

# PHYS/OCEA 4411/5411 “Atmospheric Dynamics 1”

## Assignment #4

Due: Wednesday, 2 December 2009, at the beginning of class

- 1) How deep is the low at the center of a tornado with 177 km/h wind speeds at a radius of 75 m? Assume that the geopotential gradient is constant. How does your result compare with that for a synoptic-scale low?
- 2) Using Stokes' Theorem, show that the vorticity of a fluid in uniform rotation around a point is twice the angular speed of rotation.
- 3) Show that the vertical component of the vorticity of an object due to the Earth's rotation is equal to the Coriolis parameter,  $f$ .
- 4) The thermal wind equation relates horizontal gradients in temperature to vertical gradients in the geostrophic wind. Explain with the aid of diagrams how an understanding of thickness can be used to obtain the same conceptual result.
- 5) Using free-body diagrams, explain why the magnitude of velocity vectors in the Eckman spiral can exceed the geostrophic wind speed  $u_g$ .