Dynamics of Climate Variability & Climate Change
(DEES GR5400, Fall 2020)
TuTh 2:40-3:55pm ET

Dynamics of Climate Variability & Climate Change is a CORE course of the Master of Arts Program in Climate and Society. Most people in this class are part of the Climate and Society MA Program. The rest are presumably here because you feel this information will be useful to your educational and research goals. For the C&S MA students this is the primary opportunity for you to gain a scientific understanding of the climate system. This information underpins the rest of the program's goals.

To effectively link Climate into Society, an understanding of the physical workings of the climate system is critical, but not sufficient. One must also be able to interpret climate information like forecasts and observational maps. One must be able to determine the basis of forecasts as well as their uncertainties, and to judge critically the suitability of different types of climate information to answer questions of societal interest. Much of the ability to interpret climate information rests on understanding the physical workings of the climate system. Furthermore, it is important to realize that climate variability acts on a number of time and space scales, which may be further influenced by man-made climate change. How are these various aspects of the climate realized, forecast, interpreted? These are the sorts of issues that we address through the semester.

Eventually, one will need to communicate with the public, a boss or co-worker, or even friends and family, in pursuit of linking climate and society. Therefore, one must be fluent in the language appropriate to discuss climate, its variability and its change. Solid understanding and appropriate usage of terminology will be emphasized throughout the course. There will also be a communication project, where students team up in small groups [3-4 people], select a climate science topic from a list provided by the instructors, distill and synthesize the physical understanding, debate/arguments, and societal relevance of this topic. The group presentation to a general audience provides an opportunity to research and summarize existing literature and to communicate the knowledge and skills developed in the class.

Course Summary:

Introduction
Module 1 -- the Earth's energy imbalance
Module 2 -- the Greenhouse Effect
Module 3 -- atmospheric dynamics in 1D [vertical (height)]
Module 4 -- atmospheric dynamics in 2D [latitude/height]
Module 5 -- atmospheric dynamics in 3D
Module 6 -- oceans, wind-driven dynamics
Module 7 -- oceans, density-driven dynamics
Midterm quiz/review
Module 8 -- dynamics of the El Niño-Southern Oscillation phenomenon
Module 9 -- climate variability: patterns of coherence in the midst of chaos
Module 10 -- Models, predictions and projections

Module 11 -- Predictions: ENSO, seasonal, decadal, etc.
Module 12 -- Projections: expectations of change

Learning Goals and Outcomes

- To understand the physical processes of the climate system and their variability;
- To interpret climate forecast (predictions and projections) material, including associated uncertainties;
- To start developing an awareness of the suitability of different types of climate information to address questions of societal interest;
- To read and interpret critically scientific literature and news, such as that appearing on-line (e.g. RealClimate.org), in the news (e.g. NY Times, BBC), and in scientific magazines (e.g. Science, Nature); and,
- To be able to communicate clearly and accurately on climate-related issues.

Diversity Statement

Diversity, equity, and inclusion are critical values in education, but they must be supported by a commitment to action. The instructors are committed to creating an inclusive classroom environment. They expect students to work collaboratively to create an equitable classroom environment that actively engages all students in meaningful and relevant learning, values the contributions of students' diverse backgrounds, and acknowledges systemic and institutional challenges.

Statement on Disabilities Accommodations

If you have been certified by Disability Services (DS) to receive accommodations, please either bring your accommodation letter from DS to your professor's office hours to confirm your accommodation needs, or ask your liaison in GSAS to consult with your professor. If you believe that you may have a disability that requires accommodation, please contact Disability ServicesLinks to an external site. at 212-854-2388 or disability@columbia.edu.

Statement of Academic Integrity

Graduate students are expected to exhibit the high level of personal and academic integrity and honesty required of all members of an academic community as they engage in scholarly discourse and research. In practical terms, students must not cheat on examinations; deliberate plagiarism is prohibited. Plagiarism includes buying, stealing, borrowing, or otherwise obtaining all or part of a paper (including obtaining or posting a paper online); hiring someone to write a paper; copying from or paraphrasing another source without proper citation or falsification of

citations; and building on the ideas of another without citation. Students also should not submit the same paper to more than one class.

Students engaging in research must be aware of and follow university policiesLinks to an external site. regarding intellectual and financial conflicts of interest, integrity, and security in data collection and management, intellectual property rights, and data ownership, and necessary institutional approval for research with human subjects and animals.

Class Structure:

Classes will consist of lectures and exercises and will be interactive. Each module will consist of one online lecture-based class and one online reading discussion-focused class. Material will be provided both synchronously, notably, during scheduled class time, and made available asynchronously to view before / after class. You will be asked to read or view materials and to consider questions *ahead* of class in order to motivate thinking about the physical concepts to be discussed during class. Your participation will constitute part of your grade. For this reason, and because the lectures do not strictly follow text book material, it is very important to attend class and participate.

Questions and discussion in class are **strongly encouraged**. The backgrounds of the students in the class are diverse. Raising questions on information you find confusing, or offering your perspectives or experiences on a topic under discussion, will enhance the understanding and overall gains for the entire class.

1. **Lectures & Readings-** The lectures aim to cover the physical concepts associated with the particular issue under discussion, such as Climate Change or El Niño. Since the class is structured with a problem focus, it does not follow the structure of traditional climate textbooks. There will be textbook and journal article readings to complement the lecture material. However, no textbook will be read sequentially or entirely. The science behind climate variability and climate change, and our ability to produce societally relevant information of climate continues to evolve. In order to cover our latest understanding on some issues, the class readings will draw on works such as the Assessments Report of the IPCC or scientific research papers.
   Students are expected to discuss the assigned reading material and raise questions based on the assigned readings and/or pre-class exercises. Class participation will constitute **5% of your grade**.

Powerpoint lectures will be posted to the Courseworks site prior to each lecture.

2. **Pre-Class/In-class Exercises-**During the semester, short exercises ahead of class, or in class, and follow-up classroom discussion will be fairly regular. The exercises are intended to start your thinking about the problem or physical concept that is the topic of the day. At least 10 exercises will be issued; they make up **10% of your grade** (with more exercises, each one counts for proportionally less of the grade). Each exercise will be checked and assigned 0, 1 or 2 points – full credit for each exercise will be earned by successful completion of all requested information.
3. **Homework Assignments**– Homework assignments provide an opportunity to think quantitatively or critically about the information that has been presented in the

class. **Assignments are due prior to class time (so before 2pm Eastern Time) on due date**. Late assignments will be discounted by 10% for each day late, to a minimum of 50% credit. As a courtesy to the rest of the class, homework will not be accepted once the graded assignments are returned and the solutions posted, typically 1 week after the due date. Homework assignments will count towards **30% of your grade**.

A zero-tolerance policy exists on plagiarism in this class. The answer and/or phrasing must come out of your brain. The first instance of plagiarism will receive ZERO credit for the assignment, and a note from the instructors to the director of the student's degree program. Subsequent offenses will result in more formal actions with the department and the university. Given the emphasis for this particular course on terminology and communication, even cited quotation is frowned upon, but will not be punished if done correctly. Please see also some of Columbia University's information on plagiarism (http://www.columbia.edu/cu/ssw/write/handouts/AvoidPlagiarism.htmlLinks to an external site., http://www.columbia.edu/cu/gsas/pdf-files/discipline1105.pdfLinks to an external site.).

3. **Quizzes**– There will be three quizzes, which will be based on material presented in class and on the assigned readings. These will account for **30% of your grade**.

4. **Group Project** –There will also be a communication project, where students form small teams [3-4 people], select a climate science topic from a list provided by the instructors, distill and synthesize the physical understanding, debate/arguments, and societal relevance of this topic. A presentation to a general audience will be involved, which will take place at the end of the semester. The project counts for **25% of your grade**.

Final Grades- Your final grade will be computed as follows: exercises ahead of class/in class (10%), homework assignments (30%), quizzes (30%), communication project (25%), and class participation (5%). This class is not graded on a pre-determined curve. Everyone has the opportunity to get an A. Some suggestions to ensure a good grade in this class include:

* Attend all classes and engage in the material

* Review your class notes; what is not clear? Write it down, and ask questions in class.

* Study for all exams

* Ask questions, participate and get involved with the material

* Seek help with your questions: Come to instructor and TA office hours. There is a lot of material to get through in one semester, so don't let the questions pile up on you.

Recommended Textbooks

No textbook is required or followed integrally. However, you may find the following useful:

Kump, L. R., J. F. Kasting and R. G. Crane. The earth system. [various editions and publishers]

Archer, David, 2007. Global warming: understanding the forecast. Blackwell Publishing [e-book available from Columbia libraries]

Neelin, J. David, 2011. Climate change and climate modeling. Cambridge University Press [e-book available from Columbia libraries]