METR 104: Our Dynamic Weather (w/lab)	**Lab Exercise #3:** **The Weather Complicates Things Further**	Dr. Dave Dempsey Dept. of Geosciences Dr. Oswaldo Garcia, & Denise Balukas SFSU, **Fall 2012**

(5 points)
(*Lab Section 1:* Wed., Oct. 31; *Lab Section 2:* Fri., Nov. 2)

Learning Objectives. After completing this activity, you should be able to:

- Read a meteogram to recognize that surface air temperatures are affected by yet another mechanism (*temperature advection*) not accounted for in previous lab explorations of the daily temperature cycle.
- Read a meteogram to suggest what aspect of the weather might be involved in this new mechanism and suggest how it might work.
- Read weather maps showing surface air temperatures and winds to confirm or disconfirm any idea(s) suggested by the meteogram.

Materials Needed. To complete this activity, you will need:

- Weather observations:
    - A map showing the locations of weather stations in the southern plains state, including Oklahoma City, OK (KOKC).
    - Two 24-hour meteograms for KOKC:
        - Ending 23Z January 19, 2006
        - Ending 23Z January 20, 2006
    - A weather map showing observed surface air temperature and winds in southern plains states (including Oklahoma) at 17Z January 20, 2006.
    - A weather map showing observed surface air temperature patterns as a color-filled contour map, and winds, in the same region at the same time.

I. Introduction: Some Things We've Already Learned

You learned in previous lab explorations (Lab #2, Parts II, III, IV, V, and VI) that the daily temperature cycle seems controlled mostly by:

a. absorption of solar radiation during the day
b. emission of longwave infrared radiation, which dominates at night (when there is no solar heating) but has an effect 24 hours a day
c. absorption of longwave infrared radiation emitted downward by greenhouse gases and clouds in the atmosphere (24 hours a day).

Other factors can affect the daily temperature cycle but don't drive it. Examples that we've identified so far include:

- cloudiness (which reduces solar heating of the surface during the day by reflecting some solar radiation back to space, and emits longwave infrared radiation downward and hence provides a source of heat for the surface, which is especially noticeable at night);
- conduction between the surface and the atmosphere (which can either add heat to the surface or remove it, depending on whether the surface is cooler or warmer than the atmosphere, respectively);
- evaporation of water from the surface (which removes heat from the surface and, as you might imagine, tends to be greater for ocean surfaces than for land surfaces); and
- the nature of the earth's surface (land vs. ocean)

In Lab #2, Part VI, you ran a STELLA model that simulated several common features of the daily temperature cycle and produced temperatures that probably seemed reasonably realistic. Given the relative success of that model, a legitimate question now arises: are there other factors that affect surface temperature that we haven't identified yet? If so, what might they be? This lab introduces you to one possibility.

II. Instructions. Respond in writing to the questions posed below, and turn in your responses when you're done.

We'll begin by examining and describing some meteograms from Oklahoma City, OK. First, consider the accompanying 24-hour meteogram showing weather observations recorded at Oklahoma City, Oklahoma (KOKC) on January 19, 2006 (UTC).

(Note that Oklahoma is in the Central Time Zone. Central Standard Time (CST) is two hours ahead of Pacific Standard Time and hence 6 hours behind UTC time.)

On January 19, 2006 at KOKC, the sun rose at 7:37 am CST and set at 5:46 pm CST.

Question 1. What were the minimum and maximum temperatures at KOKC on January 19, 2006? At what local standard time (CST) did they occur?

Question 2: Is there anything unusual about these observations, based on daily temperature cycles that you've seen previously in this course? (If so, what?)

Now consider the 24-hour meteogram for KOKC for January 20, 2006 (UTC).

Question 3: Briefly describe the part of the daily temperature cycle on that day starting shortly before sunrise and ending around sunset.

Question 4: Was the cycle significantly different from the day before? If so, in what way(s)?

On the meteogram for January 20, 2006 (UTC) you should see an obvious difference in the temperature pattern from the familiar, idealized daily temperature cycle that we usually see.

Question 5: Are there any mechanisms (of gaining or losing heat) that we've considered in previous labs (in particular, the STELLA model of the daily temperature cycle) that you think might account for the unusual behavior of the temperature pattern at KOKC on January 20, 2006? That is, did any of your simulations with the STELLA model produce behavior like what was observed in this case?

Question 6: If you think so, then identify the mechanism(s), comment on how you think it (or they) work to explain the unusual observations, and cite any evidence that supports your idea.

Question 7: Are there other weather observations recorded on the meteogram (besides temperature) that you think might offer insight into why the daily temperature cycle differs from observed temperature cycles that we've seen before? If so, what?

Question 8: Can you think of any way in which those other observations might help explain the difference? That is, if there's a mechanism that can affect observed surface air temperatures that we haven't considered yet, how might it work?

Consider the weather map showing observed surface air temperatures and winds, recorded at 17Z January 20, 2006. Locate the observations reported by KOKC on this map.

Question 9: Do the winds and temperatures on this map agree with those reported on the KOKC meteogram for the same time?

Consider the pattern of temperature for several hundred miles around KOKC. (For reference, the state of Oklahoma is about 200 miles across from its northern border with Kansas to its southern border with Texas.)

Question 10: In this area around KOKC, where (that is, in what direction(s) relative to KOKC) is air colder than at KOKC, where is it warmer, and where is it close to the same temperature?

Note the wind direction at KOKC at this time.

Question 11: Based on this wind observation, where (that is, in what direction) do you think that air that was at KOKC an hour earlier, has gone?

Question 12: Based on the temperatures reported in that direction at 17Z, do you think that that air, when it was at KOKC at 16Z, would have been warmer, colder, or about the same temperature reported for the air at KOKC at 17Z?

Question 13: Based on this consideration alone, what would you backward predict the temperature at KOKC to have been at 16Z (warmer, colder, or about the same)?

Consider the accompanying weather map showing color-filled contours of surface temperatures recorded at 17Z in the southern plains on January 20, 2006.

Question 14: Comment on whether this map makes it easier or harder to figure out what might have happened to the temperature at KOKC between 16Z and 17Z, and why.