

EES1117H: Climate Change Impact Assessment

Class: 12:00 - 13:30 Tuesdays, Synchronous
Lab: 13:30 - 15:00 Tuesdays, Synchronous (optional asynchronous)

1 Instructor

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3 Course

Although climate change is a global phenomenon, the varying impacts of climate change are primarily experienced at regional scales. Because many long-term planning decisions - decisions that often rely on climatological information - are made locally, we are entering an era when the availability of regional climate information at appropriate spatial scales and in accessible forms is critical. Thus, this course describes how climate information can and is being used to assess the impacts of climate change and, ultimately, inform local decision-making and adaptation strategies. The course begins by reviewing climate change over the last 150 years and the projection of future climate change using Global Climate Models (GCMs)/Earth System Models (ESMs). The climate change impact assessment (CCIA) framework is then introduced and applied to several case studies. In the computer labs, you will learn how to use open-source online platforms and tools to access projections of future climate generated by GCMs participating in the most recent phase (Phase 5) of the Coupled Model Intercomparison Project (CMIP5). Downscaling of GCM data is a key component of CCIA; both statistical and dynamical downscaling techniques will be discussed in class and explored in the computer labs. Finally, you will also acquire practical experience in CCIA by applying the techniques discussed in class to your own final project.

4 Learning Outcomes

By the end of the course you will be able to:

- apply the CCIA approach to real-world problems,
- summarize the concept of downscaling GCM data,
- describe the differences between statistical and dynamical downscaling and list the pros and cons of each,
- explain the requirement for bias-correction in CCIA and describe several bias-correction techniques,
- comfortably work with observational and GCM data for CCIA,
- critically evaluate and review CCIA techniques presented in the literature,
- present scientific results in a professional manner.

5 Expectations

We all come to this course with pre-conceived expectations about how the course will progress. To get us all on the same page, I have outlined those that I feel are most important in order to make this course a success.

As your instructor, I expect you will:

- take full responsibility for your own learning
- come on time and prepared for every class
- complete all work on time and with appropriate effort
- treat your fellow students, TA and instructor with respect
- ask questions when you don't understand or need clarification. Instructors love questions! Asking questions is a sign that you're engaged in the material
- contribute to building a positive learning community
- keep your microphone on mute unless asking a question or engaged in a break-out room discussion

As students, you are entitled to expect that I will:

- foster a constructive environment for learning
- come prepared to every class
- plan each class to help you achieve the course learning objectives
- understand that the material is challenging and that extra time may be needed to work through certain topics
- provide clear instructions for assignments and lab exercises
- provide timely and constructive feedback

6 Resources

Readings and resources will be posted on the course webpage and/or are listed in Section 19 of this syllabus. There is no textbook for this course, but there are two e-books of which that we will make use, covering many of the topics we will discuss in class:

E-Books (accessible via U of T Libraries):

- [Climate Change in Practice](#), by Robert L. Wilby, Cambridge University Press.
- [Statistical Downscaling and Bias Correction for Climate Research](#), by Douglas Maraun and Martin Widmann, Cambridge University Press

Other Recommended Resources (freely available online):

- Climate Change 2021, The Physical Science Basis (IPCC AR6 WGI)
- Climate Change 2013, The Physical Science Basis (IPCC AR5 WGI)
- Climate Change 2013, Impacts, Adaptations and Vulnerability (IPCC AR5 WGII)
- Global Warming of 1.5° (IPCC Special Report)

7 Evaluation

Your course grade will be made up of class participation, lab exercises, assignments, and a final project. All deadlines are listed below in “Section 19: Tentative Schedule”.

6.1 Class + Discussion Board Participation

Participation in activities and discussion during the synchronous lecture time and in Discussion Boards is an important component of the course and is worth 10% of your final grade.

Synchronous Lecture Time (5%): During the synchronous lecture time, there will be opportunities to engage with your fellow classmates in break-out room discussions and activities.

Discussion Boards (5%): Each week, one or two discussion questions related to the readings will be posted on a new discussion board. The discussion boards will provide an opportunity for 1) active and constructive discourse with your fellow classmates and 2) a deeper exploration of CCIA concepts and applications.

6.2 Lab Exercises

There will be five lab exercises that are designed to introduce the concepts that will be explored more deeply in the assignments. The lab exercises are worth 15% of your final mark. For these lab exercises, you are encouraged to interact with your classmates by sharing ideas and discussing the specifics of the tasks. You are, however, expected to submit your own lab exercises, and it should not be a direct copy of a classmate's. Lab exercises will be posted on the course website.

6.3 Assignments

There will be three assignments relating to the content of the course and the lab exercises, worth 35% of your final mark. If you need help in completing an assignment, please visit the TA and/or instructor's office hours. The assignments are expected to be completed independently. Assignments will be posted on the course website.

6.4 Final Project

The final project *will be completed in pairs* and will consist of completing your own climate change impact assessment for a region(s) and exposure unit(s) of your choice. The final project is worth 40% of your final mark. Further details about the final project will be posted on the course website.

Total Grade Breakdown:

1. Participation	10%
2. Lab Exercises	15%
3. Assignments	35%
4. Final Project	40%

8 Analysis and Plotting Software

We will be analyzing output from global climate models (GCMs)/Earth System Models (ESMs) using **Python** data analysis software in the computer labs/tutorials and for your assignments. We will also use other online tools to access and analyze GCM/ESM data throughout the course. We will work through many examples together in labs and clear instructions will be given in the assignments.

9 Course Web Page

The course web site is available through [Quercus](#). The Quercus system is accessible using your UTORID which has been assigned to you as part of registration. **All course information, resources, readings, assignments, lab exercises and communications will be posted on Quercus.**

It is your responsibility to check the course website frequently. You must also ensure that you use your University of Toronto email address on Quercus. To familiarize yourself with Quercus, you can find additional information [here](#).

10 Verification of Illness

A **Verification of Illness** (also known as a “doctor’s note”) is temporarily not required. Students who are absent from academic participation for any reason (e.g., COVID, cold, flu and other illness or injury, family situation) and who require consideration for missed academic work should report their absence through the online absence declaration. The declaration is available on [ACORN](#) under the Profile and Settings menu. Students should also advise their instructor of their absence.

Visit [COVID-19 Information for University of Toronto Students](#) or [UTSC COVID-19 Absence Declaration in ACORN](#) for more information.

11 Late Assignments

I understand that sometimes “life happens” (especially during the pandemic) and an assignment might be submitted late due to illness, an illness or death in the family or other sudden and unanticipated event. However, assignments submitted late will not be accepted without accompanying documentation (e.g. [UTSC illness verification form](#)). Late assignments without documentation will be deducted 10% for each 24 hour period late (weekends included).

That said, I am happy to grant extensions on submitted work within reason; however, I appreciate at least 24 hours notification of a request for an extension.

12 Academic Integrity

Academic integrity is fundamental to learning and achieving our course goals. The assignments in this course are designed to give you an opportunity to learn important skills and concepts by making honest attempts through your own thinking, writing, and hard work.

I am strongly committed to assigning grades based on my students’ honest efforts to demonstrate learning in this course. Academic dishonesty in any form will not be tolerated in my classes. All academic work in this course must adhere to the [Code of Behavior on Academic Matters](#).

13 Accessibility

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services as soon as possible.

AccessAbility Services staff are available to assess specific needs, provide referrals and arrange appropriate accommodations. To register with AccessAbility Services, begin the registration process [here](#). The sooner you let us know your needs, the quicker we can assist you in achieving your learning goals in this course.

14 Equity at the University of Toronto

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.

15 Online Courses and Recording

Notice of video recording and sharing: download permissible; re-use prohibited

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. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share or use them for any other purpose without the explicit permission of the instructor.

16 Writing and English Language

As well as the faculty writing support, please see [English Language and writing support](#) at University of Toronto. Students have commented that they found the latter address extremely helpful for writing term papers.

The following are also useful:

- Sylvan Barnett, A Short Guide to Writing About Art. 5-7th edition (New York: Harper-Collins, 1997)
- William Strunk Jr., E.B. White. The Elements of Style (New York: MacMillan Publishing)

17 Emergency Planning

Students are advised to consult the [university's preparedness site](#) for information and regular updates regarding procedures relating to emergency planning.

18 Time and Stress Management

Graduate school can be a stressful time, and even more so during a global pandemic! In order to be successful in your courses, managing your time and stress is key. If you are feeling overwhelmed there are many resources that can help you get back on track:

- Talk to me. I may not always be able to help but I'll try my best to direct you to resources that can
- Use the [Math & Stats Learning Centre](#) (Note: graduate students are welcome!)
- Use the [Writing Centre](#)
- Visit [Health & Wellness](#)
- Visit [AccessAbility Services](#)

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19 Tentative Schedule

Lectures:

Date	Topic
Jan. 11	1. Introduction + Review of Past and Future Climate Change 1.1. Review of IPCC AR6 WGI Report/SR1.5 1.2. Intro to IPCC AR5 WGII - Impacts, Adaptation and Vulnerability
Jan. 18	2. CCIA Framework + Simple Downscaling: Case Study 2.1. CCIA Framework 2.2. Introduction to Downscaling 2.3. Change Factors: Case Study
Jan. 25	3. Climate Change Scenarios 3.1. History of Climate Change Scenarios 3.2. New Era of Scenarios - Shared Socioeconomic Pathways (SSPs)
Jan. 28	Assignment 1 Due
Feb. 1	4. Advanced Statistical Downscaling 4.1. Quantile-Mapping Bias Correction
Feb. 8	4. Advanced Statistical Downscaling cont'd 4.2. Constructed Analogs 4.3. Transfer Functions 4.4. Weather Generators
Feb. 15	5. Dynamical Downscaling 5.1. Regional Climate Models (RCMs) 5.2. Bias in RCMs
Feb. 22	READING WEEK
Mar. 1	6. Downscaling Considerations + Model Selection 6.1. Limitations of Bias Correction 6.2. Model Performance and Selection
Mar. 4	Assignment 2 Due
Mar. 8	7. Guest Speaker: TBD
Mar. 15	8. Extreme Event Attribution
Mar. 18	Assignment 3 Due
Mar. 22	9. Ethics and Climate Services
Mar. 29	GROUP PRESENTATIONS
Apr. 5	GROUP PRESENTATIONS
Apr. 15	Final Project due

Readings:

Week of	Reading(s)
Jan. 11	From science to service , by Lisa Goddard in <i>Science</i> :
Jan. 18	User Needs , from the book: Statistical Downscaling and Bias Correction for Climate Research , by Douglas Maraun and Martin Widmann
Jan. 25	Emissions - the business-as-usual scenario is misleading , by Zeke Hausfather and Glen Peters in <i>Nature</i>
Feb. 1	What Shapes Climate Vulnerability? from the book: Climate Change in Practice , by Robert L. Wilby
Feb. 8	Projecting Regional Change , by Alex Hall in <i>Science</i>
Feb. 15	No reading
Feb. 22	READING WEEK
Mar. 1	A Regional Modeling Debate , from the book: Statistical Downscaling and Bias Correction for Climate Research , by Douglas Maraun and Martin Widmann RealClimate Blog Post on Model Selection
Mar. 8	Usable climate science is adaptation science , by Adam Sobel in <i>Climatic Change</i>
Mar. 15	Attributing Extreme Events to Climate Change: A New Frontier in a Warming World , by Daniel Swain et al. in <i>One Earth</i>
Mar. 22	WMO white paper on ethical climate services
Mar. 29	NO READINGS
Apr. 5	NO READINGS

Labs:

****All labs are due on the Friday following the lab posting.****

Posting Date	Topic
Jan. 18	Lab Exercise1: Understanding the Recent Past
Feb. 1	Lab Exercise 2: Navigating across three dimensions of data
Feb. 8	Lab Exercise 3: Choosing our models
Feb. 15	Lab Exercise 4: Downscaled climate data from PCIC/climatedata.ca
Mar. 8	Lab Exercise 5: Downloading Climate Data

Final Words of Advice

The expert at anything was once a beginner” - Helen Hayes

The CCIA MEnvSc program is fun, interesting and tough. It is training you to become a climate change specialist. This course and your other courses are designed to help you achieve that level of expertise. However, your course instructors need your help to get you there - you need to play an active role. Ask questions of me, your fellow students and most of all yourself. Mastery of course material requires you to fully engage in the learning process.