AOS 453 Lab #2: Cross Sections, Part I

Due: Thursday, 1 February

Objective: to become familiar with the relationships between temperature, potential temperature and normal winds in a cross section, as a prelude to MACS (the Mother of All Cross Sections) which begins next week.

The starting point is the thermal wind relationship, which relates the vertical shear of the geostrophic wind to the horizontal temperature gradient:

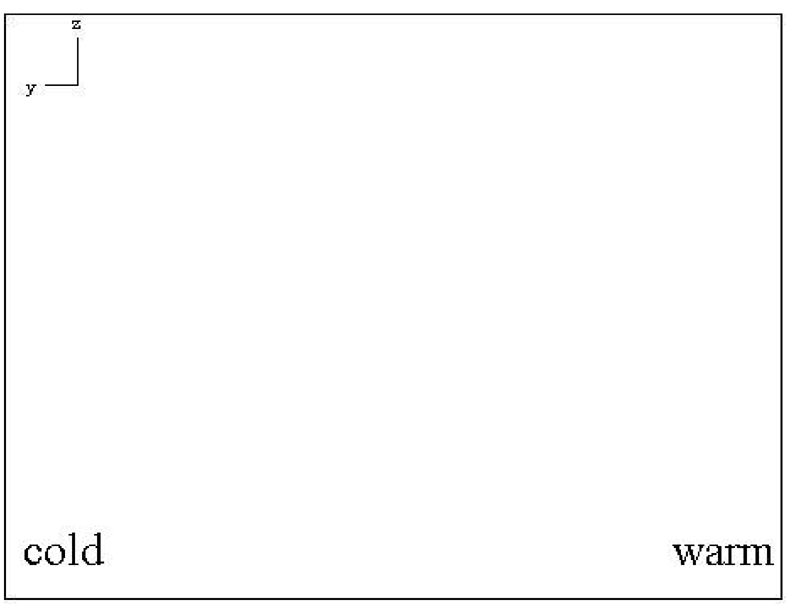
$$\frac{\partial \vec{V}_g}{\partial z} = \frac{g}{fT}\vec{k} \times \nabla T$$

or in terms of potential temperature:

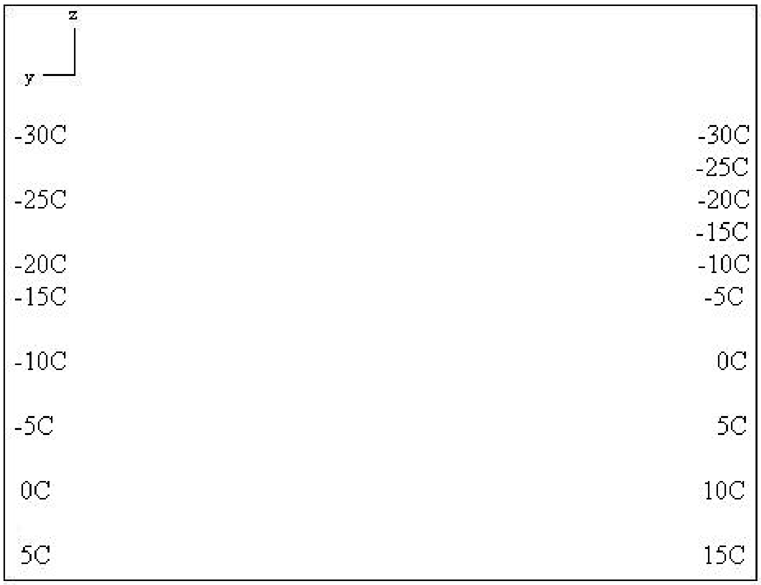
$$\frac{\partial \vec{V}_g}{\partial z} = \frac{g}{fq}\vec{k} \times \nabla q$$

Using your knowledge of the thermal wind relationship, complete the following.

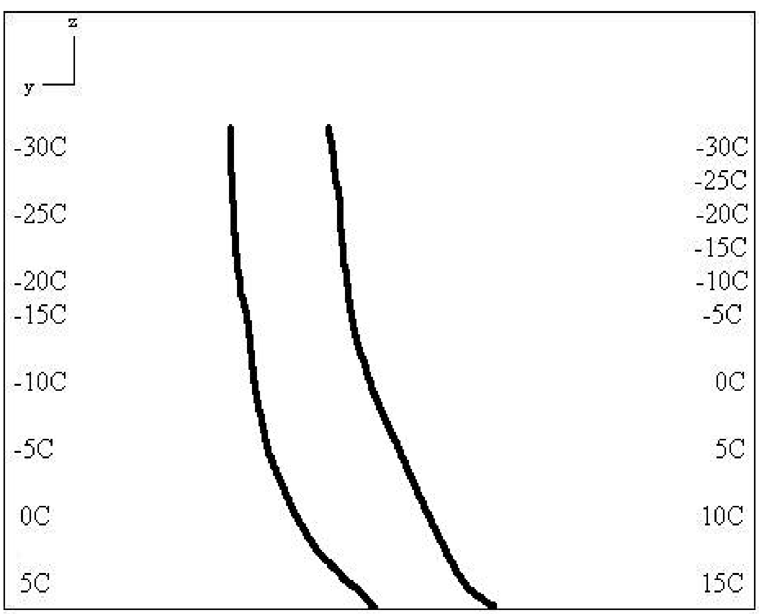
1. On the diagram below, draw isotherms assuming there is NO vertical temperature gradient. Draw a vector representing the temperature gradient. Is the shear vector into or out of the page? Draw the isotach pattern that would be associated with the temperature gradient and corresponding shear.



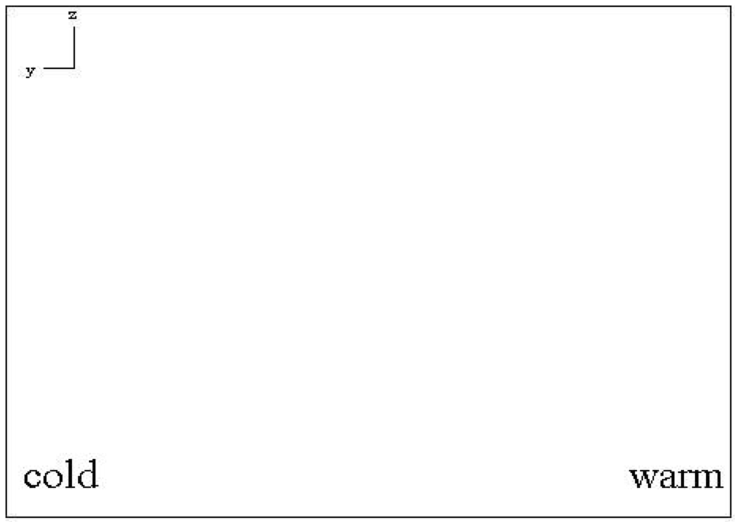
2. On the diagram below, "warm" and "cold" have been replaced with actual values of temperature along the vertical axes. Sketch the isotherms associated with these values. Where is the shear at a maximum? Where is it at a minimum?



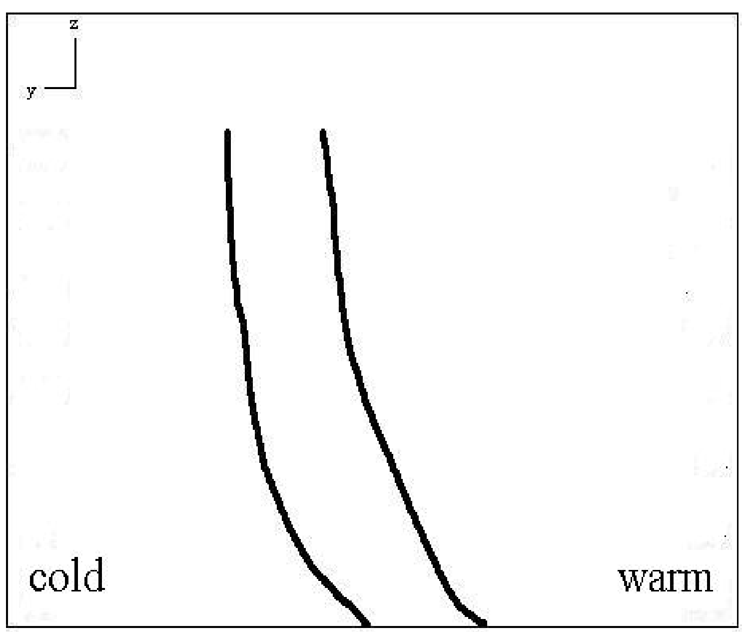
3. Now, sketch the isotherms as above, but take care that the only place a horizontal temperature gradient occurs is in the frontal zone. Now where do you find maximum and minimum shear?



4. Now, let’s consider potential temperature. Sketch an isentrope pattern for the below case, where we have relative cold and warm air at the surface. Assume that the atmosphere is either conditionally unstable or stable (i.e. potential temperature increases with height.)



5. Now, sketch the scenario above, taking care once again that the only region with horizontal temperature gradients is the frontal zone.



6. Compare the temperature and potential temperature patterns in the two frontal zones. In particular, how are the isotherms and isentropes oriented with respect to one another within the frontal zone? Why do you think this is?

7. Now, let's tie everything together. On the diagram below, sketch the isentropes associated with the values on the vertical axes. The J represents the jet center, and this time you must draw in your own frontal zone. Sketch the isotachs that agree with your isentropes and the jet / frontal zone location.