CLIM/EARTH 411: Cloud and Precipitation Processes

Monday, Wednesday, Friday 9:30 to 10:20am
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/580814*

Instructor office hours:

Synchronous:	In Office (CSRB 2543A)	
	Wednesdays:	**4 to 5pm**
	Fridays:	**2 to 3pm**
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/580814
Meeting time: MWF 9:30am – 10:20am 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

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

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

Recommended Textbooks/Chapters:

Authors: Lamb and Verlinde
Title: Physics and Chemistry of Clouds
ISBN: 1-107-08664-7

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

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 Discussion: This term we will be additionally be using Piazza for online 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/winter2023/climate411001wn2023

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 4, 6	Introduction Cloud and Precipitation Types	*Applications*	PKW Ch 1 Houze Ch 1	
2	Jan 9, 11, 13	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 18, 20	Dry and Moist Thermodynamics	*Atmospheric Thermodynamics*	R&Y Ch 1, 2 W&H Ch 3	*Final Project Consultation*
4	Jan 23, 25, 27	Moist Thermodynamics Saturation	*Atmospheric Thermodynamics*	R&Y Ch 2, 3 W&H Ch 3	HW #2 (Due Sunday) *Final Project Consultation*
5	Jan 30, Feb 1, 3	Buoyancy Convection	*Atmospheric Thermodynamics*	R&Y Ch 3, 4 W&H Ch 3	
6	Feb 6, 8, 10	Mixing Aerosols	*Atmospheric Thermodynamics* *Cloud Microphysics*	R&Y Ch 4, 5 W&H Ch 5 Pettersen Notes	HW #3 (Due Sunday)
7	Feb 13, 15, 17	**Exam 1** Cloud Characteristics Cloud Formation	*Cloud Microphysics*	R&Y Ch 6, 7 W&H Ch 6	**Exam #1 February 15**
8	Feb 21, 23, 25	Cloud Droplet Formation	*Cloud Microphysics*	R&Y Ch 6, 7 W&H Ch 6	
Winter Break	Feb 27, Mar 1, 3	**No Class**			
9	Mar 6, 8, 10	Droplet Growth Warm Clouds	*Cloud Microphysics*	R&Y Ch 7, 8 W&H Ch 6	HW #4 (Due Sunday) *Final Project Proposal*
10	Mar 13, 15, 17	Warm Clouds Cold Clouds	*Cloud Microphysics*	R&Y Ch 9 W&H Ch 6	

			Cloud		HW #5 (Due Sunday)
11	Mar, 20, 22, 24	Cold Clouds Ice Nucleation	*Microphysics Applications*	R&Y Ch 9, 10 W&H Ch 6	*Final Project Check-in*
12	Mar 27, 29, 31	Ice Nucleation Ice Crystal Growth Precipitation	*Cloud Microphysics*	R&Y Ch 10, 12 W&H Ch 6	*Final Project Check-in*
13	Apr 3, 5, 7	Graupel / Hail Severe Storms **Exam 2**	*Applications*	R&Y Ch 13 W&H Ch 6	**Exam #2 April 5**
14	Apr 10, 12, 14	Remote Sensing Field Campaigns Presentations	*Applications*	Pettersen Notes	HW #6 (Due Sunday)
15	Apr 17	Presentations			
Finals Week	April 21	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

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	

Exams (30%)

- 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.

Homework (35%)

- 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 (25%)

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 (10%)

Lecture: You are expected to attend lecture in person and be alert and engaged. However, 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. ***There will be periodic in person assigned partipication exercises. These are designed to reinforce key topics from the lectures and readings.***

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 Forum: 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 assigned class discussions on Piazza.*** Each week there will be a posted participation or 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.

University of Michigan Policies

DIVERSITY & INCLUSION STATEMENT

Diversity is a source of strength, creativity, and innovation. Our dedication to engineering for the public good is inseparable from our commitment to diversity, equity and inclusion (DEI). We lead with an equity-centered engineering mindset in how we teach, do research and support each other.

The Michigan Engineering community includes people from different races and ethnicities, gender identities, sexual orientations, ages and socio-economic backgrounds. We speak different languages, come from different cultures and countries and practice different religions. We have different abilities and disabilities, different political perspectives and life experiences. We all belong here. (Source: https://www.engin.umich.edu/culture/diversity-equity-inclusion/)

QUARANTINE OR ISOLATION DUE TO COVID-19

As they have throughout the past year and a half, policies around academic and public health are subject to change as this pandemic evolves. This course will follow all policies issued by the University, which are documented on the Campus Blueprint's FAQ (https://campusblueprint.umich.edu/faqs/). These policies may change over the course of the term, so please review the Campus Blueprint's FAQ for the most up to date information.

ACADEMIC CALENDAR & RELIGIOUS OBSERVANCES

- See: https://ro.umich.edu/sites/default/files/calendar/pdfs/Cal_2022-2023.pdf

HONOR CODE

The Honor Code outlines certain standards of ethical conduct for persons associated with the College of Engineering at the University of Michigan. The policies of the Honor Code apply to graduate and undergraduate students, faculty members, and administrators. The Honor Code is based on these tenets:

- Engineers must possess personal integrity both as students and as professionals. They must be honorable people to ensure safety, health, fairness, and the proper use of available resources in their undertakings.

- Students in the College of Engineering community are honorable and trustworthy persons.
- The students, faculty members, and administrators of the College of Engineering trust each other to uphold the principles of the Honor Code. They are jointly responsible for precautions against violations of its policies.
- It is dishonorable for students to receive credit for work that is not the result of their own efforts.

Source: https://ecas.engin.umich.edu/honor-council/honor-code/

SEXUAL AND GENDER-BASED HARASSMENT POLICY

As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. As such, I am dedicated to providing a harassment-free experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. *Sexual and/or gender-based harassment will not be tolerated in any form, including in class discussions, group work (homework and/or projects), or on social media or other online media.*

INDIVIDUAL WITH REPORTING OBLIGATIONS

It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep information that you share with me private to the greatest extent possible. However, due to my role within the University, I am considered a "Individual with Reporting Obligations (IRO)". This means that I am required to share information regarding sexual misconduct or information about a crime that may have occurred on U-M's campus with the University. The University will use this information to inform you of your rights and access to services.

Students may speak to someone confidentially by contacting the Sexual Assault and Prevention Awareness Center's (SAPAC) Crisis Line at (734) 936-3333, or using any of the other confidential resources provided on the following website: https://sexualmisconduct.umich.edu/student-resources/

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

It is the policy of the University of Michigan to maintain an academic and work environment free of discrimination and harassment for all students, faculty, and staff. The University's commitment to diversity and inclusiveness extends to students with disabilities. The University is committed to the academic success, personal development and general well-being of all students.

Source: https://registrar.engin.umich.edu/university-policy-for-students-faculty-and-staff-with-disabilities/

COURSE EVALUATIONS

Students will be provided with an opportunity to anonymously evaluate this course and your learning experience. Student participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

RECORDING OF CLASS LECTURES

Course lectures may be recorded and made available to other students in this course. As part of your participation in this course, you may be recorded. ***If you do not wish to be recorded, please contact me during the first week of class to discuss alternative arrangements.***