Geophysical Fluid Dynamics

PHYS 527 Fall 2016

Problem Assignment # 3

due 09-30-16

1. **Geostrophic balance and thermal wind** (8 points)

   (a) Starting with geostrophic flow (section 3.4 in Vallis), show that the wind shear in a two layer fluid is proportional to the interface slope (i.e., derive equation 3.59).

   (b) Vallis problem 3.2

2. **Rotating shallow water waves** (5 points)

   Work through section 3.7.2 in Vallis. Specifically,

   (a) Starting with the rotating, shallow water equations (SW.1 and SW.2), linearize, non-dimensionalize, and derive the dispersion relationship (equation 3.105).

   (b) Consider the longwave limit. What does the dispersion relation reduce to, and what physical system is this equivalent to?

3. **Potential vorticity** (6 points)

   Vallis problem 3.8.

4. **Geostrophic adjustment in rotating flow** (6 points)

   In class we derived equations for the potential vorticity (PV) for a shallow water system. Consider the initial conditions (equation 3.130), and derive the analytic solution for the streamfunction ($\psi = g\eta/f_0$) and velocity fields. In other words, derive the solutions 3.133-3.135.

5. **Hydrostatic ideal gas** (12 points)

   (a) Derive the equations of motion for a hydrostatic ideal gas. In other words, work through section 3.9.2 in Vallis.

   (b) Be the *untrusting reader* of section 3.10.2, and derive the APE for an ideal gas (equation 3.191).

6. Experiment!! Demonstrate thermal wind balance in the weather in a tank apparatus. Demonstrate in or out of class, as a group is fine. We'll set a time that works for us all. (50 points)

Paper: Literature notes. Please identify the major references you will cite for your paper. It helps to have the opportunity to write some basic notes on the content of these paper. For this, I invite you to download `litnotes.tex` and `litnotes.pdf` from my website (`http://kestrel.nmt.edu/~sessions/writingtool` and adopt it for your references. You have at least 2 weeks for this (October 7 is a good target deadline).