Climate I

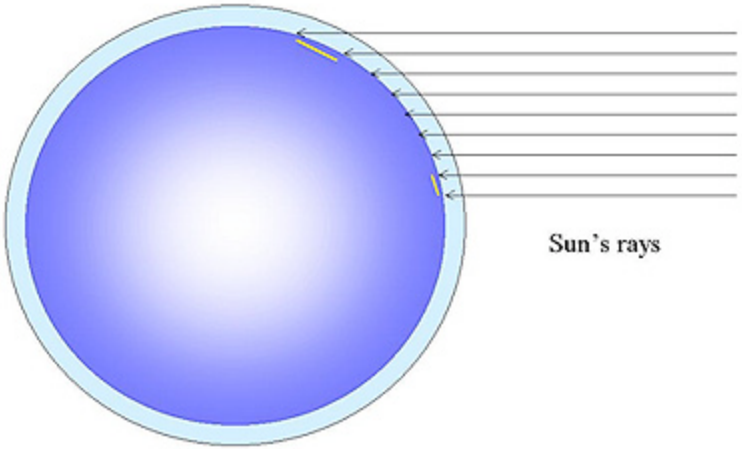
What controls the distribution of organisms on the Earth's surface?

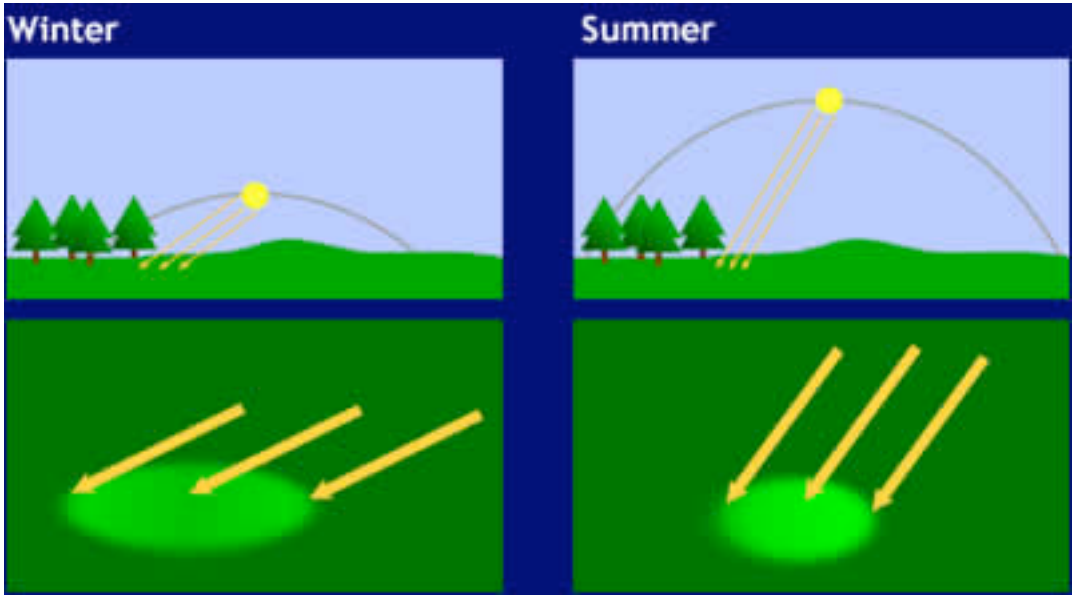
Biogeography - study of the distribution of organisms on the E's surface.

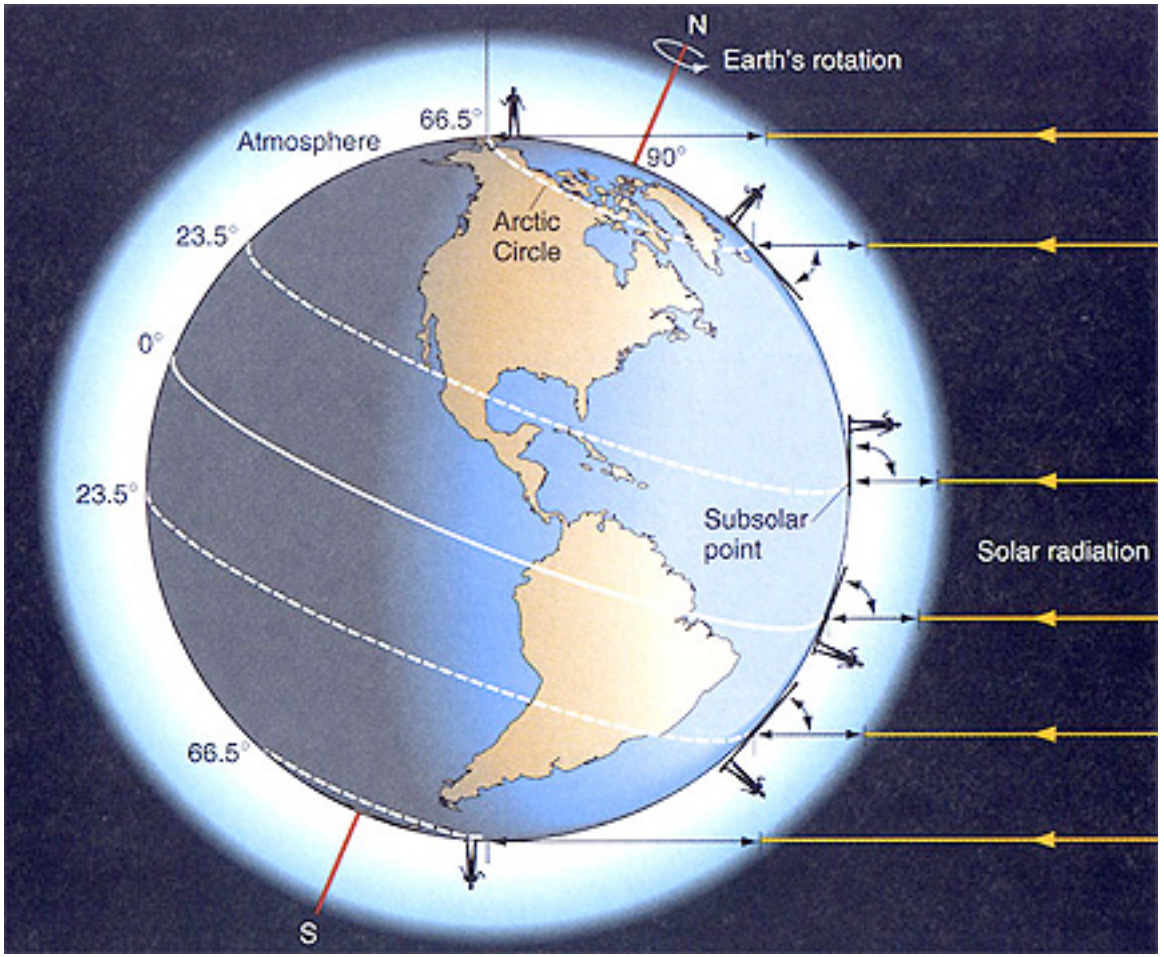
- Can be terrestrial or marine habitats - the distribution of both on earth is primarily determined by temperature, and to a lesser extent, rainfall
- Controls on the temp distribution of earth: variation in amount of incoming solar radiation and the resulting distribution of heat energy

Temp distribution is a function of:
#1-angle of incidence

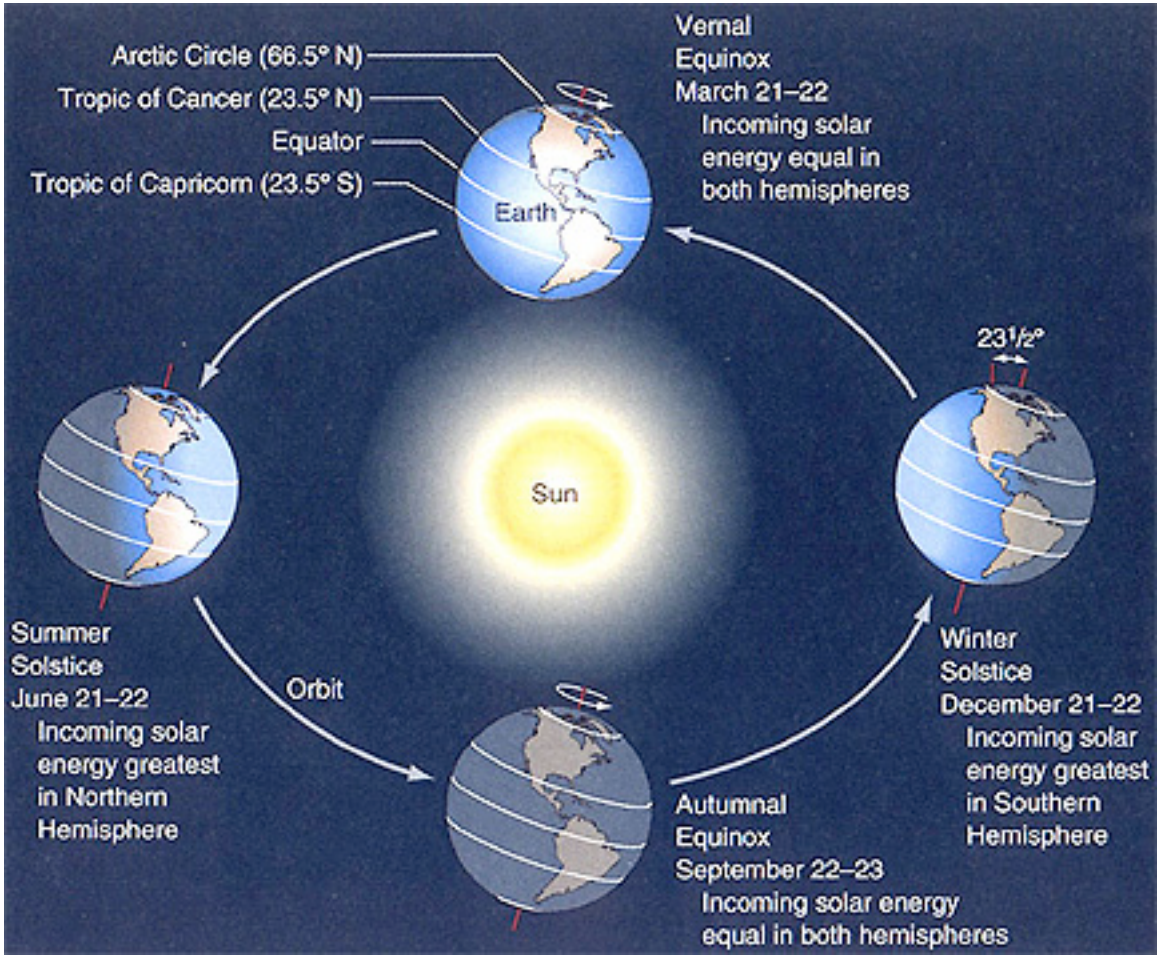
- The angle of incidence of solar radiation on the Earth's surface: most direct ~20° + and - equator, decreasing towards poles.
- The angle of incidence is seasonally controlled





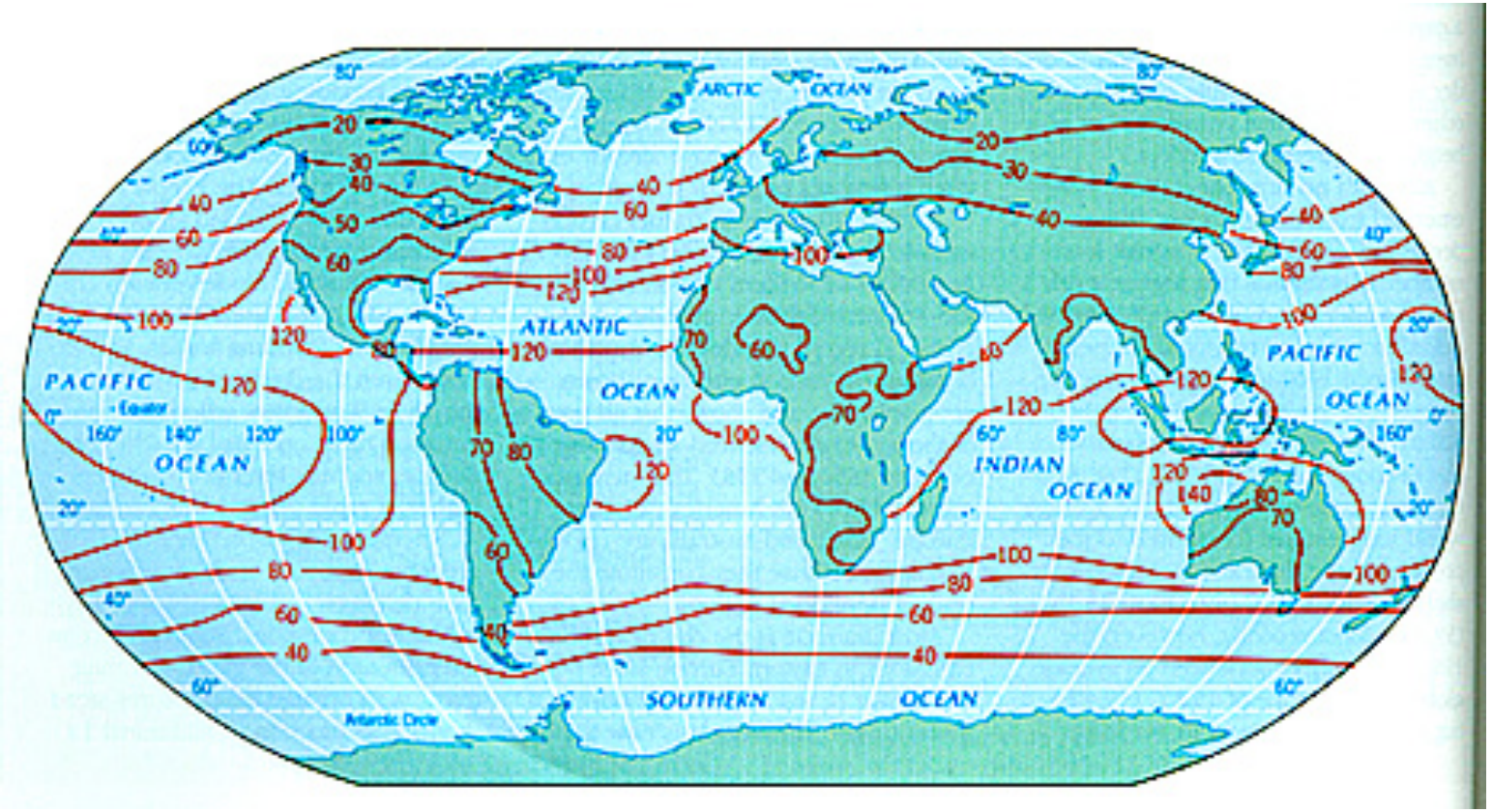


The northern hemisphere summer. More direct light is hitting the northern hemisphere.

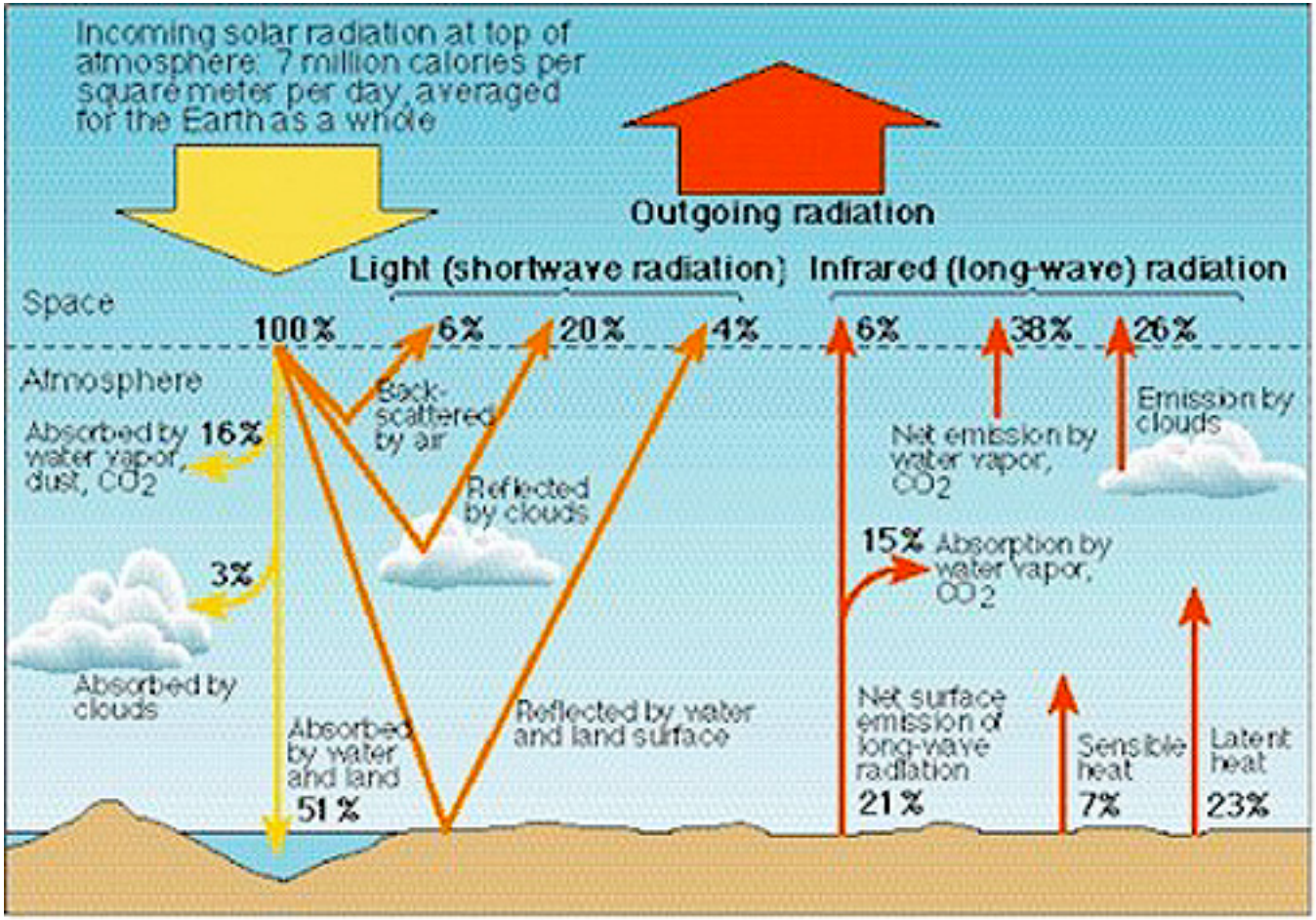


For the solstices: changes in the hemisphere that is tilted towards the Sun's direct heat incidence. The equinoxes: equality of incoming solar energy between the changing solstices.

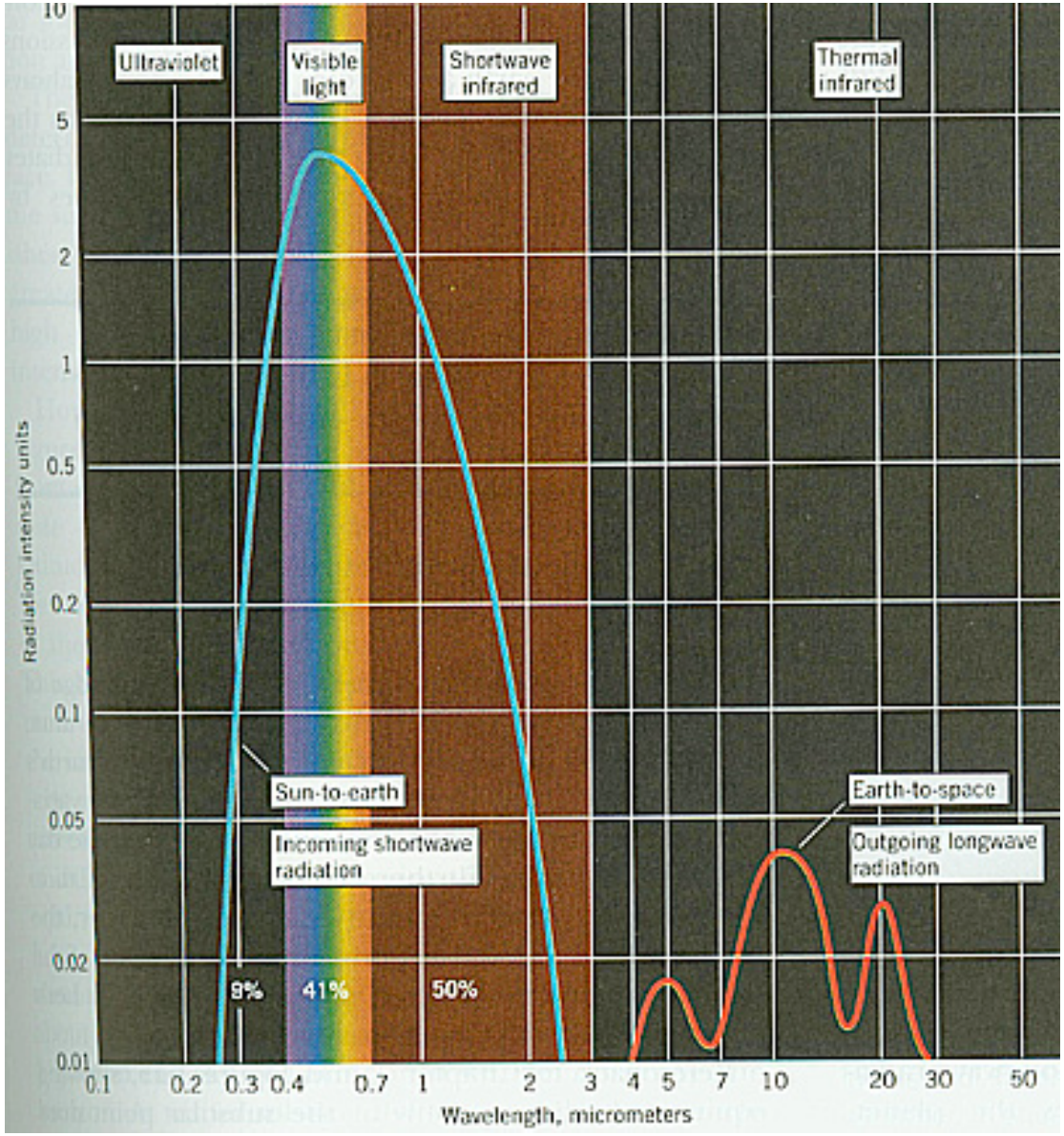
Surface heating: values in 1000 calorie per square cm (annual average). What pattern do you see?



Note equator to pole gradient: this shows that the equatorial regions are warmer than the poles = the Earth's latitudinal climate zonation.



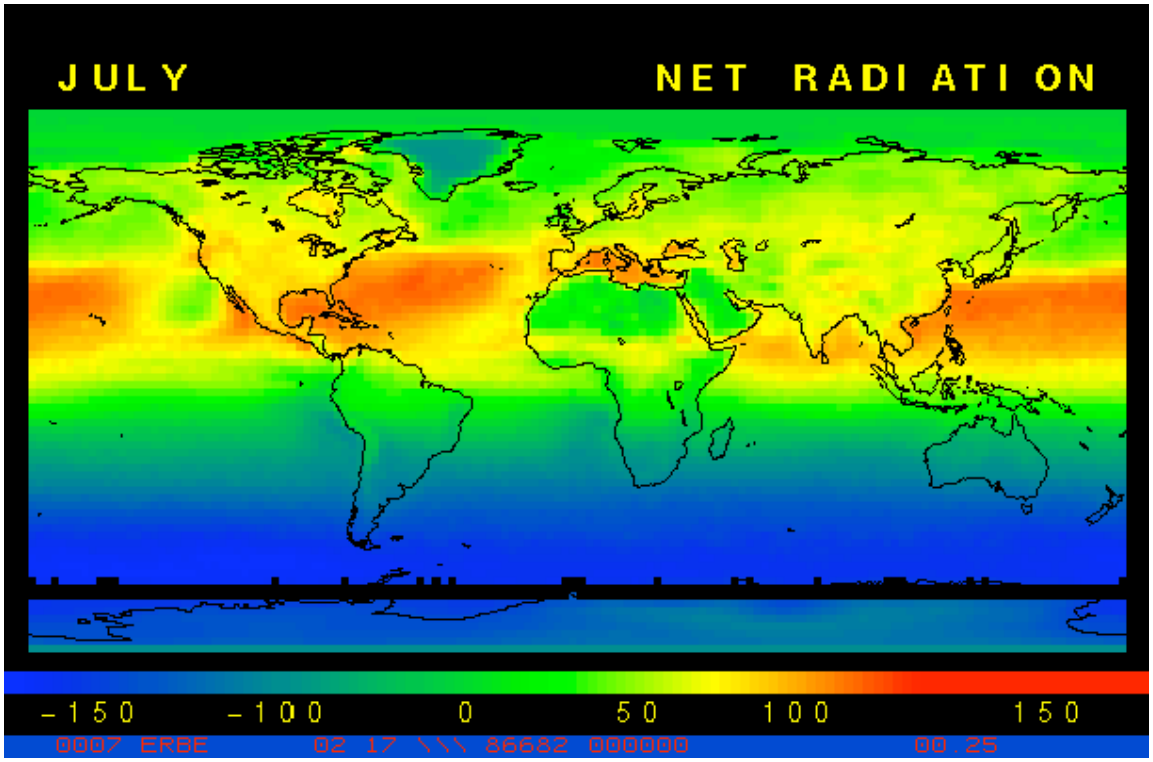
The solar radiation budget: incoming short-wave radiation and outgoing (reflected) long-wave radiation. Note that ~70% of heat is absorbed by water and land (including vegetation)



Just a reminder of the nature of radiation energy: various wavelengths behave differently; only 41% of the incoming solar radiation is in the form of visible light

#2: albedo - % sunlight reflected back into space

- Albedo varies as a function of surface material. Highest for snow and ice, lowest for ocean surface and vegetation
- Even within a latitude there is variation because of this

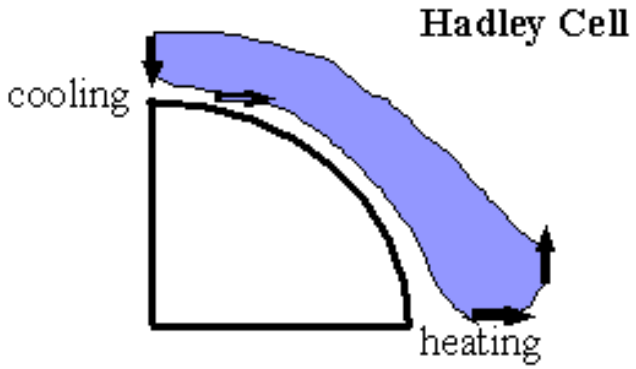


Albedo values for July: blue colors indicate highest reflectance; red colors = absorption. What pattern do you see?

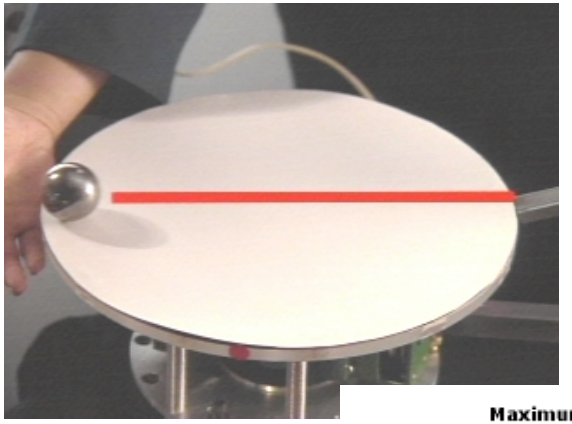
Again, it's a *general* latitudinally zonal pattern, but there are clearly effects of land vs. water.

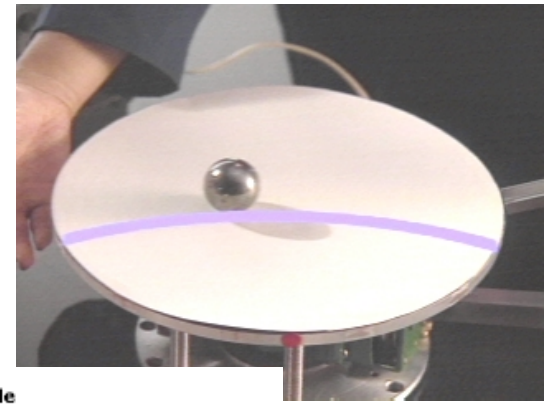
#3 movement of heat from hot to cold

- Heat flow: based on concentration of heat on the equator (from incidence and minimum albedo); heat flows from equator to poles.
- If there were no rotation to the Earth, and the Earth's surface were uniform, there would be one large circulation cell.

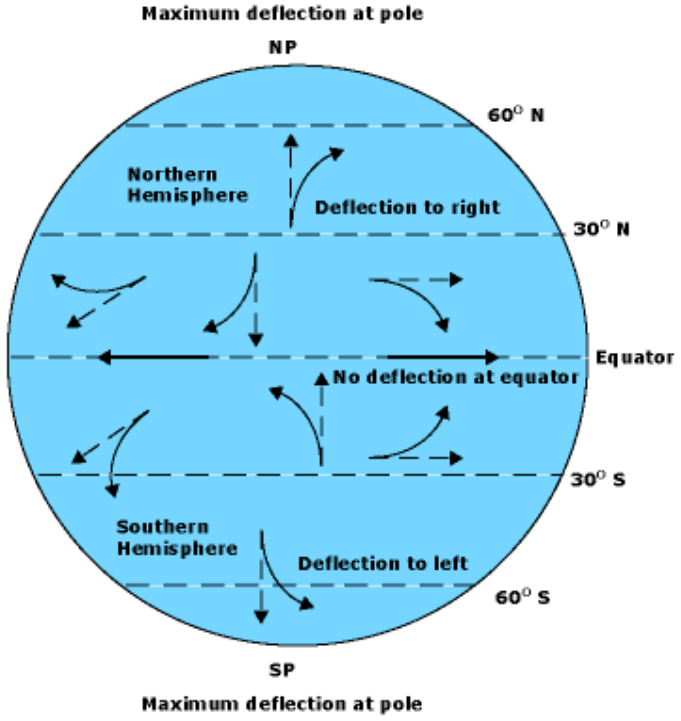


Because the Earth rotates, fluids flowing across it are unstable and break into several smaller cells. The flow in these cells across the surface are deflected = The Coriolis force

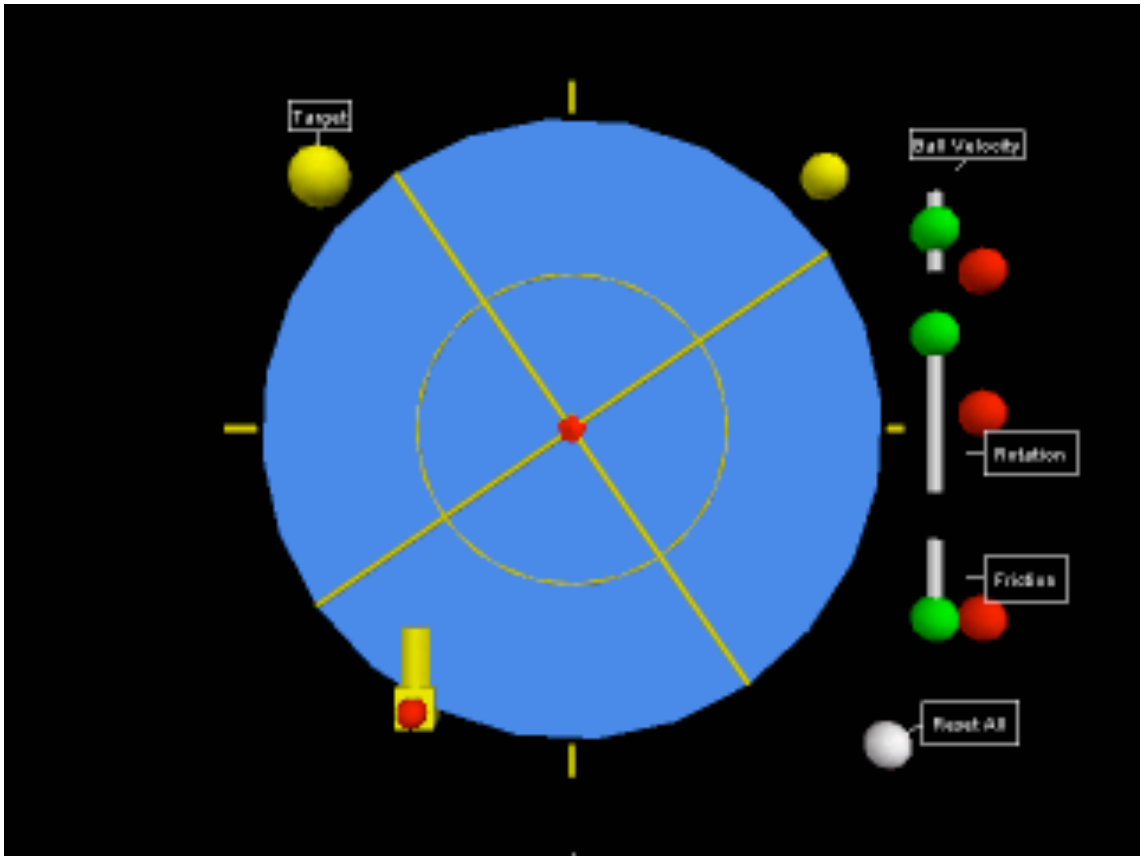




A rotating plate with a ball rolled across it: the ball will appear to curve as it rolls because the surface under the ball is moving - the arc of the path the ball makes is curved.

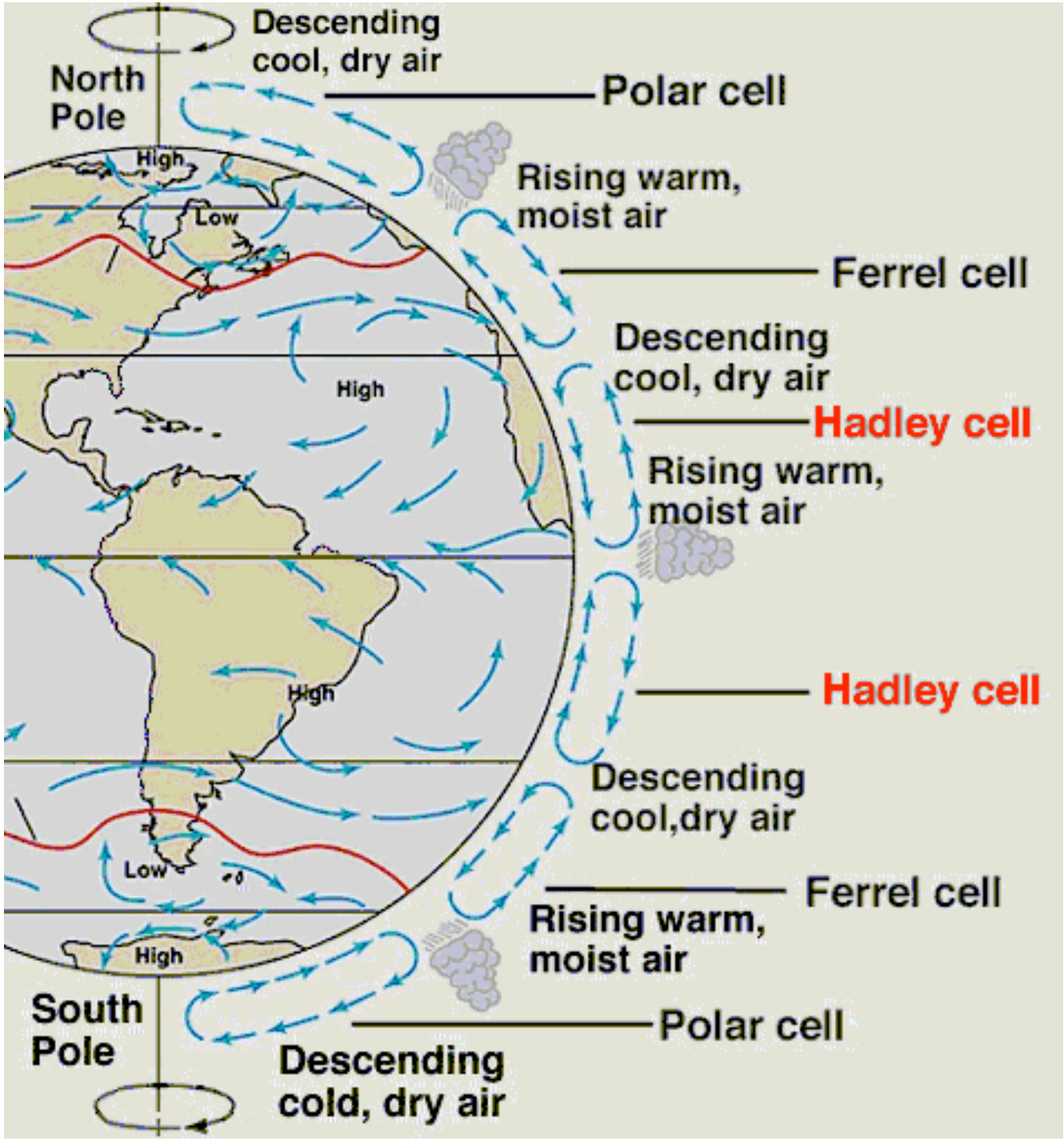


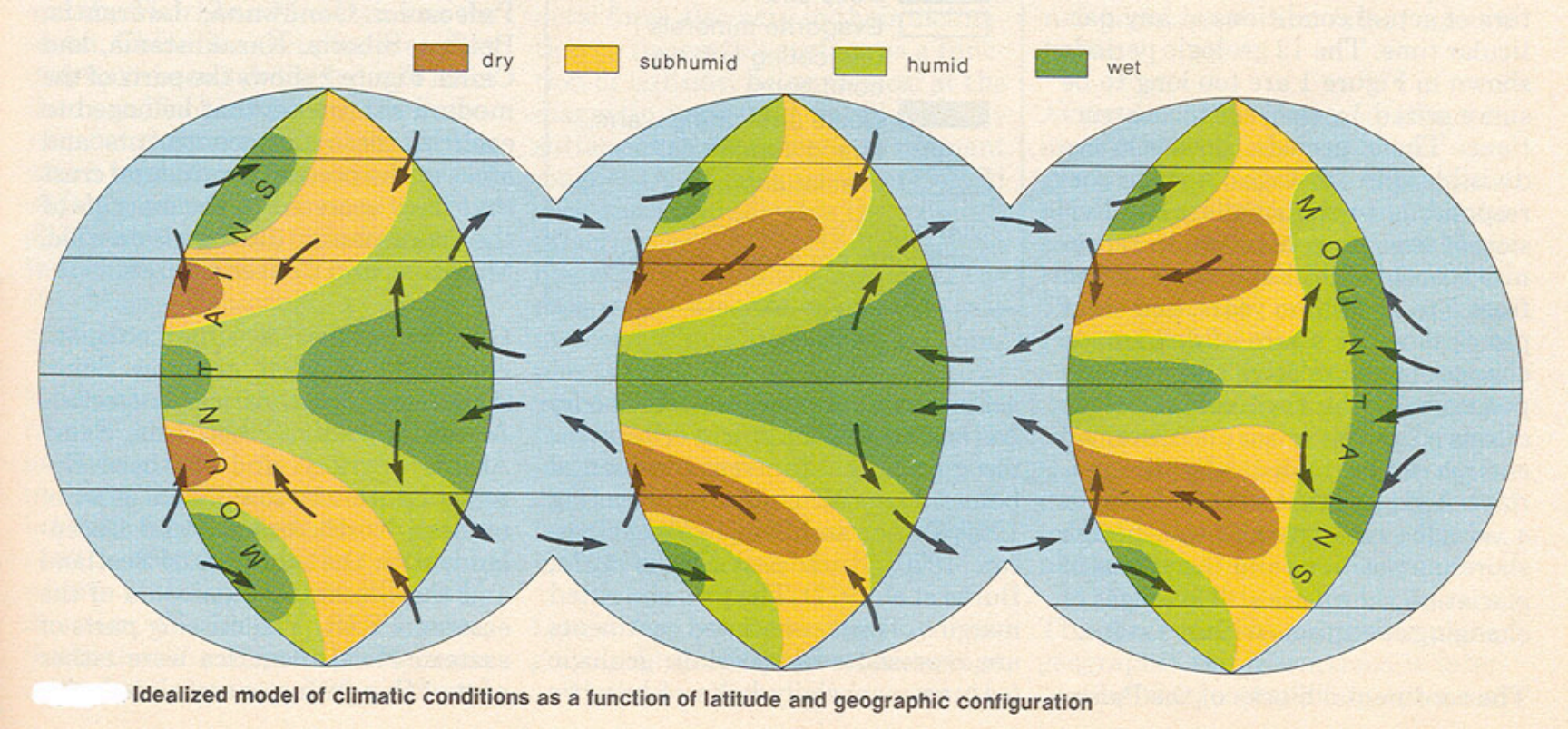
As air flows across the rotating Earth it will appear to curve its direction of flow



http://lurbano-5.memphis.edu/GeoMod/images/2/2c/Coriolis.gif

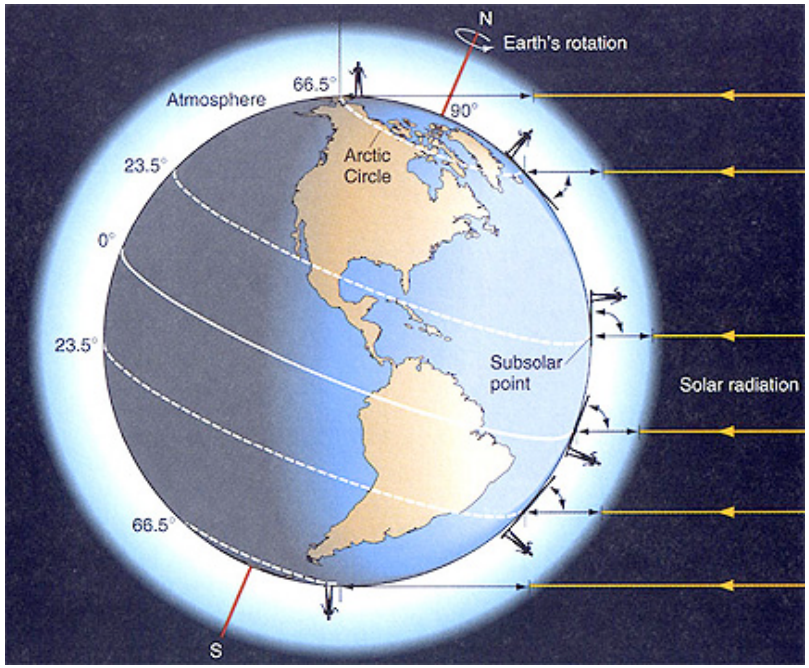
But, because the earth does rotate, and some areas are land and others ocean, the fluid flowing over the Earth's surface breaks into a series of cells. The term "Hadley cell" refers to the simple closed convection cell of rising hot air, lateral spreading, and sinking cold air





Summary diagram of general climate patterns on the Earth's surface. warm and wet equator; warm and dry belts ~ 30° and wet and cool temperate climates ~ 45°. The pattern can be altered in the presence of mountains as they deflect winds and moisture.

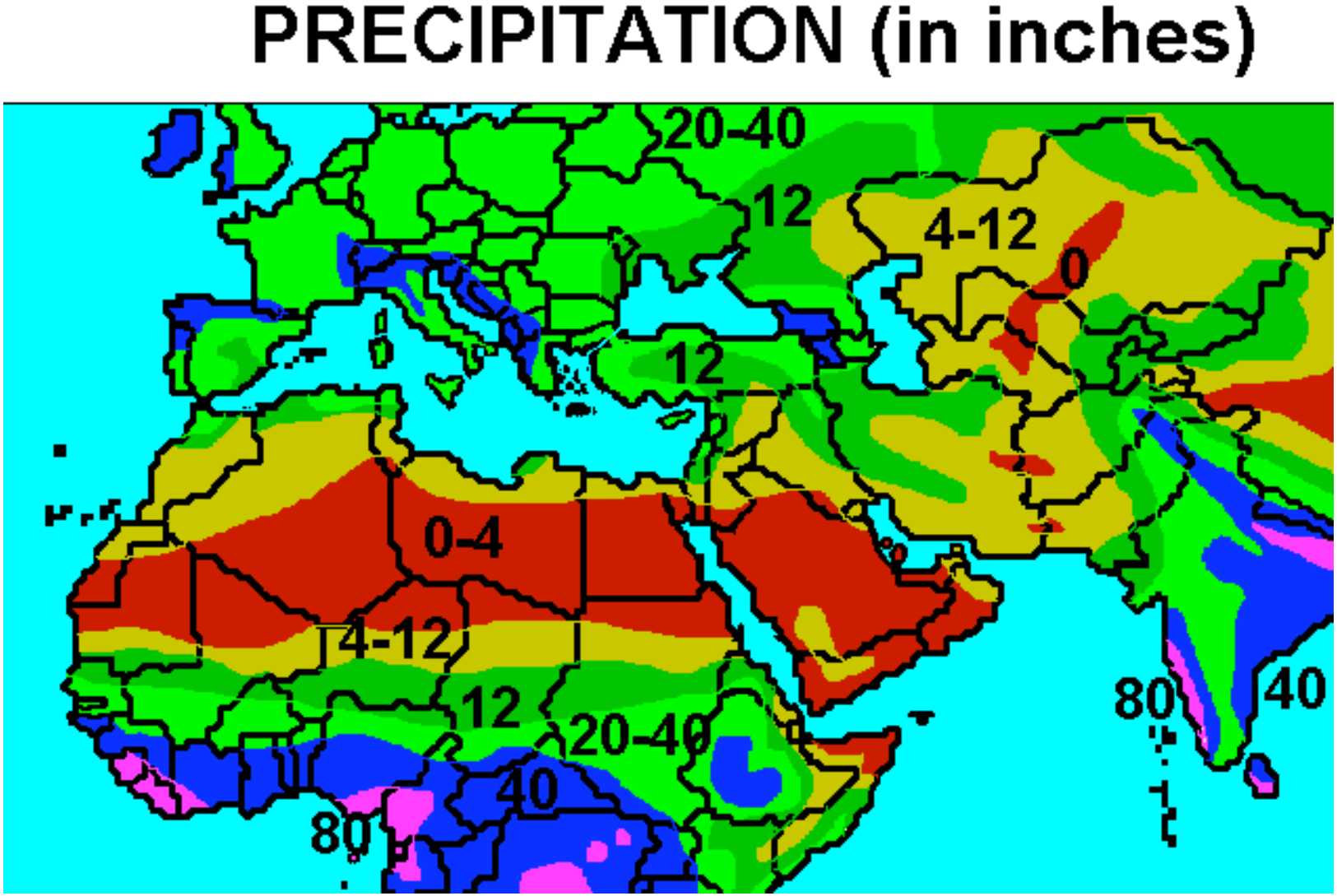
Now we need to complicate things so they model the real world. Climate belts are not parallel to the equator because the Earth is tilted on its rotational axis. Therefore, the position of the winds will move north and south as a function of the seasons.



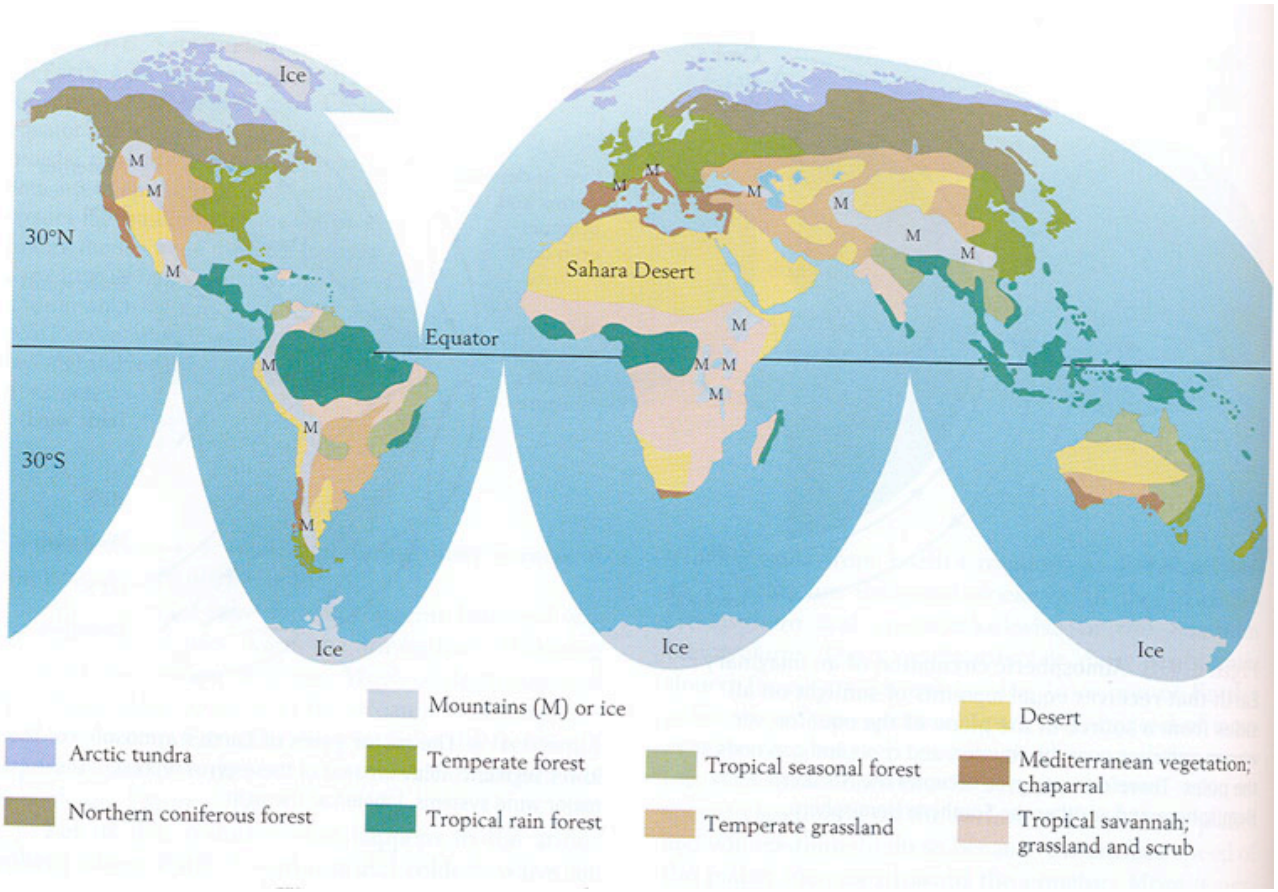
Where the trade wind belts converge on the Earth's surface is called the INTERTROPICAL CONVERGENCE ZONE (ITCZ). It is the major region on Earth where tropical storms originate because this is where two hot, wet air masses converge.

Be sure you can draw and label the major surface winds on Earth for either a northern hemisphere summer or winter, and also label the location of the ITCZ

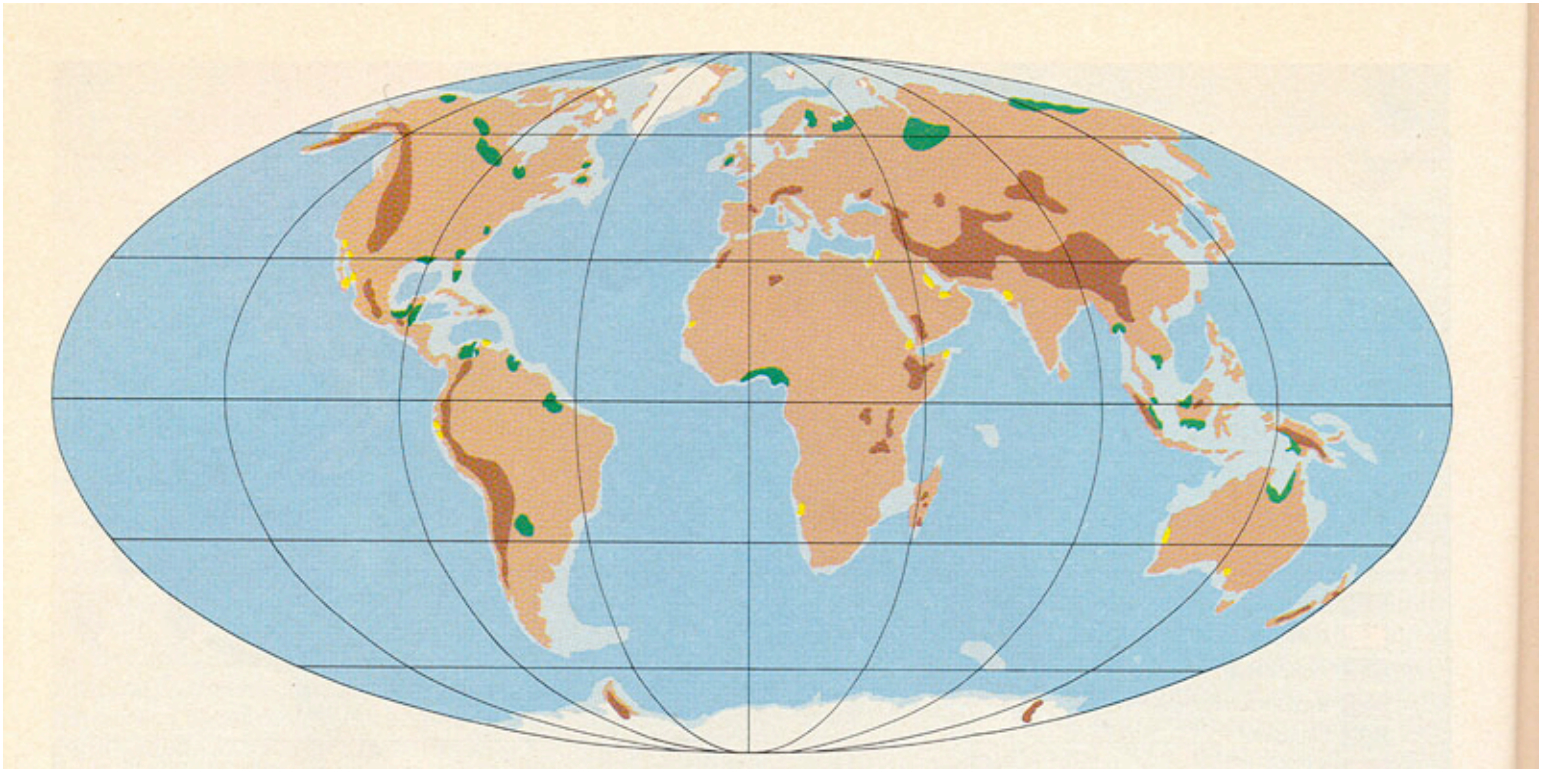
Latitudinal control on ppt



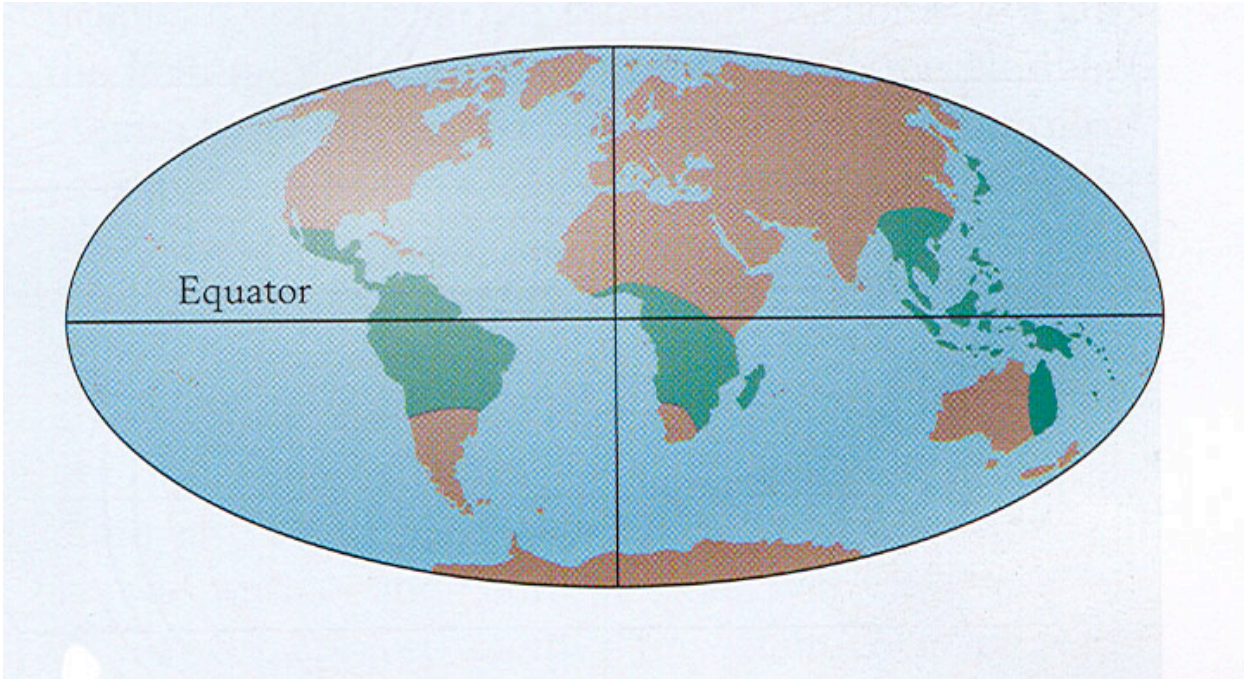
Vegetation patterns parallel climate zones (tropics - temperate - polar)



Distribution of modern climate-sensitive indicators

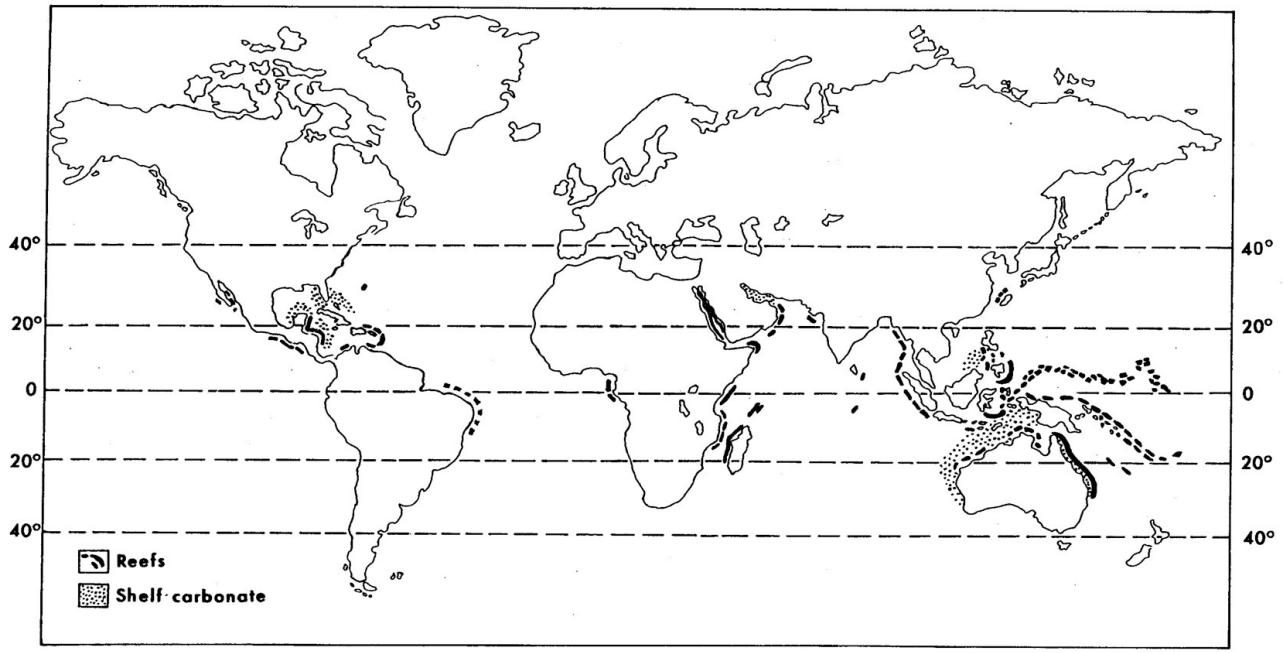


Green = peats and coal
Yellow = evaporite
White = glaciers
(dark brown = mtns)



Green= distribution of modern cycads (=palm trees)

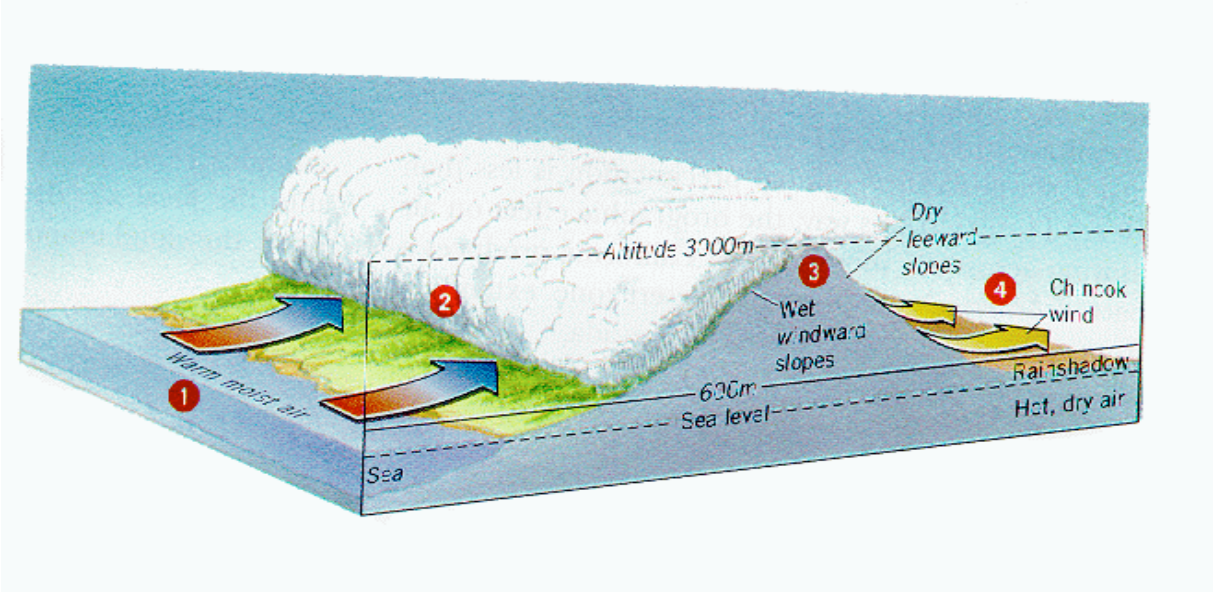
Heavy black lines = distribution of modern reefs



. Distribution of modern marine carbonate sediments in shallow water

There are local effects to this pattern, ex, orographic effects

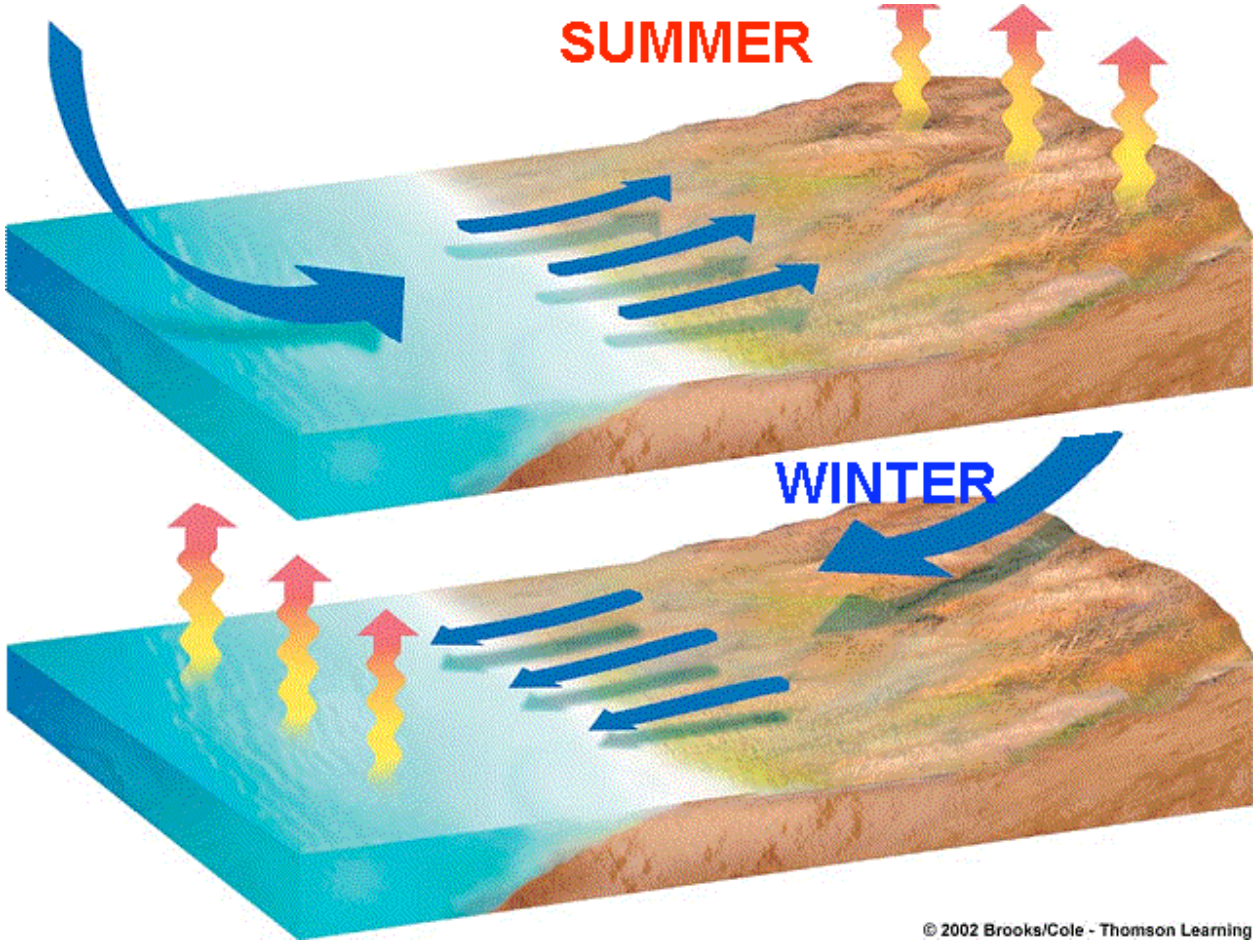
- The “rain shadow” on the lee side of mountains
- Ascending the slopes of mountains = traveling from equator to poles. Ex, Mt Mitchell in NC: base of mountain is sub-tropical/mtn top is alpine tundra.



Another local variation from differential heating of land and water

- Water has a very high heat capacity (ability to store heat energy), therefore it retains heat over the course of a day and season.
- Can occur over very local scale, ex, Lake Champlain or more regional, ex, monsoons of India…..

winter: cold, dense air flows S from mtns to Indian Ocean summer:heating of Indian continent causes air to rise, replaced by S to N flow off Indian Ocean, very moist = high rainfall

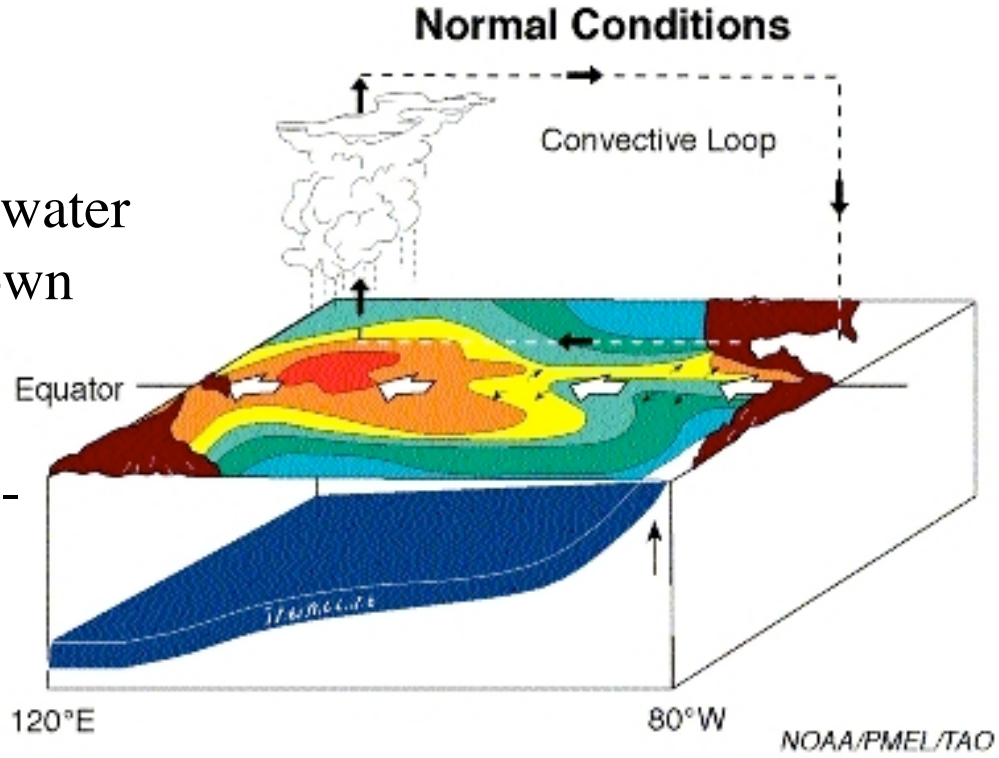


Periodic anomalies

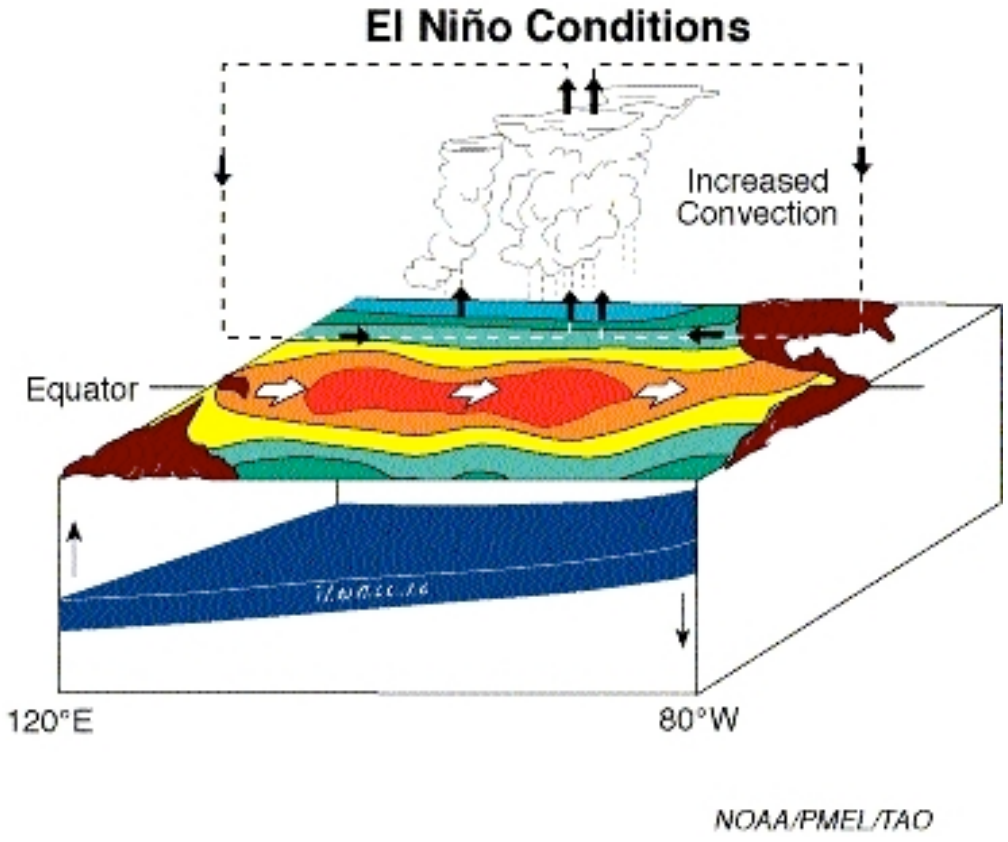
ex: El Nino

what is El Nino? Anomalous warm sea surface temperatures (SSTs) in the eastern and central Pacific Ocean, and resulting atmospheric disturbances

warm equatorial water off S. Am gets blown offshore, allowing cool water from depth to rise (= up-welling. Excellent fish harvests.



Warm water moves west across Pacific; atmosphere warms, moisture creates Asian monsoon



During an El Nino event warm SSTs along equator in Pacific; Eastern Pacific waters heat up and moisture evaporated into atmosphere moves eastward by prevailing westerly winds. Result: weak monsoon, African and western Pacific drought, western US dry summer and wet winter, southeastern US wet winter

The SST and atmospheric circulation is linked, and is called the "ENSO" (El Nino Southern Oscillation). The Southern Oscillation refers to the cyclic variation in monsoon intensity.

ENSO cycles are 4-7 years. The ultimate cause of ENSO??

The ultimate significance of ENSO?
It demonstrates the global effect of slight changes in ocean circulation as well as the linkage of ocean and atmospheric circulation

With global warming, what linked ocean/atmospheric circulations will be effected?