Synoptic Meteorology II

**Lab 1: Frontogenesis and Frontolysis**

Wednesday, February 8th, 2023

(100 pts)

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Due: February 15th, 2023, at 2:30pm

**Objectives**:

* Apply the two-dimensional frontogenesis equation to identify frontogenesis and frontolysis from real-world observations.

**Things to know:**

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

**Part I: Applying the Two-Dimensional Frontogenesis Equation**

Answer the following questions using the figures and the two-dimensional frontogenesis equation provided. Be sure to explain *how* and *why* each term in the equation is affected for each question. Interpret *y* as the across-front component and *x* as the along-front component:

1. Focusing on the confluence term in the frontogenesis equation, where would you expect frontogenesis to occur in the figure? Circle your answer and explain your reasoning. (12.5 pts)

Chart

Description automatically generated

* 1. Will frontogenesis or frontolysis occur in the example below? (Arrows indicate the wind direction; triangles indicate large mountains, with flow sloping upwards towards the mountains to the south and downward from the mountains to the north; and can be assumed to be negative.) Explain your answer. (12.5 pts)

Diagram

Description automatically generated

* 1. Would your answer be different if the atmosphere were statically unstable? Explain. (10 pts)

1. Use the figure below to answer a-b:

Shape, rectangle

Description automatically generated with medium confidence

* 1. Will frontogenesis or frontolysis occur if it is daytime? Explain your answer. (10 pts)
  2. Will frontogenesis or frontolysis occur if it is nighttime? Explain your answer. (10 pts)

1. A cold front is situated immediately to the west of a large unfrozen lake on a sunny day. Assume the wind is calm on both sides. Will frontogenesis or frontolysis occur during the day? Would your answer be different if the lake were frozen? Explain. (10 pts)

A picture containing shape

Description automatically generated

**Part II: Identify Frontogenesis in Real-time (35 pts)**

1. Find a frontogenesis OR frontolysis event in the conterminous United States (lower 48) or southern Canada that is analyzed or predicted by today’s 1200 UTC GFS model forecast to occur during the coming week. Focus on the frontogenesis formulation given by equation 19 in the lecture notes, which is the combination of deformation and divergence most frequently encountered in the real world (note: it is essentially a combination of the shearing and confluence terms from the equation provided at the beginning of the lab).

Identify where frontogenesis or frontolysis is occurring and why it is occurring. Complete the Notebook for this lab on the JupyterHub and create maps for the 925 hPa, 850 hPa, or 700 hPa for two or more consecutive analysis times to support your explanation. Include the maps when you turn in the lab.

Note #1: maps of temperature (instead of potential temperature) will typically suffice, but be aware this may prove difficult over complex terrain where elevation changes can influence temperature (usually potential temperature works best there).

Note #2: You are asked to create plots with frontogenesis calculated for you, but stating that the calculation shows frontogenesis is not a sufficient explanation on why there is frontogenesis. You need to explain why the calculation is showing frontogenesis.

Note #3: Be sure your maps follow the “good map” guidelines we came up with last semester.

* Choose a useful title.
* Pick a colormap that intuitively displays the data (e.g., one in which color variations are subtle except when there is a physical reason for a sharp variation), clearly delineates changing values, and can be interpreted by people who are colorblind.
* Contour the data at an appropriate frequency.
* Space wind barbs appropriately.
* Label your units (often in the title).
* Label your contours appropriately.
* Label your color bar.
* Plot the appropriate amount of geographic data.
* Don’t try to plot too many variables.

Note #4: Your choice and explanation of an area frontogenesis accounts for 25 out of the 35 points available for this question. The remining 10 points are reserved for completing your Python code and how well your maps follow the “good map” guidelines.

**Part III: Frontogenesis and Thermal Wind (10 pts; Graduate Students Only)**

1. Remembering the thermal wind relationship introduced last semester:
   1. Explain why you would expect a jet streak to get stronger above an area of frontogenesis. (5 pts)
   2. Explain why you would expect the jet to get weaker above an area of frontolysis. (5 pts)