1. In class, we showed that the geostrophic wind is non-divergent; however, this result changes if we assume that $f \neq f_o$ in the mass continuity equation. Derive an expression for $\frac{\partial \omega}{\partial p}$ where the wind is geostrophic with a variable $f$. How does this new term in the continuity compare to $\frac{\partial V_g}{\partial y}$? (Hint: Use scaling arguments)

2. Show that $\frac{\partial \zeta}{\partial \ln p} = -\frac{R}{f_o} \nabla^2 T$. What does this equation imply about the relationship between vorticity and temperature? Sketch a situation where vorticity increases with height? What might you call this system?

3. Derive the QG momentum equations for a location near the equator, where $L_x = 10,000$ km, but $L_y = 1000$ km. State the assumptions you are making and the proper scaling for each term. How does this compare with the midlatitude equation derived in class?

4. Print out a National Weather Service 300 hPa difax chart (ftp://tgftp.nws.noaa.gov/fax/barotrop.shtml); identify the jet streaks. With a different color, draw ageostrophic wind vectors in the appropriate locations, accounting for all features that can lead to ageostrophic winds. Indicate where you would expect upward vertical motion (Hint: use the continuity equation and that vertical motion goes to zero at the surface and model top). How well do the locations of upward motion you identified match the corresponding time satellite image?