

## Global Wind Patterns and Ocean Currents

The ocean and atmosphere act as one interdependent system. What happens in one causes changes in the other.



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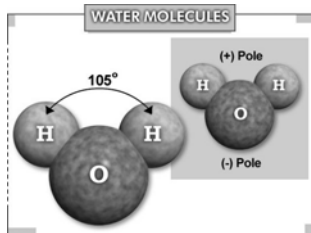
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## Characteristics of Water

- Polarity, dipole
- Hydrogen bonds



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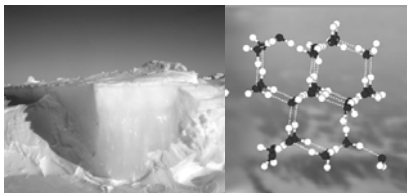
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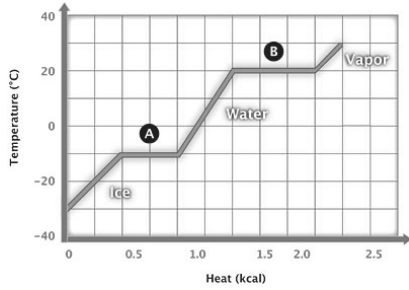
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## Heat Capacity of Water




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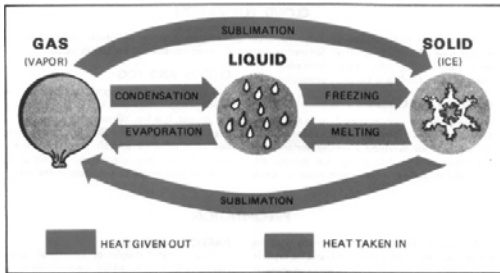


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## Phases of Water and Energy Transfer




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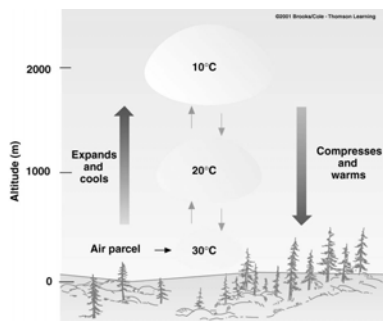
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- The Earth climate system maintains a balance between solar energy absorbed and IR (blackbody) energy radiated to space. I.e., the heat budget for the planet is balanced.

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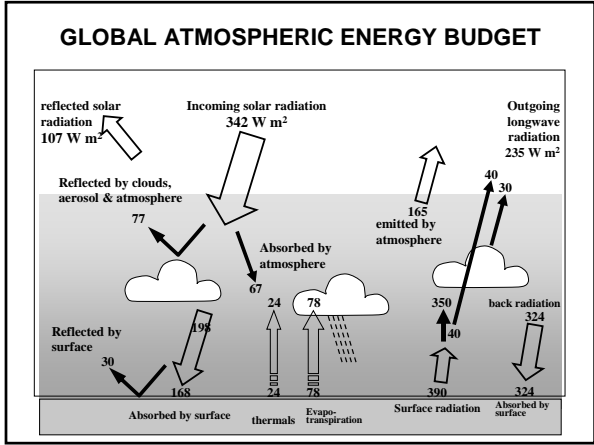
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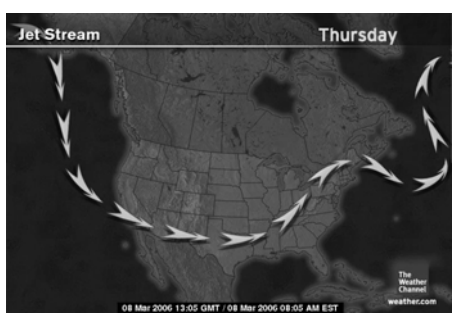
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## Large-scale wind patterns




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Higher latitudes receive slanting rays and more diffuse energy

At lower latitudes the Sun's rays are more concentrated.

The Sun's rays arrive parallel at the Earth

Uneven heating results in large-scale atmospheric circulation

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### Convection Current

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### Theoretical Wind Patterns

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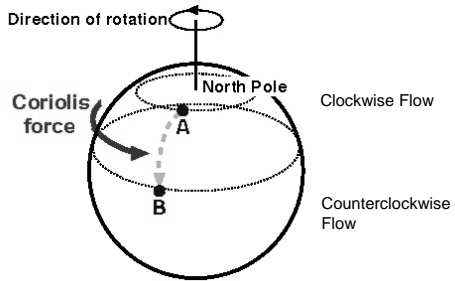
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## Coriolis Effect




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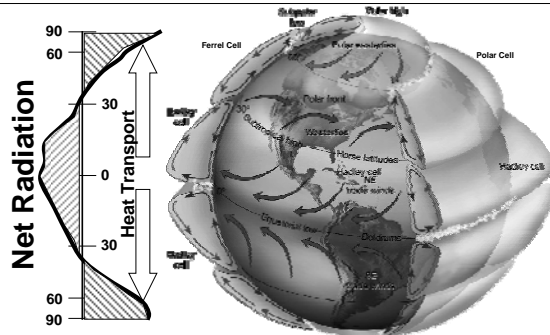
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Revision



**Idealized model of atmospheric circulation.**  
N.B. actual circulations are not continuous in space or time.

SOEE3410 : Coupled Ocean & Atmosphere Climate Dynamics

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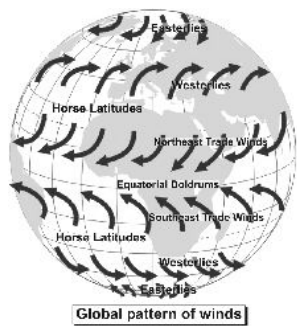
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**Global pattern of winds**

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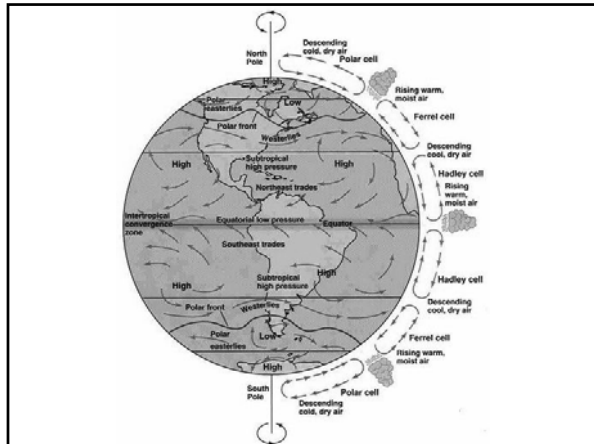
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### Small-scale winds




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Cold air is dry, dense and creates zones of high pressure.

Warm air is moist, less dense and creates zone of low pressure.

**Which direction will two air masses flow if they meet?**

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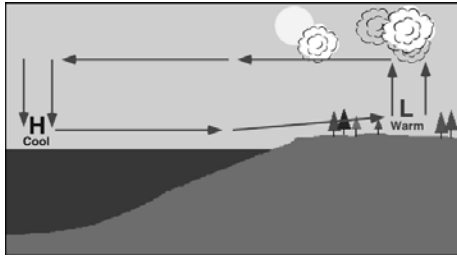


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### Sea or Lake Breeze



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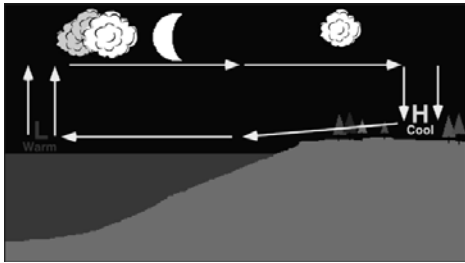
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### Land Breeze



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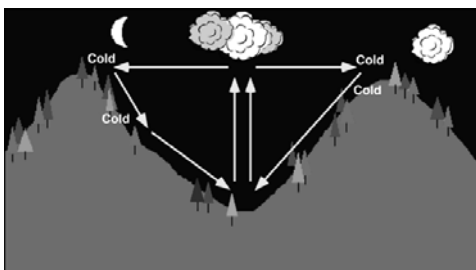
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### Mountain Breeze



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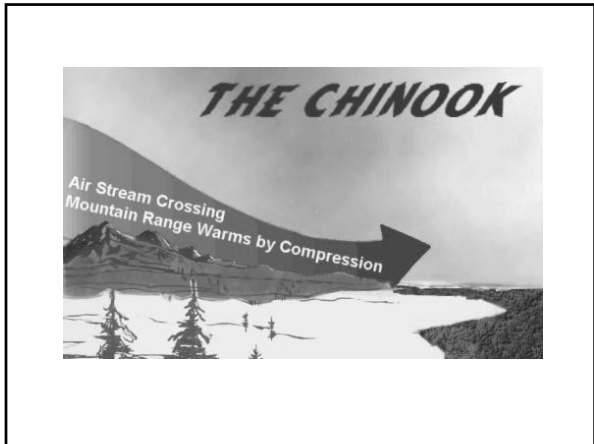
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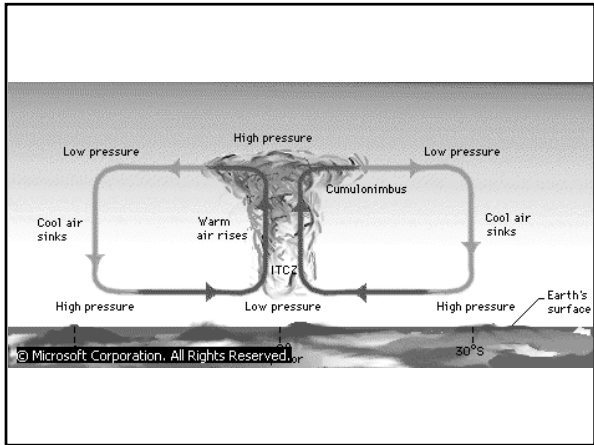
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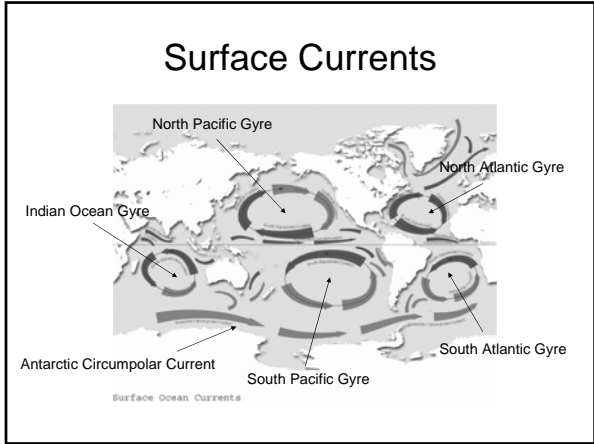
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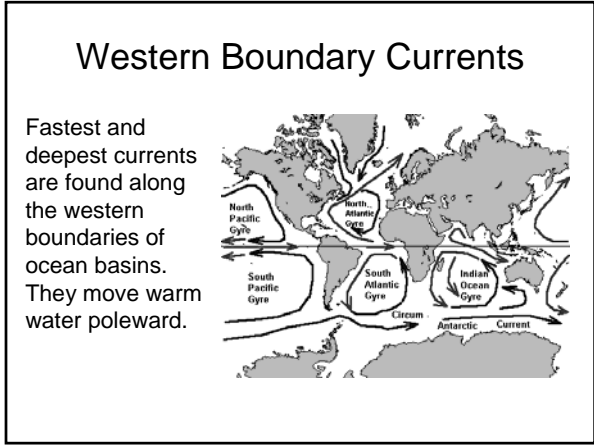
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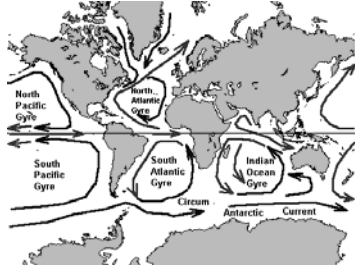
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## Eastern Boundary Currents

Eastern boundary currents are on the eastern edge of ocean basins; they are slow and diffuse. They move cold water toward the equator.



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## Surface Currents Affect Local Weather and Climate

“The coldest winter I ever spent was a summer in San Francisco.” Mark Twain

**Why is Washington D.C., located at about the same latitude as San Francisco, hot in the summer?**

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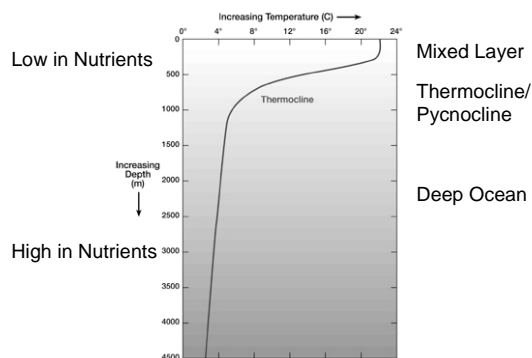
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## Horizontal Structure of Water



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## Equatorial and Coastal Upwelling



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## Thermohaline Circulation

- Driven by differences in density rather than by wind energy
- Therme (heat) + halos (salt)
- Deep water currents transport about 90% of the Earth's ocean water
- Entire ocean is involved

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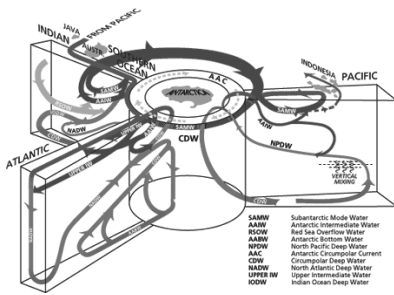
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Based on temperature and salinity (density) water masses have unique characteristics



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### Different Water Masses Don't Like to Mix!



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### Antarctic Bottom Water

- The most distinctive of the deep water masses.
- Salinity = 34.65 ppt
- Temperature = -0.5 C
- Density = 1.0279 g/cm<sup>3</sup>
- Slowly sinks to bottom and spreads into all ocean basins. Takes a 1000 years to return to surface!!

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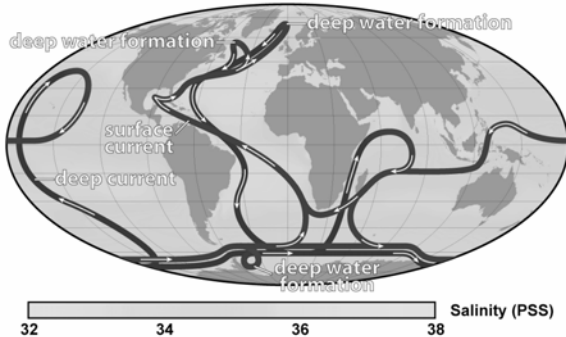
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### Thermohaline Circulation



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- For every liter of water that sinks, a liter of water must rise to the surface (another equilibrium).

- <http://www.youtube.com/watch?v=L9zjmC8InKA>

**Where is an example where water rises to the surface?**

**What are two reasons that upwelling is important?**

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### Take-home Message

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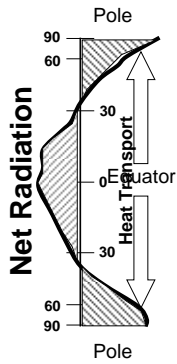
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If the equator receives excess solar energy and the poles receive deficit solar energy, why doesn't the equator boil and the poles freeze solid year-round?

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Ocean currents and global winds carry heat away from tropics (incoming energy > outgoing energy) to the polar regions (outgoing energy > incoming energy).

The atmosphere transfers about 2/3 of the total heat and the ocean transfers about 1/3 of the heat.

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What would happen if the patterns of wind and currents change?



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