

SIO 217B Atmospheric and Climate Sciences II

Exercise #12

1. a) Download files containing T_{1000} , T_{925} , T_{850} , T_{775} , T_{700} , T_{600} , and T_{500} for 1993 March 14 00Z. Calculate the average temperature of the layer between 1000 hPa and 500 hPa using the method described in Exercise #11. Plot contours of the average temperature of the 1000-500 hPa layer in the domain 20-50°N, 270-310°E using intervals of 3 °C. Download files containing Z_{1000} , Z_{850} , Z_{700} , and Z_{500} for 1993 March 14 00Z. Calculate geostrophic wind at each pressure level as in Exercise #9. Plot wind vectors over the temperature contours using the same vector scaling for each pressure level. If possible, put wind vectors for all levels on the same plot using different colors. To reduce crowding, it may be necessary to plot every third vector or so.

b) What direction (cyclonic or anticyclonic) does the geostrophic wind turn with increasing height where cold advection occurs? What direction for warm advection? In these regions, the atmosphere is baroclinic. Note that there is little change of geostrophic wind direction or speed with height in the warm sector (ahead of the cold front and behind the warm front) where the horizontal temperature gradient is weak. In this region the atmosphere is barotropic (no temperature gradient). Near the corners of the plot, there are areas where the geostrophic wind speed changes with height but the direction does not (except for a 180° sign change). In these regions the atmosphere is equivalent barotropic (a temperature gradient exists but there is no temperature advection because winds are parallel to temperature contours).
2. a) Write down equations for calculating the zonal and meridional components of thermal wind between pressure levels p_1 and p_2 ($p_2 > p_1$) in spherical coordinates.

b) Calculate the thermal wind between 1000 hPa and 850 hPa assuming that T_{925} is the same as the layer mean temperature. Plot vectors of your calculated thermal wind over contours of T_{925} in the domain 20-50°N, 270-310°E. Use intervals of 3 °C and the same vector scaling as in the previous plot. To check your results, calculate the thermal wind directly from the geostrophic wind at 1000 hPa and 850 hPa. Add this to the plot, if possible, using a different color for the vectors. There will not be exact correspondence since the layer mean temperature is not precisely equal to T_{925} . Note how the thermal wind vectors are parallel to the temperature contours with colder temperature on the left and stronger thermal wind where contours are more closely spaced.

c) **Optional.** Repeat all of the above calculations and plot the results for thermal wind between 850 hPa and 700 hPa assuming T_{775} is the same as the layer mean temperature. Repeat this for thermal wind between 700 hPa and 500 hPa assuming T_{600} is the same as the layer mean temperature.