PTYS517 Atmospheres and Remote Sensing

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location/time: Kuiper Space Sciences 312, time: Mon/Wed 9:30 – 10:45am
office hours: after class or by appointment

Course Description

Atmospheres & Remote Sensing provides an overview of the physics and chemistry of planetary atmospheres, including thermodynamics, energetics, radiative processes, chemistry, and dynamics. The course introduces the characteristics and physical processes prevalent in the atmospheres of the Solar System and exoplanets. Processes are discussed in the context of current scientific questions regarding the structures and evolution of planetary and exoplanetary atmospheres. This course will also introduce the synergy between atmospheric theory, numerical modeling and remote sensing (using both ground- and space-based observations).

Course Prerequisites

All students are assumed to have a solid foundation in undergraduate physics and calculus.

Course Learning Objectives

Planetary Atmospheres is a vast subject and only a small subset of important topics will be discussed in this 16-week course. Upon completion of this course students will have an understanding of how thermodynamics, chemistry and the transport of radiation operate together to determine the basic structure of an atmosphere. Students will also gain a deeper understanding of selected topics that include: the establishment of the vertical temperature structures and composition, scattering, cloud formation, and dynamics. Techniques used in model atmosphere calculations and retrieval algorithms will be introduced and used to illustrate practical applications. Students will also understand the basic methods for retrieving information about an atmosphere from imaging and spectroscopic observations.

After completing this course a student will be able to:

- Explain the physical processes that determine the structure and composition of an atmosphere
- Explain the transfer of radiation through a planetary atmosphere
- Describe the physical and chemical processes that drive the broad diversity of atmospheres
- Assess observations and develop observing proposals, from testable hypothesis to submittable document
- Use and develop computational models to explore specific properties of an atmosphere

Schedule of Topics (see last page of this document)

Assignments and Examinations:

Projects: There will be several projects involving planetary atmosphere data and/or numerical modeling. Basic coding skills are required (you will not need to be an expert programmer but some previous experience writing and compiling code and making plots will be helpful). Students may discuss any aspect of their projects with other classmates, but the final product should be the result of individual work. A written summary of the project will be submitted along with all source code.

Class participation and presentations: Students may be required to give presentations about recent papers and/or their projects to the class. Presentations will be graded as well as the questions and discussions they raise during other student presentations (or guest lectures). You may be called upon to ask a question at the end of a presentations.

*Homework***:** There will be 5 homework assignments.

Midterm/Final Exams: There will be two “exams”, one at the mid-point and one a the end of the semester. Depending on class size, exams may be either oral or written. (TBD)

Grading Scale

Homework:	(5, 10pts each)
Projects	(3, 15pts each)
Exams	(2, 10pts each)
Presentation	(10pts)
Max total	125 points

The final grading scale will be as follows:

Points	Letter Grade
90 – 100	A
80 – 89.9	B
70 – 79.9	C
60 – 69.9	D
< 60	E

Required Texts or Readings
There is no required textbook. However, *Principles of Planetary Climate* (Pierrehumbert) and *An Introduction to Planetary Atmospheres* (Sánchez-Lavega) are useful references. A reading list will be updated through the semester. Various additional materials can be found on the course D2L page.

Graduate Student Resources
Students are encouraged to learn about University of Arizona-provided resources on the ASUA Basics Needs website: https://asuatoday.arizona.edu/basic-needs/overview

Nondiscrimination and Anti-Harassment Policy
The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see University of Arizona’s Nondiscrimination and Anti-Harassment Policy website.

Basic University Policies
University of Arizona’s course policies are detailed on the Syllabus Policies: website

Subject to Change Statement
Information contained in the course syllabus, other than the letter grade scale and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Safety on Campus and in the Classroom
For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT). University of Arizona affiliates can obtain training resources related to active shooter events through Edge Learning.

Approximate schedule of topics

Week	Dates	Topics
1	Jan 15 (no class Jan 20)	introduction, survey of solar system and exoplanet atmospheres (no class 1/20)
2	Jan 22	atmospheric thermodynamics
3	Jan 27,28	temperature structures, hydrostatic balance, lapse rates
4	Feb 3,5	composition (chemical equilibrium, LTE, kinetics, non-eq processes)
5	Feb 10,12	opacities and the absorption coefficient
6	Feb 17,19	radiation balance and intro to RT
7	Feb 24, 26	radiative transfer equation and methods
8	Mar 3,5	departures from local-thermodynamic equilibrium (non-LTE)
	Mar 8,16	Spring Break (no class)
9	Mar 17, 19	Convection and vertical mixing
10	Mar 24, 26	Scattering & clouds
11	Mar 31	Stratospheres, solar heating and escape
12	Apr 7,9	Dynamics
13	Apr 14, 16	Dynamics
14	Apr 21, 23	Climate: seasonal variation and long-term evolution
15	Apr 28, 30	model atmospheres and retrievals (codes and techniques)
16	May 5, 7	remote sensing (telescopes, spectrographs and observations)

Homework due dates:	by end-of-day Friday (weeks ~ 4, 7, 10, 13, 16)
Exam1	Week 7 (date TBD)
Projects 1,2,3	TBD
Exam2	Week 16 (date TBD)
Presentation Day(?)	Week 12 (date TBD)

The schedule of topics, assignments, exams, etc. are subject to change.