

Atmospheric Chemistry – CHM 1415S

This course considers the processes that control the chemical composition of the atmosphere. We focus on the basic chemistry of stratospheric ozone depletion, tropospheric oxidation processes, urban air pollution, and acid rain, and then move into more advanced topics such as chemistry-climate coupling, aerosol chemistry, and the role of the biosphere. Emphasis will be given to new research findings, by discussing recent papers from the literature and listening to research seminars.

Schedule

Lectures: Tues/Thurs, 9:10 am to 10:00 am. First lecture is on **Tuesday, January 11**. Please also reserve **Fridays from 1 to 2 pm** (see below). Let the instructor know asap if you are not free at this time on Friday.

Quercus Page

This course is taught alongside the undergraduate version, CHM415S. **Please email the instructor to get access to the CHM415S Quercus page where many course elements will be posted. It is the students' responsibility to follow announcements coming for CHM415S and CHM1415S.**

Instructor

Jon Abbatt, jonathan.abbatt@utoronto.ca, LM324

Delivery Mode

The present plan is for this course to be online until at least January 31, 2022. The Zoom link will be on the CHM415S Quercus page. If we are allowed to move to in-person teaching, there will likely not be a synchronous, hybrid option, but who knows what Covid-19 will allow. If we move to in-person teaching, I will provide an audio recording after each in-person lecture.

Grading

Problem Sets	20%
Midterm assessment	20%
Research seminar questions	15%
Discussion sessions	15%
Final online assessment	30%

Problem sets – There will be four problem sets (worth 5% each), submitted online. It is ok to submit legible handwritten work that has been digitally scanned.

Midterm and Final assessments – **Delivery mode and aids-allowed TBA.** Midterm assessment: **Tuesday March 8 from 9 to 10 am**, i.e. during class time. Final assessment: **During the FAS final exam period; date TBA.**

Discussion sessions – We will schedule about 5 CHM1415S discussion sessions at a different time from the lecture slots. Please come prepared to each session to discuss the discussion papers and the seminars you have been watching. **If online, please turn your videos on if you feel comfortable doing so. Please do not attend the in-class discussions that we have in CHM415S!**

Research seminar questions/comments: **Please register for the Frontiers in Atmospheric Chemistry Seminar series: <https://facss.mit.edu/>.** You are required to attend and post three questions from at least **five** of these talks. These are questions that you would have asked the speaker if you had the opportunity to do so. Each question can be up to 3 sentences long and should be posted within one week of the seminar. After you post a question, you will see questions posted by other students in the class. Please respond to them, if you have the answer or a comment, also within a week of the seminar.

Penalties – No credit will be given for late problem sets or question posts, or for a late/missing midterm or final assessment unless there is a medical (or equivalent) justification. When there is appropriate justification for a missed problem set, it will not count and your other scores in the course

will be pro-rated accordingly. If the assessments are online and arrive late, marks will be deducted at a rate of 10%/day, i.e. if your assessment would have been graded at 80% and it arrives 25 hours late, it will receive a 60% mark instead. If you would like a re-grade for any item, submit the request via email within one week of the date at which the assignment was returned to you.

Anticipated Learning Outcomes

After taking CHM 1415S, students will be able to:

1. Demonstrate that you understand the major concepts in atmospheric chemistry both qualitatively and quantitatively
2. Apply concepts in chemical kinetics and thermodynamics to describe atmospheric chemistry at a molecular level
3. Critically analyze and discuss the scientific literature and scientific presentations in atmospheric chemistry, placing them into their correct context

To get in touch with the instructor

Office: Lash Miller 324; Tel: 416-946-7358

Email: jonathan.abbatt@utoronto.ca

Please contact me if you have any questions. Conceptual issues are best handled before or after class, at student hours, or by special appointments. Email is good for short questions. Please do not message me via Quercus – direct email is best.

Office hours

In addition to time after the lecture, there will be one hour/week of office hours via Zoom (see Quercus for link) at Friday from 9 to 10 am. It is best if you turn your videos on but only if you feel comfortable doing so. If you would like to have a private session, then email me directly and we will set up a time to meet. Office hours are not recorded.

Textbook (these books are available free online).

You are only responsible for material and papers covered in class, and not for additional material from the textbooks. That said, the recommended textbook for the course is:

Introduction to Atmospheric Chemistry, D.J. Jacob, Princeton University Press
(<http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html>)

However, Jacob does not cover everything we study. Another excellent reference is:

Chemistry of the Upper and Lower Atmosphere, B.J. Finlayson-Pitts and J. Pitts, Academic Press
(available as an e-book through UofT libraries)

Course Policies

Students with accommodations - Students with diverse learning styles and needs are welcome! The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible. Please remember that some accommodation requests are required to be submitted at least one week in advance of the course element deadline.

Learning environment - The University of Toronto is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

Privacy issues - Students may create audio-recordings of in person classes only, for their personal use. Such recordings are intended to permit class content review to enhance understanding of the topics presented.

Audio-recordings are not substitutes for attending class. Students should note that since audio and video recordings are to be permitted, their voice may be recorded by others during the class. Please speak to the instructor if this is a concern for you. Students agree to the following terms when creating audio recordings of lectures:

- Recordings are not to be distributed without the permission of the instructor via the Internet, using social media such as Facebook, peer-to-peer file sharing such as One Drive or Dropbox, or other distribution channels.
- Recordings are not to be shared with other classmates unless they are to be used in collaborative assignments, or if the instructor permits for other reasons.

Non-compliance with these terms violates an instructor's intellectual property rights and the Canadian Copyright Act. Students violating this agreement will be subject to disciplinary actions under the Code of Student Conduct.

Submission methods

Please look at the Quercus course site for directions on the submission methods.

Technology Requirements

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: <https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/>.

Advice for students more broadly regarding online learning is available here:

<https://onlinelearning.utoronto.ca/getting-ready-for-online/> This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, crashed hard drives, broken printers, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

Institutional Policies and Support

Academic Integrity - Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters

(<https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>)

outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code

of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see <https://www.academicintegrity.utoronto.ca/>). Here is an additional website to look at: <http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize>.

In sum, all your work must be your own. It is very easy to identify work that is plagiarized and the ramifications are serious.

Copyright

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited. More information regarding this is available here: <https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/>.

Accommodations for Religious Observances

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

Additional Services and Support

The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at [Student Life](#)
- Full library service through [University of Toronto Libraries](#)
- Resources on conducting online research through [University Libraries Research](#)
- Resources on academic support from the [Academic Success Centre](#)
- Learner support at the [Writing Centre](#)
- Information for [Technical Support/Quercus Support](#)

Acknowledgement of Traditional Lands

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Lecture Schedule

This lecture schedule is a rough outline for where we are heading - please don't hold me to it! Each entry with ** designates discussion of papers from the literature.

Introduction

Lecture #1 – Global environmental change, formation, and overall composition of the atmosphere

Fundamentals

Lecture #2 – Atmospheric photochemistry and kinetics

Lecture #3 – Atmospheric photochemistry and kinetics

Lecture #4 – Atmospheric chemistry models

Lecture #5 – Atmospheric mixing processes

Stratospheric Ozone Depletion

Lecture #6 – Mid-latitude ozone

Lecture #7 – Mid-latitude ozone

Lecture #8 – Polar ozone

Lecture #9 – Current understanding of ozone depletion - ** Ravishankara paper

Tropospheric Oxidation

Lecture #10 – Tropospheric chemistry: Introduction

Lecture #11 – Tropospheric chemistry: OH/NO_x/VOCs/O₃

Lecture #12 – Tropospheric chemistry: VOC oxidation mechanisms, OH measurements, special topics

Lecture #13 – Tropospheric chemistry: Biogenic VOCs - ** Lelieveld paper

Lecture #14 – Intro to urban air pollution, aerosols

Lecture #15 – Urban air pollution

Lecture #16 – Urban air pollution – ** Anenberg paper

Lecture #17 – Aerosols and tropospheric chemistry - ** Sulfur oxidation - Cheng paper

Lecture #18 – Tropospheric Halogens

Atmospheric Chemistry and Climate

Lecture #19 – Climate system and radiative forcing

Lecture #20 – Climate system and radiative forcing

Lecture #21 – Clouds and climate

Lecture #22 – Clouds and climate - ** Cziczo paper

Lecture #23 – Geoengineering and wrap-up - ** Crutzen paper