

**ATOC 1050: Weather and the Atmosphere
Summer 2013**

Homework 3 – Chapters 6-8

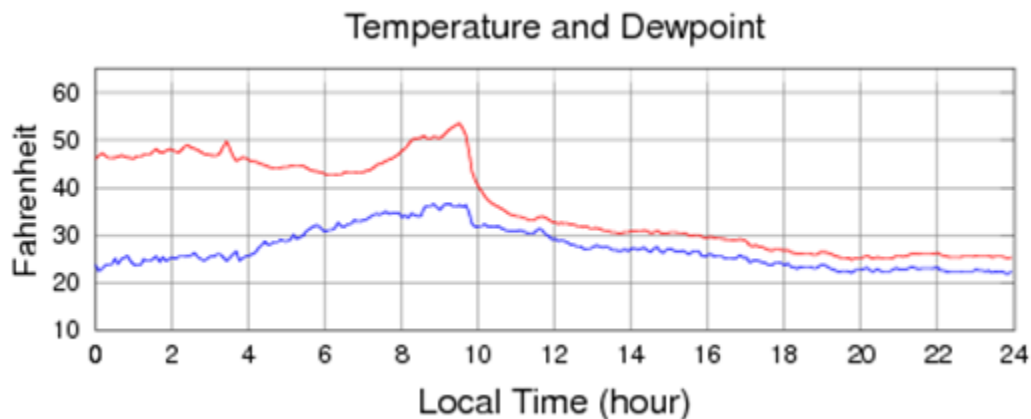
Due Thursday, June 20th by the beginning of class time

Instructions: You should submit your typed answers to the D2L “Dropbox” page. Submissions should be in PDF format and have the filename Lastname_HW3.pdf (replace with your own last name!). Make sure you use complete sentences for descriptive answers and include units for numerical answers. I won’t grade for grammar, but your answers must be understandable and unambiguous to receive full credit.

1. El Niño (Spanish for... the Niño; 2pts). In 1997-98, the strongest El Niño on record caused extreme weather around the world including droughts, flooding, heat, and even increased the global average temperature to record levels (global warming skeptics use 1997-98 to claim the global temperature has since decreased... that is what we call cherry-picking). Consider the implications of the intense El Niño.

- a) During the El Niño, very warm water moved from the western equatorial Pacific to the coastal waters off of Peru. Describe one way in which the warmer than normal water would increase rainstorm formation over the ocean (think about stability and/or moisture).
- b) These rainstorms were then advected (blown) to the Peruvian coast by westerly winds, which led to flooding rains in Peru. Describe how these same winds would also impact nutrient levels in the Peru coastal waters.

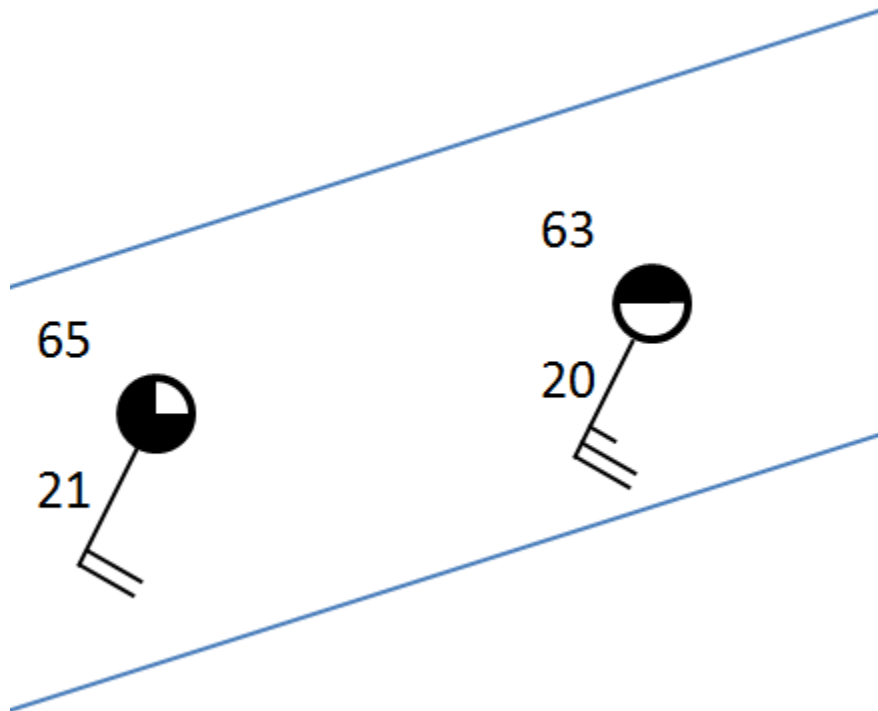
2. Frontal-Fun Time (5pts). “If you don’t like the weather in Colorado, wait five minutes.” The number of minutes varies, but the axiom rings true. The following surface air temperature plot comes from a typical spring day in Colorado.



Use the temperature chart to answer the following questions. Provide a short explanation for each answer.

- a) What type of front passed through the region at 9:30am? (it was not occluded)
- b) If the front was the only weather feature of interest, describe the general change in pressure with time throughout the day.
- c) Given the changes in both temperature and moisture, what type of air mass do you suspect moved into the region after the front passed?
- d) How did the relative humidity change after the front passed through?
- e) At 1400 LT (local time), the temperature at 1km above the surface has not yet changed due to the front. Is this 1km deep layer more or less stable than before the front passed?

3. Weather Balloon (4pts). As part of your routine as a meteorologist, you are getting ready to launch the daily radiosonde (weather balloon). However, you must be cautious, as there is a very dry forest to the north, and if the instrument lands there after the balloon bursts (near the tropopause) it could spark a forest fire. You have the following surface data to guide your decision. Blue lines are isobars.



- Based on the above data, in what direction is the lower surface pressure? How do you know?
- Assume the same pressure pattern exists at 500mb (represented as height contours), what will the wind direction be at that level above the two stations? Why would it be different than the direction at the surface?
- Describe the forces acting on the air at the surface and 500mb. In what directions do these forces point? (you don't need to specify actual directions, just tell me generally)
- Is it safe to launch the balloon on this day? Why?

4. Baroclinic Flight (4pts). You are flying a plane at a height of 500mb in the Northern Hemisphere. At the start of the flight, the air temperature outside of the plane is 0°C, and after travelling north 500km, the air temperature is -14°C. Answer the following questions and provide a short explanation for each answer.

- Assume that the colder location remains colder all the way to the surface (the entire column of air at the destination is colder than the column of air at the starting point). At which location are you flying at a lower altitude, assuming you stay at 500mb?
- Where would you expect to find a surface cyclone and where a surface anti-cyclone?
- At each location, what direction will the vertical winds be blowing in between the surface and 500mb?
- At the halfway point of the flight, what direction will the 500mb horizontal winds be blowing?

5. Bad Blog (5pts). A certain Dr. Rumack has decided to write a blog post on how climate change will impact global circulation patterns. Unfortunately, he is a medical doctor, and thus makes a critical meteorological mistake in his post! You decide to write a response on your own blog responding to his post, explaining how his error leads to the wrong conclusion. Write a 2-3 paragraph response to the misguided (but well-intentioned) doctor describing how fixing his error would actually result in wetter rainforests! Surely, you can convince him of his mistake.

Rainforest in peril: the coming dry equator

by Dr. Barry Rumack

Increasing CO₂ levels will result in the conversion of Earth's rainforests to deserts by the year 2100. This change will completely disrupt Earth's ecosystem. Rainforests are home to the greatest concentration of plant and animal species on the planet. The major rainforests also feed water into great rivers such as the Amazon and Ganges. But these critical regions may not exist for much longer, if CO₂ emissions continue.

As CO₂ concentrations increase in our atmosphere, global temperatures will rise. Higher temperatures will cause a strengthening of the Hadley cell circulation, in which air rises at the horse latitudes (30°) and sinks at the equator. Since the sinking motion at the equator becomes more intense, the air will warm through adiabatic compression and the relative humidity will drop below saturation. Clouds will no longer be able to form over the rainforests.

Obviously, without clouds, the rainforests will quickly dry up. It is up to all of you to bring this pressing problem to the attention of the world's governments. Good luck. We're all counting on you!