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Class #22
ATMOSPHERE CIRCULATION AND WINDS

- Coriolis effect
- Prevailing winds and vertical circulation
- Factors modifying global winds
    - Differential heating of land and sea

What drives the global wind patterns?

1. Convection

- Warm, moist air rising at Equator
- Cold, dry air sinking at poles (an elsewhere, see more below)

2. Coriolis effect: Winds traveling long distances are deflected....
… **right-hand turn** in Northern Hemis.
… left-hand turn in Southern Hemis.

Detailed look at Coriolis effect:

Due to earth's rotation, each point on the earth's surface is moving through space in a daily circle. The speed is rather large!

90° Latitude	0 km/hr
60° Latitude	800 km/hr
30° Latitude	1400 km/hr
0° Latitude	1600 km/hr

Winds and ocean currents have....

- an initial velocity and direction, and....
- an initial rotational velocity that depends upon latitude.

As they cross latitudes, winds are rotating at different velocities than Earth's surface.
Result: Apparent deflection to observers on the earth's surface.

Example 1: Think of a missile...

1. Fire from North Pole, southward
2. Watch from space- a straight line path
3. But…Earth rotates beneath it
4. So, a person in Chicago looking up at it is moving eastward in space- ~1000km/h! Ask this person: Is the missile moving due south? NO, it looks like it is moving westward in addition to its southward speed.

Example 2: Fire the missile from the equator.

1. Because of the earth's rotation, the point from which the missile is fired is moving in space to the east at 1600km/hr.
2. Fire the missile due north from the perspective of the person on the earth
3. Viewed from space, the missile is actually moving eastward in addition to northward.
4. As the missile reaches high latitude, this eastward motion is faster than the speed of the earth's rotation, so from the point of view of the person on the ground, the missile is not going due north. It has a strong eastward motion. Again, and apparent right hand turn.

Winds and ocean currents moving eastward or westward also deflect to make right hand turns. In those cases, the deflection can be understood in terms of centrifugal forces.

IMPORTANT: When I say "right hand turn" this is from the point of view of a molecules of air or water moving with the flow of air or water, NOT in map view!

Amount of wind/current deflection depends on ...
- ... time of travel (how long it moves)
- ... distance of travel (how far it moves)

So....Winds and ocean currents are deflected a lot because they are in continuous motion over long distances. Water moving in a toilet is not- too quick and too short a distance- Urban Myth!

Coriolis Effect: Practical result:
Things moving long distances on earth tends to be deflected by Coriolis "force"
Deflection in N hemis.: "TO THE RIGHT"
…(i.e., right hand turn relative to initial direction)
…in S hemis.: TO THE LEFT

GLOBAL WIND SYSTEM
Because of the Coriolis effect, we have 3 convection cells in the N. Hemisphere, 3 in the S. Hemisphere
Major zones (= convection cells)
1. Trade Winds (Blow from the east)
   - equator to 30 degrees latitude, roughly.
2. Westerlies (Blow from the West)
   - 30 to 60 degrees (this is what we have in Illinois)
3. Polar Easterlies
   - 60 degree to the poles

But it's obviously more complicated than that....
Convection cells occur at the
- Global scale
- Continental scale (see more below)
- Local scale (see more below)

Convergent & divergent zones between convection cells :
- Convergent -- air masses come together + rise
- Divergent -- sinking air comes down and spreads out

Descending air:
- high atm. pressure
- dry air

Ascending air:
- low atm. pressure
- rising moist air- high rainfall

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MODIFICATION OF GLOBAL WIND PATTERNS by smaller-scale convection

-- Air vs. land Temperature Contrasts:

- Seasonal heating/cooling cycles
- Daily " / " "

Recall from earlier in the course:

- Oceans and lakes -- little T change
- Land areas -- greater T change

1. Convection in coastal areas

Daily cycle of winds in many places: (think Miami Beach)

- Day: onshore winds (land is hotter, air rises there, draws air in from ocean)
- Night: if the land cools enough so it is cooler than the ocean, the winds reverse

San Francisco in the summer: Same issue, larger scale, though

- Land heats up in the central valley, 100 mi. inland- Air rises, this drives winds....
- Onshore winds bring warm, moist air over cool water (upwelling near the coast)
- This creates Fog- moves inland (cool, clammy weather)

2. Seasonal monsoons (India, southeast Asia)

Same idea, but 1) larger scale and 2) seasonal, instead of daily

Summer: Hot Asian continent - rising air above it
Creates onshore winds (and rain); India, southeast Asia

Winter: Cold continent, offshore winds- dry season

3. Seasonal changes in wind patterns and pressure zones over continents and oceans

Summer: High Pressure areas over oceans (cooler; water doesn't heat up as much as land)
Low …. over continents (hotter, air rises there)

Winter: Low Pressure areas over oceans (stormy)
High ….. over continents

Semi-permanent seasonal zones of different pressure. This greatly influences wind directions because of item 4 next...

4. (related to #3 above)Winds circle around H and L pressure zones- deflected by Coriolis effect:

Low pressure draws air toward the center of a low pressure zone, but picture yourself being an air molecule moving inward. The Coriolis effect makes you turn toward your right, so you cannot go straight in to the center. You spiral inward. So air flows counterclockwise around low pressure zones. Air flow is:

- Clockwise around (and out of) High Pressure zones (N. Hem.)
- Counterclockwise around (and into) Low Pressure cells (N. Hem.)

These semi-permanent seasonal wind patterns/motions are superimposed on the Trades, Westerlies, etc.

Hurricanes are very intense low pressure systems. Spiraling of winds around the center of a hurricane is particularly obvious- see satellite images.