

# Atmospheric Chemistry Syllabus

## Department of Physics and Atmospheric Science

### CHEM/OCEA/PHYC 4595 Fall 2025

*Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.*

*We recognize that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.*

#### Course Instructor

| Name         | Email               | Office Hours |
|--------------|---------------------|--------------|
| Rachel Chang | rachel.chang@dal.ca | TBD          |

#### Course Description

A fundamental introduction to the physical and chemical processes determining the composition of the atmosphere and its implications for climate, ecosystems, and human welfare. Origin of the atmosphere. Nitrogen, oxygen, carbon, sulfur cycles. Climate and the greenhouse effect. Atmospheric transport and turbulence. Stratospheric ozone. Oxidizing power of the atmosphere. Regional air pollution: aerosols, smog, acid rain.

#### Course Prerequisites

MATH 1000, PHYC 1190/1290 or PHYC 1300, and CHEM 1011/1012 or equivalent

Students are expected to have a basic understanding of chemistry, physics, and solving differential equations.

#### Course Structure

##### Course Delivery

Lectures will be delivered in person with approximately weekly in-class assignments. It is expected that students will write tests and the final exam on-campus or in another proctored environment. Students connecting to online resources from outside Canada are responsible for

ensuring awareness and compliance with any applicable laws in the country from which they are connecting.

### Lectures

Monday, Wednesday, Friday 8:35 - 9:25 In Sir James Dunn Building Room 304

## Course Materials

Introduction to Atmospheric Chemistry (1<sup>st</sup> ed), by D.J. Jacob, 1999 (available at the bookstore and at <https://acmg.seas.harvard.edu/education-introduction-atmospheric-chemistry/>)

Make sure to check the errata at the bottom of the page.

Other useful texts:

- Chemistry of the Upper and Lower Atmosphere, by B.J. Finlayson-Pitts & J.N. Pitts, 2000
- Atmospheric Chemistry and Physics, by J.H. Seinfeld and S.N. Pandis, any of the 3 editions
- Modeling of Atmospheric Chemistry, by G.P. Brasseur and D.J. Jacob, 2017

## Assessment

| Assessment                | Weight (% of final grade) | Date                         |
|---------------------------|---------------------------|------------------------------|
|                           | <u>4595 / 5595</u>        |                              |
| <i>In-class Exercises</i> | 15% / 15%                 | Most Fridays                 |
| <i>Assignments</i>        | 15% / 25%                 | Throughout                   |
| <i>Tests</i>              | 35% / 30%                 | Oct 24, Nov 24 (TBC)         |
| <i>Final exam</i>         | 35% / 30%                 | Posted by Registrar's Office |

### *In-class Exercises*

A portion of most Friday classes will be set aside for students to work together to answer synthesis questions on the material covered that week. Each group will submit their answer at the end of the class. Evaluation will be based on effort, creativity, and participation. You must not use AI at any point during these exercises. The exercise with the lowest marks will be dropped. Bonus marks (up to 5% total on the final grade) will be awarded for submitting the complete solution by the start of the next class.

### *Assignments*

Assignments will be posted throughout the term for students to work on outside of class. They can be submitted online through Brightspace or by paper in class. Students may need to use computing software to do calculations and make basic graphs (e.g. Excel, R, Python, Matlab, Igor, IDL, etc.). If you need help with this, please contact the instructor (or TA if we have one). Assignments, with the exception of the final one, are intended to be an individual effort. Although you can discuss the problem with fellow students, collaboration between students in the writing of solutions is not allowed. You must write the solutions alone.

The final assignment will be completed in teams assigned by the professor that will build off of the other assignments. A ~5-page report (including figures) written in the form of a scientific

paper will be due December 10. Each team member will also need to submit a statement describing their own contributions as well as their team mates'. A full rubric for the final assignment will be provided in November. AI may be used to help with coding but interpretation of figures must be your own.

### Tests

Two tests will be written in class and will include material up to one week before the test date. Students are permitted to use a scientific calculator and a one-page aide sheet, but not any device which would enable cheating during a test. The final exam mark can replace one test mark if it results in a higher grade.

### Final exam

The final exam will be scheduled by the registrar's office (available October 17) and written during the exam period. Students are permitted to use a scientific calculator and a double-sided aide sheet, but not any device which would enable cheating during the exam.

Conversion of numerical grades to final letter grades follows the

#### [Dalhousie Grade Scale](#)

|             |            |            |           |
|-------------|------------|------------|-----------|
| A+ (90-100) | B+ (77-79) | C+ (65-69) | D (50-54) |
| A (85-89)   | B (73-76)  | C (60-64)  | F (0-49)  |
| A- (80-84)  | B- (70-72) | C- (55-59) |           |

### Course Policies on Missed or Late Academic Requirements

- In-class exercises are due at the end of class. The exercise with the lowest grade will be discarded when computing the average grade.
- Assignments will be accepted up to one week after the due date without penalty, after which they will no longer be accepted. Feedback for late assignments may be delayed or of lower quality.
- Students are required to write the Final Exam during the scheduled time, except under extenuating circumstances (i.e. worthy of a medical note). A missed exam will be made-up as soon as possible after the original time.

### Course policy related to AI

You may use AI-driven tools to assist your learning, but you may not use them to produce work to be submitted for evaluations. It is strongly recommend that you read the recent report on *cognitive offloading* by researchers at MIT: <https://www.media.mit.edu/publications/your-brain-on-chatgpt/> (Kosmyna et al., 2025). The findings are rather grim, showing that users who habitually use AI to perform tasks that require critical thinking gradually accrue a *cognitive deficit*: i.e., over time, researchers have found that an AI user's critical thinking skills degrade.

I hope that this course will provide you with a deep understanding of atmospheric chemistry and problem solving; but acquiring this understanding necessarily requires YOU to do the thinking and build the neural networks in your brain. Unless you are confident that you are using AI in a

way that amplifies your learning (e.g., generating some practice problems or conceptual questions to help you prepare for a test), then I strongly recommend against using AI at all.

Nataliya Kosmyna, Eugene Hauptmann, Ye Tong Yuan, Jessica Situ, Xian-Hao Liao, Ashly Vivian Beresnitzky, Iris Braunstein, and Pattie Maes. "*Your brain on chatgpt: Accumulation of cognitive debt when using an ai assistant for essay writing task.*" arXiv preprint arXiv:2506.08872 (2025).

### **Learning Objectives**

- Develop critical-thinking skills
- Identify dominant processes affecting atmospheric composition
- Integrate knowledge of atmospheric chemistry to formulate simple models

## University Policies and Statements

### Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or [elders@dal.ca](mailto:elders@dal.ca). Additional information regarding Mi'kmaq and Indigenous Relations (including the Elders in Residence program, Land Acknowledgements, Understanding Our Roots, and much more) can be found at: <https://www.dal.ca/about/mission-vision-values/mikmaq-indigenous-relations.html>

### Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about/mission-vision-values/global-relations.html>

### Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre ([https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.html)) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro ([https://www.dal.ca/campus\\_life/ssc.html](https://www.dal.ca/campus_life/ssc.html)).

## **Conduct in the Classroom – Culture of Respect**

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

## **Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <https://www.dal.ca/about/mission-vision-values/equity-diversity-inclusion-and-accessibility/about-office-equity-inclusion.html>

## **Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

<https://www.dal.ca/content/dam/www/about/leadership-and-governance/governing-bodies/code-student-conduct.pdf>

## **Fair Dealing Policy**

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: <https://www.dal.ca/content/dam/www/about/leadership-and-governance/university-policies/fair-dealing-policy.pdf>

## **Student Use of Course Materials**

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.