ATS 601: Atmospheric Dynamics I
Course Syllabus for Fall 2025

Class: 10:00AM - 10:50AM Tuesday and Thursday, room ATS-West 121

Instructor

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Course Focus

Atmospheric dynamics constitutes a branch of the larger field of geophysical fluid dynamics which itself is embedded in the general field of fluid mechanics. Geophysical fluid dynamics aims at understanding the underlying mechanisms of atmospheric and oceanic motion over a vast range of spatial and temporal scales. Interestingly, while we do have the governing equations and understand their meaning, it is still not easy to derive understanding of the phenomena we observe from them. To make progress we simply the equations to the regime specific to a specific phenomenon (e.g. a low-pressure system, or sea breeze), and then use solutions from the simplified systems to build an overview of the whole atmosphere again. This course covers the fundamentals of geophysical fluid dynamics with an emphasis on the atmospheric component, and shows how to build these simplified equations, solve them, and gain a good basic overview of the workings of the atmosphere.

During this course you will:

- learn how to physically interpret the equations of motion,

- become familiar with atmospheric dynamics jargon,
- learn to make useful simplifications to the governing equations to better understand specific phenomena, and how they interact with each other,
- run and analyze output from a simple atmospheric circulation model,
- practice writing-up scientific results in a professional manner.

Scheduling

Lectures will be in person Tuesday and Thursday 10:00-10:50AM. However, there may be occasions when lectures need to be rescheduled. The dates and times of the canceled and rescheduled lectures will be posted on the course website and discussed in class.

Course Expectations

The following list presents the minimum requirements for passing this course:

- attend lectures and participate,
- keep up with the reading - this is incredibly important,
- submit all assignments on time and at an acceptable level of quality (it is expected that you will spend *at least* 2 hours of effort outside of class for each hour of class time),
- satisfactorily complete all exams

Course Prerequisites

You are expected to be familiar with basic high-school and college-level mathematical concepts. Minimal time will be spent in lecture reviewing these topics:

- algebra
- basic calculus (e.g. how to take a derivative and an integral)
- vector calculus (e.g. dot products, cross products)

If you are concerned about your background in these areas, please speak with the instructor. While the concepts, tools, and techniques explored in this course will be taught within the context of atmospheric science, there are no atmospheric science prerequisites.

You will be expected to write and implement computer code throughout this course. You are free in your choice of software, but note, the instructor will not spend office hours debugging your code for you.

Outline

The following is an outline for the class. Reality will almost surely deviate slightly from this outline.

1. **Introduction**
2. **Some basic maths**
3. **The atmosphere as a continuum**
4. **The Governing equations**
5. **Vorticity and circulation**
6. **The Primitive equations**
7. **Scaling equations and the dominant balances**
8. **The shallow-water dynamics**
9. **Quasi-geostrophic theory, an introduction**
10. **Waves**
11. **Stability**
12. **Turbulence, predictability and chaos**

Course Web Page

The course web site will be used for posting notes and homework assignments and providing additional resources. The course web site is available through Canvas.

Grading

The overall course grade will be made up of homeworks and assignments.

Homework

There will be approximately 1 homework per week throughout this course (although it can occasionally be slightly more or less), with homeworks typically due on Tuesdays.

If you need help in completing the assignment, first ask your peers for assistance and then request help from your TA and instructor second. You are *encouraged* to interact with your classmates by sharing ideas and discussing the specifics of the material and homeworks. You are, however, expected to hand-in your own homework assignment, and it should not be a direct copy of your classmate's.

Your homework assignments must be clear and legible (see discussion below on LaTeX). All variables should be defined, all steps described, and all figures and sketches of good quality. By doing this, you are not only being nice to the instructor and the TA who have to read your work, but you will gain practice in presenting your results clearly and professionally as required for your careers as scientists.

Texts & Resources

There is no required textbook for this course, however, I have linked three incredibly useful textbooks on Canvas that are freely available to you online via the CSU library. The lecture material will rely mostly on the lecture notes (to be distributed during the course). There is one required resource in this course - **the internet**. Google is amazing - use it. One of the most important things to learn in graduate school is "how to look it up." If the the approach from class isn't clear to you, odds are that someone else has come up with an alternative method of explaining the concept that jives with your learning style. So Google it!

Many of the materials including notes and homeworks in this course are borrowed from the course materials of Prof. Wayne Schubert, Prof. Thomas Birner, Prof. Dave Randall, Prof. Dave Thompson, and Prof. Elizabeth Barnes. Additionally, the course website lists a few highly recommended texts that, while not required, are fantastic resources for this course and beyond.

Software

Analysis & Plotting Software

You are required to have an analysis and plotting software package (often they are one and the same) with which you can do the homeworks. I do not care what you use, but I recommend you talk with your advisor to determine what will be most useful for you and your future research.

Optional: LaTeX

LaTeX[1] is a type-set program that takes macro code and formats it into a final (often pdf) document. For example, this syllabus was written with LaTeX. The end result is a clean, consistently formatted document. More and more scientists are using LaTeX to write-up their research, and journals are increasingly preferring LaTeX files to Mircrosoft Word files for manuscript submission.

A main reason to use LaTeX is the ease with which mathematical symbols, equations, etc. are formatted. In addition, including figures is efficient: the user does not "cut and paste" the figure into the text, but rather places the actual document path of the figure in the LaTeX code. Thus, whenever the figure is changed, it is automatically updated in the manuscript file. LaTeX is free and can be used on all common operating systems (e.g. Linux, Mac, Windows).

Covid-19 Information

Important information for students: All students are expected and required to report any COVID-19 symptoms to the university immediately, as well as exposures or positive tests from a non-CSU testing location.

If you suspect you have symptoms, or if you know you have been exposed to a positive person or have tested positive for COVID, you are required to fill out the COVID Reporter (https://covid.colostate.edu/reporter/). If you know or believe you have been exposed, including living with someone known to be COVID positive, or are symptomatic, it is important for the health of yourself and others that you complete the online COVID Reporter. Do not ask your instructor to report for you. If you do not have internet access to fill out the online COVID-19 Reporter, please call (970) 491-4600. You may also report concerns in your academic or living spaces regarding COVID exposures through the

[1] pronounced "LAY-tek" or "LAH-tek".

COVID Reporter. You will not be penalized in any way for reporting. When you complete the COVID Reporter for any reason, the CSU Public Health office is notified. Once notified, that office will contact you and, depending upon each situation, will conduct contact tracing, initiate any necessary public health requirements and notify you if you need to take any steps.

For the latest information about the University's COVID resources and information, please visit the CSU COVID-19 site: https://covid.colostate.edu/

CSU Honor Pledge

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (`http://catalog.colostate.edu/general-catalog/policies/students-responsibilities/#academic-integrity`) 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.