Synoptic Meteorology II

**Lab 7: Isentropic Analysis**

Wednesday, April 12th, 2023

(100 pts)

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Due: April 19th, 2023, at 2:30 pm

**Learning Objective**:

* To use isentropic charts to evaluate forcing for vertical motion.

**Things to know:**

Feel free to use the Internet and collaborate with your colleagues when answering these questions. For the entire lab, the requested plots must be obtained using the Jupyter Notebook on our JupyterHub before you can complete the questions.

**Part I: Identifying Forcing for Vertical Motion Using Isentropic Analysis (47 pts)**

1. Using the JupyterHub, create the following maps for January 3rd, 2023 at 0000 UTC (20 pts):
   1. 300 K pressure (hPa), mixing ratio (g/kg), and wind (kt)
   2. 925 hPa geopotential height (m), temperature (°C), and wind (kt)
   3. 850 hPa geopotential height (m), temperature (°C), and wind (kt)
   4. 700 hPa geopotential height (m), temperature (°C), and wind (kt)
   5. 700 hPa Q-Vectors, Q-Vector divergence
2. Outline all areas of isentropic ascent in red on the 300 K map you created for January 3rd, 2023 at 0000 UTC. Identify the region with the strongest forcing for ascent with an X (hint: you can do this qualitatively by considering what advection represents: the wind direction relative to the gradient’s direction through the dot product, the gradient’s magnitude, and the magnitude of the wind perpendicular to the gradient). Explain why you outlined this region as having the strongest forcing for ascent. (9 pts)
3. Outline all areas of isentropic decent in blue on the 300 K map you created for January 3rd, 2023 at 0000 UTC. Identify the region with the strongest forcing for decent with an X. Explain why you chose this region as having the strongest forcing for descent. (9 pts)
4. How well do your analyzed areas of ascent and descent on your 300 K map for January 3rd, 2023 at 0000 UTC, match up with the active precipitation shown in the attached radar image? (2 pts)
5. What impact will precipitation (and the associated latent heat release) have on the vertical motion magnitude implied through isentropic principles? How might that change your interpretation of your 300 K map for January 3rd, 2023 at 0000 UTC? (7 pts)

**Part II: Comparing Isobaric and Isentropic Analysis (28 pts)**

1. Describe the similarities between the structures of the isobars around the low-pressure system on the 300 K isentropic surface, and the isotherms at 925, 850, and 700 hPa for January 3rd, 2023 at 0000 UTC. Is this what you would expect, conceptually? Explain. (9 pts)
   1. Using your 700 hPa map for January 3rd, 2023 at 0000 UTC, is frontogenesis or frontolysis occurring in Illinois, Indiana, and Ohio? Explain. (5 pts)
   2. Frontogenesis can also be identified on isentropic charts in much the same way as on isobaric charts. Using your 300 K map for January 3rd, 2023 at 0000 UTC, describe how the wind barbs are oriented with respect to the isobars on the 300 K isentropic surface in Minnesota, Iowa, and Wisconsin. How does this compare to your 700 hPa map? (7 pts)
2. Using 300 K and 700 hPa Q-Vector maps for January 3rd, 2023 at 0000 UTC, compare and contrast the inferred forcing for vertical motion on each map. Are the areas of descent and ascent the same or different? Explain (7 pts)

**Part III: Identifying Isentropic Lift Using Real-Time Data (25 pts)**

1. Using the JupyterHub, create a 300-K isentropic analysis including pressure (hPa), mixing ratio (g/kg), and wind (kt) using the latest GFS analysis. (10 pts)
2. Using the 300-K map you created in question 9, identify one region each of isentropic ascent and descent. How do your identified regions of ascent and descent compare with real-time satellite and/or radar observations? Use Tom Galarneau’s real-time QG diagnostics page to obtain the corresponding QG analyses of forcing for vertical motion. Explain if the areas of decent and accent match between the isentropic and Galarneau QG maps. **Turn in all maps and satellite images with the completed lab.** (15 pts)

**Part IV: Identifying Forcing for Vertical Motion Using Isentropic Analysis, continued (Graduate Students Only; 10 pts)**

1. On the attached 300 K isentropic analysis, mark an area of strong ascent with a red X and mark and an area with strong descent with a blue X. (6 pts)
2. Based on the attached 300 K map, is precipitation likely in Milwaukee, WI? Explain. (4 pts)

**Diagram, surface chart

Description automatically generated with medium confidence**

Map

Description automatically generated