SIO 217B Atmospheric and Climate Sciences II

Exercise #22

1. a) Download the files containing geopotential height of the 1000, 925, 850, 775, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, and 30 hPa levels (a total of sixteen levels) for 1993 March 14 00Z. Create a longitude-height cross-section figure by plotting how the geopotential height of each pressure level varies between 260-300°E along the 35°N latitude line. A suitable height range for this figure is between -1 km and +25 km (actually kgpm), which includes the entire troposphere and the lower third of the stratosphere. Note how the trough tilts westward with increasing height.

   b) Looking at the figure, at approximately what elevation and longitude is the meridional component of geostrophic wind strongest? Is the strongest meridional wind northward or southward? Note that the strongest meridional geostrophic wind may not necessarily occur at the same height as the jet stream, which is based on total (zonal + meridional) wind.

   c) Looking at the figure, do you think temperature above the level of strongest meridional wind is warmer on the western side or the eastern side of the cross section? Briefly explain your reasoning.

2. a) **Optional.** Now create a cross-section figure with pressure rather than geopotential height as the vertical coordinate. Of course, simply plotting how the pressure of each pressure level varies between 260-300°E will create a series of boring horizontal lines. Therefore, we will introduce a new pressure parameter, p^*,

$$p_N^* = p_N \exp[-(Z_N - \langle Z_N \rangle) / H]$$

   where p is regular pressure, N is level (e.g., 1000, 925, 850, etc.), Z_N is the geopotential height of pressure level p_N, and $\langle Z_N \rangle$ is the average geopotential height of pressure level p_N between 260-300°E along the 35°N latitude line. Let scale height H = 8 km. Create a longitude-pressure cross-section figure by plotting how p^* of each pressure level varies between 260-300°E along the 35°N latitude line. A suitable pressure range for this figure is 1000 hPa at the bottom and 0 hPa at the top (thus comprising the entire atmosphere). Note how the troposphere is small relative to the stratosphere in terms of height but large in terms of mass. Also note how the trough tilts westward with decreasing pressure.

   b) **Optional.** In pressure coordinates, the trough is deepest and has the steepest slopes (e.g., zonal pressure gradient) at the surface. Why is the meridional component of geostrophic wind not strongest at the surface?