

ENV1007 – THE WARMING PAPERS
SCHOOL OF THE ENVIRONMENT, UNIVERSITY OF TORONTO
Fall 2023

Climate change, which is driven by global warming, is one of the most pressing global environmental crises of our generation and our children's and grandchildren's generations. Although the crisis has only been recognized in the public sphere in the past couple of decades, the foundations of our understanding of global warming are almost two centuries old. We will use *The Warming Papers*, a compilation of the canonical papers describing the scientific logic of global warming, as our guide. This course will lay out the scientific logic of global warming from Jean-Baptiste Joseph Fourier's 1824 paper on what would come to be known as the greenhouse effect, through to the most recent discoveries, and will cover climate physics and the carbon cycle.

COURSE CONTACT INFORMATION:

Instructor: Prof. Debra Wunch

Office: Room MP 707A (South side of the 7th floor of the Burton Tower, Department of Physics, 60 St. George Street)

Email: dwunch@atmosp.physics.utoronto.ca

I welcome inquiries by email, and I will always try to reply to email inquiries within 2 business days (i.e., excluding weekends).

INSTRUCTOR BIOGRAPHY:

I am fascinated by the Earth's carbon cycle, which is the flow of carbon between the land, oceans, and atmosphere. Measurements of the atmosphere are key to understanding these processes: they constrain the sources and sinks of carbon and help determine the impacts of increasing fossil fuel emissions into our atmosphere. My research focuses on making precise and accurate measurements of atmospheric greenhouse gases from the ground and from space and interpreting the measurements in the context of the carbon cycle.

COURSE WEBSITE:

Quercus will be used for the course website. The home page of the website will be used for all class announcements. It is your responsibility to check regularly to keep up on course announcements and assignment due dates!

COURSE MEETING TIMES:

Lectures: 3 hours/week, Tuesdays 2:10 pm – 5 pm. On alternate weeks, the Centre for Global Change Science Distinguished Lecturer seminars will be held during the third hour of class from 4:10-5pm.

COURSE OBJECTIVES:

In this course, we will explore the two hundred years of climate physics and carbon cycle discoveries that have informed our current understanding of global warming. By the end of the course, you will be able to:

- Explain the main physical arguments that govern global warming, citing the original papers in which the discoveries were first documented. This objective will be achieved by writing short summaries of each paper, by presenting the material in depth to peers, attending cutting-edge

seminars, and leading and participating in class discussions.

You will have a choice of final report topics. Depending on your interests, you will learn to:

- Critically evaluate new scientific literature by writing a literature review of an area in climate science that emerged after the papers in *The Warming Papers* collection were written. As part of this literature review, you will demonstrate your ability to predict the impacts of this new research on predicting Earth’s climate.
- Critique and evaluate arguments currently used in the public debate on climate change by writing thoughtful responses to op-ed pieces. You will demonstrate your ability to extend the logical consequences of the op-ed arguments.

In addition, you will:

- Improve your writing skills through weekly writing assignments and the final report.
- Improve your oral speaking skills through presenting in front of peers, leading and participating in class discussions, and attending seminars presented by leaders in the field of climate science.

These logical, oral, and writing skills will be transferrable to your future careers as graduate students and beyond, and in other aspects of your life. Written communication is important for writing your thesis, scholarly papers, op-eds, and reports for future employers. Oral communication skills are important for your graduate seminars, thesis defense, and (the inevitable!) discussions on climate change in social or family settings.

COURSE MATERIAL REQUIREMENTS:

For this course, you will need internet access to retrieve the course readings (from electronic resources at the Library and other websites), and a computer with presentation software (e.g., PowerPoint) and word processing software (e.g., Word, LaTeX, or Markdown).

COURSE TEXTS:

This course will use *The Warming Papers*, edited by David Archer and Raymond Pierrehumbert, which is available for download via the U of T library at the following address: <https://ebookcentral-proquest-com.myaccess.library.utoronto.ca/lib/utoronto/detail.action?docID=1184146>. Note that not all chapters can be downloaded at once, but you can download the chapters as needed.

Other materials are available online through the library or course website. Recommended texts: *The Discovery of Global Warming* by Spencer Weart (<http://go.utlib.ca/cat/11948757>); *The Global Carbon Cycle* by David Archer (<http://go.utlib.ca/cat/12223253>); *The Long Thaw* by David Archer (<http://go.utlib.ca/cat/11383151>).

COURSE EVALUATION:

16 %	Weekly summary abstracts starting in week 2
30 %	Presentations and leading class discussions (~3 per student depending on enrolment)
35 %	Final Report
5 %	Contribute to class discussions

14 %	Attendance at, and summary of, at least two CGCS (or other related) seminars
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SUMMARY ABSTRACTS:

- There will be assigned readings for each class, and at the beginning of each class, a short (~1-2 page, double-spaced) summary of the readings will be submitted by each student through Quercus. These summaries should contain the following information:
 - The title and authors of the paper(s) summarized
 - The main take-away points of the paper (this can be in point form)
 - How this paper advanced our understanding of the forecast of global warming
- The summary abstracts are not required for students who are presenting a paper that week, but those students will upload their presentations to Quercus in lieu of a summary abstract
- *The summary abstracts will be graded on a 3-point scale*
 - 3 – main points were correctly and concisely stated, the context of the paper was clear, the writing style was clear
 - 2 – the main points and context were mostly correct, writing was generally clear
 - 1 – some of the main points or context were incorrect, and/or writing was unclear
 - 0 – the main points or context were generally incorrect, and/or writing was unclear, or no work was handed in

PRESENTATIONS:

- You will prepare presentations on topics determined at the start of the semester.
- There will be up to three presentations in each lecture period by different presenters.
 - The presenters will be responsible for presenting their assigned papers (typically one or two per in-class hour) and any relevant additional information required to fully understand the context for the work. The presentation should take around 20-40 minutes.
 - At the end of the presentation, the presenters will offer the main “take-away points” from the papers, and a few “discussion points” to begin a class discussion.
 - The presenters will then lead a class discussion for the remainder of the hour.
- *The presentations will be graded based on Organization, Subject Knowledge, Visual Aids, Delivery, and Discussion.*

SEMINAR ATTENDANCE:

- You are encouraged to attend all *Centre for Global Change Science (CGCS) Distinguished Lecturer seminars during the term, which are held every other Tuesday from 4:10-5pm* (<https://cgcs.physics.utoronto.ca/seminars/>). These seminars are delivered by experts in their field of global change science. If the seminar series clashes with your schedule, you could watch lectures from the 2020-2021 online series (but you will not have the opportunity to ask questions). Alternatively, other seminars can be chosen after discussing your choices with me.
- I recommend that you join the CGCS mailing list to be kept up to date on speakers, topics, and room numbers. I believe you can do so by using the CGCS contact form (<https://cgcs.physics.utoronto.ca/contact/>).
- You will select two CGCS (or approved alternate) lectures for which you will hand in a 1-2-page (double-spaced) summary of the lecture, including a paragraph on how the material links with

the material covered in class. The deadline for the summary will be in class the following week (i.e., a week later). *The summaries will be graded on a 3-point scale:*

- 3 – *the main ideas from the seminar were correctly and concisely described, the concepts linking the seminar with the class material was clear, and the writing style was clear*
- 2 – *the main points and context were mostly correct, and writing was generally clear*
- 1 – *some of the main points or context were incorrect, and/or writing was unclear*
- 0 – *the main points or context were generally incorrect, and/or writing was unclear, or no work was handed in*
- You will also evaluate the presenter’s presentation style using the same rubric used to evaluate your own in-class presentations, and you will hand in the rubric with your lecture summary, including a reflection on the aspects of the presentation you enjoyed or appreciated. *The rubric and reflection will be given a grade of 1 if submitted; 0 if not or if incomplete.*

FINAL REPORTS:

There are two styles and several possible topics for the final report, and you may choose a topic of your choice after consultation with me. The paper should be about 2000 words in length and it will be due on the last day of term. I will be available to provide feedback on your chosen topic and outline of your report between weeks 6 and 9.

COURSE SCHEDULE (subject to change based on enrolment/interest):

Week	Activity
1	Introduction to the course material, assignment of papers and presentation dates; The Greenhouse Effect (Presented by Prof. Wunch)
2	Eunice Foote; Wagging the Dog (Presented by Prof. Wunch)
3	By the Light of the Silvery Moon; The Balance of Energy
4	The Birth of the General Circulation Model
5	Aerosols; Ocean Heat Uptake and Committed Warming; Taking Earth’s Temperature (Jones et al.)
6	Taking Earth’s Temperature (Fu et al.; Mann et al.)
7	Ice Sheets and Sea Level; The Public Statement (Presented by Prof. Wunch); The Sky is Rising!
8	Denial and Acceptance; Bookends
9	One If by Land (Bolin; Tans et al.)
10	One If by Land (Cox et al.); Two If by Sea (Broecker & Takahashi; Walker & Kasting)
11	Two If by Sea (Kennett & Stott); On Ocean pH (Caldeira & Wickett)
12	On Ocean pH (Riebesell et al.); Tiny Bubbles; Wrap-up

STUDENT RESOURCES and POLICIES:

ABSENCES:

- You are responsible for making up missed material from lectures. If you miss a deadline, you must contact Prof. Wunch as soon as possible and no later than one week after returning to class.
- Legitimate absences from class for medical, personal, family or other unavoidable reasons must be documented by a detailed letter requesting consideration and one of the following:
 - 1) UofT Verification of Illness or Injury Form;
 - 2) Student Health or Disability Related Certificate;
 - 3) A College Registrar's Letter or
 - 4) Accessibility Services Letter.
- The late penalty for assignments is a reduction in your mark of 10% per day of lateness. After five days, late assignments will not be accepted. If you cannot attend your scheduled presentation date(s), please tell Prof. Wunch as far in advance as possible, so other students can take the time slot.

WRITING AT THE UNIVERSITY OF TORONTO:

There are a number of College Writing Centres at the University of Toronto (<http://www.writing.utoronto.ca/writing-centres/arts-and-science>) that you can use as resources to assist you in organizing and writing your formal report and other assignments. The main Writing at the University of Toronto website can be found via the web (<http://www.writing.utoronto.ca/>). They provide a lot of useful information under the Advice section of their website and you are encouraged to consult them for assistance with your written assignments. They also offer a series of workshops entitled "Writing Plus". These are detailed at <http://www.writing.utoronto.ca/writing-plus>. Finally, the English Language Learning program (ELL) offers different skills development programs that may be beneficial (<http://www.artsci.utoronto.ca/current/advising/ell>).

REMINDER ABOUT UNIVERSITY POLICY ON POSTAL ADDRESSES AND ELECTRONIC MAIL ACCOUNTS:

You are required to keep your contact information your ROSI account up to date with current and valid postal and university-issued e-mail addresses. It is your responsibility to monitor this e-mail account as it is the one that will be used to contact you during this course. For more information, please refer to <http://www.governingcouncil.utoronto.ca/policies/studentemail.htm>.

ACCOMMODATIONS:

If you have a learning need requiring an accommodation the University of Toronto recommends that students immediately register at Accessibility Services at <http://www.studentlife.utoronto.ca/as>.

Location: 4th floor of 455 Spadina Avenue, Suite 400

Voice: 416-978-8060

Fax: 416-978-5729

Email: accessibility.services@utoronto.ca

The University of Toronto supports accommodations of students with special learning needs, which may be associated with learning disabilities, mobility impairments, functional/fine motor disabilities, acquired brain injuries, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, psychiatric disabilities, communication disorders and/or temporary disabilities, such as

fractures and severe sprains, recovery from an operation, serious infections or pregnancy complications. You are also invited to communicate with Prof. Wunch at any time about your learning needs. Confidentiality of learning needs is respectfully and strictly maintained.

EQUITY, DIVERSITY, and EXCELLENCE

[This is from <http://www.governingcouncil.utoronto.ca/policies/stateequdivexc.htm>, but it is included here because it is important.]

At the University of Toronto, we strive to be an equitable and inclusive community, rich with diversity, protecting the human rights of all persons, and based upon understanding and mutual respect for the dignity and worth of every person. We seek to ensure to the greatest extent possible that all students enjoy the opportunity to participate as they see fit in the full range of activities that the University offers, and to achieve their full potential as members of the University community.

Our support for equity is grounded in an institution-wide commitment to achieving a working, teaching, and learning environment that is free of discrimination and harassment as defined in the Ontario Human Rights Code. In striving to become an equitable community, we will also work to eliminate, reduce or mitigate the adverse effects of any barriers to full participation in University life that we find, including physical, environmental, attitudinal, communication or technological.

Our teaching, scholarship and other activities take place in the context of a highly diverse society. Reflecting this diversity in our own community is uniquely valuable to the University as it contributes to the diversification of ideas and perspectives and thereby enriches our scholarship, teaching and other activities. We will proactively seek to increase diversity among our community members, and it is our aim to have a student body and teaching and administrative staffs that mirror the diversity of the pool of potential qualified applicants for those positions.

We believe that excellence flourishes in an environment that embraces the broadest range of people, that helps them to achieve their full potential, that facilitates the free expression of their diverse perspectives through respectful discourse, and in which high standards are maintained for students and staff alike. An equitable and inclusive learning environment creates the conditions for our student body to maximize their creativity and their contributions, thereby supporting excellence in all dimensions of the institution.

ACADEMIC INTEGRITY:

Academic integrity is fundamental to learning and scholarship at the University of Toronto. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that the U of T degree that you earn will be valued as a true indication of your individual academic achievement, and will continue to receive the respect and recognition it deserves.

Familiarize yourself with the University of Toronto's *Code of Behaviour on Academic Matters* (<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>). It is the rulebook for academic behaviour at the U of T, and you are expected to know the rules. Potential offences include, but are not limited to:

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgement
- Copying material word-for-word from a source (including lecture and study group notes) and not placing the words within quotation marks

- Submitting your own work in more than one course without the permission of the instructor
- Making up sources or facts
- Including references to sources that you did not use
- Obtaining or providing unauthorized assistance on any assignment including:
 - working in groups on assignments that are supposed to be individual work
 - having someone rewrite or add material to your work while “editing”
- Lending your work to a classmate who submits it as his/her own without your permission

On tests and exams:

- Using or possessing any unauthorized aid, including a cell phone
- Looking at someone else’s answers
- Letting someone else look at your answers
- Misrepresenting your identity
- Submitting an altered test for regrading

Misrepresentation:

- Falsifying or altering any documentation required by the University, including doctor’s notes
- Falsifying institutional documents or grades

You can get further guidance on academic integrity from the website of the Office of Student Academic Integrity at: www.artsci.utoronto.ca/osai/students.

All suspected cases of academic dishonesty will be investigated following the procedures outlined in the [Code of Behaviour on Academic Matters](#). If you have any questions about what is or is not permitted in this course, please do not hesitate to contact me. If you have questions about appropriate research and citation methods, you are expected to seek out additional information from me or other available campus resources like the [College Writing Centres](#), the [Academic Success Centre](#), or the [U of T Writing Website](#).