ATM 316 Homework #3 Questions. Due 10 Oct 2016.
Fall, 2016 – Fovell

This homework also functions as a pre-midterm.

1. If the rotating Earth were a perfect sphere, at most latitudes apparent gravity would not point directly towards the center of mass. Succinctly explain why. Draw picture(s) and label them completely. I expect to see vector algebra in your answer.
2. The wind velocity (m/s) at the location of the star in the figure below is $\vec{U} = 3\hat{i} + 3\hat{j}$. There is no vertical wind component. Compute the temperature advection at the location of the star, in K per second. Show your work. Be sure to specifically state whether this is cold advection, warm advection, or no advection.
3. A rocket on the spherical, rotating Earth is initially located at latitude $\phi = 40^\circ$N is launched westbound at a speed of $u_0 = 2000$ m/s. Its motion remains strictly horizontal. By what distance, and in which direction, is the rocket deflected by the Coriolis acceleration after it travels for 250 seconds?

4. The rocket in the previous problem is seen by a stationary observer looking westward to curve to the south as it flies westward. There is no wind or drag influencing the rocket. Gravity is not a factor. Can you explain how this might be possible?
5. The horizontal flow field is described by \( \vec{U} = -\frac{1}{2} y \hat{i} + \frac{1}{2} x \hat{j} \). Compute both the horizontal divergence and the vertical component of vorticity for this flow field. Show your work.

6. The 500 mb wind is from the southwest at 10 m/s. The 1000 mb wind is westerly at 5 m/s. What is the shear between the two layers? Please express the shear as a vector, and compute its magnitude. Also, draw a picture and label it completely.