

Geophysical Fluid Dynamics

PHYS 527

Fall 2016

Problem Assignment # 2

due 09-09-16

1. **Primitive equations** (5 points)

Starting with the full momentum equations in spherical coordinates (Vallis eqn 2.47), apply the hydrostatic, shallow fluid, and traditional approximations to derive the primitive equations. For each approximations, write down the explicit terms that are neglected.

2. **Important approximations** (14 points)

For each of the following approximations, describe the conditions under which the approximations are valid and write down what the explicit approximation is (for example, the f -plane approximation assumes the Coriolis parameter is constant). Please use complete sentences.

- (a) f -plane
- (b) β -plane
- (c) Boussinesq
- (d) Anelastic approximation
- (e) Hydrostatic balance
- (f) Geostrophic balance
- (g) Thermal wind balance

3. **Exner function** (8 points)

Vallis problems 2.2

4. **2D flow on an f -plane** (6 points)

Vallis problem 2.4a,b

5. **Convection** (5 points)

Vallis problem 2.11a

6. **Geopotential height** (5 points)

Vallis problem 2,12