Synoptic Meteorology II

**Lab 9: IPV Anomalies**

Wednesday, May 3rd, 2023

(100 pts)

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Due: May 10th, 2023, at 2:30 pm

**Learning Objective**:

* To identify and understand IPV anomaly structure in the upper troposphere and potential-temperature anomaly structure at the surface.

**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: Upper-Level Structures Associated with IPV Anomalies**

1. Using the JupyterHub, create a vertical cross-section between 1000-100 hPa of potential temperature and the v-component of the wind at 45°N between 145°W and 80°W at 1200 UTC on March 7th, 2023 (7.5 pts)
2. At what longitude(s) and pressure levels) would you find cyclonic absolute vorticity on the cross-section that you made in question 1? What about anticyclonic absolute vorticity? Explain your answers.(10 pts)
3. Describe the change in static stability in the midtroposphere (~500 hPa) as you head from west to east along the cross-section from question 1. (5 pts)
4. Based on your answers to questions 2 and 3, and focusing on the upper troposphere (500-100 hPa), at what longitudes is a positive IPV anomaly found? At what longitudes is a negative IPV anomaly found? At what pressure levels are they most intense? Explain your answers. (10 pts)
5. At what longitudes is the dynamic tropopause closest to the surface? At what longitudes is the dynamic tropopause highest above the surface? Explain your answers. (10 pts)

**Part II: Surface Structures Associated with Potential-Temperature Anomalies**

1. Using the JupyterHub, create a vertical cross-section between 1000-100 hPa of potential temperature and the v-component of the wind at 25°N between 120°W and 85°W at 1200 UTC on March 7th, 2023 (7.5 pts)
2. Using the vertical cross-section you created in question 6, compare and contrast the static stability between 900-650 hPa and 650-300 hPa near 102.5°W. (5 pts)
3. Judging from the near-surface meridional wind, what direction of rotation is evident around this feature? What type of pressure system is characterized by this type of rotation? Explain your answer. (10 pts)
4. Based on your answers to questions 7 and 8, what is the sign of the associated potential-vorticity anomaly? Explain your answer. (10 pts)

**Part III: Identifying IPV Anomalies in Real-Time (25 pts)**

1. Using GFS data visualized at [tropicaltidbits.com](https://www.tropicaltidbits.com/analysis/models/), identify a case (either in the 0-h analysis or at a future forecast time) of a positive IPV anomaly that extends from the surface to the mid- to upper troposphere. An example of such a situation is attached to this lab. Prepare a vertical cross-section of wind and potential temperature using the cross-section feature at [tropicaltidbits.com](https://www.tropicaltidbits.com/analysis/models/) that is similar to the example attached to this lab.

Next, please answer the following questions for the case you identified:

* Describe the structure of absolute vorticity, wind, and static stability fields for both anomalies, as we did in Parts I-II.
* What is the minimum sea-level pressure for the cyclone accompanying the warm surface potential-temperature anomaly?
* Is the cyclone associated with precipitation?

Answering the last two questions will require you to access the maps in which mean sea-level pressure and precipitation are depicted. Turn in all maps, including the vertical cross-section and associated surface pressure / precipitation, with your lab.

**Part IV: IPV and the Pettersen-Sutcliffe Development Equation (Graduate Students Only; 10 pts)**

1. If a surface cyclone is more statically stable at its center than its surroundings, what does this mean about the rate at which the cyclone may deepen? Use the Pettersen-Sutcliffe development equation to explain your answer. (5 pts)
2. If cyclone development is limited by the static-stability term, what other term in the Pettersen-Sutcliffe Development equation could act to overcome its limiting influence? Hint: Assume we know nothing about temperature advection and/or differential cyclonic vorticity advection. Explain your answer. (5 pts)

![A picture containing surface chart

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