3/24/08

The Oceans: Class 24

SURFACE CURRENTS

- Major surface currents
- Ekman transport
- Rotary motion - gyres --
- Western boundary currents
- Upwelling and downwelling
- Eddies

MAJOR SURFACE CURRENT SYSTEMS: driving forces:

Initiated by global winds

- Trade Winds (low lat.)
- Westerlies (mid lat.)

Deflected by continents and Coriolis effect

- System of E-W currents (wind-driven) and
- N-S "boundary"currents (deflection)

Gyres: circular sets of currents

- See Fig. 7-3 for a simplified diagram- gyres

See Fig. 7-4 in Thurman and Trujillo- Detailed map of currents

See Fig. 7-13 for map of currents around Antarctica- Southern Ocean, connects the other oceans

No need to memorize current names, except for a few that are clearly emphasized in class

Ekman Transport: In which direction is water moved when the winds blows across its surface?

1) Coriolis effect: Motion of the uppermost layer is deflected to the right of the wind's force (roughly 45 degree angle)

2) Now consider the next layer deeper:

- Motion slower than upper layer
- Force from upper layer is at 45 degrees to the wind
- Coriolis effect deflects motion relative to THAT direction

3) Successively deeper layers

- Same idea again- and speed keeps decreasing with depth
- Movement negligible below about 150m
- Spiral pattern- See figure in text

4) Add up the combined movement in all layers….

Ekman Transport: The overall movement of water is PERPENDICULAR to the wind direction!!!!!!! ...in N. Hemisphere, 90 degrees *to the right*

A Detailed Look at the Gyres

1. Ekman transport tends to force water into the gyre
   - This creates a subtle "hill" or mound of water. See figure in text
   - Example: middle of North Atlantic Gyre (a.k.a. the Sargasso Sea) is 1.5 m higher than edges.

2. Gravity tends to force water downhill out of the gyre

These two forces roughly balance- so water moves around and around (there is some flow into gyre).

Currents on the western sides of the gyres:

- Strong, narrow, deep
- Example: The Gulf Stream

Currents on the eastern sides:

- Slow, broad, shallow
- Canary Current- Eastern Atlantic

Why are currents more intense on the western sides?

1. Trade winds compress currents against continents there
2. Coriolis effect is greater at higher latitudes (difficult to see this, but the strong Coriolis effect at high latitude works against the compression (item 1 above) as the currents move toward the continents)

UPWELLING AND DOWNWELLING INDUCED BY EKMAN TRANSPORT

Ekman transport can....

1) Drive surface waters apart creating zones of upwelling,
2) Force them together creating zones of downwelling
3) Drive surface waters away from coasts (upwelling)
4) or force them onto coasts (downwelling)

Regions of important upwelling and downwelling

- Equatorial upwelling in the open ocean
- Antarctic Divergence (roughly 60° South Lat.; Polar easterlies meet westerlies)
- Coastal upwelling- west sides of continents (esp. South America and Africa)
- Seasonal upwelling and downwelling along some coasts due to seasonal wind changes (e.g., N.W. USA)

Upwelling: Nutrients!

EDDIES IN SURFACE CURRENTS

At edges of currents:

Rings of rotating water, 10-100 km wide

Example: In the Gulf Stream:

Cold/Water boundary has curves/meanders

Curves get increasingly pronounced- big loops

Eddies become pinched-off

Waters in eddies have different temperature, salinity, etc. than the water masses or currents in which they are embedded

Rotary motion in eddies can extend to great depths and even stir-up bottom sediments; they are analagous to "storms" in the oceans