

## **ATOC 5060: Atmospheric Dynamics**

### **Final exam study guide**

We have covered almost all the material in Holton, with an emphasis on chapters 6, 7, 8 and 10, and some of 12. Much of this is based on quasi-geostrophic theory developed in chapter 6, and the more fundamental material in chapters 1-4. You should review these sections, including problems at the end of the chapter, in addition the reading assignments given on the web site expand on Holton's more "traditional" of many topics. You review also the homework assignments and the objectives of weekly exercises and projects. The following list could motivate your detailed review. These are study questions, not sample questions.

- What is the method of normal modes? How would one linearize an equation?
- How can one determine if an equation (system of equations) has a wave-like solution?
- What is the condition for exponential growth of waves?
- What makes waves "trapped"?
- What is the restoring force for gravity waves? What about for Rossby waves?
- Are baroclinic waves Rossby waves?
- Does baroclinic wave growth involve energy conversion? What are the mechanisms?
- Does baroclinic wave growth require a rotation or a beta effect?
- How is thermal wind balance maintained in baroclinically unstable systems?
- How is thermal wind balance maintained in the Ferrel cell?
- Why is the westerly jet not in excess of 150 m/s?
- What is the difference between potential energy, internal energy and available potential energy? Why would one suggest that surfaces of available potential energy coincide with potential temperature surfaces?
- Which direction do inertia-gravity waves turn? Does energy travel parallel to group velocity of phase speed? What about momentum?
- Why/when can the atmosphere be treated like a shallow water system?
- Is the shallow water system non-divergent? Is adiabatic flow between two potential temperature surfaces non-divergent?
- What determines the width of the Hadley cell? Why is the temperature gradient in the tropics small?
- Why would we think eddy vorticity flux is related to acceleration of the zonal flow? How is this related to EP flux?
- What is critical line breaking? How is this different (what is the difference in heat and momentum flux/divergence) from reflection?
- How are Ertel, Rossby and QG potential vorticity related? Is Rossby PV quasi-geostrophic?
- How can one estimate the amplitude of a mountain wave from an aircraft flying at constant pressure?
- What's the difference between stirring and mixing? What has this got to do with Stokes theorem?
- Why is there more vorticity at the poles?
- Do you expect cyclonic storms to be to the north, at the center, or to the south of a westerly jet? Can baroclinic instability occur near an Easterly jet? Under what conditions?
- If we represent the atmosphere as a number of layers taken to be shallow water system, how is this different to assuming the atmosphere is stratified?
- What is the difference between mixing and stirring? Does stirring increase mixing? Which is more important for the general circulation?
- Can inertial instability be considered analogous to hydrostatic instability?
- Is the period of a buoyancy wave greater in the stratosphere?
- Can one obtain acoustic waves from a quasi-geostrophic system?
- If you were on a planet with a large Rossby number, what would you expect the circulation to be like?
- If there was no friction (on earth) would you still have a Ferrel cell? Would you still have westerly surface winds?
- Why/when can we write the advection as a flux divergence? What would be the advantage?
- What assumptions lead to the quasi-geostrophic equations? What assumptions lead to the primitive equations? What is the Boussinesq approximation?
- How is angular momentum related to vorticity?