

# Ocean Currents

The Reality of Sending a  
Message in a Bottle

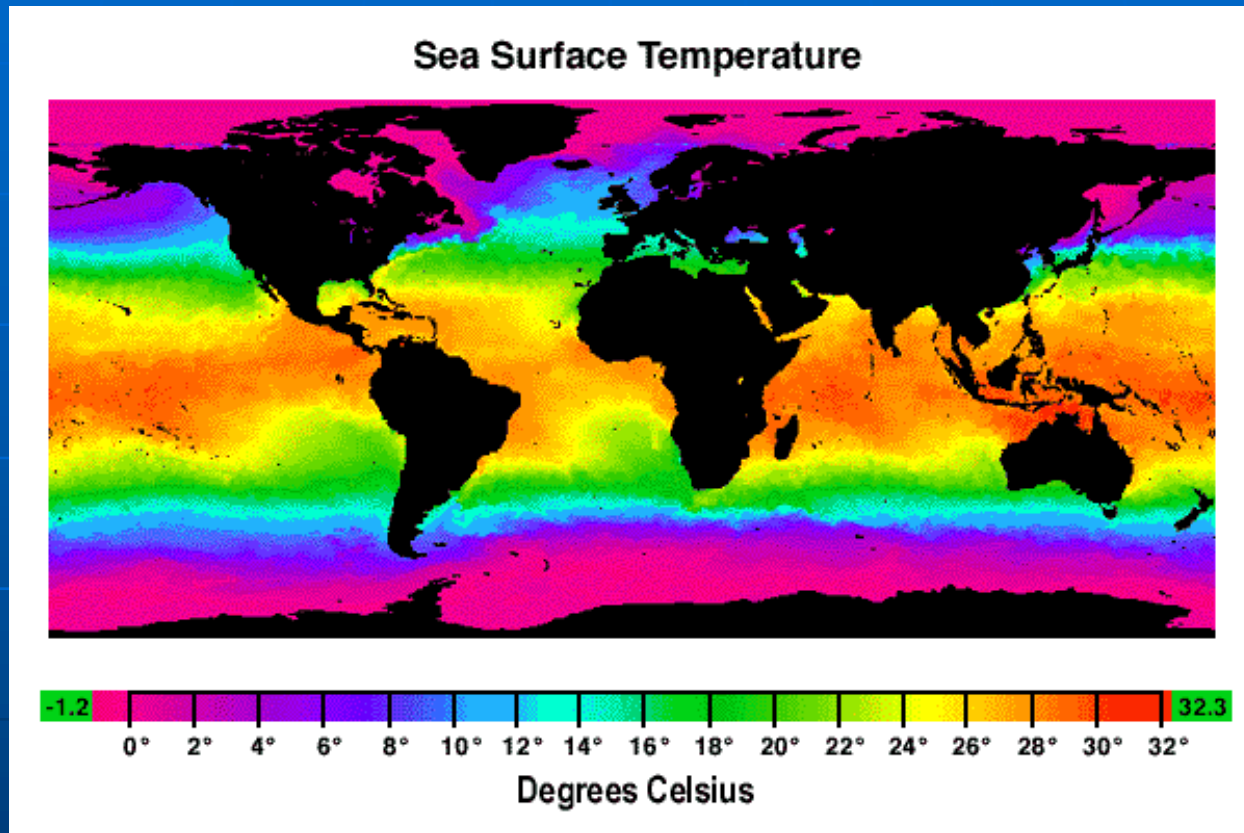
# Ocean Current Layers

- Surface Currents – upper 10% of the ocean; upper 400 meters
- Pycnocline – the layer between surface and deep waters; where a rapid change in temperature, salinity and density occur
- Deep Current – lower 90% of the ocean

# Ocean Water Properties

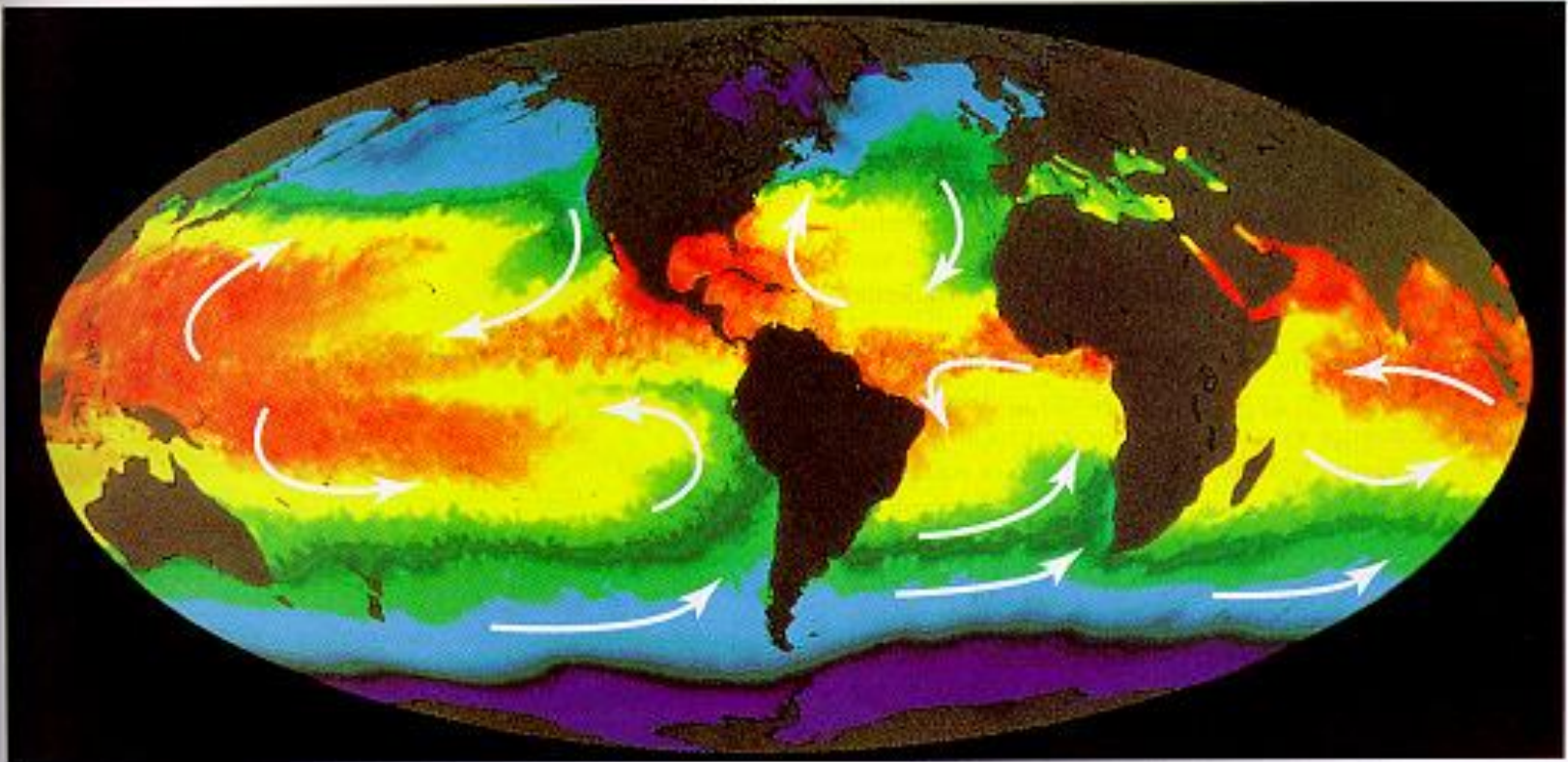
- How they impact ocean currents
  - Temperature – heat rises!
  - Salinity – salty water sinks!
  - Density – a function of temperature and salinity

# Ocean Surface Temperatures



[http://www.bigelow.org/shipmates/sstemp\\_lg.gif](http://www.bigelow.org/shipmates/sstemp_lg.gif)

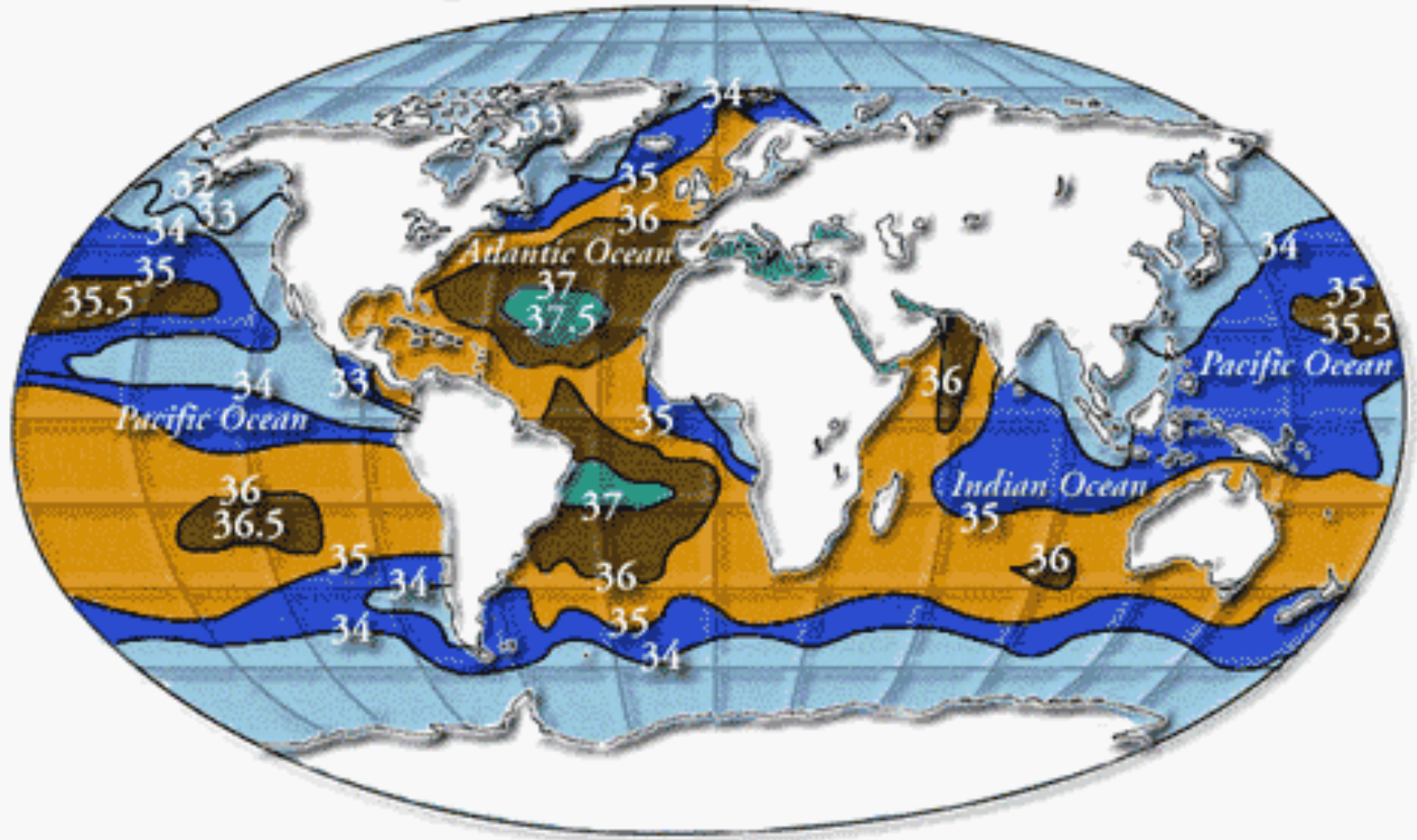
# Temperature vs. Currents



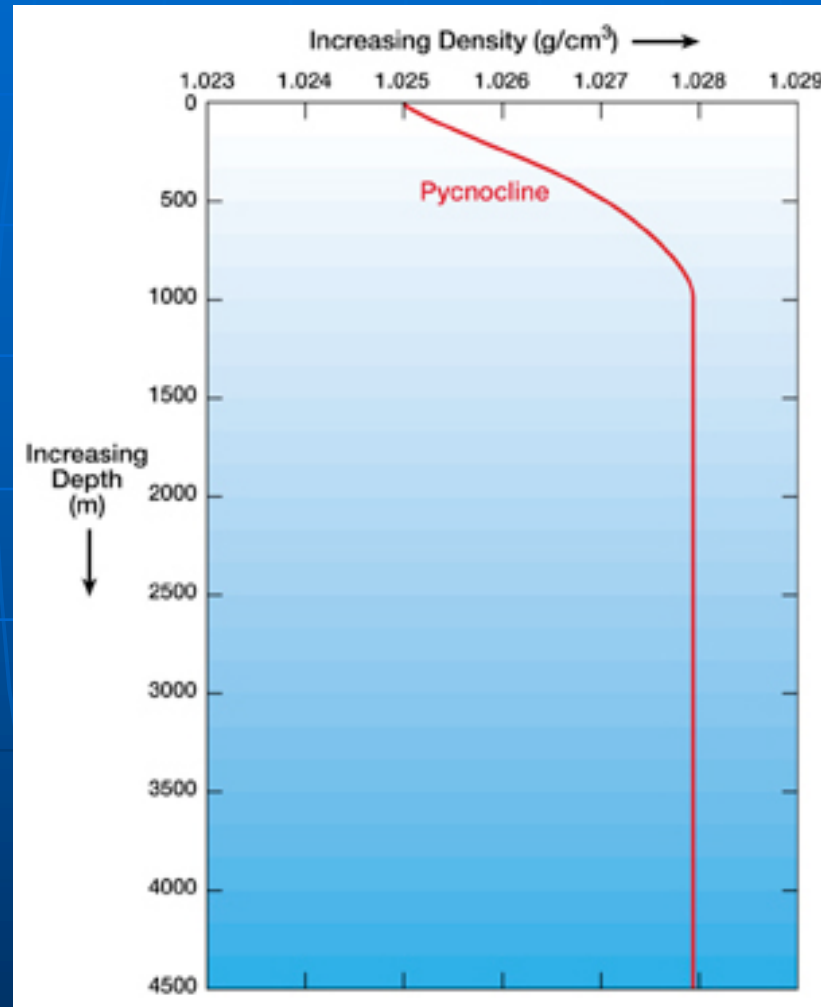
<http://earth.usc.edu/~stott/Catalina/Oceans.html>

# Ocean Surface Salinities

*Surface Salinities of the Oceans (‰)*



# Ocean Density



<http://www.windows.ucar.edu/tour/link=/earth/Water/density.html&edu=high>

# Primary Current Forces

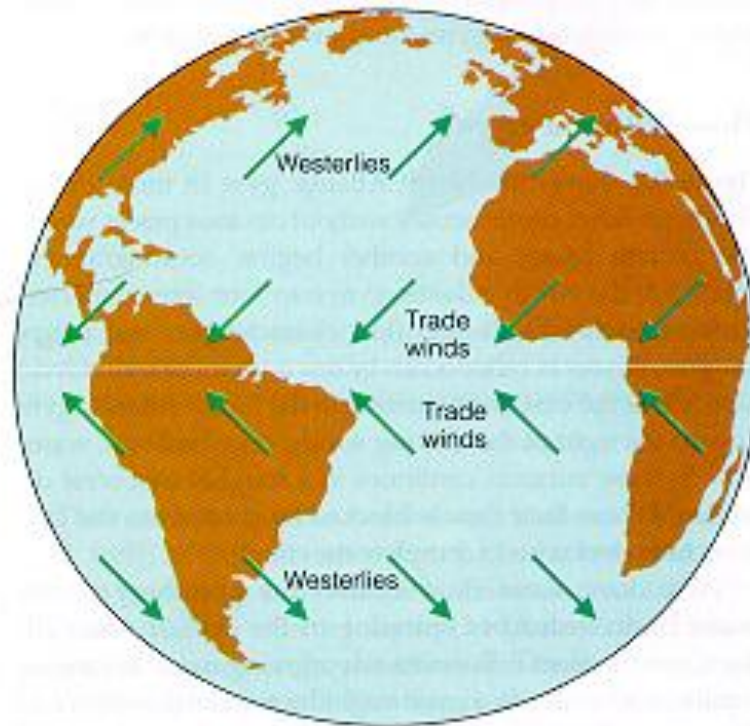
- These Start the Water MOVING:
  - Solar Heating
  - Winds
  - Gravity
  - Coriolis Force/Effect



# Current Forces Explained

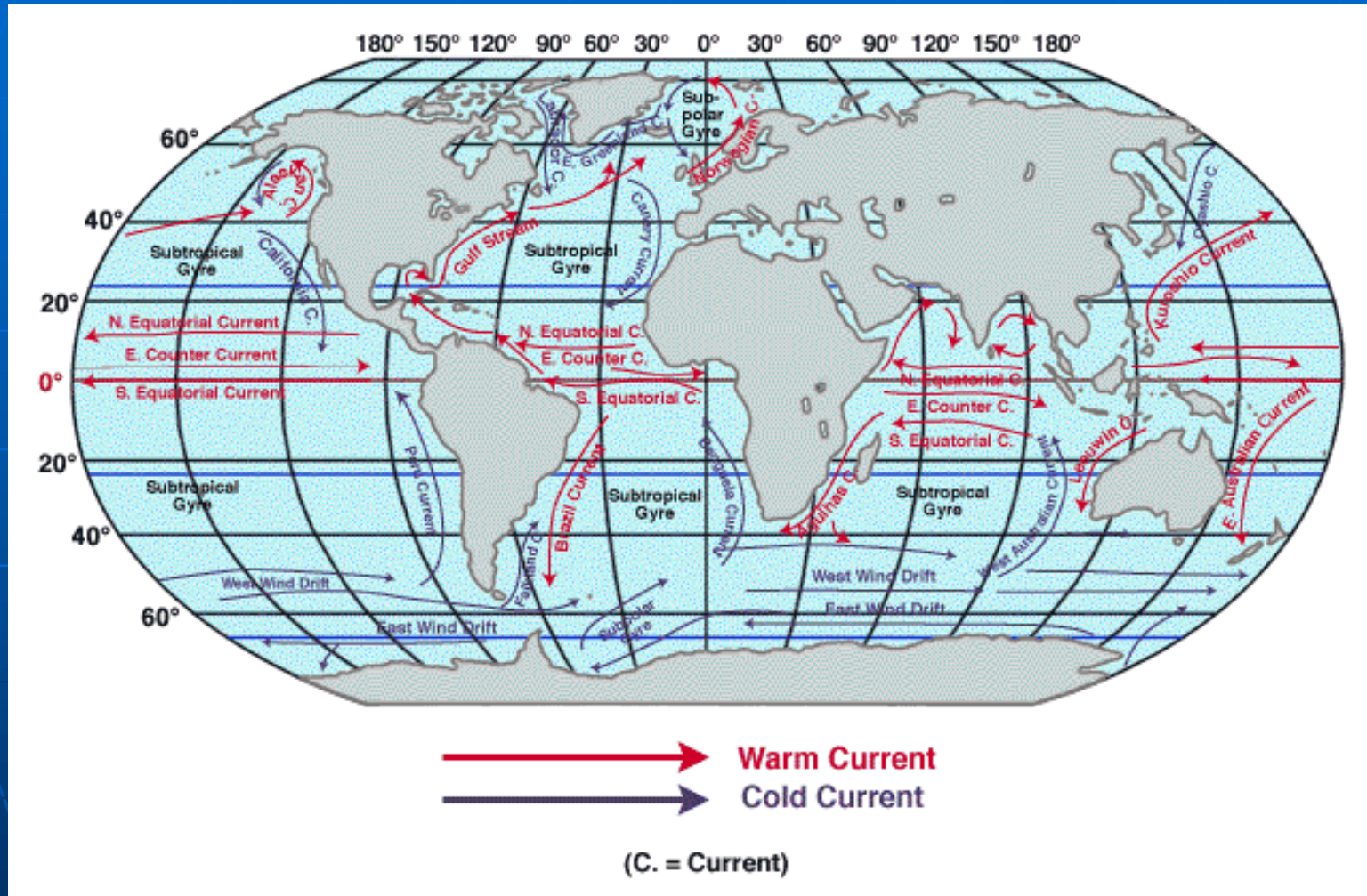
- Sun/solar heating - causes water to expand and move
- Winds - push the water; winds blowing for 10 hrs across ocean will cause the surface water to flow @ ~2% wind speed; wind has the greatest effect on surface currents
- Gravity - pull water downhill or pile against the pressure gradient (high/low); influences tides

# Winds



**Figure 9.1** Winds, driven by uneven solar heating and Earth's spin, drive the movement of the ocean's surface currents. The prime movers are the powerful westerlies and the persistent trade winds (easterlies).

# Wind Driven Ocean Currents



# Current Influences (cont'd)

- Coriolis effect/force - Force due to the Earth's rotation, capable of generating currents. It causes moving bodies to be deflected (bent) to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The "force" is proportional to the speed and latitude of the moving object. It is zero at the equator and maximum at the poles

<http://www.csc.noaa.gov/text/glossary.html>

# Surface Currents

- Surface current – with surface circulation is less dense and influenced by winds
  1. Warm surface currents: wind and Earth's rotation
  2. Cold surface currents: flow towards the equator
  3. Upwelling current: cold, nutrient rich; result of wind
  4. Western Boundary currents: warm & fast
  5. Eastern Boundary currents: broad, slow, cool & shallow, associated with upwelling
- Ex: *Gulf Stream* = surface current that is the upper 20% of the ocean, western boundary current

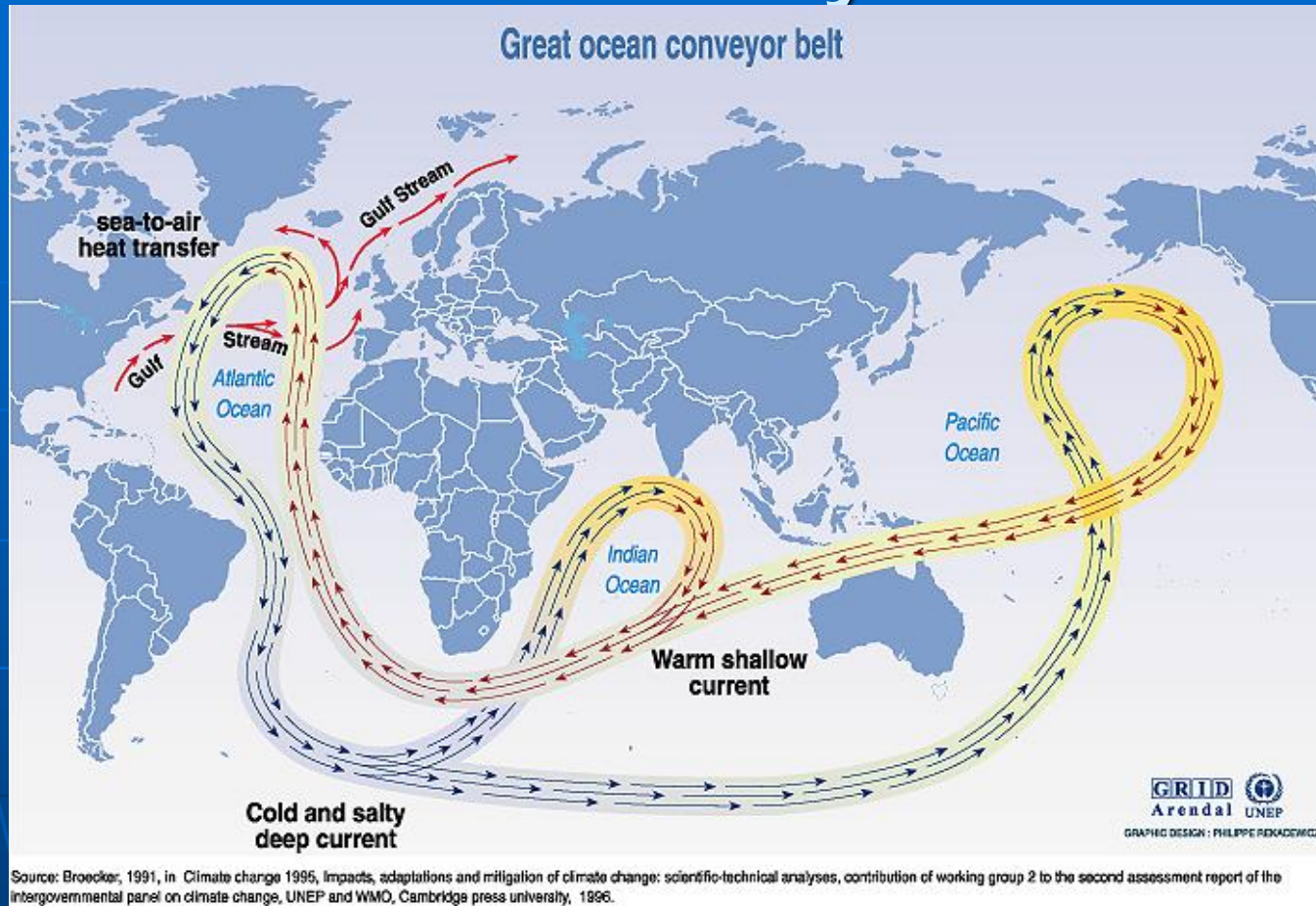
# Deep Currents

- Deep water – cold, dense, salty; move by density forces and gravity; move slower than layers above
  - Thermohaline Circulation: is global ocean circulation. It is driven by differences in the density of the sea water which is controlled by temperature and salinity. In the North Atlantic it transports warm and salty water to the North. There the water is cooled and sinks into the deep ocean. This newly formed deep water is then exported southward. This slow ( $\sim 0.1$  m/s), but giant circulation has a flow equal to about 100 Amazon Rivers. Once the water are in the deep, they remain there for up to 1000 years.

<http://www.climate.unibe.ch/~christof/div/fact4thc.html>

- Ex: *Global Conveyor Belt* = deep current that is the lower 20% of the ocean; takes 1,000 years to complete the cycle

# Global Conveyer Belt



- Thermohaline circulation links the Earth's oceans. Cold, dense, salty water from the North Atlantic sinks into the deep and drives the circulation like a giant plunger.

<http://www.columbia.edu/cu/record/23/11/13.html>

Graphic - <http://www.grida.no/climate/vital/32.htm>

# Other Currents

- Gyres – large mounds of water; large circular currents in the ocean basin
- Ex: *North Atlantic Gyre* = consists of 4 separate currents – N. Equatorial, Gulf Stream, N. Atlantic Drift and Canary Currents



# Ocean Currents & Living Things

- Currents are important to marine life as they help move food and nutrients making them available for photosynthesis, metabolic requirements and or consumption.