ATMOSSC 5952: Dynamical Meteorology II
Spring, 2026

Instructor	Prof. Zhengyu Liu,
Class Meetings	TR 12:45-2:05pm, 01/12/2026-04/27/2026
Classroom	Derby Hall, Room 070 (in person)
Credits	3
Course website	
Prerequisites	ATMOSSC 5951, MATH2255 or MATH2174, or consult instructor

Instructor Information:
Prof. Zhengyu Liu
1106 Derby Hall
Phone: 614/292-7948
Email: liu.7022@osu.edu
Office Hour: after class and email appointment over zoom.

Text Book
Handout on CarmenCanvas
Individual Lecture notes on CarmenCanvas
Homework key on CarmenCanvas (after homework)

Course Objectives
The basic objective of this course is to provide students with the advanced knowledge of the fundamentals of atmospheric dynamics beyond ASP5951. The knowledge will facilitate students' comprehension of meteorological processes that determine the weather and climate. This increased comprehension of important physical processes will improve students' ability to analyze and to forecast the state of the atmosphere and climate.
One distinctive feature of this class, different from other ASP classes, is the heavy derivation of basic equations. This is a key part of the class and is absolutely necessary for you to truly understand many basic physical concepts. This will be reflected in exams and quizzes.
The intention of this class is enable you to combine physical concepts with basic math equations such that you can have a deep understanding of the dynamics that control the atmospheric and climate variability.
The course is designed as the last dynamic course for senior undergraduate and graduate students in Geography Department, but also applies to students in other departments interested in theories of rotating fluid dynamics.

Course Structure
The class will meet two days per week for 80 minutes each day. Lectures present material on dynamic processes and their applications. Important equations are derived and the implications of assumptions discussed. Examples of atmospheric and oceanic problems are discussed.

Course Description
This course discusses advanced dynamic theories for large-scale atmospheric motion in the framework of quasi-geostrophic dynamics. The course studies the shallow water system in the first half and the stratified flow in the second half. The major concepts to be discussed are: scaling analysis, the shallow water system, potential vorticity, the quasi-geostrophic system, Rossby waves and baroclinic instability.

Textbook
Zhengyu Liu, Dynamic Meteorology II (handout)

Grading:
40% homework
30% mid-term, 30% final exam,

Detailed Requirements
Examination: Each examination will contain both descriptive questions and derivation questions. The descriptive questions focus on major physical concepts. The derivation questions test your basics in understanding the dynamics quantitatively.

Homework assignments: Homework assignments will be due in class every 1-2 weeks. The homework assignments are designed to accomplish two goals. The first goal is to give students some experience solving basic dynamic problems using concepts introduced in class. A second goal is to make students think about the dynamic processes that occur in certain atmospheric phenomena. More challenging problems may require students to combine dynamic principles in order to arrive at the solution to the problem.

Class attendance: Class attendance will be registered each class in person, which may have impact on the final grade if the attendance is extremely poor without reason.

Other Policies
Units: Numerical answers are incomplete unless they are accompanied by the correct simplified units. Points will be deducted on examinations and homework assignments if units are incorrect, unsimplified, or missing.
Late policy: Assignments and corrections are due on the stated date. Late homework will not be accepted unless you have the permission from the instructor in advance.
Academic Misconduct: All examination and homework answers are expected to be the work of the student whose name appears on them. Copying another student's work is plagiarism and is considered to be academic misconduct.
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the Committee (Faculty Rule 3335-5-847). For additional information, see the Code of Student Conduct (http://studentaffairs.osu.edu/info_for_students/csc.asp).
Disability Services: The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me, in person, as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.
SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

References:
1: Gill, A. E., Atmosphere-Ocean Dynamics, 1981, *Academic Press*.
2: Holton, J. R., An Introduction to Dynamic Meteorology (3rd or later editions), *Academic Press*.

Course Content

The course chapters are listed as follows:
The sections and subsections with "*" are extra materials that will not be discussed in the class. They are left in the handout for your own interest and future reference.

Part I: Dynamics of Shallow Water System

Chapter 1: Basics (2 weeks)
Sec.1.1: Basic equations,
Lecture 1: Forced Rossby wave I

Sec.1.3: Circulation, vorticity and Kelvin's Theorem
Lecture 2: Circulation, vorticity and Kelvin's Theorem

Sec.1.4: Potential vorticity conservation
Lecture 3: Potential vorticity conservation

Sec.1.5: Shallow water waves on f-plane
Lecture 4: Sallow water waves

Chapter 2: Shallow Water Rossby Wave Dynamics (3 weeks)
Sec.2.1: Quasi-geostrophic equation
Lecture 5: QG equation

Sec.2.2: Rossby waves
Lecture 6: Rossby wave

Sec.2.3: Group velocity and energy propagation
Lecture 7: Group velocity

Sec.2.5: Forced waves
Lecture 8: Forced Rossby wave I
Lecture 9: Forced Rossby wave II

Chapter 3: Forced Circulation (1 week)
Sec.3.2: Ekman dynamics
Lecture 10: Ekman Layer

Part II: Dynamics of Stratified Flow

Chapter 4: Basics of Stratified Fluid (1 weeks)
Sec.4.1: Basic equations
Lecture 11: Equations for Stratified Fluid
Sec.4.2: Vorticity equation
Lecture 12: Vorticity Equation
Sec.4.3: Ertel potential vorticity
Lecture 13: Ertel Potential Vorticity

Chapter 5: Rossby Wave Dynamics (3 weeks)
Sec.5.1: Quasi-geostrophic equation for stratified flow
Lecture 14: Stratified QG Equation
Lecture 15: QG Diagnosis I: Tendency Equation
Lecture 16: QG Diagnosis II: Omega Equation

Sec.5.2: Rossby waves in stratified fluid
Lecture 17: Rossby wave in stratified fluid

Sec.5.3: Vertical normal modes
Lecture 18: Vertical normal modes

Sec.5.4: The Elliassan-Palm theorem
Lecture 19: E-P Theorem

Chapter 6: Instability Theory (2 weeks)
Sec.6.1: Instability problem
Sec.6.3: Energetics
Lecture 20: Energetics of Baroclnic Instability

Sec.6.4: The Eady problem.
Lecture 21: Eady Problem