Atmospheric Chemistry – CHM 1415F

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: Mon/Wed, 9:10 am to 10:00 am. First lecture is on **Monday, September 14**. The last lecture is scheduled for the fall make-up day on **Thursday, December 10.** This make-up lecture slot will only be used if necessary; it compensates for the Monday class lost due to Thanksgiving.

Delivery Mode

The course has a dual delivery mode, with synchronous on-line and in-person components. Only those students registered for the in-person component can physically attend class; attendance will be taken. Details on how to register for each component will be forthcoming. Masks must be worn and physical distancing recommendations obeyed. If wearing a mask influences my ability to be clearly heard, please let me know and I will speak up! All online activities – lectures, student hours, online assessments – will take place through **Bb Collaborate**, which is embedded within Quercus. Please familiarize yourself with Bb Collaborate before the class starts. All lectures and discussion periods within lecture time will be recorded but student hours will not be.

Grading *(Note: No in-person assessments)*

Problem Sets	20%
Midterm online assessment	15%
Research seminar summaries	30%
Final online assessment	35%

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 online assessments – Course textbooks, course notes and lectures, and calculators are allowed but the use of the internet and student-student collaboration are **not** allowed. The length of the midterm assessment is equivalent to the length of an in-class, 1-hour midterm test. However, you will be given 24 hours to complete the assessment starting at **6:00 pm on Thursday October 29.** Likewise, the length of the final assessment is equivalent to a 2-hour final exam. However, you will be given 24 hours to complete the assessment during the Final Online Assessment Period in December; date to be announced.

Discussion papers – We will have in-class group discussions about **five** important papers from the literature. Please come prepared to each class to discuss these papers, by either answering or asking questions.

Research seminar summaries: There is a new atmospheric chemistry seminar series starting this fall: https://facss.mit.edu/. **Please register for it!** You are required to attend and provide a summary of at least **five** of these talks (more details below).

Important – No credit will be given for late problem sets or for a late 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 your assessments 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 1415F, students will be able to:

1. Understand major topics in atmospheric chemistry both qualitatively and quantitatively.
2. Apply fundamental concepts in chemical kinetics and thermodynamics to understand atmospheric chemistry at a molecular level.
3. Critically analyze and summarize the scientific literature in atmospheric chemistry, with an emphasis on placing the research into its correct scientific context.
4. Develop experience in oral discussions of a scientific subject.
5. Appreciate the role of strong scientific understanding of environmental phenomena.

Contact Information for Jon Abbatt

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.

Student hours

There will be two hours/week when any questions can be asked of the instructor. Times will be arranged once everyone's schedules are firm. These sessions will be open to anyone to attend but an expectation is that if you are online, you should be prepared to either ask questions or for me to ask you questions, i.e. you cannot be a silent bystander! If you would like to have a private session, then email me directly and we will set up a time to handle matters that cannot be addressed in public office hours. Student 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

University statement regarding a positive 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*."

This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session.

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/. In particular, 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, 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.

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.

During assessments:

1. Using or possessing unauthorized aids.
2. 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/).

Use of Turnitin

Students may be required to submit work to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their work to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

Copyright

If a student wishes to copy or reproduce lecture 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 prohibited. More information regarding this is available here: https://teaching.utoronto.ca/ed-tech/audio-video/copyright-considerations/

Accessibility Needs

Students with diverse learning styles and needs are welcome in this course. 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.

Lecture Schedule

This lecture schedule is just a rough outline for where we are heading - please don't hold me to it! Each lecture labeled with an * will involve discussion of papers from the literature. I will give you at least one week warning in advance of the class involving paper discussion.

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: OH, NO_x, CO, CH_4

Lecture #11 – Tropospheric chemistry: OH, NO_x, CO, CH_4

Lecture #12 – Tropospheric chemistry: OH measurements

Lecture #13 – Tropospheric chemistry: VOC oxidation

* Lecture #14 – Tropospheric chemistry: Biogenic VOCs (Lelieveld paper)

Lecture #15 – Urban ozone

* Lecture #16 – Tropospheric chemistry: Sulfur oxidation (Cheng paper)

Lecture #17 – Marine halogens

Atmospheric Chemistry and Climate

Lecture #18 – Climate System and radiative forcing

Lecture #19 – Climate System and radiative forcing

Lecture #20 – Clouds and climate

* Lecture #21 – Clouds and climate (Cziczo paper)

* Lecture #22 – Geoengineering (Crutzen paper)

Lectures #23 and #24 – These lecture spots are reserved for special lectures, make-up lectures, review for the Final Online Assessment.

Research Seminars

Please submit summaries of **five** talks you listened to in the FACSS series. The seminars are on Fridays at 1 pm so, if you can, reserve this time in your schedule. However, some of the lectures will be recorded (as per the speaker's permission) so you may be able to view them asynchronously.

The summary should be roughly half-page long (12 point font, single spaced). Each summary should address the following points so that the reader could gain the main points from the seminar without attending it.

1. Topic: What is the main topic of the paper? What its importance to atmospheric chemistry?
2. Methods: What were the major methods used?
3. Insights: What new insights does this paper present? What uncertainties remain in the field?
4. Questions: List two questions you would have wanted to (or did!) ask the speaker.

Also, I will organize a couple of times during the semester when we get together to just chat about the seminars you have listened to. Which were the fun talks and which were duds? So much of science has informal interactions of this type, and such opportunities will be lacking this year. This discussion is entirely voluntary, off-the-record, and not graded.