CLIMATE 479
ATMOSPHERIC CHEMISTRY
Winter 2021
3 credits

Professor:
Dr. Eric Kort
2553 Space Research Building

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Location and Time:
TuTh 1:30-3:00 Zoom

Virtual Format:
Plan to give lecture, lead discussion and answer question 'live' during class time with recording.

VIRTUAL PLAN: Much like Fall 2020, Winter 2021 will be different from normal. In this class, I am aiming to maximize learning of Atmospheric Chemistry in a safe and fun manner. I ask for your feedback and adaptability – I will listen and try to change/adapt as needed. I will try to cater the course to best serve everyone. This syllabus outlines course plans and includes a notional schedule. I expect it is likely the schedule will change as we go, and I will update you as this happens.

COURSE DESCRIPTION: This course is an introduction to the chemistry of Earth's atmosphere, with a specific focus on the stratosphere and troposphere. We will focus on the fundamental natural processes controlling trace gas and aerosol concentrations in the atmosphere, and how anthropogenic activity has affected those processes at the local, regional, and global scales. Specific topics include composition and structure of Earth's atmosphere, stratospheric ozone depletion, chemistry of the regional and global troposphere, and urban smog and trends in air pollution.

PREREQUISITES: CHEM 130 (General Chemistry) and MATH 216 (Differential Equations)

TEXT: *Introduction to Atmospheric Chemistry* (D.J. Jacob);
http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html

Optional supplementary texts that can be helpful:
Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, J.H. Seinfeld, S.N. Pandis (3rd Edition), 2016.

Chemistry of the Upper and Lower Atmosphere: Theory, Experiments and Applications, Barbara J. Finlayson-Pitts and James N. Pitts, Jr., 2000. Available online:
http://www.sciencedirect.com/science/book/9780122570605

Atmospheric Chemistry and Global Change, by Guy P. Brasseur, John J. Orlando, Geoffrey S. Tyndall, 1999, Oxford University Press. Available online through UM Library:

Other Useful References:
- Climate Change, The 5th IPCC (Intergovernmental Panel on Climate Change) Climate

Change 2013 the Physical Science Basis and Climate Change 2014 Synthesis Report. http://www.ipcc.ch/

- WMO (World Meteorological Organization), *Scientific Assessment of Ozone Depletion: 2010,* Global Ozone Research and Monitoring Project—Report No. 52, 516 pp., Geneva, Switzerland, 2011 http://www.esrl.noaa.gov/csd/assessments/ozone/2010/report.html
- *Scientific Assessment of Ozone Depletion: 2014* http://www.esrl.noaa.gov/csd/assessments/ozone/2014/

GRADING:

Weight	Type	Date
25%	Homework	Throughout semester
15%	Quiz 1	~23 Feb
15%	Quiz 2	~30 Mar
10%	Participation	
20%	Term Paper	20 Apr
15%	Presentation	13/15 Apr

HOMEWORK POLICY: The initial plan is for ~5 homework assignments during the semester. These will consist of quantitative and qualitative written problem sets addressing topics covered in the lectures and reading, as well as some inclusion of peer-reviewed papers. Assignments are due at the beginning of class on the specified due dates. Each day (or fraction of a day) the assignment is late, the grade will be reduced by 10%.

TERM PAPER AND PRESENTATION: The term paper due at the end of the semester can be either (1) a review of the literature on a topic determined with the instructor, or (2) a research paper on your own project. Some possible topics (though by no means an exhaustive list) are at the end of the syllabus. The presentation will be in class during the last week of class, and will include a 15 minute presentation on your work.

WRITTEN QUIZZES: There will be two quizzes during the semester (see dates above). These will be closed book, closed note exams.

HONOR CODE: Read it: http://www.engin.umich.edu/students/honorcode/ All policies apply.

LEARNING GOALS: There are a range of backgrounds and interests of students in the class, and my primary goal is to introduce the basic concepts of atmospheric chemistry as they pertain to atmospheric science. This includes (1) developing an in-depth knowledge of chemical processes in the atmosphere (including chemical kinetics, photochemistry, physical chemistry, thermodynamics and biogeochemical cycling during atmospheric transport) and apply these concepts in homework problems and exam questions; (2) calculating atmospheric concentrations of trace constituents, equilibrium constants, chemical decay rates, and other chemical information as applied to the atmosphere, as applied in homework problems and exam questions, and (3) be able to describe various atmospheric chemistry issues related to regional air quality and global climate, and the impacts on society and human health.

CLASS RECORDING

Course lectures may be audio/video 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 [eakort@umich.edu] the first week of class (or as soon as you enroll in the course, whichever is latest) to discuss alternative arrangements.

DISABILITY STATEMENT

The University of Michigan is committed to providing equal opportunity for participation in all classes, programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, project, etc…).

MENTAL HEALTH & WELLBEING

Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressures 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 a variety of resources, many which are listed on the Resources for Student Well-being webpage. You can also search for additional well-being resources here.

<u>CLIMATE 479: Atmospheric Chemistry: </u>Winter 2021: Tentative Course Outline

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

Reading from Jacob (J) and optional from Seinfeld and Pandis (S&P)

Wk	Date	Topic	Reading	
1	19 Jan	Intro & atmospheric composition	J1	
	21 Jan	Fundamentals: Structure, physics and transpo	J2, 4	
2	26 Jan	Fundamentals: radiation and photolysis	J7	
	28 Jan	Fundaments: GHG, climate metrics, lifetimes		
3	2 Feb	Simple atmospheric models	J3	
	4 Feb	Introduction to chemical kinetics	J9; S&P3	
4	9 Feb	Stratospheric chemistry	J10; S&P5	
	11 Feb	Stratospheric chemistry		
5	16 Feb	Stratospheric chemistry		
	18 Feb	Stratospheric chemistry/REVIEW		
6	**23 Feb**	**QUIZ 1**		
	25 Feb	Tropospheric chemistry	J11; S&P6	
7	*2 Mar*	*No Class: Mental Sanity*		
	4 Mar	Tropospheric chemistry		
8	9 Mar	Tropospheric chemistry		
	11 Mar	Tropospheric chemistry	J12	
9	16 Mar	Tropospheric chemistry (isoprene)		
	18 Mar	Acid Rain/atmospheric sulfur cycle	J13	Paper topics due
10	*23 Mar*	*Well Being break*		
	25 Mar	Atmospheric aerosols/REVIEW		
11	**30 Mar**	**QUIZ 2**		
	1 Apr	Aqueous chemistry	S&P7	
12	6 Apr	Air quality: trends and modeling	J13	
	8 Apr	SLCP: chemistry-climate interactions	J8	
13	**13 Apr**	**Project presentations**		
	15 Apr	**Project presentations**		
14	**20 Apr**	**Written paper due**		

Potential term paper topics

A review of the literature on:
Role of denitrification in stratospheric ozone hole
Polar stratospheric cloud formation and chemistry
Lightning NO_x and atmospheric oxidizing capacity
Very-short lived halogen species and stratospheric chemistry
Stratosphere-troposphere exchange and impacts on chemical budgets
Oxidizing capacity as determined from observed methyl chloroform or ^{14}CO
Isotopes in atmospheric chemistry (sulfate, nitrate, water, or hydrocarbons)
Methane trends (paleo, preindustrial-to-present, or recent decades)
Methane role in oxidizing capacity and/or air quality
Chemistry occurring on dust or other aerosols
Sources of baseline ozone levels in surface air
Atmospheric budgets of oxygenated volatile organic compounds (e.g., acetone, ethanol, methanol, glyoxal, etc.)
Tropospheric halogen chemistry
Peroxy acetyl nitrate and long-range pollution transport
Isoprene oxidation and secondary aerosol or ozone formation
Paleo atmospheric composition
Planetary atmosphere (choose a planet or set of chemical reactions)
Radiative forcing from non-CO_2 species
Trends in regional air pollution (choose a pollutant/region)
Mercury oxidation pathways
Dry deposition
Wet removal (gases or aerosol)
Emissions from the biosphere: soil NO_x, isoprene, terpenes, wildfires, or methane

Alternative – write a research paper on your own project:
Describe and draw conclusions from a short data analysis project from a field campaign, monitoring network, applying a simple model, or your own relevant research (lab, field, or modeling, note this should not be focused on a question central to any thesis work already underway). Talk to the instructor if you'd like to take on your own project but need help finding a dataset or model to use.