EVAT 5410: Atmospheric Dynamics (4 credits)
Spring 2021
Lecture: MWF 10:00 a.m. – 10:50 a.m.
Lab: Fridays 2:00 p.m. – 5:00 p.m.

## Instructor

Kevin Grise
Email: kmg3r@virginia.edu
Office Hours: TBD

## Teaching Assistant

Mitchell Kelleher
Email: mkk5rx@virginia.edu
Office Hours: TBD

## Course Description

In this class, we'll cover the nuts and bolts of motions in the atmosphere, with a particular focus on synoptic-scale and global-scale motions. This course provides the fundamental theoretical knowledge necessary to answer the following questions:

- Why do the winds blow from west to east at mid-latitudes?
- Why does air spin counterclockwise around low-pressure systems in the Northern Hemisphere and clockwise in the Southern Hemisphere?
- Because we can't easily measure vertical motion in the atmosphere, how can we determine where air is going to rise and form clouds and precipitation?
- Why are there ridges and troughs in the jet stream that lead to cold air outbreaks and heat waves at mid-latitudes?
- What processes are responsible for the rapid growth of mid-latitude weather systems?

This course is a foundation for advanced study and research in atmospheric science, meteorology, and atmosphere-related disciplines.

## Who Should Take This Class?

- Graduate students specializing in atmospheric science
- Upper-level undergraduate students who are considering graduate school in atmospheric science, meteorology, or a closely-related discipline
- Upper-level undergraduate students who are planning to work in an atmosphere-specific field (forecasting, National Weather Service, etc.)
- Graduate and undergraduate students with a strong quantitative background, who are interested in learning more about the theory for how the atmosphere works

**Prerequisites**

- Two semesters of calculus (MATH 1310 & 1320, or equivalent) required; multivariate calculus (Calculus III; Math 2310) recommended
- EVSC 3300 (Atmosphere and Weather), or one semester of physics (PHYS 1425 or equivalent) required

**Recommended Textbooks**

- *An Introduction to Dynamic Meteorology, 5th Edition,* by James R. Holton and Gregory J. Hakim, 2012
- *Applied Atmospheric Dynamics* by Amanda H. Lynch and John J. Cassano, 2006

Students should not feel obligated to purchase a textbook, and are encouraged to talk with the instructor prior to purchasing a textbook. Holton and Hakim is very mathematical in its treatment of atmospheric dynamics and is appropriate for graduate students focusing on atmospheric science. Lynch and Cassano is more conceptual in its treatment of atmospheric dynamics and is appropriate for students that are relatively new to atmospheric science concepts.

**Other Useful References**

*Atmospheric Science: An Introductory Survey* by John M. Wallace and Peter V. Hobbs, Academic Press, 2006 (Second Edition)
*Atmospheric and Oceanic Fluid Dynamics* by Geoffrey K. Vallis, 2006

**Assessment and Evaluation**

Exam 1 (due Friday March 5): 15%
Exam 2 (due Friday April 2): 15%
Final Exam (due Thursday May 13 by noon EDT): 20%
Lab Assignments: 50%

*Exams:* Two midterm exams and one final exam will be given. The exams will primarily be quantitative problem solving and essay-type questions to explain the application of theoretical knowledge to real-world examples. Exams may also include some short answer questions. The final exam will be cumulative. This semester, exams will be in a "take home" format (i.e., an open-notes assignment that students will have at least 48 hours to complete).

*Lab Assignments:* Weekly lab sessions will review essential concepts from the MWF lectures, provide practice with quantitative problem solving skills, and showcase the application of theoretical knowledge to real-world examples. The lab session will have weekly assignments, which will be due during the following lab session. These lab assignments are critical to the course, as they provide practice for the types of quantitative and longer-answer questions that can be expected on exams. Students are encouraged to work together to solve the problem sets, but must turn in their own solutions. Copying of another student's solutions is a violation of the Honor Code. **The lowest lab assignment grade for the semester will be dropped.**

*Grading Scale*

| | | |
|---|---|---|
| A+: 98-100 | A: 90-97 | A-: 87-89 |
| B+: 84-86 | B: 76-83 | B-: 73-75 |
| C+: 70-72 | C: 63-69 | C-: 60-62 |
| D+: 57-59 | D: 53-56 | D-: 50-52 |

F: Less than 50

**Preliminary Course Outline**

- Introduction to Atmospheric Dynamics
- Fundamental and Apparent Forces Acting in the Atmosphere
- Lagrangian and Eulerian Views of the Atmosphere
- Hydrostatic Balance
- Mass Continuity
- Surface Pressure Tendency
- Geostrophic Balance
- Thermal Wind Balance
- Gradient Wind Balance
- Ageostrophic Flows
- Rossby Waves
- Baroclinic Instability
- Circulation, Vorticity, and Potential Vorticity
- Quasi-Geostrophic Theory

A detailed course outline is provided under the Schedule tab on the course Collab website. Please check the outline regularly as it will be updated throughout the semester with readings, lecture notes, and assignments.

**Questions??**

Class participation and asking questions in class is strongly encouraged.

Questions outside of class can be addressed to either the instructor or graduate teaching assistant via email, or on Zoom during office hours. Please schedule an appointment to meet with the instructor and TA outside of office hours.

**A Word about the Spring 2021 Semester and the Online Format of the Course**

As we start this semester, it's fair to say that many of us are preoccupied with the challenging time that we are living in. Many of us are concerned about our own health and/or the health of friends and family. Many of us have felt or are feeling socially isolated and unable to connect in person with friends or family. Many of our families are suffering from financial difficulties, are grieving over the loss of a loved one, or know of someone who is. Many of us are deeply concerned about our world, our nation, and the injustices and inequalities that persist in our society.

In light of these issues, I would encourage all of us to be especially compassionate and forgiving to one another as we go through this semester. It is my intention as your professor to be as accommodating as possible this semester. Everyone's situation is unique, so please don't hesitate to reach out to me to make alternative arrangements if you feel that you will have personal difficulties fulfilling the requirements of the class as specified on the syllabus.

The online format of the course this semester allows for the course to operate in as close to "normal" format as possible. However, because of technology limitations or personal circumstances, you may be unable to participate regularly in the synchronous class meeting times on Monday, Wednesday, and Friday mornings. All class sessions will be recorded for students who are unable to attend, but please make every effort to attend as many of the Zoom class sessions as possible. The material in this class is, at times, quite complicated, and I think it will greatly improve your understanding of the material if you are able to ask me questions in real time as I introduce new course content.