

SYLLABUS

ATS 710 Geophysical Vortices

Spring Semester 2026

Professor: Michael M. Bell

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Time and Location: MW 11:00 am - 12:15 pm in ATS West 121

Office Hours by appointment

First day of instruction 1/21/26, last day of instruction 5/8/26

Student Outcomes: This is a graduate level course on dynamical and thermodynamical structure of geophysical vortices from observational, experimental, and theoretical viewpoints. Topics covered include two-dimensional vortex dynamics, invertibility principle, Green functions, point vortex and moment idealizations, vortex axisymmetrization, vortex merger, two-dimensional and three-dimensional quasi-geostrophic turbulence, vortex Rossby waves, Eliassen's balanced vortex model, Ooyama's 1969 hurricane model, Spin down at small and large Rossby number, balance theories, vortex alignment, tropical cyclogenesis and intensification via convectively forced vortex Rossby waves, tornadoes, water spout and dust devils. Students will review seminal and recent theoretical, observational, and modeling studies to obtain working knowledge of the current state of the science.

Topic Outline

1. Basics of tropical cyclone structure and intensification dynamics
2. Vortex Rossby Waves and instabilities
3. Balance theories and Eliassen equations
4. Vortex vertical alignment theory
5. Maximum potential intensity theory
6. Hurricane boundary layer and air-sea interaction theory
7. Translation to impacts of heavy rain and wind damage

Instructor may modify this schedule as needed to adjust the order in which material is presented, and some classes will be rescheduled.

Course procedures: The course will be based on research papers from the refereed literature. No textbook is required. There will be no exams. Lectures will be given by the instructor, guest lecturers, and enrolled students. Each student will prepare and deliver oral presentations on journal articles and facilitate class discussion. Each student will conduct a research project for a more in-depth study of one related topic. Course evaluation will be based on class participation, presentations, journal summaries, and research project participation.

Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (<http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf>) and the Student Conduct Code (<http://www.conflictresolution.colostate.edu/conduct-code>). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

We want you to be able to fully participate in the learning experience. Student resources for food, financial, and housing security; transportation; child care; health care; violence; and immigration issues are compiled at basicneeds.colostate.edu.

An additional list of student resources, which includes information on learning/ accommodation resources, mental-health resources, student case management, and religious observances is at the following link: <https://col.st/2FA2g>