Chapter 7 Part I: Weather and Climate
Weather vs. Climate

- **weather**: \(_____\)-term (day to day or seasonal) properties of the atmosphere (temperature, pressure, humidity, precipitation, solar radiation, cloud cover, wind direction & speed);

- **climate**: general, \(_____\)-term weather of a region (____________ and longer time scales).
Major Factors Influencing Climate

1. _______________ of the Atmosphere and Greenhouse Effect

2. Incoming Solar Radiation ____________: leads to uneven heating of troposphere from beneath;

3. Air circulation patterns: determined by
   - Uneven heating of Earth's surface, due to Earth’s ___;
   - ___________ changes due to Earth's tilt on axis & revolution about the sun;
   - Location of land and water masses (land heats up and cools down faster than water)
   - ___________: caused by Earth's rotation on its axis
   - Large scale ________________ cells;

4. Ocean currents (Part II)
   - influenced by factors that influence air circulation plus differences in water density.

5. Milankovitch Cycles (Part II): long–term variations in incoming solar energy
How much carbon is in the atmosphere in ppm?

0.038% = _____________________________________

(Note: current value is ______ ppm and rising by ~ 2 ppm/yr)
Greenhouse Effect

The greenhouse effect is a natural process in which certain gases trap heat close to Earth’s surface.

Gases that trap heat:
- CO₂
- H₂O vapor
- methane
- ozone
- nitrous oxides
- CFC’s

Without the greenhouse effect, Earth would be cold & lifeless.
The atmosphere thins by half about every ________ Thickness of Atmosphere
Layers of the Atmosphere

_________________: lowest layer of the atmosphere. All weather happens here.
Very cold temperatures at high altitudes (in the troposphere). Less matter to retain heat.
When is the Earth closest to the sun?

It is actually in the ________________ for the Northern Hemisphere. This illustrates that while distance from the sun does have some impact, this slight variation in distance does not matter as much as another factor.
Discuss with your table partner:

Why is sunlight at the equator more intense? Compare a flashlight shining directly on a surface (90 angle) vs. at an acute angle. Why does the intensity change?
Angle of Incoming Sunlight and Intensity

Light at an angle is _________ intense than light that is directly overhead,

The same amount of light is spread over a _____________ ______ when it is at an angle.

The lower the angle, the _________ intense the light.

The equator receives more ___________ (__________ angle) light throughout the year.
Seasons
The seasons are caused by the tilt of the Earth on its axis by ________

- Tropics (Cancer/Capricorn) = 23.5° (N/S)
- Artic circle = 66.5° (90° – 23.5°)
Video: Mechanism of the Seasons

http://www.youtube.com/watch?v=q4_-R1vnJyw
The tilt of Earth’s Axis defines:

- Arctic Circle: 66.5°N = 90°-23.5°
- Antarctic Circle: 66.5°S
- Tropic of Cancer: 23.5°N
- Tropic of Capricorn: 23.5°S
**Summer solstice** (~ June 21st) for northern hemisphere
North pole tilted __________ the sun
Sun directly on Tropic of _______ (23.5° N)
__________ day in Northern Hemisphere

**Autumnal Equinox** (~ September 22nd)
Tilt of axis ________ to sun (not towards or away)
Sun directly on ________________
_______day and night at all latitudes

**Winter solstice** (~ December 22nd)
Sun directly on Tropic of ________________ (23.5 ° S)
Longest day in the ________________ Hemisphere

**Vernal (Spring) Equinox** (~ March 21st)
Sun directly on ________________
__________ day and night at all latitudes
In the arctic in the summer, and the antarctic in the winter, the sun never _______.

However, it is always at a fairly _____ angle, so it is never very ________________.

Thus, the climate stays cold year-round, unlike summer at lower latitudes.
Discuss with your table partner:

Review the orbit of the Earth around the sun and determine how the tilt of the Earth affects sun position and length of day throughout the year. After we fill in the charts on this slide together work with your table partner to fill in the following slide.

<table>
<thead>
<tr>
<th>Location</th>
<th>Position of sun at midday on June 21st</th>
<th>Length of Day</th>
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<tbody>
<tr>
<td></td>
<td>Directly overhead</td>
<td>≈ 12 hours</td>
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<td></td>
<td>South</td>
<td>Much greater</td>
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<td></td>
<td>North</td>
<td>Greater</td>
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<td></td>
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<td>Much less</td>
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<td></td>
<td>Less</td>
</tr>
<tr>
<td>Dhaka, Bangladesh (23.5°N)</td>
<td></td>
<td></td>
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<tr>
<td>Kampala, Uganda (O°)</td>
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<td></td>
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<tr>
<td>Cusco, Peru (13.5 °S)</td>
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<tr>
<td>Tierra del Fuego, Arg. (55 °S)</td>
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<tr>
<td>Location</td>
<td>Position of sun at midday on September 22(^{nd})</td>
<td>Length of Day</td>
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<td>• Less</td>
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<tr>
<td>Kampala, Uganda (0°)</td>
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<td></td>
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<tr>
<td>Cusco, Peru (13.5 °S)</td>
<td></td>
<td></td>
</tr>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Position of sun at midday on December 22nd</th>
<th>Length of Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhaka, Bangladesh (23.5°N)</td>
<td>• Directly overhead</td>
<td>• ≈ 12 hours</td>
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<tr>
<td></td>
<td>• South</td>
<td>• Much greater</td>
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Tilted towards the sun

Tilt is parallel to the sun

Tilted away from the sun
Passive solar design can take into account different angles of sun.
3 Types of Heat Transfer

Conduction = Transfer of heat energy due to __________________ (particles collide)

Radiation = Energy is transferred through _______________ radiation (i.e. infrared rays)

Convection = Movement within a __________ (liquid or gas) as hotter, less dense fluid rises.
Water’s Moderating Effect on temperature

Water has a _________ specific heat, which means that it takes _____________ energy to heat water compared to most other substances.

(Because it takes extra energy to break the hydrogen bonds between water molecules).

So water changes its temperature more ______________ and has a _________________ effect on temperature.
Seattle is further north than Minneapolis, but has much more moderate weather due to its proximity to an ocean.

Seattle: Minneapolis:
Jan. average high temp (°F): 49  22
Jan. average low temp (°F): 37  4
July average high temp (°F): 76  83
July average low temp (°F): 57  63
London and Winnepeg are at similar latitudes, but London is near an ocean, and Winnepeg is in the middle of the North American continent.

<table>
<thead>
<tr>
<th></th>
<th>London:</th>
<th>Winnepeg:</th>
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</thead>
<tbody>
<tr>
<td>Jan. average high temp (°F):</td>
<td>49</td>
<td>13.8</td>
</tr>
<tr>
<td>Jan. average low temp (°F):</td>
<td>40</td>
<td>-0.6</td>
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<tr>
<td>July average high temp (°F):</td>
<td>74</td>
<td>80.1</td>
</tr>
<tr>
<td>July average low temp (°F):</td>
<td>59</td>
<td>61.7</td>
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</tbody>
</table>
Discuss with your table partner:

• Is the relationship direct or inverse?
• Relate what you know about how air changes as it is heated to why increased temperature has this effect on the amount of water vapor the air can hold.
• Why does dew sometimes form overnight?

Study the graph to review the effect of temperature on the water vapor capacity of air.
The Effect of Temperature on Air’s Water Vapor Capacity

There is a ___________ relationship between the temperature and the amount of water vapor air can hold. (Increased water vapor capacity at increased temperature)

Because hot air is __________ dense, it has a __________ capacity to hold water vapor.

As air cools, it may become _______________ with water vapor and the excess water vapor ____________.
Discuss with your table partner:

Referring to the previous graph that shows the effect of temperature on the maximum water capacity of air, try to answer the questions on the following three slides.
The chart below shows that besides deserts, the arctic tundra is one of the biomes with the lowest average annual precipitation. Explain why this is the case.

Since the tundra has ___________average temperatures, there is ___________available water vapor in the air. (Cold air holds _______ water vapor.)
Relative humidity is the amount of water vapor in the
air compared to the maximum it can hold at that
temperature and pressure:

Relative Humidity = \left(\frac{\text{Amount of H}_2\text{O vapor}}{\text{Maximum H}_2\text{O vapor}}\right) \times 100

If the air cools down without a change in the water
content (no evaporation or precipitation), what
happens to its relative humidity?
Discuss with your table partner:

Since air conditioners take in hot air and make it cooler, what happens to the water vapor capacity as the air temperature decreases? How must air conditioner design take into account this change?
Since the hot air can hold more moisture (like the image on the left) that same amount of water has a _______ relative humidity. As air cools, its relative humidity___________(if no change in water vapor content).
Dew point = temperature at which _______________ will form (for given temperature and humidity).

Use the chart below to determine the dew point for air that:

• Is 75 °F and has 80% humidity

• Is 75 °F and has 100% humidity
Dew point = temperature at which condensation will form (for given temperature and humidity). Use the chart below to determine the dew point for air that:

- Is 75 °F and has 80% humidity
- Is 75 °F and has 100% humidity
- Is 68 °F
- Is 75 °F and has 100% humidity

![Air Temperature Chart]
Frost

- During the day, the air warms and its water vapor capacity goes _____.
- At night, the air cools and its water vapor capacity _______
- If a solid surface is chilled below the dew point of the air and the surface itself is colder than ____________, ice will form on it.
Different pressure zones are caused by heating at the earth’s surface. Unlike air trapped in a closed system, air in the atmosphere expands and rises as it is heated and creates a __________ pressure zone at the surface.

Low pressure at location of heating.
Air Pressure and Precipitation

Low pressure: often associated with ___________________________

• The rising column of air in a low pressure zone ________as it enters the upper atmosphere.
• As air cools it can not hold as much _______________ so it ___________________.

High pressure is usually associated with _____________ skies.
• Descending air _______ and so it can hold more water vapor

A. [Diagram showing high pressure and descending air]
B. [Diagram showing low pressure and rising air]

Map of North America with L for low pressure and H for high pressure.
WIND

Winds arise from the uneven heating of the earth’s surface due to:

• ___________ of light

• Differences in __________ of surface materials (i.e. water vs. land)

Creates differences in air ________________.

Air will flow from ________ pressure to ________ pressure.
Air Pressure and Wind

- Air moves ______________ from high pressure areas and towards areas of low pressure.
- Differences in air pressure between adjacent regions is what causes ____________.
Discuss with Your Table Partner

Explain the local wind patterns of sea breezes and land breezes. At what time of day do they occur?

Sea breezes (from a body of water) usually occur during the _______. The land heats up _______ than the water. The air over the land is _______ and therefore is _______ dense with a _______ air pressure so wind blows from the sea towards the land.

Land breezes usually occur during the ____________. The land cools off _______ than the water, so the ____________ pressure is over the ____________ and wind moves from the _______ towards the _______.
Air Pressure and Wind

- ____________ = lines of equal pressure (usually measured in millibars -- mb)
- The more closely spaced the isobars, the more ____________ changes with distance, and the _______ the winds will be…
The more ticks on the blue wind “feathers” the higher the winds.
The closer the isobars, the higher the winds.