AT 351 Lab 3:
Seasons and Surface Temperature (Ch. 3)

Question #1: Seasons (20 pts)

A. In your own words, describe the cause of the seasons.

Our seasons are regulated by the amount of solar radiation received at the earth's surface. This amount of energy is primarily determined by the angle at which sunlight strikes the earth's surface, and how long the Sun shines at a given latitude. The angle at which sunlight reaches the Earth's surface and the length of the day are dictated by the tilt of the Earth's axis of 23.5 degrees.

B. In the Northern Hemisphere we are closer to the sun during the winter than during the summer. Based on part (A), why then is our winter colder?

In the Northern Hemisphere summer the northern half of the world is directed toward the sun. As a result the Earth’s surface receives more direct sunlight over a longer period of time. Conversely, during the Northern Hemisphere winter the Earth is oriented away from the sun. As a result the Earth’s surface receives less direct sunlight over a shorter period of time. Remember if the sunlight is more direct, the intensity of the solar radiation received at the surface is greater.

C. In mid latitudes days are longer than night between the spring and fall equinoxes (the time after March 20th up until September 22nd). Why is this?

In March and September the Northern Hemisphere tilts neither towards nor away from the Sun. The sun rises due east and sets due west and the day and night are of equal length. In June the Earth tilts toward the sun. During the transition from the Spring to Fall equinoxes, the sun rises in the northeast, passes its highest point in the sky and sets in the northwest, spending more than 12 hours above the horizon at any given NH latitude.
D. It is known that with respect to the earth’s orbit around the sun, the earth’s angle of tilt is 23.5 degrees. If this tilt changed to 30 degrees, would Ft. Collins experience more, less, or the same amount of daylight during the northern hemisphere summer? What latitude would be considered the new ‘Arctic Circle’?

**Ft. Collins would experience more daylight.**
The new ‘Arctic Circle’ would be $90 - 30 = 60$ degrees

**Question #2: Temperature Control** (10 pts)

A. Latitude is not the only temperature control in our atmosphere. If it were, we would expect all places at the same latitude to have identical temperatures. Other than latitude, what 4 factors control surface temperature? Please explain (HINTS: 1. coastlines vs. the plains 2. ocean energy transfer 3. mountainous terrain vs. the plains 4. clouds).

**Land/Ocean distribution: Land heats much more rapidly than the Ocean. Coastal regions therefore have less extreme temperature ranges. During the winter, the Ocean is warm relative to land. During the summer the ocean is cooler relative to the warm land. For example, the winter temperatures in California are not as cold as they would be for a more inland location, such as Boise Idaho. This is because the winds received in California have moved across the ‘warm’ ocean. Where as the winds that moves across Boise have moved across the ‘cold’ land surfaces. The opposite is true during summer months, where the ocean helps to keep temperatures cooler in coastal windward locations.**

**Ocean currents: Warms ocean currents (i.e. the Gulf Stream) transfer warm tropical water to higher latitudes. As an example: The Gulf Stream keeps wintertime temperatures in Great Britain and much of western Europe warmer than would be expected for their latitude. The January mean temperature in London (51oN) is 8.1oF higher than NYC (40oN)**

**Elevation: Recall that typically temperature decrease with height in the troposphere. Consequently if a geographical location is at a higher elevation its monthly mean temperatures**
will be lower than a location at a similar latitude, but lower elevation.

Cloud cover/Albedo: During daytime hours clouds reflect solar radiation back to space—therefore the max temperature is lower than if the sky were clear. At night the temperature will not fall as low because clouds limit the loss of heat.

A. The figure below illustrates the monthly mean temperatures for Eureka, CA and New York City, NY. Which curve is most representative of Eureka, CA and which is more representative of NYC? Explain the differences in the two curves. Note Eureka and NYC are located at roughly the same latitude.

This example illustrates the effect of continentality. Land is quick to heat and quick to cool. Conversely water is slow to heat and slow to cool. As a result continental regions experience greater temperature extremes. In the above example even though Eureka and New York are at coastal locations located at the same latitude. The winds that blow across NYC have moved across the continent. The winds received at Eureka have moved across the ocean.

Question #3: Diurnal Cycle (15 pts)

A. Although the intensity of incoming solar radiation is greatest at local noon, the warmest part of the day is most often mid-afternoon. Why?
Although the intensity of the incoming solar radiation is greatest at noon the air temperature has not reached its maximum value. This is because the amount of energy received by the earth’s surface is greater than the amount of energy emitted by the surface. Therefore the surface will continue to absorb solar radiation and emit IR radiation. Consequently the air will continue to warm. When the amount of energy received at the earth’s surface equal the amount of energy emitted by the earth’s surface, the air temperature will fall.

B. The chart below illustrates the daily temperature cycle for an overcast day and a clear day. Which of the curves is representative of an overcast day? Explain the reason for your choice.

During daytime hours clouds reflect solar radiation back to space—therefore the max temperature is lower than if the sky were clear. At night the temperature will not fall as low because clouds limit the loss of heat by absorbing and re-emitting IR radiation.

C. Wind can play an important role in an area’s local vertical temperature distribution. Below, Figure 1 shows the vertical temperature profile at Green Bay, WI while Figure 2 shows the same plot for Aberdeen, SD. Both temperature profiles are from 17 September 2005 at 12 UTC (7 am local time). Which city
experienced a windy night and which city experienced relatively calm winds? Explain your reasoning.

Green Bay, WI is experiencing a calm night while Aberdeen, SD is experiencing strong winds. Winds mix the atmosphere resulting in a small temperature lapse rate (nearly constant temperature with height). While Green Bay has a lapse rate of roughly 10 deg C in the lowest 240 m, Aberdeen has a lapse rate of only 2 deg C in nearly the same vertical distance.
Question #4: Reading Weather Maps (5 pts)

In the map below, mark the location of Fort Collins. Now find the following information for Ft. Collins (don’t forget units where applicable):

Universal Time 11Z    Local Time 04    Date 2 Feb 2010

Wind Speed 4kt    Surface Pressure 1018 mb