



# ATMOSPHERIC RADIATION AND REMOTE SENSING

## **INSTRUCTOR INFORMATION**

Instructor: Prof. Christine Chiu

Email: [Christine.Chiu@colostate.edu](mailto:Christine.Chiu@colostate.edu)

Meets in person Tuesdays and Thursdays 9:30 to 10:45 in Room 231 Scott Building.

Also meets online via Echo 360 (through Canvas)

Office Hours: by appointments

Communication Policy: Responses to emails will be provided within 48 hours

## **PREREQUISITES FOR COURSE**

PH 142, MATH 261

## **COURSE DESCRIPTION & OBJECTIVES**

Introduction to the role of remote sensing measurements in observing and monitoring land and ocean, atmospheric temperature, humidity, trace gases, aerosols, clouds, and precipitation. Coverage of the fundamentals of atmospheric radiation to explain a variety of remote sensing techniques, and hands-on experience in collecting real-world data to connect satellite remote sensing theory and practice for weather and climate variables. Upon the completion of this course, students will be able to:

- Summarize and contrast commonly used satellite orbits and scan strategies for applications in weather and climate sciences
- Explain and outline the fundamentals of how atmospheric radiation works and interacts with the Earth's environmental system
- Identify and formulate the physical principles of remote sensing observations that are based on extinction, emission, and scattering radiative processes
- Develop and evaluate retrieval methods for observing the Earth's environmental system using passive and active sensors

## **TEXTBOOK / COURSE READINGS**

G. W. Petty, A First Course in Atmospheric Radiation, 2006, 2nd Ed., Sundog Publishing.

<https://sundogpublishingstore.myshopify.com/products/a-first-course-in-atmospheric-radiation-g-w-petty>



## **COURSE MODULES**

This course is divided into five modules. These modules include readings, videos, questions for knowledge check, and a quiz from MetEd. The idea is to reduce stress by including many low-stakes assessments.

### **Module 1: Introduction**

- 1.1. What is remote sensing?
- 1.2. Why is remote sensing important for weather and climate sciences?
- 1.3. Characteristics of the atmosphere
- 1.4. Remote sensing platform and satellite orbit
- 1.5. Scan strategy and measurement resolution

### **Module 2: Extinction-based remote sensing principles and applications**

- 2.1. Properties of radiation
- 2.2. Irradiance, radiance, and solid angle
- 2.3. Planck function and related laws
- 2.4. Molecular absorption and emission
- 2.5. Direct transmission by a slab atmosphere: The basis
- 2.6. Direct transmission by a slab atmosphere: Beer's Law

### **Module 3: Emission-based remote sensing principles and applications**

- 3.1. Emission Radiative Transfer
- 3.2. Emission-based application: Remote sensing of sea surface temperature
- 3.3. Emission-based application: Remote sensing of sea ice
- 3.4. Emission-based application: Remote sensing of water vapor and clouds
- 3.5. Emission-based application: Remote sensing of cirrus cloud
- 3.6. Principles of atmospheric sounding

### **Module 4: Scattering-based remote sensing principles and applications**

- 4.1. Introduction to scattering
- 4.2. Overview of scattering regimes
- 4.3. Rayleigh scattering
- 4.4. Mie scattering
- 4.5. Scattering Radiative Transfer: Single scattering approximation
- 4.6. Scattering Radiative Transfer: The Adding and Doubling Method
- 4.7. Scattering-based application: Remote sensing of aerosols
- 4.8. Scattering-based application: Remote sensing of clouds
- 4.9. Scattering-based application: Remote sensing of precipitation

### **Module 5: Active remote sensing principles and applications**

- 5.1. Remote sensing of wind
- 5.2. Lidar remote sensing
- 5.3. Radar remote sensing

## COURSE MATERIALS & EQUIPMENT

Lecture notes, instructor-created videos, journal articles, access to Engineering computing cluster

## PARTICIPATION/BEHAVIORAL EXPECTATIONS

You should expect to spend at least three hours per week viewing the online materials (for online students) and an additional two to four hours per week doing readings and homework assignments. Please review the [core rules of netiquette](#) for some guidelines and expectations on how to behave in an online learning environment.

## COURSE POLICIES

Late assignments can be acceptable if you discuss with me in advance.

## GRADING POLICY

Grade	Range
A+	100% to 96.67%
A	<96.67% to 93.33%
A-	<93.33% to 90.0%
B+	<90.0% to 86.67%
B	<86.67% to 83.33%
B-	<83.33% to 80.0%
C+	<80.0% to 76.67%
C	<76.67% to 70.0%
D	<70.0% to 60.0%
F	<60.0% to 0.0%

As a student enrolled in this course, one of your responsibilities is to submit course work by the due dates listed in Canvas. With that said, I take my role as your instructor very seriously, and, in fact, I care about how well you do in this course and that you have a satisfying, rewarding experience.

To that end, it is my commitment to you to respond individually to the work you submit in this class and to return your work in a timely manner. Assignments will be returned within 7 days. (If, however, due to unforeseeable circumstances, the grading of your work takes longer than the times I have listed here, I will keep you informed of my progress and make every effort to return your work with feedback as soon as I can.)



ASSIGNMENT	GRADE POINTS	GRADE PERCENTAGE
Graded assignment #1 (individual)	10	10
Graded assignment #2 (individual)	20	20
Graded assignment #3 (group)	20	20
Class project (group)	30	30
In-class and MetEd Quizzes	20	20
<b>Total:</b>	<b>100</b>	<b>100 %</b>

\*Keep a copy of all work created for the course, including work submitted through Canvas course learning management system.

## CANVAS INFORMATION & TECHNICAL SUPPORT

Canvas is where course content, grades, and communication will reside for this course.

- [Login for Canvas](#)
- [Canvas Support](#)
- For passwords or any other computer-related technical support, contact the [Central IT Technical Support Help Desk](#).
  - (970) 491-7276
  - [help@colostate.edu](mailto:help@colostate.edu)

The [Technical Requirements](#) page identifies the browsers, operating systems, and plugins that work best with Canvas. If you are new to Canvas quickly review [the Canvas Student Orientation](#) materials.

## ACADEMIC INTEGRITY & CSU HONOR PLEDGE

This course will adhere to the CSU [Academic Integrity/Misconduct](#) policy as found in the General Catalog and the [Student Conduct Code](#). Academic integrity lies at the core of our common goal: to create an intellectually honest and rigorous community. Because academic integrity, and the personal and social integrity of which academic integrity is an integral part, is so central to our mission as students, teachers, scholars, and citizens, I will ask that you affirm the CSU Honor Pledge as part of completing your work in this course. Further information about Academic Integrity is available at CSU's [Academic Integrity - Student Resources](#).

## UNIVERSAL DESIGN FOR LEARNING/ACCOMMODATION OF NEEDS

I am committed to the principle of universal learning. This means that our classroom, our virtual spaces, our practices, and our interactions be as inclusive as possible. Mutual respect, civility, and the ability to listen and observe others carefully are crucial to universal learning.

If you are a student who will need accommodations in this class, please contact me to discuss your individual needs. Any accommodation must be discussed in a timely manner. A verifying



memo from [The Student Disability Center](#) may be required before any accommodation is provided.

The Student Disability Center (SDC) has the authority to verify and confirm the eligibility of students with disabilities for the majority of accommodations. While some accommodations may be provided by other departments, a student is not automatically eligible for those accommodations unless their disability can be verified and the need for the accommodation confirmed, either through SDC or through acceptable means defined by the particular department. Faculty and staff may consult with the SDC staff whenever there is doubt as to the appropriateness of an accommodative request by a student with a disability.

The goal of SDC is to normalize disability as part of the culture of diversity at Colorado State University. The characteristic of having a disability simply provides the basis of the support that is available to students. The goal is to ensure students with disabilities have the opportunity to be as successful as they have the capability to be.

Support and services are offered to student with functional limitations due to visual, hearing, learning, or mobility disabilities as well as to students who have specific physical or mental health conditions due to epilepsy, diabetes, asthma, AIDS, psychiatric diagnoses, etc. Students who are temporarily disabled are also eligible for support and assistance.

Any student who is enrolled at CSU, and who self-identifies with SDC as having a disability, is eligible for support from SDC. Specific accommodations are determined individually for each student and must be supported by appropriate documentation and/or evaluation of needs consistent with a particular type of disability. SDC reserves the right to ask for any appropriate documentation of disability to determine a student's eligibility for accommodations as well as in support for specific accommodative requests. The accommodative process begins once a student meets with an accommodation specialist in the SDC.

### **THIRD-PARTY TOOLS/PRIVACY**

Please note that this course may require you to use third-party tools (tools outside of the Canvas learning management system), such as Slack and others. Some of these tools may collect and share information about their users. Because your privacy is important, you are encouraged to consult the privacy policies for any third-party tools in this course so that you are aware of how your personal information is collected, used, and shared.

### **UNDOCUMENTED STUDENT SUPPORT**

Any CSU student who faces challenges or hardships due to their legal status in the United States and believes that it may impact their academic performance in this course is encouraged to visit [Student Support Services for Undocumented, DACA & ASSET](#) for resources and support.

Additionally, only if you feel comfortable, please notify your professor so they may pass along any additional resources they may possess.

## **TITLE IX/INTERPERSONAL VIOLENCE**

For the full statement regarding role and responsibilities about reporting harassment, sexual harassment, sexual misconduct, domestic violence, dating violence, stalking, and the retaliation policy please go to: [CSU Policy: Title IX Sexual Harassment](#).

If you feel that your rights have been compromised at CSU, several resources are available to assist:

- Student Resolution Center, 200 Lory Student Center, 491-7165
- Office of Equal Opportunity, 101 Student Services, 491-5836

A note about interpersonal violence: If you or someone you know has experienced sexual assault, relationship violence and/or stalking, know that you are not alone. As instructors, we are required by law to notify university officials about disclosures related to interpersonal violence. Confidential victim advocates are available 24 hours a day, 365 days a year to provide support related to the emotional, physical, physiological and legal aftermath of interpersonal violence. Contact the Victim Assistance Team at: 970-492-4242.

## **RELIGIOUS OBSERVANCES**

CSU does not discriminate on the basis of religion. Reasonable accommodation should be made to allow individuals to observe their established religious holidays. Students seeking an exemption from attending class or completing assigned course work for a religious holiday will need to complete the [Request Form](#) at least one full week prior to the event.

Once turned in, the Division of Student Affairs will review the request and contact the student accordingly. If approved, the student will receive a memo from the Dean of Students to give to their professor or course instructor.

Students are asked to turn in the request forms as soon as the conflict is noticed. Similarly, unanticipated conflicts requiring a religious observance, such as a death in the family, can also be reviewed.

## **CSU PRINCIPLES OF COMMUNITY**

**Inclusion:** We create and nurture inclusive environments and welcome, value and affirm all members of our community, including their various identities, skills, ideas, talents, and contributions.

**Integrity:** We are accountable for our actions and will act ethically and honestly in all our interactions.

**Respect:** We honor the inherent dignity of all people within an environment where we are committed to freedom of expression, critical discourse, and the advancement of knowledge.

**Service:** We are responsible, individually and collectively, to give of our time, talents, and resources to promote the well-being of each other and the development of our local, regional, and global communities.



**Social Justice:** We have the right to be treated and the responsibility to treat others with fairness and equity, the duty to challenge prejudice, and to uphold the laws, policies and procedures that promote justice in all respects.

## **DIVERSITY AND INCLUSION**

The [About webpage of the Vice President for Diversity](#) includes a comprehensive statement of CSU's commitment to diversity and inclusion.