

Introduction to Atmospheric Physics

PHYS 475 (UG) Cross-listed with PHYS 575 (Grad)

Exploratory Hall, Room 1004

Spring Semester, 2023

Mondays, 7:20-10:00 pm

DRAFT: January 23, 2023

Catalog description: Introduction to the basic physical and chemical processes that operate in the Earth's atmosphere. Emphasis is on those concepts that provide description of the atmosphere's state, and those processes that relate to global change and atmospheric evolution. Topics include equilibrium structure, thermodynamics, radiation, dynamics, and other important physical processes.

Introduction

This course will focus on the physical processes that control the state, variability, and long-term evolution of the atmosphere. Topics will include an overview of the history of the Earth's atmosphere, and the Earth's atmosphere in the context of comparative planetary atmospheres.

Topics Include:

- **Atmospheric thermodynamics**
- **Hydrostatics**
- **Phase transformations of water**
- **Radiation transfer**
- **Spectroscopy**
- **Cloud physics**
- **Atmospheric chemistry**
- **Atmospheric motions**
- **Climate Change**

Specific Course Goals:

To provide the student with:

- 1) an overview of the physical and chemical processes which control the state and evolution of planetary atmospheres.
- 2) an understanding of the key scientific discoveries and remaining unanswered questions in atmospheric science.
- 3) an overview of the primary scientific principles and analytical tools used in atmospheric science studies, including both remote and *in-situ* techniques.

Instructor and Contact Information

Michael E. Summers

Professor of Planetary Sciences and Astronomy

Planetary Hall, room 235

Email: msummers@gmu.edu

Office Hours (Always with appointment please!): Tuesdays: 2-3pm.

You are encouraged to contact me if you are having any problems with the course, have questions on the material, or have any questions about atmospheric science in general.

Please schedule a time in advance, so that I can be sure to be available and plan sufficient time for discussion. I have a complicated schedule this semester, and I occasionally get called into unplanned and unexpected meetings. Thus, I cannot promise to be available every day during office hours - so appointments are essential. If you cannot talk during normal office hours, then I will set up another time to meet with you that is mutually acceptable.

Course Blackboard website: <https://gmu.blackboard.com/>

In order to comply with student privacy laws, faculty and students need to use their GMU email accounts when corresponding with each other.

Course format:

- (1) **Lectures** covering material in the Wallace and Hobbs text.
- (2) **Homework** assignments designed to illustrate various aspects of topics encountered the lectures. **Homework submissions by phone will not be accepted**
- (3) **Reading assignments** both from the text and supplemental material
- (4) **Quizzes** on the reading assignments. **THERE ARE NO MAKEUPS ON QUIZZES**
- (5) **Two in-semester exams**
- (7) **A term paper/project** that focuses on a topic in atmospheric sciences chosen by the student in consultation with the instructor.

Class notes will be posted on GMU Blackboard, usually after the lecture. Access to course is via Blackboard with your GMU login and password.

Quizzes: A very short quiz on the assigned reading will be given about once a week. These quizzes will typically be 5-10 questions and take about 5 minutes, assuming you have read the assigned material. The signed quiz will stand for the attendance. You should expect a quiz each lecture over the assigned readings.

AGAIN: THERE ARE NO MAKEUPS ON QUIZZES. I WILL DROP YOUR LOWEST QUIZ SCORE TO ACCOUNT FOR UNEXPECTED ABSENCES.

Class lecture notes, as well as additional readings, will be posted on GMU Blackboard.

- You are responsible for reading and understanding all the material in the required text, as well as all additional readings.
- Read the assigned material BEFORE in-class discussion.
- Participate in classroom discussions!
- Attending class is essential to successful completion of this course.

Lectures: The lectures will follow the chapters of the text; additional materials that represent recent developments in atmospheric science will also be presented. You are responsible for

all of the material covered in the lectures in addition to that in the assigned readings. Again, you should read the assigned material BEFORE they are discussed in class.

- **As a rule of thumb - you should spend at least as much time studying on your own as you spend in the classroom.**
- **Please be on time for the online lectures. Arriving late will negate your opportunity to take the quiz and be counted in attendance.**
- **Availability of Lectures and Presentations:** After each lecture, I will post the lecture PowerPoint file on Blackboard that contains that day's presentation which you can download.

PLEASE DO NOT SHARE ANY COURSE CONTENT WITH ANYONE OUTSIDE OF OUR CLASS! THIS MATERIAL IS PROPRIETARY AND IS THE TOPIC OF A BOOK IN PREPARATION.

Exam and Homework Policies:

- Anyone caught cheating on an exam or quizzes will be given a zero for that exam/quiz and will be referred to the George Mason University Honor Council.
- All exams/quizzes are closed book, computer, phone, and notes, etc.
- Generally, late homework is not accepted. Students might be permitted to submit late homework on a case-by-case basis.
- If you have a conflict and cannot take an exam on the scheduled day, let me know ahead of time.
- Late exams will be permitted with an acceptable explanation and if performed within one week of the original exam.
- Make-up exams must be scheduled IN ADVANCE with instructor permission.
- Homework is mainly from end-of-chapter questions.

Attendance: Because you are responsible for ALL of the assigned materials AND announcements (including exam information, and e.g., change in dates), attending class is essential. Oral announcements made in class are binding and it is your responsibility to find out what has occurred in any class you might miss.

Required Text:

Atmospheric Science, An Introductory Survey, 2nd Edition, John M. Wallace & Peter V. Hobbs, Academic Press, 2006, ISBN 0-12-732951-X

Tentative Course Schedule

First day of class: Monday, January 23, 2023

Last day course meets: Wednesday, May 1

Spring Break: March 13-18

Tentative Weekly Schedule: Numbers corresponds to Chapters in Wallace & Hobbs:

(1,2) Introduction and Overview of the Atmosphere

(3) The Earth System

(4,5) Atmospheric Thermodynamics

- (6) Atmospheric Radiation
- (7) Atmospheric Chemistry
- (8,9) Clouds
- (10) Atmospheric Dynamics
- (11) Weather – brief coverage
- (11) The Boundary Layer – brief coverage
- (12) Climate History
- (13) Climate Change (IPCC Reports: <http://ipcc.ch/>)
- (14) Future Climate Expectations

This will be a fast-paced course! It is very important to keep up with the chapter readings.

Religious Holidays and Observations:

<http://ulife.gmu.edu/calendar/religious-holiday-calendar/> is available to help minimize difficulties for students of different faiths. **It is the student's responsibility to speak to the instructor in advance should their religious observances impact their participation in class activities and assignments.**

Course Policy and Grading:

	PHYS 475 - Undergraduate	PHYS 575 - Graduate
*Homework:	30%	20%
**Two exams:	30%	20%
Term Paper/Project:	30%	50%
***Participation (Quizzes):	10%	10%

Numerical Grade Ranges:

- A: 90-100%
- B: 80-90%
- C: 70-80%
- D: 60-70%
- F: Below 60%

Quizzes – Expect a very short quiz on the reading assignment each week. AGAIN – THERE ARE NO MAKEUPS ON QUIZZES, BUT I WILL DROP YOUR LOWEST QUIZ GRADE. Make-up exams must be scheduled IN ADVANCE, with instructor permission.

Tentative Exam Schedule:

- Exam #1: March 6**
- Exam #2: May 1**
- Final Exam: May 15, 7:30-10:10pm**

Term Paper Presentations

Final papers due at the time scheduled for the Final Exam

Course Participation (10% of grade):

Each week there will be assigned reading, typically from the Wallace & Hobbs text. There will be frequent short quizzes, typically 4-5 questions on the assigned reading. The quiz will stand for your attendance. There will be approximately 10-12 quizzes in the semester. The attendance & quiz grade will count for the class participation grade (10%).

Classroom conduct: Discussions, whether face-to-face or electronic, should be conducted with a high level of respectful civil discourse. Disruptive behavior, whether in person or in a virtual classroom environment, may result in a student being asked to leave the class, or temporarily barred from participating in class activities.

Makeup Policy:

Students will be permitted to submit late homework on a case-by-case basis. Late exams will be permitted if with an acceptable explanation and if performed within one week of the original exam. Late term papers will not be accepted. If the student does not submit the final paper at the time scheduled for the final exam, and an incomplete grade is not pre-approved by the instructor, then an F will be filed for the student.

Term Paper/Project:

A term paper is required in this course. The goal of the term paper is to study a specific topic or area of research in much more depth than that covered in the regular course lectures. The topic is chosen by the student and must be approved by the instructor. Generally, the term paper topic will be related to topics discussed in the lectures, but a fair degree of latitude will be allowed in the choice of topic. I will be glad to help students pick a topic, to narrow its focus, and to help find reference materials. Students are encouraged to choose a topic that fascinates them and to begin working on their paper within the first few weeks of the semester. Students will be expected to give the class a brief update every 2-3 weeks. Term papers are almost always the highlight of the course.

The term paper must follow standard guides for research papers, and have the following sections:

Abstract: This should be an overview of what has been done and the results of your project.

Introduction: This explains why this project is of interest and what the goals of the paper are. In addition, any relevant historical and/or scientific background for the paper will be included here.

Body of Paper: This section describes the main research topic that you have chosen. Be sure to include a clear statement of the scientific topic, methods, observations, and current understanding or theory. This section should include a significant number (10-15) references to primary scientific literature and/or review articles. Please include figures and their corresponding captions within the body of the paper.

Conclusions: This should be a short statement of what you have learned from your study.

References: Bibliography is essential and will be considered in grade.

The paper must be typed, double spaced, and have ~ 20-25 pages of text, and at least 3 figures (may have more, include captions for all figures). **Please number all pages.**

Graduate Student Requirements:

Graduate students are expected to complete all the reading and homework assignments expected of the undergraduates, and in addition participate in all classroom discussions. On the homework assignments, the level of work for PHYS-575 students is expected to be appropriate to that for typical graduate level courses.

Term paper/project – important dates:

Title/topic due – Monday, February 13

Abstract (1 paragraph), outline, and key references –March 6

Final paper due at Final Exam Date/Time

Additional recommended books:

Physics and Chemistry of the Solar System, 2nd Edition, J.S. Lewis, Academic Press, 2004.

Theory of Planetary Atmospheres, 2nd Edition, J.W. Chamberlain, D.M. Hunten, Academic Press, 1986.

Photochemistry of Planetary Atmospheres, Y.L. Yung, W.B. Demore, Oxford, 1998.

Earth: Evolution of a Habitable World, J. I. Lunine, Cambridge, 1998.

Astrobiology, a Multidisciplinary Approach, J.I. Lunine, Addison-Wesley, 2004.

Useful websites:

American Meteorological Society:

<http://www.ametsoc.org/>

National Aeronautics and Space Administration:

<http://www.nasa.gov>

National Oceanic and Atmospheric Administration:

<http://www.noaa.gov/>

The Weather Channel:

<http://www.weather.com/>

NASA: Updates on all US space missions:

www.nasa.gov

The exo-planet encyclopedia:

<http://exoplanet.eu/>

The Intergovernmental Panel on Climate Change:

<http://ipcc.ch/>

Students with Disabilities:

If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Resources at 703/993-2474.

All academic accommodations must be arranged through that office.

George Mason University Honor Code:

<http://www.gmu.edu/departments/unilife/pages/honorcode.html>

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously, and violations are treated gravely.

What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form.

Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind), please ask for guidance and clarification.

To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the University Community have set forth this:

Student members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

If you have questions about the meaning of these terms, please ask. We expect you to hold to this standard by carefully citing sources used in your work and by doing your own work on tests and individual assignments.

At a minimum follow these guidelines:

- Work identified as individual should be strictly your own.
- Cheating on exams or presenting another's work as your own (plagiarism) will result in a zero grade for the assignment.
- **YOU SHOULD EXPECT THAT ALL MATERIAL SUBMITTED IN WRITING WILL BE SCANNED WITH PLAGIARISM CHECKING SOFTWARE. PLAGIARISM WILL BE FORWARDED TO THE HONOR COUNCIL.**
- Material that is drawn from written or electronic sources must be appropriately cited. For on-line discussion it is usually enough to simply reference a text page or web site. In a paper, a bibliography and appropriate in-text citations are mandatory. If in doubt about how to do this contact an instructor.

ADDITIONAL NOTES

- **If you email me, please remember to include your name and the course that you are taking.**

- **There are no makeups on quizzes.**
- **I do NOT accept any work by phone images.**