CLIM/EARTH 411: Cloud and Precipitation Processes

Monday, Wednesday, Friday 9:00 to 10:00am
Location – In Person: *SRB 2424*
Instructor: *Dr. Claire Pettersen*
Email: *pettersc@umich.edu*
Office: *CSRB 2543A*
Class Website on Canvas: *https://umich.instructure.com/courses/496442*

Instructor office hours:

Synchronous:	In Office (CSRB 2543A) or the classroom (CSRB 2424) on Wednesdays 10:00 to 11:00am and Fridays 10:00 to 10:30am, Zoom via Canvas on Thursdays 2 to 3pm, or by appointment
Asynchronous:	Piazza, Monday - Friday

Course Information

Catalog description: Atmospheric thermodynamics related to cloud formation; the special nature of water substance; nucleation of phase changes in the free atmosphere; the structure and content of clouds; the development of physical characteristics of precipitation; and the dynamics of precipitating systems; applications of observing clouds and precipitation.
Credits: 3
Advisory prerequisite(s): CLIMATE/SPACE 350, MATH 216
Please consult with the Instructor if these prerequisites are not met

COURSE LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- Demonstrate an understanding of key physical processes essential in the formation of clouds and precipitation
- Assess different cloud types based on specific macro- and micro-physical characteristics such as location (vertical and spatial), size, hydrometeor phase, and texture
- Describe the role of aerosols in the formation of liquid droplets and ice particles within clouds as well as the impact of aerosols on cloud lifetime, climate, and precipitation
- Outline key differences between warm, cold, and mixed-phase cloud and precipitation processes

- Summarize and analyze different means of observing clouds and precipitation from a range of platforms (e.g., ground-based, airborne, satellite)

Course Details

Instructional Modality: In person, synchronous
Canvas Course URL: https://umich.instructure.com/courses/496442
Meeting time: MWF 9:00am – 10:00am Eastern Time Zone
Location: CSRB 2424

Required Textbooks/Chapters:

Authors: Rogers and Yau
Title: A Short Course in Cloud Physics, 3rd Edition
ISBN: 0-08-057094-1

Author: Houze
Title: Cloud Dynamics, 2nd Edition
ISBN: 0123568803

Author: Wang
Title: Clouds and Precipitation
ISBN: 1-107-23425-5

Recommended Textbooks/Chapters:

Authors: Wallace and Hobbs
Title: Atmospheric Science an Introductory Survey, 2nd Edition
ISBN: 0127329501

Authors: Cotton, Bryan, and van den Heever, 2nd Edition
Title: Storm and Cloud Dynamics
ISBN: 9780120885428

(All books and chapters are provided on Canvas under **Library Tools**)

Class discussions: This term we will be using Piazza for class discussion (please see Participation Expectations below). The system is highly catered to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to the teaching staff, you should post your homework or topic questions on Piazza. I will be active on Piazza Monday through Friday, but only student feedback should be expected on weekends. If you have any problems or feedback for the developers, email team@piazza.com. Course Pizza home page:

If you are not yet signed up, please sign up here:
https://piazza.com/umich/winter2022/climate411001wn2022

Tentative Schedule

This schedule is approximate and will possibly change during the semester. Updates will be reflected on Canvas.

Week	Dates	Topics	Theme	Reading	Assignments
1	Jan 5, 7	Introduction Cloud and Precipitation Types	*Applications*	PKW Ch 1 Houze Ch 1	
2	Jan 10, 12, 14	Intro to Applications Dry Thermodynamics	*Applications* *Atmospheric Thermodynamics*	PWK Ch 2 R&Y Ch 1 W&H Ch 3	HW #1 (Due Sunday)
3	Jan 19, 21	Dry and Moist Thermodynamics	*Atmospheric Thermodynamics*	R&Y Ch 1, 2 W&H Ch 3	*Final Project Consultation*
4	Jan 24, 26, 28	Moist Thermodynamics Buoyancy	*Atmospheric Thermodynamics*	R&Y Ch 2, 3 W&H Ch 3	HW #2 (Due Sunday)
5	Jan 31, Feb 2, 4	Buoyancy Convection Mixing	*Atmospheric Thermodynamics*	R&Y Ch 3, 4 W&H Ch 3	*Final Project Consultation*
6	Feb 7, 9, 11	Cloud Characteristics Aerosols	*Cloud Microphysics*	R&Y Ch 5, 6 W&H Ch 6 Pettersen Notes	HW #3 (Due Sunday)
7	Feb 14, 16, 18	Cloud Formation **Exam 1**			
8	Feb 21, 23, 25	Cloud Droplet Formation	*Cloud Microphysics*	R&Y Ch 6, 7 W&H Ch 6	*Final Project Proposal*
Spring Break	Feb 28, Mar 2, 4	**No Class**			
9	Mar 7, 9, 11	Droplet Growth Warm Clouds	*Cloud Microphysics*	R&Y Ch 7, 8 W&H Ch 6	HW #4 (Due Sunday)
10	Mar 14, 16, 18	Warm Clouds Ice Nucleation	*Cloud Microphysics*	R&Y Ch 9 W&H Ch 6	
11	Mar, 21, 23, 25	Cold Clouds Ice Crystal Growth	*Cloud Microphysics* *Applications*	R&Y Ch 10, 12 W&H Ch 6	HW #5 (Due Sunday) *Final Project Check-in*
12	Mar 28, 30, Apr 1	Severe Storms Radar Remote Sensing Observations	*Applications*	R&Y Ch 11, 13	*Final Project Check-in*

13	Apr 4, 6, 8	Observations **Exam 2**			
14	Apr 11, 13, 15	Field Campaigns Presentations	*Applications*	Pettersen Notes	HW #6 (Due Sunday)
15	Apr 18	Presentations			
Finals Week	April 25	No Class - Final Project			*Final Project Due*

GRADING

Exams 1 and 2 (15% each)	30%
Homeworks	35%
Final Project	25%
Class Participation	10%

The following grading scale will be used:

A : [93.3 – 100]
A- : [90.0 - 93.3)
B+ : [86.7 - 90.0)
B : [83.3 - 86.7)
B-: [80.0 - 83.3)
C+: [76.7 - 80.0)
C : [73.3 - 76.7)
C-: [70.0 - 73.3)
D: [60.0 - 70.0)
F: <60

Exams

- All exams will be done in class. No working together.
- Mid-term exams will not be cumulative – they will only encompass the topics reviewed between exams.

Weekly Time Management

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
CLIM/EARTH 411 Weekly Overview	Lecture		Lecture		Lecture		
				Office Hours	Office Hours		
	Required Readings, Homework, Write ups						
	Discussion Post Due 9am		Discussion Posted 9am (Week –1)		Homework Posted 12N (Week –1)		Homework Due 10pm
	Piazza Discussions - instructor and students					Piazza Discussions - students	

Homework

- Homework is assigned to Canvas on Fridays by 12N and due Sunday at 10pm (+1 week).
- Questions on the homework may be on concepts presented during the same week it is due or from prior classes.
- Graded homework will be returned the following Friday before class.
- Homework should be submitted via Canvas (see notes on Canvas on how to submit and scan)
- **Late Homework Policy:** Homework received after the due date and time will incur a 25% reduction and homework turned in more than 72 hours after the due date will not be accepted.
- Please contact me if you require additional time due to unforeseen circumstances.

Final Project

The final project will consist of a literature review on a cloud and/or precipitation topic relevant to the course and of particular interest to you. You will be expected to start choosing and defining your project topic in late January/early February, and will submit a project proposal the week after the first mid-term exam. You will report the results of your work in a written and oral presentation at the end of the semester. The total project grade will be a combination of your individual grades on the proposal, written report, and oral presentation. Additionally, you will have two required meetings with me to discuss potential topics and update on your progress. You will be responsible for scheduling time with me to meet about the project. I will provide sample topics and a grading rubric during the semester. The final project will contribute 25% toward your final course grade. The final project grading breakdown is as follows:

- Final project written report 10%
- Oral Presentation 5%
- Project Proposal 5%
- Initial Consultation 2.5%
- Progress Check-in 2.5%

Participation

Lecture: You are expected to attend lecture in person and be alert and engaged. However, I understand that this semester is unique. If you miss class due to circumstances beyond your control, lecture recordings and the presentations will be posted on the canvas page. Please let me know if you are expecting a long absence from live lectures.

You are also encouraged to ask questions during lecture. If you have a question after lecture, please use Piazza and post your question there. I encourage you to ask any and all relevant questions – it is cliché, but there really are no bad questions when it comes to cloud physics and radiation.

Piazza: The purpose of the course Piazza is for students to help each other get through difficult homework problems and understand course concepts. You are expected to participate in the weekly class discussions on Piazza. This is part of what your participation grade is based on, which is 10% of your final grade. Each week there will be a posted participation/discussion question or topic to be answered/addressed on Piazza. These exercises are meant to help you become familiar with topics in class through the application of online tools and resources. Additionally, these Piazza posts can and will lead to further discussion on topics of particular interest in class.