ATS 622 (Atmospheric Radiation)

Colorado State University, Department of Atmospheric Science

Lectures: 9:00 – 9:50 Tuesdays and Thursdays

Location: ACRC 212B

Instructor Contact Information

Prof. Steven Miller (Steven.Miller@colostate.edu)

Office hours: 11 am - 12 pm on Tuesdays, or by appointment
Location: ACRC 106

Teaching Assistant Contact Information

Spencer Jones (Spencer.Jones@colostate.edu)

Office hours: 2 - 3 pm on Tuesdays and Thursdays
Location: ACRC 212B

Course Description

This is an introductory graduate-level course on fundamentals of electromagnetic radiation and the radiative properties/processes involving the gaseous atmosphere, aerosols, moisture and clouds. We introduce basic laws and processes for how radiation flows (transfers), showing how radiation determines Earth's energy budget and how meridional imbalances drive the atmospheric circulation, weather and climate. We relate these fundamentals to basic research questions and as a basis for practical applications, including remote sensing. The main teaching method of this course is lectures, with assignments that aim to develop comprehension and hone practical skills.

Course Goals

The objective of this course is to provide you with a core understanding of how radiation interacts with Earth's atmosphere, to give you better appreciation for the underpinning importance of radiation in driving our weather and defining our climate, and to provide you with the essential tools for taking advantage of radiation to observe, measure, 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 will come out of this course being able to:

- Describe and explain theoretical principles of radiative processes, down to the atomic level, focusing on solar and terrestrial sources.
- Quantify the effects of radiation, including heating/cooling of the atmosphere, and understanding how Earth's energy budget drives atmospheric circulation.
- Relate the optical properties of an earth/atmosphere scene to its physical properties by understanding how radiation interacts with materials.
- Apply knowledge of atmospheric radiation toward develop simple radiative transfer models to support a variety of 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, 472 pp., available from Sundog Publishing. (ISBN-13:978-0-9729033-1-8).
- 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, inclusive and active learning environment for students.

Grading

- Attendance: **5 points**
- Participation: **5 points**
- Homeworks (4): **10 points each (40 total)**
- "Quiz-works" (10): **2 points each (20 total)**
- Final Exam (Take Home): **30 points**
- **TOTAL:** **100 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. Groups of up to 3 are allowed to work together on homework assignments, but please submit individual materials and answer in your own words where applicable. "Quiz-works" are to be worked on individually, and are meant to be short assessments of basic comprehension.

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

Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy and the Student Conduct Code. Any 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.

Schedule of Topics, Homework (H) and Quiz-work (Q) Assignments, & Readings

(Please Complete Readings Prior to Lecture)

Week #	Date (2026)	Lecture #	Topic	Assignments/Reading
1	1/20	00	Intro to Atmospheric Radiation	--
1	1/22	01	Radiation Basics	Petty 2.1-2.6, 3.1-3.2
2	1/27	--	**AMS Week <No Class>**	--
2	1/29	--	**AMS Week <No Class>**	--
3	2/3	02	Radiometry	Petty 2.7, H1
3	2/5	03	The Planck Function	Petty 6.1-6.2, Q1
4	2/10	04	Intro to Radiative Transfer (RT)	Petty 7.1-7.3
4	2/12	05	Non-Scattering RT	Petty 8.1-8.2, Q2
5	2/17	06	Atmospheric Weighting Functions	Petty 7.4
5	2/19	07	The Sun: Structure & Spectra	Stephens 5, Q3
6	2/24	08	The Sun: Insolation	Stephens 5
6	2/26	09	The Earth; Window-Gray Approximation	Stephens 6, Q4
7	3/3	10	The Earth; Greenhouse Effect & Role of Water Vapor	Petty 5.2 Stephens 6, H2
7	3/5	11	Earth's Radiation Budget (ERB)	Stephens 7, Q5
8	3/10	12	Clouds in the ERB	Stephens 7
8	3/12	13	Aerosols in the ERB	Stephens 16
9	3/17	--	**Spring Break**	--
9	3/19	--	**Spring Break**	--
10	3/24	14	Intro to Scattering: Dielectrics	Petty 4.2, 12.1, Q6
10	3/26	15	Rayleigh Scattering	Petty 12.1-12.2
11	3/31	16	Mie Scattering	Petty 12.3, H3
11	4/2	17	Geometric Optics Scattering	Petty 4, 12.3, Q7
12	4/7	18	Single-Scattering RT	Petty 11.1-11.2, 11.4
12	4/9	19	Multiple-Scattering (2-Stream) RT	Petty 13.2-13.5
13	4/14	20	Doubling/Adding, Monte Carlo RT	Petty 13.7-13.8, Q8
13	4/16	21	RT Emulator (S. Jones)	H4
14	4/21	22	Intro to Molecular Spectroscopy	Petty 8.3, 9.1-9.2
14	4/23	23	Gas Absorption: Line Broadening	Petty 9.3
15	4/28	24	Gas Transmission: Line Models	Petty 10.1-10.2.1, Q9
15	4/30	25	Gas Transmission: Band Models	Petty 10.2.2-10.3
16	5/5	26	Atmospheric Radiative Heating & Cooling	Petty 10.4 Stephens 11-12, Q10
16	5/7	27	Course Review	--
17	**5/11 (Mon)**	--	**Extended Office Hours** 11 AM – 1 PM	--
17	**5/12**	--	**Final Exam (Take-Home)** Assigned 12 PM; Due 5/13 12 PM	--