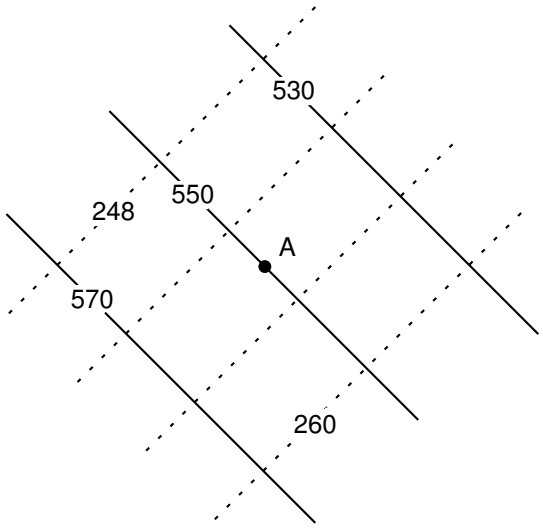
Atmospheric Sciences 435, Spring 2008
Problem Set 7
Due Monday, Apr 21

Problem 1 *The thermal windshear: a simple example*

The figure below shows an idealized distribution of geopotential height $Z = \Phi / g$ (solid lines—contours labeled in units of 10 m) and temperature (dashed lines—contours labeled in units of K) on the 500 hPa pressure surface.



(a) Sketch a vector indicating the geostrophic wind direction at point A.

(b) Do you expect the wind at point A to change direction with height? If so, sketch the direction of the geostrophic shear vector $\partial \mathbf{V}_g / \partial z$ on the figure. Does the wind rotate clockwise or counterclockwise as z increases?

(c) What is the sense (positive or negative) of the geostrophic temperature advection $-u_g \, \partial T/\partial x - v_g \, \partial T/\partial y$ at point A?

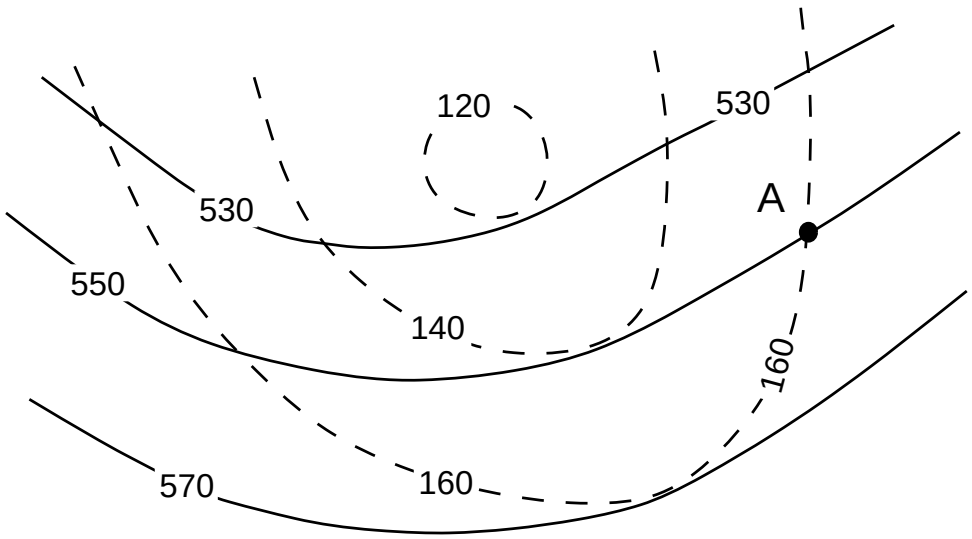
(d) How would your answers to (b) and (c) change if the labels on the temperature contours were reversed (i.e., if the lower label read 248 K and the upper label 260 K)?

(e) Based on your analysis above, what is the general relation between the sign of the local temperature advection and the direction that the wind rotates with height?

More thermal wind on the back!

Problem 2 *The thermal windshear in a cyclone*

The figure below shows the contours of constant height $Z = \Phi/g$ (in units of 10 m) for the 850 hPa (dashed) and 500 hPa (solid) surfaces of constant pressure.



(a) Using only the height informaion (i.e., without inferring winds), shade on the figure where you expect the layer between 850 hPa and 500 hPa to be warmest. (Just shade the general area). Justify your answer.

(b) Sketch the geostrophic wind vector at point A on the figure for both the 850 hPa and 500 hPa pressure surfaces.

(c) Do the vectors sketched in (b) and the temperature diagnosis from (a) satisfy the thermal windshear relation (at least roughly)? Explain your answer graphically.