

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 9.

Quercus Page

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

Instructor

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

Delivery Mode

The course will be delivered in-person in SS2105. I will provide an audio recording after each in-person lecture.

Grading

Problem Sets	20%
Midterm exam	15%
Research seminar summaries and questions	15%
Participation during paper discussions	10%
Final exam	40%

Problem sets – There will be four problem sets, submitted online. It is ok to submit legible handwritten work that has been digitally scanned. While ok to discuss the PSs with others in the class, you must submit your own work, ie. you must write up the assignment entirely yourself.

Midterm and Final Exams – Midterm exam: Thursday February 29 during class time in SS2105, closed book. Final exam: During the FAS undergraduate final exam period; date TBA.

Paper discussions: We will discuss research papers in class six times during the semester. I expect you to participate in these discussions, either asking questions or answering them when posed. Please don't dominate the discussion but please don't stay silent either.

Research seminar questions/take-home messages/discussion board: Before the end of March, please watch three research seminars on atmospheric chemistry, preferably live (but recorded is ok, if you cannot find live talks). These could be in any UofT department, in the Center for Global Change Science (cgcs.physics.utoronto.ca), Southern Ontario Center for Atmospheric Aerosol (www.socaar.utoronto.ca), or elsewhere (e.g., there are many archived talks from NCAR Atmospheric Chemistry Observations and Modeling group (www2.aom.ucar.edu)). In one page of text max for each seminar, write 1 or 2 paragraphs which summarize the main points from the talk and then provide three questions you would have asked (or did ask!) the speaker.

Penalties – No credit will be given for late problem sets or seminar summaries, or for a late/missing midterm or final exam unless there is a medical (or equivalent) justification. When there is appropriate justification for a missed problem set or midterm, it will not count and your other scores in the course will be pro-rated accordingly. If you miss the final exam, there will be a makeup.

Anticipated Learning Outcomes

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

1. Demonstrate an understanding of 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 office hours, or by special appointments. Email is good for short questions. Please do not message me via Quercus – use direct email instead.

Office hours

Monday from 3:00 to 4:00, LM324. Wednesday from 2:00 to 3:00, via Zoom

<https://utoronto.zoom.us/j/88171396243>

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 may be very useful:

Introduction to Atmospheric Chemistry, D.J. Jacob, Princeton University Press

<https://acmg.seas.harvard.edu/education/introduction-atmospheric-chemistry>

Note that there is a draft 2nd edition of this book that we will **not** be using.

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; dates/content may vary somewhat. 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 – Air pollution, aerosols

Lecture #15 – Air pollution, aerosols

Lecture #16 – Air pollution, aerosols – ** Anenberg paper and Lewis paper

Lecture #17 – Air pollution, aerosols – ** 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 – Geoengineering and wrap-up – ** Keith Video

Lectures #22, #23 (offline, on video) – Clouds and climate