Atmospheric Radiation

ATS 622, Department of Atmospheric Science
10:00 – 10:50 Mondays and Wednesdays
ATS 101 (Large Classroom; Main ATS Building)

Instructor Contact Information

Prof. Steven Miller (Steven.Miller@colostate.edu)
Office hours: 2-3 pm on Tuesdays and 1-2 pm on Wednesdays
Location: ACRC 106

Teaching Assistant Contact Information

Spencer Jones (Spencer.Jones@colostate.edu)
Office hours: 2-3 pm on Mondays and Thursdays
Location: ACRC 110

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 basic laws and mechanisms in radiation transfer; demonstrates how they drive and influence Earth's climate system; and relates these fundamentals to well-defined research questions and applications. The main teaching method is lectures, with assignments that aim to develop students' comprehension and practical skills.

Course Goals

The objective of this course is to provide you a general, high-level understanding of how radiation interacts with Earth's atmosphere, to give you better appreciation for the underpinning importance of radiation to driving weather and climate, and to provide you with the essential tools for how we can use radiation to observe and characterize the Earth system remotely (i.e., preparing you for follow-on courses such as ATS 652 (Introduction to Remote Sensing), ATS 721 (Theoretical Topics in Radiative Transfer), ATS 737 (Satellite Observations of Atmosphere and Earth)), and ATS 753 (Global Hydrological Cycle). 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 assignment materials will be available on the class google drive.

The instructor uses the following textbooks (copies available in the library) to supplement lectures:

RECOMMENDED TEXT:

- Petty, G. W., 2006: A First Course in Atmospheric Radiation, Sundog Publishing, 472 pp., available from http://www.sundogpublishing.com.
- Stephens Radiation Course Notes (supplied by instructor)

OPTIONAL TEXTS:

- Stephens, G. L., 1994: Remote Sensing of the Lower Atmosphere, An Introduction, Oxford University Press, 523 pp.
- Liou, K.-N., 2002: An Introduction to Atmospheric Radiation, Academic Press, 583 pp.
- Coakley, J., P. Yang, 2014: Atmos Radiation: A Primer with illustrative solutions, Wiley, 256 pp.

Class Participation

Participation and engagement during prompts in class are encouraged. All interactions and discussions in the classroom are aimed to provide a supportive and active learning environment for students.

Grading

- Assignment 1: **10 points**
- Assignment 2: **10 points**
- Midterm Exam: **20 points**
- Assignment 3: **15 points**
- Assignment 4: **15 points (small groups)**
- Final Exam: **30 points**

Assignments will be due at the date and times indicated on the materials.

Please note that no late assignments will be accepted without prior instructor approval.

To ensure accessibility and inclusion, accommodations for students with established plans will be granted in accordance with guidelines of the CSU Student Disability Center.

A Note on the Exams

The examinations are designed to evaluate your comprehension of the material taught in the lectures and supported by the reading materials; they are not designed to trick you, intimidate you, or assess your ability to memorize the full derivations of complex equations.

Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy and the Student 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. You will be notified whenever important changes are made.

***Preliminary* Schedule of Topics and Assignments** *(Readings suggested prior to attending Lecture)*

Week #	Date (2024)	Lecture #	Topic	Assignments/Reading
1	1/17	INTRO	Course Intro	---
2	1/22	1	E/M Radiation Basics	Petty 2.1-2.6, 3.1-3.2
2	1/24	2	Radiometry Basics	HW1 Assigned (due 2/2) Petty 2.7
3	1/29	3	Planck Function	Petty 6.1-6.2
3	1/31	4	Intro to Radiative Transfer (RT)	Petty 7.1-7.3
4	2/5	5	RT Non-Scattering	Petty 8.1-8.2
4	2/7	6	Weighting Function	Petty 7.4
5	2/12	7	The Sun; Structure & Spectra	Stephens Notes Sec 5
5	2/14	8	The Sun; Insolation	Stephens Notes Sec 5
6	2/19	9	The Earth; Window-Gray	HW2 Assigned (due 3/1) Stephens Notes Sec 6
6	2/21	10	The Earth; Greenhouse	Petty 5.2 Stephens Notes Sec 6
7	2/26	11	Earth's Rad Budget (ERB)	Stephens Notes Sec 7
7	2/28	12	Clouds In the ERB	Stephens Notes Sec 7
8	3/4	13 / REVIEW	Intro Scattering / Midterm Review	Petty 4.2, 12.1
8	3/6	EXAM	Midterm Exam	--
9	3/11	BREAK	Spring Break	--
9	3/13	BREAK	Spring Break	--
10	3/18	14	Rayleigh Scattering	Petty 12.1-12.2
10	3/20	15	Mie Scattering	Petty 12.3
11	3/25	TA	Geometric Optics Scattering & HW Discussion: Mie Code	HW3 Assigned (due 4/5) Petty 4, 12.3
11	3/27	16	RT Single Scattering	Petty 11.1-11.2, 11.4
12	4/1	17	RT Multiple Scattering (2-Stream)	Petty 13.2-13.5
12	4/3	18	RT Doubling/Adding	Petty 13.7-13.8
13	4/8	TA	HW Discussion: SBDART	HW4 Assigned (due 4/26)
13	4/10	19	Intro Molecular Spectroscopy	Petty 8.3, 9.1-9.2
14	4/15	20	Gas Abs Line Broadening	Petty 9.3
14	4/17	21	Transmission: Line Models	Petty 10.1-10.2
15	4/22	22	Transmission: Band Models	Petty 10.2-10.3
15	4/24	23	Radiative Heating & Cooling	Stephens Notes Sec 11-12
16	4/29	24	Clouds & Aerosols in Radiation	Stephens Notes Sec 16
16	5/1	REVIEW	Course Review	--
17	5/6	EXAM	Final Exam (10 AM – 12 PM)	--