PHY2504S - Advanced Atmospheric Dynamics, Jan-Apr 2010

Summary and Syllabus:

For latitudes outside the Earth's tropics, the general circulation of the atmosphere and oceans is dominated by "quasi-geostrophic" fluid motions. These are motions that are strongly influenced by both the Earth's rotation and the stratification of the atmosphere and ocean. In this course, we develop an understanding of this class of dynamics using scaling and simplified models. There will be a focus on atmospheric dynamics, but much of the material is relevant to the study of ocean dynamics. The course includes analytic and numerical exercises, a class project and presentation and a mid-term test.

Some background in fluids and atmospheric science will be assumed, but interested students without this background will be able to keep up if they do some additional reading and homework.

Topics include:

- Equations of motion
- Circulation, vorticity and potential vorticity
- Shallow water theory: Gravity waves, Kelvin waves, Rossby waves, Geostrophic adjustment
- Quasi-geostrophic theory for shallow water, 2-layer and continuously stratified systems
- Baroclinic instability and importance for mid-latitude dynamics

Concepts to learn:

- Effects of rotation (coriolis effect) and differential rotation (beta effect).
- Effects of baroclinicity
- Circulation, vorticity, potential vorticity and their importance for understanding of atmospheric dynamics and forecasting.
- The dynamics of gravity waves, Kelvin waves and Rossby waves.
- Quasi-geostrophic scaling
- Quasi-geostrophic theory for the shallow water, 2-layer and continuously stratified flow
- Baroclinic instability
- The relevance of quasi-geostrophic motions for atmospheric dynamics

Skills to develop:

- Lagrangian and Eulerian viewpoints
- Analysis of wave dynamics in simplified fluid systems
- Hydrodynamic stability and instability

- Scale analysis for fluid dynamics
- Research report writing and presentation
- Simple numerical analysis and data analysis

Course schedule: The time of the course lectures are still to be determined according to the preferred times for the participating students and room availability. The course will consist of approximately 24 lecture hours with 2 hours of lectures in most weeks.

Contact information: *Instructor*: Isla Simpson, MP602, isla@atmosp.physics.utoronto.ca, Tel:416 978 8365

Course website: I will use my personal website for the course which can be found at http://www.atmosp.physics.utoronto.ca/∼isla/PHY2504HS.html.

Evaluation: 5 Problem Sets (50%), Midterm test (15%), Project (8-10 page paper + 20 min presentation) (25%), Class Participation (10%)

Notes on Assignments:

- The problem sets involve mathematical and numerical exercises.
- The numerical exercises are based on the Python programming language and software packages. This is free open source software which is being used in undergraduate courses as well. The packages include matlab-style plotting and numerical analysis. Please see compwiki.physics.utoronto.ca to get started.
- The project should cover a chosen topic in atmospheric or oceanic dynamics and can include a literature review and some numerical investigation or mathematical analysis.
- Please submit a project plan by the beginning of Reading week. You can propose a project involving a collaboration between you and another student if you wish.