Syllabus
Atmospheric Physics
(Physics 4200/6200)
Fall Semester 2023

Instructor Information:

Instructor:	Prof. Jens Oberheide http://globaldynamics.sites.clemson.edu/index.html
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Office Hours:	Monday 12:15 – 1:15 pm; I have an open door policy: I encourage you to come on an as needed basis any time.
Class Hours & Modality:	MWF 11:15 – 12:05, Humanities Hall Room 358; in-person; you may leave class if I have not arrived after 15 minutes

Course Mode of Delivery

This section gives you the big picture of how we are going to do the course. Most importantly, talk to me if anything comes up that impacts your ability to meet course expectations. I can only help if you let me know!

This is a traditional physics class. I will work out the physics on the board and will discuss its meaning with the class.

This is an in-person class and in-person attendance is expected if you don't have an online-only accommodation. The class will not be recorded, except if warranted by special circumstances. I will treat you as professionals and won't police attendance but will certainly make sure that you don't miss too many classes.

Doing problems is critically important to understand the material (and physics in general). As such, ***weekly/biweekly homework*** will be assigned and graded. You will get feedback on your assignments and (most) solutions will be made available.

There will be one midterm exam (tentatively on Wed, October 11) and one final exam (on Tue, Dec 12). The date of the final exam may be moved to earlier December due to travel.

This Syllabus applies to all sections of PHYS 4200 and PHYS 6200, if not stated otherwise. ***See the 6000-level requirements and honors requirement for special provisions.***

Course Information

Course Rationale: The course is intended as an introductory class for third- or fourth year undergraduates studying atmospheric physics as part of a physics degree and for graduate students in their early stages of studying atmospheric physics. It is also useful for undergraduate students of applied mathematics, physical chemistry and engineering who have an interest in the atmosphere. The emphasis of the course is on the underlying physics including atmospheric thermodynamics, radiative transfer, atmospheric fluid dynamics and elementary atmospheric chemistry. For details see the table of contents in the book by Andrews. The course will cover the whole book. Atmospheric applications are developed mainly through selected in-class examples and through homework problems. While the course will mainly address the troposphere, stratosphere, and mesosphere, that is, the region between the ground and about 90 km altitude, some topics will be expanded to include the thermosphere and the atmospheres of the Earth-like planets Mars and Venus. Some atmospheric measuring techniques, while not the focus of the course, will also be introduced as appropriate.

Objectives and Learning Outcomes:

1. Be able to apply basic thermodynamic concepts, Newton's laws, conservation laws and basic electrodynamics to explain the structure and general circulation of the atmosphere.
2. Demonstrate a quantitative understanding of the relationships among physical variables describing atmospheric structure and dynamics, such as temperature, pressure, density and winds through application of algebra and simple calculus to their governing equations.
3. Be able to apply the principles of energy transfer by electromagnetic radiation and basic molecular spectroscopy to determine heating and cooling rates in the atmosphere. This includes obtaining and applying the radiative transfer equation.
4. From basic fluid dynamics, obtain the Navier-Stokes equation on a rotating sphere in various coordinates, approximations and simplifications and apply it to general problems in atmospheric dynamics including vorticity, waves, and instability.
5. Apply the thermodynamical, radiative and dynamical concepts above to explain the chemical structure of the stratosphere, including the ozone hole and catalytic cylcles.
6. Be able to apply the key concepts above to physically explain climate change.
7. Recognize standard remote-sensing and in-situ measuring techniques and be able to discuss their strengths and weaknesses for attacking specific questions in atmospheric physics.

Course Outline: The book from Andrews includes 9 chapters and we will spend most of the time on chapters 1-6. Chapters 7-9 are special topics (techniques, climate change, modeling) that the atmospheric and space physics groups covers in separate courses. However, we will still touch on the basic there, too.

- ***Class:*** In each lesson, you will learn the key topics from the course material in the book by Andrews. You are expected to read the relevant text ***before each class***.

- ***Homework:*** These assignments will give you the chance to apply what you have learned and to demonstrate development of your skills related to the course content. You will turn in a ***handwritten*** solution during class. Typed homework solutions are a waste of time and will not be accepted. Each assignment will include questions related to the textbook material. These assignments will be your homework grade and you will have one week to turn in your solution. Homework will be assigned every 1-2 weeks, depending on the material. I anticipate roughly 7-8 assignments**.**
- ***Canvas:*** We are not going to use Canvas a lot but I will post homework solutions and other docs (like the syllabus or notetaking instructions) there.

Method of Teaching: This is a lecture course based upon a textbook. You should prepare by reading the chapters and try to solve as many problems as possible. Exams will be administered in class.

Grading: Assignments in this course are divided into these general categories, which carry the following weight in your final grade calculations:

Category	Weight
Written Homework	40%
Midterm exam	30%
Final exam	30%

There will be ***one midterm exam*** (tentative date: Wed, October 11 during class) and one ***final exam*** (tentatively Tue, Dec 12). The final exam date may need to be move to early December to accommodate travel plans by the instructor and students. Exams are closed book and no notes. However, you will be allowed to prepare your own equation sheet (1 page, front and back, handwritten) for the exams.

The ***one lowest homework score will be*** dropped for the final grade calculation. ***Late homework won't be accepted*** if you do not give me a very good reason.

You are treated as a professional in the course. Accordingly, the grading is strict, but fair. Reading the directions and grading criteria provided for each assignment is the key to understanding how you will be graded.

Letter grade: A: 85-100%; B: 70-85%; C: 55-70%; D: 40-55%; F:<40%

Required Textbook: *An Introduction to Atmospheric Physics* (Second Edition) by David G. Andrews; Cambridge University Press, ISBN 978-0-521-69318-9, 2010, 237 pages; List Price ~US$ 75; it is important that you have the 2nd edition. **The lecture will follow this book!**

Web Sites: The course web site is on Canvas, accessible at https://clemson.instructure.com/courses/204275. There is only one Canvas site for all

sections of PHYS 4200 and PHYS 6200. It will be used to post homework solutions, class notes, and some needed material such as the syllabus – so, essentially a file repository.

Honors Section Requirements

If you're in the honors section, you are required to complete **one** longer assignment towards the end of the semester. This will be an approximately **5-page comprehensive summary** of a topic not covered in class. The summary should be written in the style of lecture notes. You will be given **~30 minutes in class and then teach this material to the full class**. I may ask you for minor/major revisions of the summary as needed. The assignment counts toward the written homework result and will be graded as unsatisfactory, satisfactory after major revision, satisfactory as is/after minor revision. For an unsatisfactory assignment, 10% will be deducted from your written homework result (e.g., 90% in the written homework will be downgraded to 80%). For a satisfactory after major revision assignment, the deduction will be 5%. A satisfactory as is/after minor revision assignment will result in no deduction.

6000-level Requirements

If you are in the 6000-level course, you're generally expected to demonstrate a higher (MS) level of competency. As such, you may get a (partially) different set of homework problems and/or exam questions. In addition, you will be assigned one project related to a special topic. There will be 3-4 weeks of time to study the subject including further reading of more advanced textbooks and contemporary scientific literature and to turn in a comprehensive write-up of at least 10 but not more than 15 pages. The write-up will be graded and counts 50% of the homework grade. Projects will be assigned after the midterm break.

Course Policies

Prerequisites: MATH 1080 AND PHYS 2080 or PHYS 2210; or consent of the instructor.

Attendance Policy: This course is designed for active in-person learning and engagement. Attendance and active participation in this course will provide the most benefit for learning. Since you are treated as professionals in the course, ***attendance is not required but highly recommended. I reserve the right to drop any student from the course who stops attending/participating for extended periods of time***

Any exam that was scheduled at the time of a class cancellation due to inclement weather will be given at the next class meeting unless contacted by the instructor. Any assignments due at the time of a class cancellation due to inclement weather will be due at the next class meeting unless contacted by the instructor. Any extension or postponement of assignments or exams must be granted by the instructor via email or other means of communication within 24 hours of the weather-related cancellation.

University Policies

Academic Integrity: The Clemson University statement on academic integrity reads: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating or stealing in any form."

Student Accessibility Statement: Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the instructor know and are encouraged to request accommodations through SAS (Student Accessibility Services) as soon as possible. To request accommodations through SAS, please see this link: https://www.clemson.edu/academics/studentaccess/register.html. You can also reach out to SAS with questions by calling 864-656-6848, visiting SAS at the ASC Suite 239, or stopping by the office as a drop-in appointment.

Clemson University Title IX Statement: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This Title IX policy is located on the Access and Equity website. Ms. Alesia Smith is the Clemson University Title IX Coordinator, and the Assistant Vice President of Equity Compliance. Her office is located at 223 Brackett Hall, 864-656-3181 and her email address is alesias@clemson.edu. Remember, email is not a fully secured method of communication and should not be used to discuss Title IX issues.

Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency: (a) Ensure you are signed up for emergency alerts (https://www.getrave.com/login/clemson), (b) Download the Rave Guardian app to your phone (https://www.clemson.edu/cusafety/cupd/rave-guardian/), (c) Learn what you can do to prepare yourself in the event of an active threat (http://www.clemson.edu/cusafety/EmergencyManagement/)