MAR 582: Advanced Atmospheric Dynamics

Class time: TBA
Instructor: Professor Edmund Chang (101 End, x2-6170, kar.chang@stonybrook.edu)
Office hours: TBA

Course Description:
Application of the concepts of balanced flow and potential vorticity thinking - conservation and inversion - to study wave propagation, baroclinic instability, evolution of cyclones and baroclinic waves, and wave-mean flow interactions.

Learning Objectives:
• Understand the concepts of conservation, invertibility and vorticity thinking, and apply these concepts to study atmospheric wave propagation and instability
• Apply idealized numerical model simulations to examine wave propagation and instability to illustrate the concepts learned in the class

Course Content:
The first part of the course will deal with large scale waves in the atmosphere. We will start with the barotropic vorticity equation, using barotropic Rossby waves as a simple example to illustrate the major principles -- conservation, invertibility, and (potential) vorticity thinking -- that we will try to internalize over the course of the semester. We will see how PV thinking can help us “understand” wave propagation and instability. We will then move onto the shallow water equations, illustrating adjustment under gravity in a rotating system, and the differences between rotating and non-rotating systems.

The second part of the course will deal with potential vorticity dynamics in a continuously stratified system. We will use potential vorticity thinking to study waves and instabilities, focusing on mid-latitude systems, mainly based on the quasi-geostrophic equations. Then we will discuss the application of instability theory to understanding baroclinic wave and cyclone life cycles.

The final part will be on other important topics, including wave-mean flow interaction, more on gravity waves, tropical waves, Hadley cell dynamics, etc. How much will be covered depends on how much time is left as well as the interest of the group.

Since this is an advanced topics elective course, we do not really have a “set” list of topics that we definitely have to cover (except for the first 2 paragraphs above which I definitely would like to cover, which makes up about 2/3 to 3/4 of the course). Hence I encourage you to ask questions or make comments whenever you have something that you want to discuss more, and you can suggest topics
that you want to discuss and if those topics are of interest to the majority of the class we could discuss those instead.

**Textbook:**

There are no textbooks for this course. Books which will be useful includes parts of Holton: “An Introduction to Dynamic Meteorology”, Gill: “Atmosphere-Ocean Dynamics”, and Pedlosky: “Geophysical Fluid Dynamics”. Students who are theoretically inclined should try to master these books. The lectures will be based on printed class notes that I will distribute ahead of lecture time. It will be helpful if you read it prior to class time. We will also read and discuss some important review and research articles.

**Course Requirements:**

There will be no exams. There will be regular problem sets. To pass the course, students must complete the problem sets satisfactorily.

There will be two types of problem sets. The first type (about 4-5 problem sets) will compose of mostly analytical problems (50%) -- basically manipulation of the mathematical equations to derive results or solve problems. For these problems, you can discuss with each other concerning how to solve the problems, but each student must write up his/her own solution to be handed in.

The second type (about 4 problem sets) will consist of using simple numerical models to illustrate aspects of atmospheric dynamics (wave propagation, instability, geostrophic adjustment, etc.). These problem sets will require some (relatively simple) modifications of mostly fortran codes. For these numerical problems, I will allow you to work in groups of two -- if you are not so familiar with fortran (or manipulation and display of large data sets with, e.g., Grads, or your favorite data manipulation and display program, such as MATLAB) you should try to pair up with a student who is familiar with these. For these exercises, I can accept one write-up from each group (30%).

There will be a term project, in which students will work in groups and expand on one of the numerical model exercises in greater depth. Students will make a presentation and hand in a report on the day when final exam is scheduled for this class in lieu of the exam (20%).

**Americans with Disabilities Act:** If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC(Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

**Academic Integrity:** Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

**Critical Incident Management:** Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.