

Atmospheres and Remote Sensing

PtyS 517 Spring 2019

Tuesday and Thursday from 11:00 a.m.-12:15 p.m. Once folks' schedules have settled down, we may arrange a time slot for some occasional make up classes.

Space Sciences 312

Instructor: Adam Showman, Space Sciences 432, 621-4021
showman@lpl.arizona.edu
Office hours: after class or by appointment.

Course Objectives: This course will provide an overview of the fundamental physical processes that govern the structure and behavior of atmospheres. The target audience is beginning graduate students in the planetary science department at the University of Arizona, although graduate students and advanced undergraduates from across the University are also welcome.

Approximate Outline:

Overview/statics [8 lectures]: Introduction to the current state and composition of atmospheres; motivation for some of the interesting problems in this field. Description of air; basic thermodynamics; physics of vertical structure.

Radiative transfer [9 lectures]: the nature of radiation; absorption and scattering of radiation by gases and particles; equations of radiative transfer; thermal structure of atmospheres in radiative equilibrium; retrieval of information from spectra of atmospheres.

Dynamics [9 lectures]: Equations governing the motion of air; dynamical regimes; physics of large-scale motion; waves; response of atmospheres to radiative forcing; turbulence.

Clouds physics [3 lectures]: Cloud types; moist adiabats; condensation; physics of particle growth and sedimentation; effects of clouds on the structure and motion of atmospheres.

Textbook: There is no required textbook. I will hand out detailed course notes that will serve as an informal textbook for the course. There are two recommended textbooks for supplementary reading. The first is *An Introduction to Planetary Atmospheres* by Agustin Sanchez-Lavega. This is a broad-scope textbook covering the basics of radiative transfer, dynamics, clouds, and other relevant topics. The second is *Planetary Climates* by Andrew P. Ingersoll, which is a small, "bedtime reading" book that gives a great overview of the current state of understanding in planetary atmospheres by one of its founding fathers.

You should also be aware of the following books, which provide more detailed looks at the various aspects we'll cover.

Overviews of atmospheric science

Atmospheric Science: An Introductory Survey by Wallace and Hobbs
Principles of Atmospheric Chemistry and Physics by Goody
The Physics of Atmospheres by Houghton
An Introduction to Atmospheric Physics by Andrews
Theory of Planetary Atmospheres by Chamberlain and Hunten
Principles of Planetary Climate by Pierrehumbert
Atmospheric Evolution on Inhabited and Lifeless Worlds by Catling and Kasting
Exoplanetary Atmospheres: Theoretical Concepts and Foundations by Heng
Exoplanet Atmospheres by Seager

Radiative transfer:

An Introduction to Atmospheric Radiation by Liou
Atmospheric Radiation: Theoretical Basis by Goody and Yung
A First Course in Atmospheric Radiation by Petty

Dynamics:

An Introduction to Dynamic Meteorology by Holton
Atmosphere-Ocean Dynamics by Gill
Geophysical Fluid Dynamics by Pedlosky
Atmospheric and Oceanic Fluid Dynamics by Vallis
Middle Atmosphere Dynamics by Andrews, Holton, and Leovy

Clouds and chemistry:

Microphysics of Clouds and Precipitation by Pruppacher and Klett
A Short Course in Cloud Physics by Rogers and Yau
Atmospheric Chemistry and Physics: from Air Pollution to Climate Change
by Seinfeld and Pandis
Photochemistry of Planetary Atmospheres by Yung and DeMore
Introduction to Atmospheric Chemistry by Hobbs

Prerequisite: The course is intended for introductory planetary science graduate students. Basic vector calculus and differential equations will be used, and basic familiarity with physics will be needed (some of this will be developed as we go along).

Grades: The grade will be based on several components, weighted as follows:

40% Homework
30% Midterm
30% Final

We will have approximately 7–8 homework assignments, whose goals are to give you quantitative practice with the concepts introduced in this course. It is fine to work together in

discussing the homework, but you should make sure that you do all of the problems and write up your homework yourself.

Course policies:

Feedback: Please let me know how you think the course is going. Suggestions for improvements and ideas for things to try (e.g., topics or activities you'd like to see) are both welcome.

Late work: If an assignment is due, you are responsible for turning it in, even if you are absent. All assignments are due at the beginning of class on the due date. Any assignments turned in after that time will be considered late. I will try to be understanding, but I reserve the right to enforce the following policy: Late assignments turned in within one week of the due date will receive one-half credit, after which they will receive zero credit. Please talk to me if you think you can't finish an assignment on time.

Special needs: Students with disabilities who require reasonable accommodations to fully participate in course activities or meet course requirements must register with the Disability Resource Center. If you qualify for services through DRC, bring your letter of accommodations to me as soon as possible.

Academic Integrity: It is strongly recommended that all students read the *University of Arizona's Code of Academic Integrity*. All students in this course are expected to abide by this code, which will be strictly enforced. Cheating will not be tolerated in any form. Submission of any written work that partially or fully duplicates material from the web, your fellow students, or any other source constitutes plagiarism. Students are encouraged to work together on the homework sets, but unique written responses must be handed in by each student. Instances of plagiarism will lead to a zero on that assignment, with harsher penalties for repeat offenses or extreme cases. Plagiarism on the midterm or term project will lead to a failing grade for the course.

Significant dates:

Thursday January 10: First class

March 2-10: Spring break, no class

Feb 28, March 12, March 14: possible midterm dates (negotiable)

Wednesday May 1: Last day of classes

Tuesday May 7, 10:30 a.m.–12:30 p.m.: Final exam slot