CLIMATE 479
ATMOSPHERIC CHEMISTRY
Fall 2024
3 credits

Professor:
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Location and Time:
TuTh 12:00-1:30pm CHRYS133

In this class, we aim to maximize learning of Atmospheric Chemistry. 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);
https://acmg.seas.harvard.edu/education/introduction-atmospheric-chemistry

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 6th IPCC (Intergovernmental Panel on Climate Change) Climate Change 2023 the Physical Science Basis and Climate Change.
  http://www.ipcc.ch/
- *Scientific Assessment of Ozone Depletion: 2022* https://csl.noaa.gov/assessments/ozone/

GRADING:

Weight	Type	Date
25%	Homework	Throughout semester
10%	Quiz 1	~24 Sept
10%	Quiz 2	~22 Oct
10%	Quiz 3	~12 Nov
10%	Participation	
20%	Term Paper	3 Dec
15%	Presentation	3/5 Dec

HOMEWORK POLICY: The initial plan is for ~4 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.

PARTICIPATION: This class will meet in person, and attendance and engagement is expected and included as part of your grade. If you are unable to come to class (sick, Covid, etc…), email Prof. Kort in advance of class. An alternate activity will be assigned so you can get participation credit. All lectures will be recorded and shared via lecture capture. This can be used for catching up on excused absences (due to illness) as well as to study/review materials. The lecture capture recordings are not a substitute for attending class in person.

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

HONOR CODE: Read it: https://bulletin.engin.umich.edu/rules/ 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 will 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.

DISABILITY STATEMENT

The University of Michigan is committed to providing equal opportunity for participation in all classes, programs, services and activities. If you have approved accommodations please follow the UM system and also notify me early in the semester so we can provide appropriate accommodation.

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.

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.