

PHYSICAL METEOROLOGY

ATMS 455

SPRING 2024

Physical meteorology refers to the study of optical, electrical, acoustic, and thermodynamic phenomena, atmospheric composition and radiative properties, and cloud and precipitation physics. This course will visit many of these fascinating topics and you will develop a solid understanding of the physical processes influencing various atmospheric phenomena. The topics that you study here will likely provide a firm foundation for the specialized subjects that you may encounter later in your career. Ask lots of questions and have fun!



PROFESSOR

Dr. Christopher Godfrey

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Office hours: **3:45–4:45 p.m. Wednesdays** and **12:45–1:45 p.m. Thursdays**, or by appointment. You may call my office (it bounces to my cell phone) during regular business hours. You may send me as many email messages as you wish. If my door is open at any other time, please drop in.

CLASS INFORMATION

Meeting times: MW 2:00–3:15 p.m.

Location: Robinson Hall, room 238

Required text: None.

Optional text: Wallace, J. M., and P. V. Hobbs, 1977: *Atmospheric Science: An Introductory Survey*. Academic Press, 467 pp. (First or second edition)

Prerequisite: ATMS 305: Atmospheric Thermodynamics and Statics

Website: <https://www.atms.unca.edu/cgodfrey/courses/atms455/>

GETTING QUESTIONS ANSWERED

I will be either in my office or available on Google Meet during scheduled office hours (find the QR code on my door). Just drop in. If at any other time you have a question and my office door is open, you are more than welcome to visit. Otherwise, email is by far the best way to reach me and you will usually get a speedy reply. You may also schedule an appointment with me. Please don't hesitate to ask questions about class, other coursework, or the stresses of college life whenever the need arises.

IMPORTANT DATES

Monday, 26 February 2024	Exam I	2:00–3:15 p.m.
Friday, 8 March 2024	Research paper draft deadline	Individual meetings
Wednesday, 3 April 2024	Exam II	2:00–3:15 p.m.
Monday, 22 April 2024	Research paper due	5:00 p.m.
Wednesday, 8 May 2024	Final Exam *	11:30–2:00 p.m.

*Out of fairness to all, those who are graduating this semester may not take the final exam at a different time.



COURSE OUTLINE

This course outline is subject to modifications, depending on the interests of the class and available time.

1. Composition and structure of the atmosphere
 - a. Atmospheric composition
 - b. Properties of atmospheric layers
 - c. Gravitational effects
 - d. Variation of pressure, temperature, and density with height
2. Atmospheric optics
 - a. Perspective phenomena
 - b. Terrestrial refraction and its optical effects
 - c. Astronomical refraction
 - d. Refraction by particulates—rainbows and halo phenomena
 - e. Diffraction phenomena—coronas and glories
 - f. Rayleigh scattering
3. Solar and terrestrial radiation
 - a. Properties of radiation and radiation laws
 - b. The solar spectrum
 - c. The spatial and temporal distribution of solar energy
 - d. Longwave radiation and the greenhouse effect
 - e. Surface and global energy budgets
4. Cloud microphysics
 - a. Atmospheric aerosols
 - b. Cloud droplet growth
 - c. Cold cloud microphysics
 - d. Meteorological radar principles
5. Meteorological acoustics
 - a. Sound propagation in the atmosphere
 - b. Refraction of acoustic energy
 - c. Sounds of meteorological origin
6. Atmospheric electricity
 - a. Fundamental principles of electrostatics
 - b. Origin and distribution of ions
 - c. Charge separation in clouds
 - d. Lightning



EVALUATION

There will be two preliminary exams and a comprehensive final exam to assess your progress through the semester. The preliminary exams will take place during the class meeting times. Several problem sets will strengthen your skills and reinforce the lecture material. These problem sets will be assigned as we make sufficient progress on each topic, but you can expect approximately one problem set every one and a half to two weeks and you will have one week to complete each assignment. You will also prepare a research paper to gain an even deeper understanding of a particular topic with the additional goal of learning how to review scientific literature and prepare references.

There will be no opportunities for make-up exams. Exams must be taken on the scheduled date and at the scheduled time. If you miss the exam, you miss the grade. The *only* exceptions to this rule are: (1) serious medical condition (illness or injury) of you or an immediate family member; (2) University excused absence; (3) jury duty; or (4) military orders. Only in such instances will an exam be dropped or rescheduled depending on your best interests, but *only if I am notified at least 24 hours in advance*. Except under the circumstances described above, **homework is due at 5:00 p.m.** on the scheduled due date. I will accept homework up to 24 hours late (5:00 p.m. the following day) for a 50% late penalty. *Homework more than 24 hours late will not be graded.* In the event of an unforeseen circumstance that causes you to miss an exam or homework due date, *you must notify me by phone or e-mail within 24 hours of the event.* Appropriate documentation must accompany any excused absence and should be attached to a late homework assignment. Please review the guidelines for submitting homework, available on Moodle, prior to submitting your first assignment.

RESEARCH PAPER

Please prepare a brief paper (4–6 pages) based on current peer-reviewed scientific literature (i.e., recent books or journal articles) that reviews or discusses a topic from the field of physical meteorology. Your goal is to explain to the reader the current state of the scientific literature on your subject (i.e., you are writing a literature review). You may select the topic from the lecture material or choose something in which you have a particular interest. This is a wide range of topics since the scope of physical meteorology generally includes almost any process or phenomenon of the atmosphere with the exception of dynamic processes. The paper must include a reference list prepared following AMS guidelines. Electronic submission via Moodle is required. See the class website for a list of potential topics and further information.

I will review a printed draft of your research paper during a 15-minute one-on-one virtual meeting that you will schedule with me on or before 5:00 p.m. on Friday, March 8. I expect that most meetings will occur during the week of March 4, but we can meet earlier if you wish. The goal is to provide you with some tips and identify trouble spots so that the final draft meets my expectations. I will assign grades for this meeting using the following criteria:

- A (100 pts): Complete draft of four to six pages with at least five peer-reviewed references.
- B (90 pts): Three to five pages and/or fewer than five peer-reviewed references.
- C (75 pts): One to two pages with inadequate references.
- D (60 pts): Show up to the meeting with a topic, but with less than a page of writing and/or inadequate references.
- D- (50 pts): Show up to the meeting without a research topic.
- F (0 pts): No appointment or fail to show up to an appointment.

GRADING

Preliminary Exams	30%
Homework Assignments	30%
Research Paper (draft)	5%
Research Paper (final)	15%
Final Exam	20%

I reserve the option to curve the final grades upward at my discretion. However, you are guaranteed *at least* the following based on your final score before applying any curve:

A	≥92.0%	C	72.0–77.9%
A-	90.0–91.9%	C-	70.0–71.9%
B+	88.0–89.9%	D+	68.0–69.9%
B	82.0–87.9%	D	60.0–67.9%
B-	80.0–81.9%	F	<60.0
C+	78.0–79.9%		

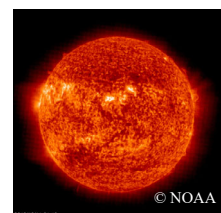
Final grades are not negotiable. If you see a problem with any other grade, you may plead your case no later than 14 days from the date I return the assignment to the class. I do make mistakes. Under no circumstances will your grade be *lower* if you see me with a question.

ACADEMIC INTEGRITY

Since the point of this or any class is to learn, you may collaborate on homework assignments, but *you absolutely must make sure that you hand in your own work*. Copying your friend's answers will not only be obvious to me, but will result in both of you sharing the credit for that answer. For example, if you do a fantastic job on a homework assignment and then let three of your friends copy *any part of it*, you will each receive a maximum grade of 25% for the assignment. Please do not plagiarize someone else's work and hand it in as part of your research paper. If you do so, expect to fail both the assignment and the course.

NOTES

Students with disabilities who require accommodations in this course are requested to speak with the professor as early in the semester as possible. Students requiring reasonable accommodations must register with the Office of Academic Accessibility by providing supporting documentation. The Office of Academic Accessibility is located in the OneStop Student Services Center, 011 Ramsey Library, phone (828) 232-5050.



PANDEMIC ADDENDUM

Students who attend class in-person instead of virtually tend to earn better grades. Yet common illnesses and new variants of the COVID-19 virus still circulate, and I want this and every classroom to be a safe and healthy place for everyone. Please always demonstrate respect for yourself, your classmates, your professor, and their families and friends. If you have been exposed to COVID-19, influenza, RSV, or any other illness (i.e., someone you have been around within the last three days has tested positive or displayed obvious symptoms), tested positive yourself within the past five days, or have any symptoms (e.g., fever, runny nose, congestion, sore throat, lethargy, etc.) please **DO NOT COME TO CLASS**. You can participate remotely via Zoom if you let me know of your need for a remote connection prior to 9:10 a.m. on the day of class. There will be *no penalty* if you need to participate remotely to promote safety!