the heat deficit polar regions. Additionally the ocean and atmosphere must move freshwater to balance regions with excess dryness with those of excess rainfall. The movement of freshwater in its vapor, liquid and solid state is referred to as the hydrological cycle.

Heat Transfer by Ocean Currents

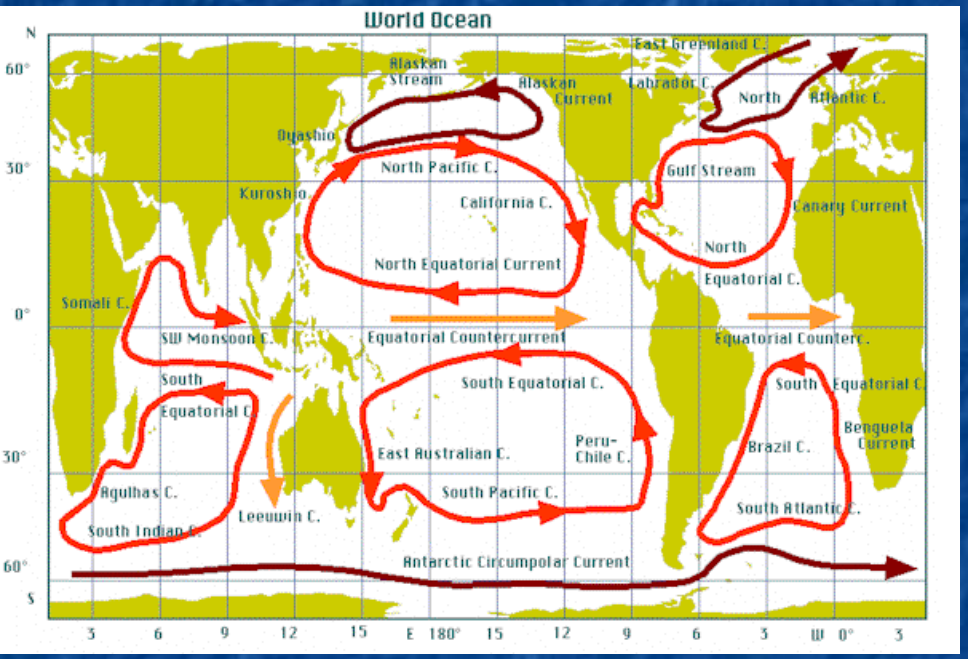
- The ocean and atmosphere work together to move heat and freshwater across latitudes, as required to maintain a quasi-stationary climate pattern. The wind-driven and thermohaline ocean circulation accomplish this task for the ocean, by moving warm waters poleward, colder water toward the Equator.
- Heat exchange between ocean and atmosphere is a product of a number of processes: solar radiation heats the ocean; net long wave back radiation cools the ocean; heat transfer by conduction and convection between the air and water generally cools the ocean as does evaporation of water from the ocean surface

Thermohaline Circulation*



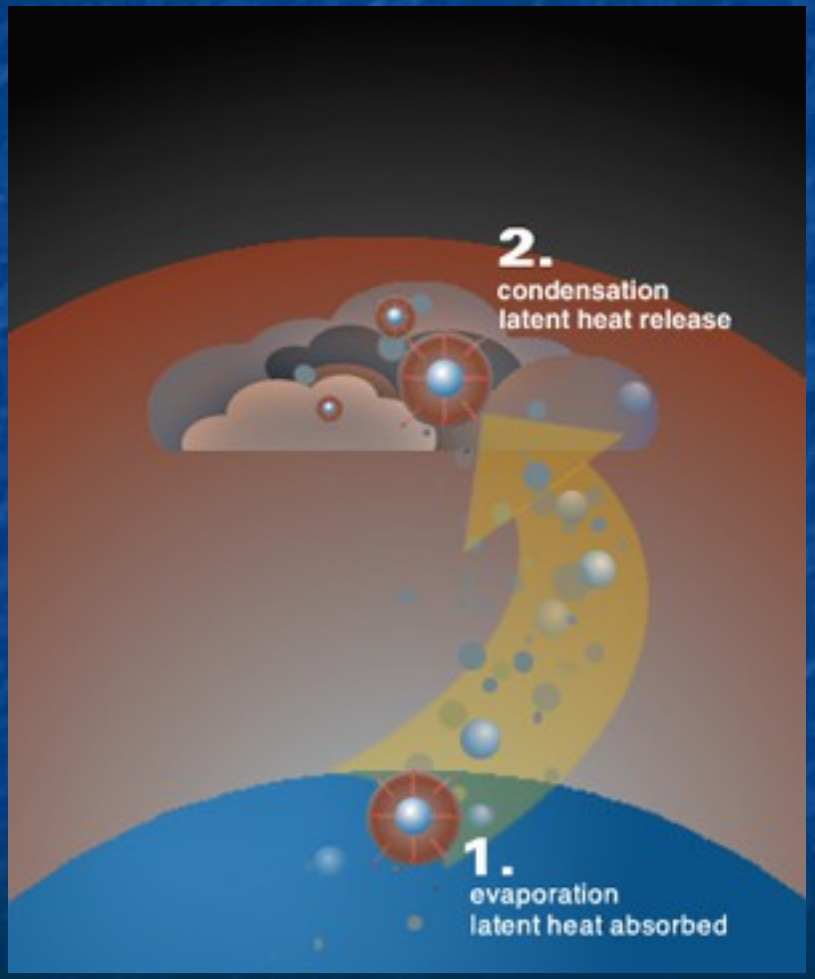
- There is a large-scale pattern to the way that seawater moves around the world ocean. This pattern is driven by changes in water temperature and salinity that change the density of water. It is known as the Global Ocean Conveyor or thermohaline circulation

Boundary Currents



- Because we live on a rotating earth, the eastern and western boundary currents flow at different speeds -- you should have noticed this characteristic in your drawings of drifter movements since the arrows on the west sides (left side on maps) of the oceans are generally longer than those on the east (right) sides -- signifying more movements in the same amount of time.

Evaporation



- As the sun beats down and the ocean warms, water from the upper layer of the ocean evaporates. The conversion of liquid to vapor requires a lot of energy, so evaporation cools the top layer.
- Trade winds carry the vapor to the area where the north and south trade winds converge called the intertropical convergence zone (ITCZ). There the moist air rises and cools. The water vapor condenses on tiny particles suspended in the air called nuclei, forming clouds. This condensation releases energy, heating the surrounding air. The warmed air then rises higher, drawing up more moisture from the ocean.

Precipitation

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

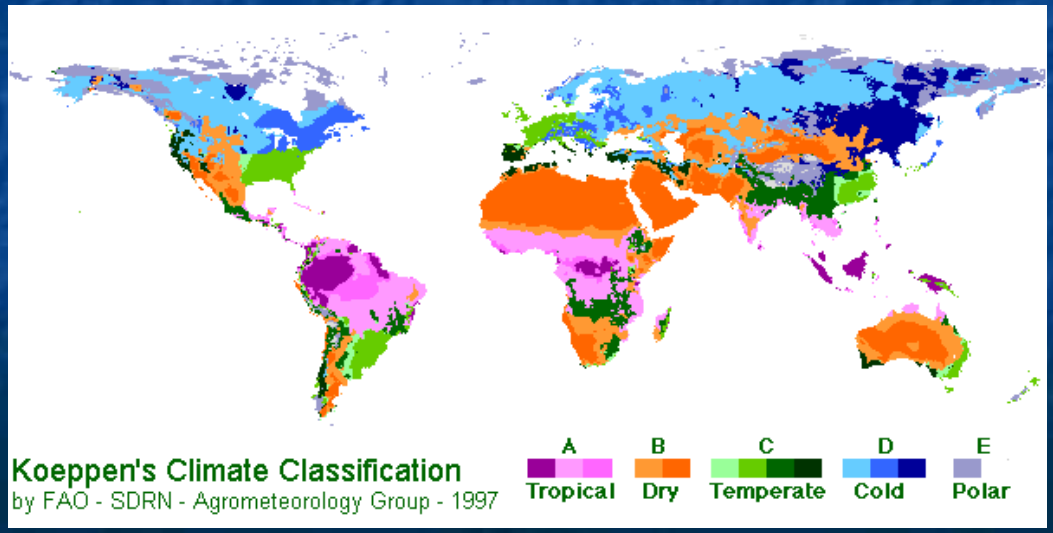
Global Cloud and Precipitation Simulation for January
Water vapor is displayed in white and total precipitation in orange.

Precipitation

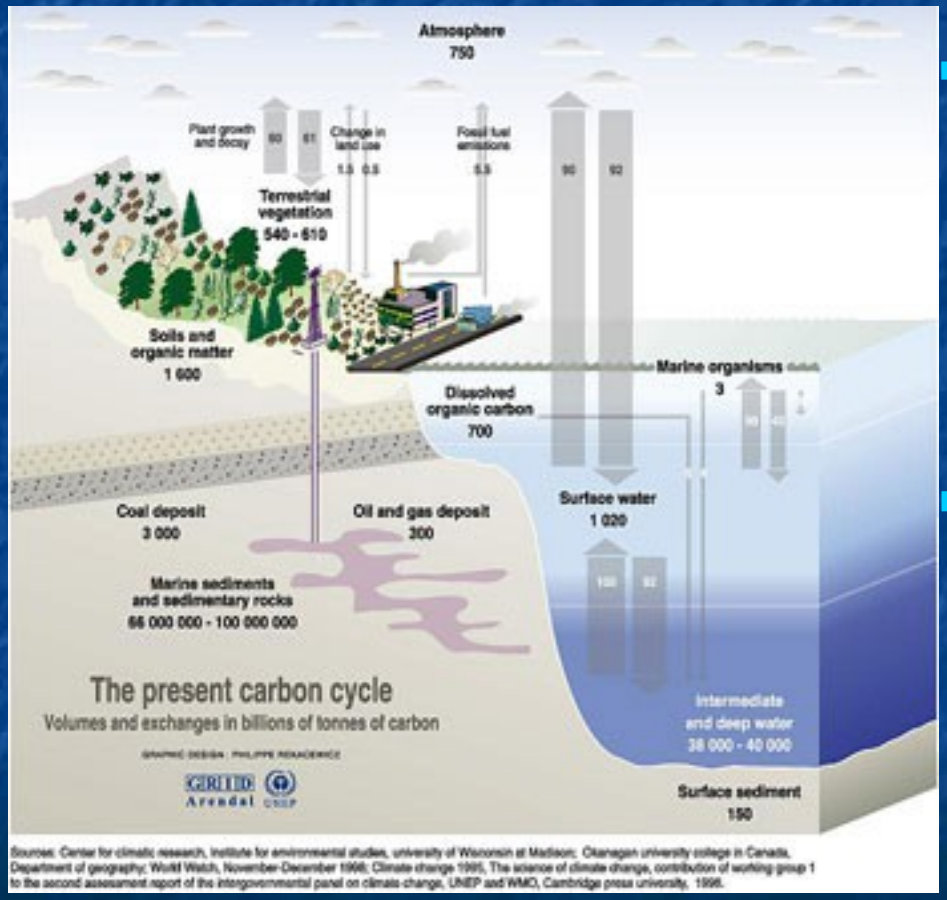
- The tropical ocean is the source of most of the rainfall throughout the world. Some of the most consequential rainfalls are generated by the seasonal monsoons, especially over Asia.
- In the summer, the centers of continents heat up, drawing moist air from the cooler ocean. The heavy monsoon rains over much of Asia not only provide these countries with critical moisture, they release tremendous amounts of latent heat which helps drive atmospheric circulation. A similar process fuels the North American monsoons, which provide important summer rainfall to the southwestern United States and northwestern Mexico.

Climate Zones

- Climate is the characteristic condition of the atmosphere near the earth's surface at a certain place on earth. It is the long-term weather of that area (at least 30 years). This includes the region's general pattern of weather conditions, seasons and weather extremes like hurricanes, droughts, or rainy periods. Two of the most important factors determining an area's climate are air temperature and precipitation.



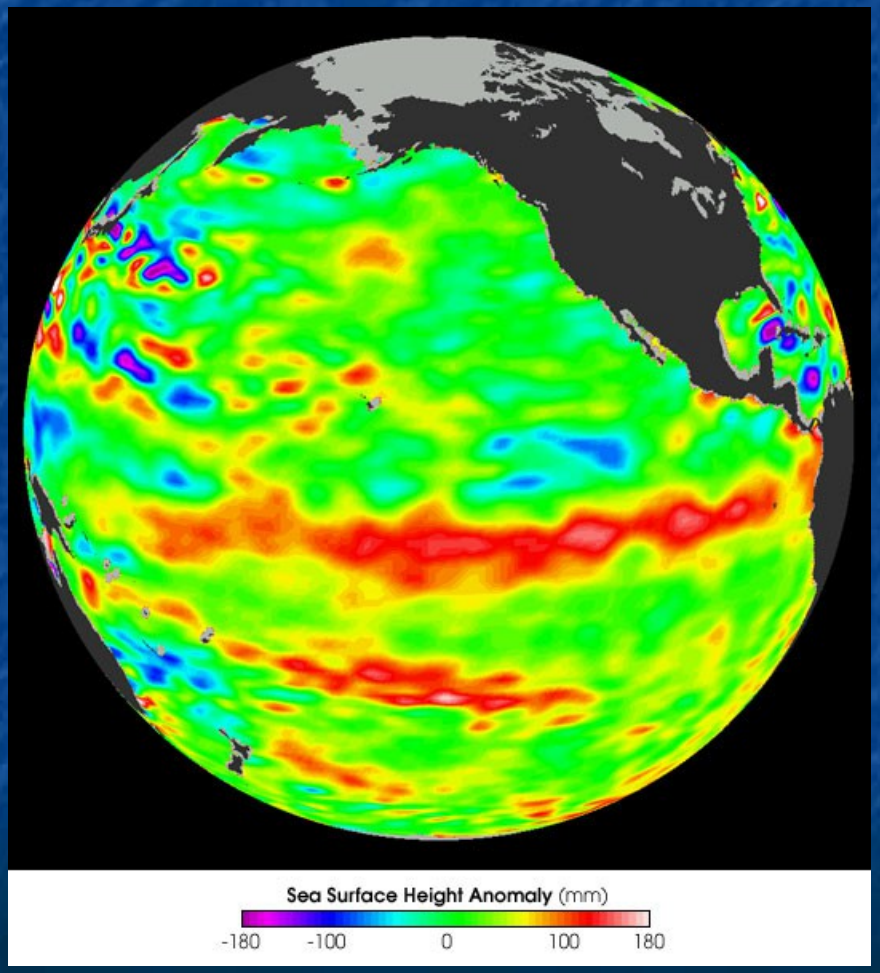
Ocean as a CO2 Reservoir



Sources: Center for climatic research, Institute for environmental studies, university of Wisconsin at Madison; Okanagan university college in Canada, Department of geography; World Watch, November-December 1998; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

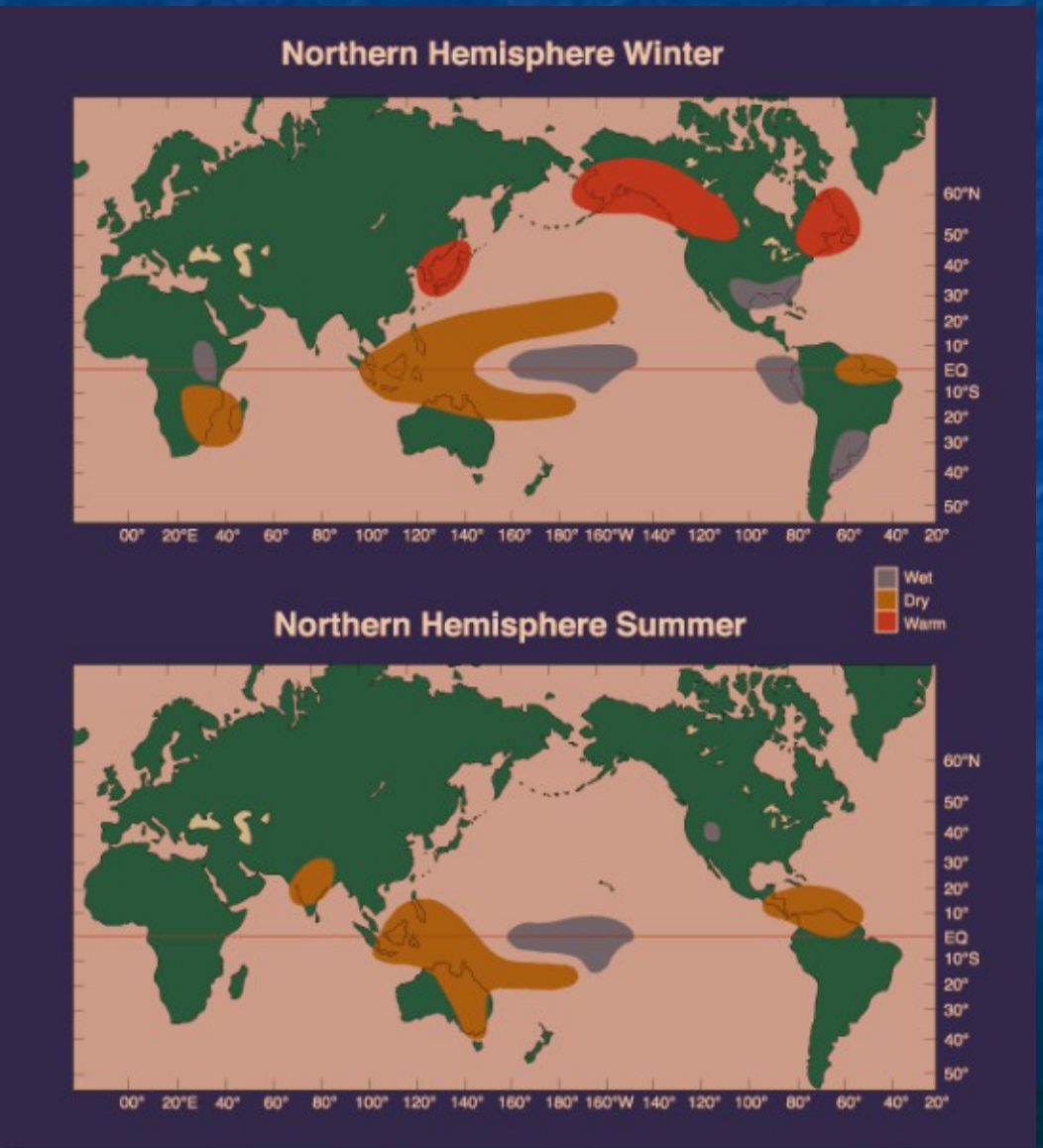
- photosynthetic marine organisms remove carbon dioxide from the environment to build carbohydrates. The formation of minerals such as limestone and of fossil fuels from the remains of these organisms permanently removes carbon dioxide from the environment.
- *Ocean water also holds tremendous quantities of carbon dioxide, 40 times more than the atmosphere. It absorbs almost half of the carbon dioxide released from the burning of fossil fuels.*

ENSO and Climate*



- warm-water conditions off the western tropical coasts of the Americas, occurring irregularly but usually around Christmas time, caused by weakening trade winds and causing depleted fisheries, heavier-than-normal rain in the central and eastern Pacific, and drought in the western Pacific.

ENSO and Climate



- A strong El Niño is often associated with wet winters over the southeastern US, as well as drought in Indonesia and Australia. Keep in mind that you aren't guaranteed these effects even though there is an El Niño going on; but the El Niño does make these effects more likely to happen.