Atmospheric Radiation

ATS 622–001, Department of Atmospheric Science
11:00 – 11:50 Mondays and Wednesdays, ACRC 212B
2018 Spring Term

Instructor Contact Information

Prof Christine Chiu
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ACRC 203
Office hours: By appointments

Teaching Assistant Contact Information

TBD

Course Description

This is an introductory graduate level course on fundamentals of electromagnetic radiation and the radiative properties/processes involving the atmosphere, aerosols, clouds, and precipitation. This course introduces crucial laws and mechanisms in radiation transfer; demonstrates how they drive and influence our climate system; and relates these fundamentals to well-defined research questions. The main teaching method is lectures, with assignments and team project that aim to develop students' practical skills. Assignments are designed for students to reflect the level of understanding, while team project is designed to promote peer instructions and students' critical thinking. No prerequisite is needed.

Course Goals

Students who complete this course successfully will be able to:

- Describe and explain theoretical principles of radiative processes, focusing on solar and terrestrial radiation.
- Quantify radiative effects, heating/cooling rates, and interpret their roles in the Earth's radiation energy budget.
- Apply knowledge of atmospheric radiation and develop radiative transfer simulations for relevant research topics.

Course materials

Lecture slides and detailed notes will be available on Canvas in due course. The instructor uses the following textbooks (copies available in the library) to supplement lectures:

- Petty, G. W., 2006: A First Course in Atmospheric Radiation, Sundog Publishing, 472 pp., available from http://www.sundogpublishing.com.
- Liou, K.-N., 2002: An Introduction to Atmospheric Radiation, Academic Press, 583 pp.
- Coakley, J. and P. Yang, 2014: Atmospheric Radiation: A Primer with illustrative solutions, Wiley, 256 pp.
- Goody, R.M. and Yung, Y.L., 1995: Atmospheric Radiation: Theoretical Basis, Oxford University Press, 544 pp.
- Thomas, G.E. and Stamnes, K., 2002: Radiative Transfer in the Atmosphere and Ocean, Cambridge University Press, 548 pages.

Class Participation

Students' participation and engagement are strongly encouraged. All interactions and discussions in the classroom are aimed to provide a supportive and active learning environment for students.

Grading

- Assignment #1: **20 points**
- Assignment #2: **15 points**
- Mid-term Exam: **30 points**
- Class Team Project: **35 points**

Homework will be due at the date and times indicated. No late homework assignments will be accepted without prior approval. Mid-term exam is closed book and closed notes. Class team project requires students to program radiative transfer, deliver an oral presentation, and develop/answer project questions.

Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf) and the Student Conduct Code (http://www.conflictresolution.colostate.edu/conduct-code). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

Disclaimer

The instructor reserves the right to make modifications to this information throughout the semester.

Preliminary Schedule of Topics, Readings, and Assignments

Date	Topics / Assigned Readings	Deadlines
01/17 (W)	• Logistics • **Session 1: Overview –** why we should care about atmospheric radiation; its relevance to meteorology, climate, remote sensing	
01/22 (M)	Session 1 (continued)	
01/24 (W)	• **Session 2: Basis –** characteristics of electromagnetic radiation; definition of irradiance, radiance and solid angle; Planck function and related laws	
01/29 (M)	Session 2 (continued)	
01/31 (W)	Session 2 (continued)	
02/05 (M)	• **Session 3: The Sun**	
02/07 (W)	• **Session 4: Absorption, emission and scattering by a slab of atmosphere –** Beer's Law, Kirchoff's Law	
02/12 (M)	Session 4 (continued)	
02/14 (W)	• **Session 5: Scattering and absorption by particles in the atmosphere –** Rayleigh scattering, Mie scattering, Geometric optics; multiple scattering	
02/19 (M)	Session 5 (continued)	Assignment #1 due
02/21 (W)	Session 5 (continued)	
02/26 (M)	Session 5 (continued)	
02/28 (W)	• **Session 6: Equation of radiative transfer and its solutions**	
03/05 (M)	Session 6 (continued)	
03/07 (W)	Session 6 (continued)	
03/12 (M)	*Spring break – no class*	
03/14 (W)	*Spring break – no class*	
03/19 (M)	*Meeting – no class*	

Date	Topics / Assigned Readings	Deadlines
03/21 (W)	• **Mid-term exam**	2-hr exam
03/26 (M)	Session 6 (continued)	
03/28 (W)	Session 6 (continued)	
04/02 (M)	• **Session 7: Absorption and emission by atmospheric gases –** absorption mechanisms; vibration-rotation spectra, electronic spectra; line broadening; band models and correlated-k distribution	
04/04 (W)	Session 7 (continued)	
04/09 (M)	Session 7 (continued)	Assignment #2 due
04/11 (W)	Session 7 (continued)	
04/16 (M)	Session 7 (continued)	
04/18 (W)	• **Session 8: Radiative heating and cooling rate**	
04/23 (M)	• **Session 9: Radiative-convective equilibrium**	
04/25 (W)	Session 9 (continued)	
04/30 (M)	• **Session 10: The planetary radiation budget and the role of aerosols and clouds**	
05/02 (W)	Session 10 (continued)	
05/07 (M)	• **Project oral presentations**	
05/11 (F)	• **Quiz on team projects (online)**	