Synoptic Meteorology II

**Lab 4: QG Omega Equation**

Wednesday, March 8th, 2023

(100 pts)

Name:­­­­­­­ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**Learning Objective**:

* Identify areas of temperature advection and differential geostrophic relative-vorticity advection and their contribution to vertical motions.

**Things to know:**

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

**Part I: Identifying Regions of Vertical Motions (75 pts)**

1. Using the JupyterHub, create the following plots for 1200 UTC on February 11th, 2015: (9 pts)
   1. 500 hPa Absolute Vorticity and Geopotential Heights
   2. 925 hPa Absolute Vorticity and Geopotential Heights
   3. 700 hPa Temperature, Geopotential Heights, and Wind Barbs
2. Using the plots you created in Question 1:
   1. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point A**. What is the inferred sign of vertical motion at this location from each forcing term? Explain. *Note: The 925 and 500 hPa wind speeds can be inferred from the isohypses under the constraint of geostrophic balance.* (9 pts)
   2. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point B**. What is the inferred sign of vertical motion at this location from each forcing term? How does the satellite imagery included on the last page of this lab compare to your analysis? Explain. (9 pts)
   3. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point C**. What is the inferred sign of vertical motion at this location from each forcing term? How does the attached satellite imagery compare to your analysis? Explain. (9 pts)
   4. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point D**. What is the inferred sign of vertical motion at this location from each forcing term? How does the attached satellite imagery compare to your analysis? Explain. (9 pts)
   5. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point E**. What is the inferred sign of vertical motion at this location from each forcing term? How does the attached satellite imagery compare to your analysis? Explain. (9 pts)
   6. Identify both the sign and relative magnitudes of differential geostrophic relative-vorticity advection and 700 hPa temperature advection at **Point F**. What is the inferred sign of vertical motion at this location from each forcing term? How does the attached satellite imagery compare to your analysis? Explain. (9 pts)
   7. Develop one or more hypotheses describing why your estimation of vertical motion might not perfectly match the satellite imagery. (12 pts)

**Part II: Using the QG Omega Equation for Real-Time Applications (25 pts)**

1. Identify one region of 700 hPa ascent in real-time using the 0-hour (analysis) forecast for any time between 1200 UTC March 8th, 2023 to the present. This can be done here: <https://apps.nssl.noaa.gov/tgalarneau/realtime/qg_new/OmegTot.html>

Diagnose and explain the identified ascent using QG omega principles, then evaluate it against satellite and/or radar imagery (that you will need to obtain from another source rather than plot in a Jupyter Notebook). To help in defending your answer, please use the JupyterHub to create the maps listed below for the corresponding GFS analysis.

Be sure to turn in all maps including your satellite and/or radar images.

Required Maps

* 1. 500 hPa Absolute Vorticity and Geopotential Heights
  2. 925 hPa Absolute Vorticity and Geopotential Heights
  3. 700 hPa Temperature, Geopotential Heights, and Wind Barbs

**Part III: Using the QG Omega Equation with Skew-T, Ln-p diagrams (Graduate Students Only; 10 pts)**

1. Focusing on the temperature advection and diabatic heating terms of the QG omega equation, use the attached skew-T, ln-p diagram to diagnose the vertical motions over the specified layers. Be sure to explain your reasoning.
   1. 900-750 hPa (5 pts)
   2. 750–650 hPa (5 pts)

Chart

Description automatically generated

A picture containing text

Description automatically generated