Synoptic Meteorology I

**Lab 7: Thermal Wind**

Wednesday October 26th, 2022

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Due: November 2nd, 2022, at 2:30pm

**Objectives**:

* Evaluate the relationship between geostrophic vertical wind shear and temperature gradients/thermal wind using vector diagrams.
* Identify backing/veering in soundings to infer horizontal temperature advection.
* Identify the associated forcing from temperature advection for vertical motion (including) signs and relative magnitudes.
* Qualitatively understand horizontal temperature advection from geopotential height patterns and isotherms.

**Things to know:**

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

**Part I: Vector Diagrams (30 pts)**

Using vector diagrams, the thermal wind equation, and a paragraph, show that:

1. If the airflow is southerly at low levels, layer-mean temperatures will increase if the upper-level flow is westerly. (10 pts)
2. If a southwest-to-northeast-oriented cold front just passed and the low-level winds are northerly, the upper-level winds should have a westerly component. (10 pts)

1. If the low-level wind is out of the southeast and the upper-level wind is out of the northwest, in what direction or range of directions must the mid-level wind be from for there to be warm-air advection over this layer? What about cold-air advection? (10 pts)

**Part II: Assessing Horizontal Temperature Advection Using Point Soundings (25 pts)**

1. Complete Part I of the Jupyter Notebook. (5 pts)
2. For the Skew-*T*, ln-*p* diagram you created for Davenport, IA (KDVN) on September 9, 2014, identify all layers (below 200 hPa) of cold- and warm-air advection (write these as, for example: CAA: 925-750 mb). (10 pts)

1. Using the Skew-*T*, ln-*p* diagram you created for Omaha/Valley, NE (KOAX) on December 15, 2008, identify the isobaric level of the front. What type of front is it? What information from the sounding did you use to determine the altitude at which the front is located and which type of front it is, and why? (10 pts)

**Part III: Understanding Horizontal Temperature Advection Using Geopotential Height Patterns (45 pts)**

1. Complete Part II of the Jupyter Notebook. (10 pts)
2. In the 850 hPa map you created for 0000 UTC February 19, 2022 what type of temperature advection is occurring in SD, northern NE, southern MN, and northern IA? Explain your answer. (10 pts)

1. Using the plotted geopotential height lines below, draw isotherms so that the region in the center of the diagram has cold-air advection. Discuss your answer. (15 pts)

A picture containing icon

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1. Using the Rapid City, SD (KRAP) Skew-*T*, ln-*p* and the 850 hPa map you created for 0000 UTC February 19th, 2022, do you infer the same sign of horizontal temperature advection between these two charts? Explain your answer. (10 points)

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

Graphical user interface, chart

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1. Using the map above, identify all areas of warm air advection and cold air advection *east of the Rocky Mountains* (~105°W). (8 pts)
2. One thing that we will learn next semester is that warm-air advection at a given level is associated with rising air across that level and that cold-air advection at a given level is associated with sinking air across that level. Assuming that sufficient moisture is present to produce precipitation, where do you think precipitation might be happening on the map above? (2 pts)