CLIMATE 463
AIR POLLUTION METEOROLOGY

Winter 2025
3 credits

Professor:
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Time and Location:
T/Th 10:30-12:00
North Campus: 2153 GG Brown

Drop-In Hours: Thursdays after class (12-1PM)
or by appointment

COURSE DESCRIPTION:

Air pollution meteorology is the study of how meteorological processes near the Earth's surface influence concentrations of different pollutants, as well as the influence of these pollutants on meteorology. Because we live and breathe in this lower layer of the atmosphere (or the atmospheric boundary layer), air pollution has negative impacts on human and ecosystem health and can degrade infrastructure. In this course, we will gain an understanding of sources of air pollution, their transport and transformation that can occur in the atmosphere, and their ultimate fate. We will discuss regulations on air pollutants, methods to observe criteria pollutants to ensure compliance with regulations, and modeling techniques to understand these processes. We will also touch on current topics in the field, including differential exposure to air pollution as a source of inequality within society and climate-driven changes that are altering air quality.

Learning objectives include:
1. Understand the importance of air pollution to society at local, regional, and global scales
2. Understand the atmospheric transport processes that disperse air pollution from source regions, and be able to use simple tools to model these processes
3. Understand the processes that remove pollution from the atmosphere
4. Be able to think holistically about how emissions, atmospheric dynamics, and local geography affect air pollution

TEXT: There is no required text for this course, however depending on your background, supplemental reading may be helpful. Suggested readings for these three texts are provided in the syllabus if you want to enhance your understanding of the lecture notes. For meteorology and atmospheric science topics:

***Atmospheric Science, Second Edition: An Introductory Survey*,** J.M. Wallace and P.V. Hobbs, Academic Press, 2006. An excellent intro level textbook that covers all of the atmospheric science basics.

An Introduction to Boundary Layer Meteorology, Roland B. Stull, Kluwer Academic Publishers, 1988. This is an old textbook, but still a classic.

For basic atmospheric chemistry:

Introduction to Atmospheric Chemistry (D.J. Jacob). The second edition is available online here, which was updated in 2021 though not yet published. The first edition (1999) is also available online here.

If you want to get into more detail on atmospheric physics or chemistry:

Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, J.H. Seinfeld, S.N. Pandis (3rd Edition), 2016. This book is huge, but it has it all.

GRADING:

Weight	Type	Date
25%	Homework	8 Assignments
25%	Test 1	Tuesday, 4 February
25%	Test 2	Tuesday, 25 March
--	Test 3 (optional)	Wednesday, 30 May 10:30-12:30
25%	In-Class Exercises (4)	See syllabus

ASSESSMENTS: There will be three types of grade assessments in this course:

1. **TESTS (50% of grade; 25% each):** There will be a total of three tests during the semester: two in-class tests and one during the final exam period. Your best two scores will count towards this component of the grade assessment – if you are happy with your Test 1 and 2 scores, then Test 3 is option.. These quizzes will include short answer questions and problem solving similar to homework assignments.
2. **HOMEWORK (25% of grade):** There will be about eight homework assignments throughout the semester. See the below schedule and Canvas for assignments and approximate due dates. In the event that the course schedule changes, updates to the schedule below will be noted in class and announced on Canvas.
3. **IN-CLASS ACTIVITIES (25% of grade):** We will have six possible in-class activities of which four will count towards your in-class grade. This means you can miss two activities during the semester with no penalties. In-class activities will be small group work on relevant problems.

HOMEWORK POLICY: Homework assignments will comprise problems and analysis that applies concepts learned in lecture. Homework is due at the beginning of class on the specified due dates. You will be allowed two late homework assignments (with up to a week extension) with no questions asked. Please contact me to discuss if you need additional accommodations beyond these two late assignments. Please upload all relevant work to Canvas for grading, along with any input data files that you may have used.

HONOR CODE: This class is being taught through the College of Engineering, and thus all involved are subject to the College of Engineering Honor Code
http://www.engin.umich.edu/students/honorcode/
All policies apply, so please do not hesitate to ask questions.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES: Participants with unique learning needs are strongly encouraged to talk to the instructor as soon as possible to gain

maximum access to course information. All discussions will remain confidential. The University of Michigan policy is to provide, on a flexible and individualized basis, reasonable accommodations to students who have documented disability conditions (e.g., physical, learning, psychiatric, vision, hearing, or systemic) that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact UM Services for Students with Disabilities (https://ssd.umich.edu/) & instructor to discuss individual needs for accommodations.

STUDENT WELL-BEING: Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being.

COURSE POLICIES

Communication: Information about the course will be shared through (1) Canvas announcements and (2) a class Slack channel (link from the Canvas page). Unless your question involves a personal issue, please ask your question on Slack so that everyone can benefit from the response. For personal questions or late requests, please email me at alsteine@umich.edu and I will make every effort to respond to emails within a day.

Course Recordings: Course lectures and labs will be audio/video recorded and made available asynchronously. As part of your participation in this course, you may be recorded. If you do not wish to be recorded, please contact me the first week of class (or as soon as you enroll in the course, whichever is latest) to discuss alternative arrangements.

CLIMATE 463: Air Pollution Meteorology: Winter 2025: Tentative Course Outline

Homework (H) assigned (A) and due dates (D)

Wk	Date	No.	Topic	In-Class	Reading	Homework
1	9 Jan	1	Course overview; History of air pollution			
2	14 Jan	2	Met: Basic atmospheric science intro		W&H Ch. 1	HW1A
	16 Jan	3	Met: Atmospheric thermodynamics		W&H Ch. 3	
3	21 Jan	4	Met: Atmospheric transport (global, synoptic)		W&H Ch. 8	HW1D/HW2A
	23 Jan	5	Met: Atmospheric boundary layer Pt 1	Activity 1	W&H Ch. 9	
4	28 Jan	6	Met: Atmospheric boundary layer Pt 2			HW2D
	30 Jan	7	Met: Atmospheric boundary layer Pt 3	Activity 2		
5	**4 Feb**		**Test 1**			
	6 Feb		*No class: ALS out of town*			
6	11 Feb	8	Chem: Units of atmospheric chemistry		Jacob Ch. 1	HW3A
	13 Feb	9	Chem: Atmospheric box models	Activity 3	Jacob Ch. 3	
7	18 Feb	10	Chem: Sources part 1			HW3D/HW4A
	20 Feb	11	Chem: Sources part 2			
8	25 Feb	12	Chem: Transport			HW4D/HW5A
	27 Feb	13	Chem: Chemistry in the boundary layer	Activity 4		
	4 Mar		**No class: Winter break**			
	6 Mar		**No class: Winter Break**			
9	11 Mar	14	Tropospheric gas-phase chem: Part 1		Jacob Ch. 12	HW5D/HW6A
	13 Mar	15	Tropospheric gas-phase chem: Part 2			
10	18 Mar	16	Atmospheric aerosols: Chemistry&climate		Jacob Ch. 8	HW6D
	20 Mar	17	Review for Test 2	Activity 5		
11	**25 Mar**		**Test 2**			
	27 Mar		*No class: ALS out of town*			
12	1 Apr	18	Modeling: Plume dispersion Part 1		S&P Ch. 18	HW7A
	3 Apr	19	Modeling: Plume dispersion Part 2			
13	8 Apr	20	Modeling: Plume dispersion Part 3			HW7A/HW8D
	10 Apr	21	Other atmospheric models	Activity 6		
14	15 Apr	22	Impacts of pollution on humans&ecosystems			HW8D
	17 Apr	23	Urban heat islands			
15	22 Apr	24	Class synthesis&wrap-up: Review for Test 3			
	30 Apr		**Test 3 (10:30-12:30PM from UM schedule)**			