

Winter 2025
Atmospheric Chemical Transport Modelling
Civil and Environmental Engineering
ENVE 5106 (v2)

Teaching Team

Instructor: Amir Hakami (amir_hakami@carleton.ca)

Office hours: by appointment

TA: N/A

Course Description and requirements

1) Course schedule

Lectures: Please refer to the public class schedule

2) Course description

Fundamentals of Eulerian atmospheric modelling; overview of global and regional atmospheric models, basic principles of numerical methods used in air quality models; applications of air quality models; uncertainty and sensitivity analysis in air quality modelling.

3) Prerequisites and recommended knowledge

None

4) Precluded courses

None

5) Learning Outcomes

By the end of this course you should have developed strong conceptual understanding of the basic concepts of air quality modelling. You should:

- Gain understanding of the main types of atmospheric models, their distinctions, functional principles, limitations, applications, and evaluation of these models.

- Understand the general structure of chemical transport models and the main processes represented in these models, including advection, turbulent diffusion, gas-phase chemistry, and aerosol dynamics/thermodynamics.
- Become familiar with some of the numerical techniques used to solve science processes in CTMs such as advection, diffusion, and chemistry.
- Learn fundamentals uncertainty analysis, and forward and adjoint sensitivity analysis, with focus on atmospheric modelling applications.
- Become familiar with applications of CTMs in various fields, including in regulations and policy, health impact assessment, environmental justice, climate change mitigation, etc.
- Become familiar with the peer review process, through critical examination of the strength and weaknesses of journal publications.
- Conduct independent research and analysis of a relevant topic by applying the knowledge gained in this course towards completion of an independent project.

6) Graduate Attributes

Engineering programs are accredited by the Canadian Engineering Accreditation Board (CEAB). As part of this process, we collect Graduate Attributes (GA) data to assess how effectively we are teaching or conveying the GAs with a goal to continually improve our programs. The GA data are aggregate data for a course and are NOT linked to student names or student numbers. This course is not designated for GA assessment; however, the following GAs are covered in this course.

GA - Indicator	Assessment Tool
GA1: Knowledge base	NA
GA2: Problem analysis	NA
GA3: Investigation	NA
GA7: Communication skills	NA
GA9: Impact of Engineering on the society and Environment	NA
GA12: Lifelong learning	NA

For information on GAs and continual curriculum improvement, visit the [Accreditation section of Engineers Canada website](#).

7) Accreditation Units

N/A

8) Textbook(s)/References

Students are not required to purchase textbooks or other learning materials for this course. Your main source for course content should be your notes and the assigned journal articles. The following two books are recommended for those interested in, or working on aerosols.

- Jacobson, M. Z., Fundamentals of Atmospheric Modelling, Cambridge University Press, 2005 (2nd ed) (List price: \$139.95).

- Seinfeld, J. H.; Pandis, S. N., Atmospheric chemistry and physics: from air pollution to climate change, Wiley-Interscience, 2016 (3rd ed) (list price: \$208.95).

9) Topics and Tentative Plan

The following timeline is approximate and due dates are subject to change.

Number of Lectures	Topics
3	Introduction to models, various atmospheric models, CTM structure, model evaluation
5	Modelling of main processes and numerical solutions: advection, diffusion, chemistry, aerosol dynamics and thermodynamics
4	Probing techniques and source receptor relationships: sensitivity analysis, source attribution, source apportionment. Decision support. Uncertainty analysis.

10) Evaluation and Marking Scheme

Evaluation in the course is based on the following breakdown:

20 % Assignments

50 % Article review and discussion (written and oral)

- In-class discussion of journal articles, 3 written reviews

30 % Term paper and presentation

- Topic suggestion by students by January 22
- List of additional topics posted by January 29
- Finalized topic by February 5
- Detailed outline by February 12
- Topic presentations (10 minutes + 10 minutes Q&A) in the last three weeks
- Term paper due on April 8

a) Missed term work and exams

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work or midterm exams are held responsible for immediately informing the instructor concerned and for alternate arrangements with the instructor and in all cases this must occur no later than three (3) days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult [Section 4.4 of the University Calendar](#).

b) Final Examination

N/A

c) Late Submission Policy

Penalties for late submissions are 10% within an hour, 25% within 8 hours, and 50 % within a day. Submissions after 24 hours receive no credit. If solutions are posted (or provided in another fashion, e.g., the PA session) within a day from the due date, late submissions won't be accepted.

11) Academic dates

Students should be aware of the academic dates (e.g., last day for academic withdrawal) posted on the Registrar's office web site <https://carleton.ca/registrar/registration/dates/academic-dates/>

Academic Integrity and Plagiarism

- a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: <https://carleton.ca/engineering-design/current-students/fed-academic-integrity> Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.
- b) One of the main objectives of the Academic Integrity Policy is to ensure that **the work you submit is your own**. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using another's data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
- failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks.

Copyright

The materials (including the course outline, slides, posted notes, videos, labs, projects, assignments, quizzes, exams, and solutions) created for this course are intended for personal use only. They may not be reproduced, redistributed, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without written permission from the author(s), both during and after the semester.

Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](#) at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at **613-520-6608** or pmc@carleton.ca.

You should request your academic accommodations in the [Ventus Student Portal](#), for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm. For final exams, the

deadlines to request accommodations are published in the [University academic calendars](#) for both undergraduate and graduate students.

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF\)](#).

Pregnancy Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF\)](#).

Religious Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF\)](#).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the [Sexual Violence Prevention & Survivor Support](#).

Engineering Academic Advising

[The Engineering Academic Support Service](#) assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.

Academic Advisors Contact can be found here: <https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/>.

Student Mental Health and Wellness

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's [Wellness Services Navigator](#) is designed to help students connect with mental health and wellness resources.

If you need to talk to someone from the department for more information and support with connecting to resources, you can contact the following faculty members, depending on your program. Or contact the department at orCEEUGChair@cunet.carleton.ca.

ACSE: Prof. [Elie Azar](#)

Email: Elie.Azar@carleton.ca, Office: 3432 Mackenzie

CIVE: Prof. [Heng Khoo](#)

Email: heng.khoo@carleton.ca, Office: 3364 Mackenzie

ENVE: Prof. [Shoeleh Shams](#)

Email: shoelehshams@cunet.Carleton.ca, Office: 4242 Mackenzie

Here is a list of on-campus and off-campus recourses:

1. **Carleton's Wellness Desk:** Located at [204A MacOdrum Library](#), is a space for students to learn about resources, connect with our Wellness Coordinator, and decompress during stressful times of the year. You can pop into the Wellness Desk any time during its hours of operation – no appointments necessary! <https://wellness.carleton.ca/mental-health/wellness-desk/>
2. **Carleton's Health and Counselling Services:** To book an appointment contact the main clinic by calling (613) 520-6674. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away. <https://carleton.ca/health/>
3. **Residence Counselling and Wellness Service:** Counselling services specifically for students in residence. <https://carleton.ca/health/residence-counselling/>
4. **Therapy Dogs:** Carleton's therapy dogs are around campus with their owners (who are Carleton University staff and faculty) to comfort and provide support to help you thrive as a university student. <https://carleton.ca/wellness/dogs/>
5. [Emergencies and Crisis](#) and [Emergency Numbers](#)
6. **Good2Talk (1-866-925-5454):** Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, addictions and well-being to post-secondary students in Ontario, 24/7/36 <https://good2talk.ca/>
7. **Empower Me:** Undergraduate students have access to free counselling services in the community through Empower Me, either in person, by telephone, video-counselling or e-counselling. **This free service is accessible 24/7, 365 days per year.** Call **1-844-741-6389 (toll free)** to make an appointment with a counsellor in the community. More information is available <https://students.carleton.ca/services/empower-me-counselling-services/>
8. **The Walk-In Counselling Clinic (off-campus community resource):** The walk-in Counselling Clinic have offices in various locations across Ottawa and the greater Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic **offers services in many languages** and is free and confidential. More information can be found at: <https://walkincounselling.com/>
9. **Distress Centre of Ottawa and Region:** Available 10am-11pm, 7 days/week, 365 days/year. **Distress Line:** 613-238-3311, **Crisis Line:** 613-722-6914 or 1-866-996-0991, **Text:** 343-306-5550. <https://www.dcottawa.on.ca/>

10. **Distress and Crisis Ontario**, Available for chat 2 pm – 2 am EST. <https://www.dcontario.org/>
11. **BounceBack Ontario (Toll-Free: 1-866-345-0224)** is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness. <https://bouncebackontario.ca/>.