Synoptic Meteorology I

**Lab 2: Isoplething Upper-Air Data**

Wednesday September 14th, 2022

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Due: September 21st, 2022, at 2:30pm

**Objectives:**

* Isopleth 300, 500, and 850 hPa maps
* Identify common features at each level
* Learn how to plot upper-air observations in Python.

**Things to know:**

Feel free to use the Internet and collaborate with your classmates when answering these questions. For Parts I, II, and III, the requested data and plots must be obtained using the Jupyter Notebook on our JupyterHub before you can complete the questions. Be sure to review the concepts covered in this Notebook rather than just complete the tasks it requires, as you may be asked to use these concepts in a future lab.

**Part I: Isoplething at 300 hPa (30 pts)**

This level of the atmosphere is best for identifying upper-tropospheric troughs, ridges, and jets.

1. Complete Part I of the Lab 2 Jupyter Notebook Python tutorial. (5 pts)
2. Using the 300 hPa map you created in the Jupyter Notebook, isopleth the geopotential height (called isohypses) every 60 m, using 9600 m as the base contour. (10 pts)
3. Isopleth the wind speeds (called isotachs) at 50 kt, 75 kt, and 100 kt. Shade in the regions with blue/purples. (7 pts)
4. Identify the trough and ridge axes. Use dashed lines along the trough axis or axes and zig-zagged lines for the ridge axis or axes. (5 pts)
5. Identify where the jet stream is and draw a thick blue streamline through the jet stream.(3 pts)

**Part II: Isoplething at 500 hPa (30 pts)**

Similar to 300 hPa, this chart can be used for identifying midtropospheric troughs and ridges. In addition, the 500 hPa analysis is best for identifying storm tracks since surface cyclones tend to follow the winds at this level. Finally, 500 hPa is also near the level of non-divergence (which we will discuss more later in the semester), meaning that this is the altitude at which tropospheric vertical motions are typically maximized in magnitude.

1. Complete Part II of the Lab 2 Jupyter Notebook Python tutorial. (5 pts)
2. Using the 500 hPa map you created in the Jupyter Notebook, isopleth the geopotential height (called isohypses) every 60 m, using 5700 m as the base contour. (10 pts)
3. Draw the 50 kt isotach. Shade in the regions exceeding this value in blue or purple. (6 pts)
4. One important feature of this level (and most other mid- and upper-tropospheric levels) is the “geostrophic” relationship between the isohypses and the wind speed/direction.
   1. Do the winds tend to blow parallel or perpendicular to the isohypses? (3 pts)
   2. Identify a region where the isohypses are relatively close together. Roughly what are the wind speeds here? (3 pts)
   3. Identify a region where the isohypses are relatively spaced out. Are the winds speeds faster or slower than in (b)? (3 pts)

**Part III: Isoplething at 850 hPa (40 pts)**

In addition to identifying the lower-tropospheric wind flow, such as may be associated with a low-level jet, this chart is useful in identifying changes in temperature and moisture associated with near-surface fronts as well as lower-tropospheric cyclones and anticyclones.

1. Complete Part III of the Lab 2 Jupyter Notebook Python tutorial. (5 pts)
2. Using the 850 hPa map you created in the Jupyter Notebook, isopleth the isohypses east of the Rockies every 30 m, using 1500 m as the base contour. (10 pts)
3. Label any closed-off regions of locally high or low heights by drawing a blue “H” or a red “L” respectively, at their centers (e.g., at the location of highest/lowest heights, which typically corresponds to relatively light winds). (3 pts)
4. Isopleth the temperature (called isotherms) east of the Rockies (~105°W). Contour at 5°C intervals in dashed red lines. (10 pts)
5. Why are some data missing across the western US? (4 pts)
6. Isopleth the dewpoint temperature (called isodrosotherms) east of the Rockies (~105°W) using 12°C and 16°C contours. Shade the regions with dewpoint temperature between 12-16°C in light green and the regions with dewpoint temperature exceeding 16°C in dark green. (6 pts)
7. Fronts are regions where the wind direction, temperature, and moisture tend to change abruptly with horizontal distance. Circle an area on your map where you think a front might be located and describe why you chose that location below. (7 pts)

**Part IV: Graduate Students Only (10 pts)**

1. Looking at the lows your identified at 850 hPa and the troughs you identified at 250 hPa, how are the 850 hPa lows positioned relative to the 250 hPa troughs? (5 pts)
2. What is the orientation of the wind relative to the isotherms to the southeast of a trough or low at 850 hPa? (2.5 pts)
3. What is the orientation of the wind relative to the isotherms to the northwest of a trough or low at 850 hPa? (2.5 pts)