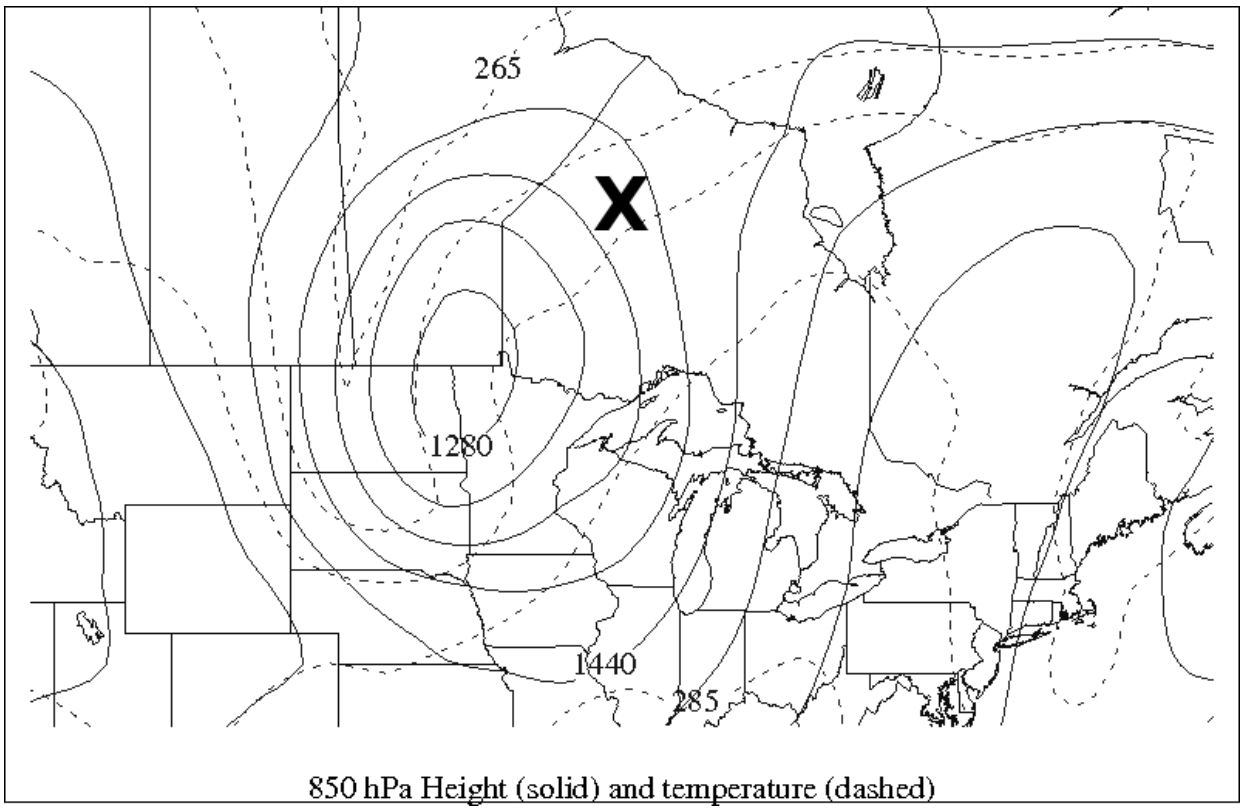
ATM 511 Final Exam

Answer each of the following questions in the space provided. Make sure to show all work. The point values for each problem are located at the end of each question.

1) The following figure shows 850 hPa geopotential height (solid) and temperature (dashed). Using the Q vector method, evaluate the sense of the temperature gradient at the X. Be sure to show all work. (8)



850 hPa Height (solid) and temperature (dashed)

(b) Sketch a cross section of the potential temperature and the semi-geostrophic Sawyer-Eliassen (SE) circulation normal to the temperature contours at the X. How does this circulation differ from the QG SE circulation? (8)

(c) How would this circulation change if the static stability was increased? Why? (8)

(d) Estimate the diabatic heating gradient at the X that would be necessary for the magnitude of the temperature gradient to remain constant with time. In addition, identify a physical process that could be responsible for the diabatic heating gradient. (12)

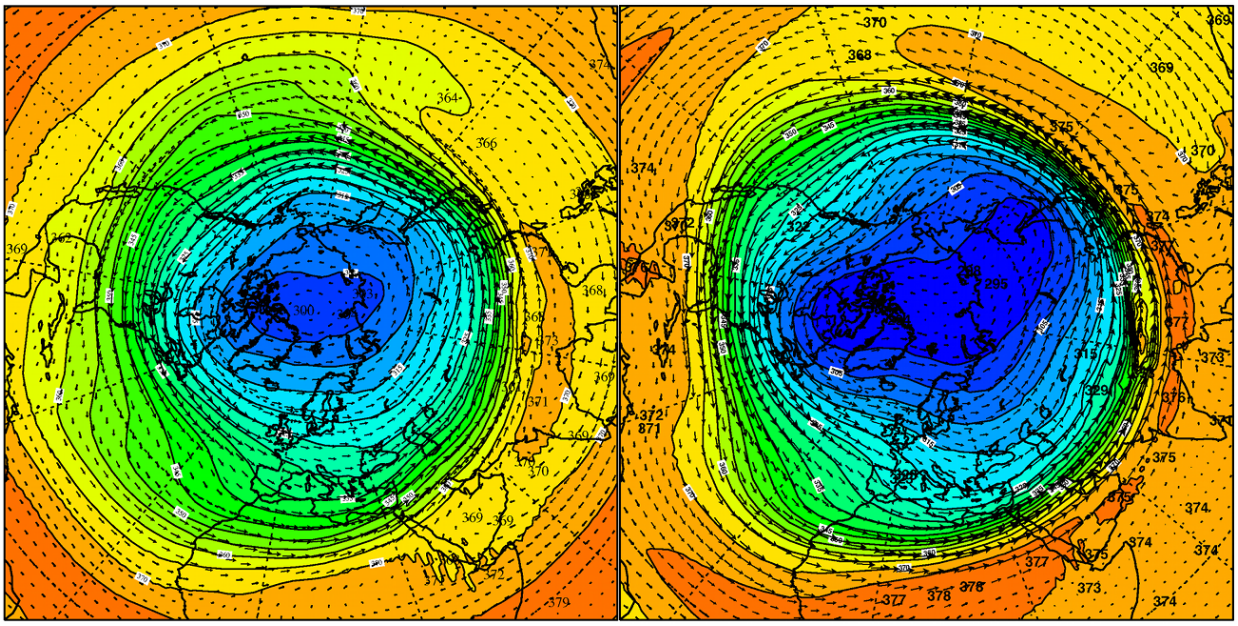
2) At many times during the past, a vast area of the Northern Hemisphere was covered by ice sheets. Describe how the synoptic and planetary scale weather systems would be different relative to the current climate. Make sure to use ideas described in class within your answer. (16)

3) Describe the main difference between a semi-geostrophic and quasi-geostrophic set of equations. (6)

4) Explain why regions downstream of mountain ranges are characterized by frequent, but weak cyclones. What kind of situation would promote more intense or longer-lasting cyclones in this region? (10)

5) During the Northern Hemisphere summer, the Sahara desert becomes relatively warm compared to the Sahel region its the south. This temperature difference is associated with a jet that attains maximum amplitude around 700 hPa. What does this structure imply about the vertical profile of the horizontal temperature gradient? Why? (10)

6) The following figure shows potential temperature and wind on the 2 PVU surface during September-November (left) and December-February (right). Identify the locations where you might expect the most frequent occurrence of upper-level frontogenesis. Use proper dynamical reasoning in your answer. (10)



(b) During what time of year would you expect to have the most frequent occurrence of downstream development over the Northern Hemisphere? In addition, identify locations where you might expect phenomenon that are associated with the amplification of the downstream flow. Provide a dynamical reason for your answer. (12)