

## EARS 78/178: Climate Dynamics

**Instructor:** Erich Osterberg, 205 Fairchild Hall, 646-1096,  
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**Meeting Times:** 10A: Tues and Thurs 10:10 – 12:00 in Steele 315

**Class Web Site:** <https://canvas.dartmouth.edu>

**Prerequisites:** EARS 14 or EARS 15 or equivalent, and Math 8 or equivalent.

### **Required Texts:**

*Global Physical Climatology 2<sup>nd</sup> Edition* by Hartmann (2016)

### **Recommended Texts:**

*Atmosphere, Ocean and Climate Dynamics* by Marshall and Plumb (2008)

*Atmospheric Science* by Wallace and Hobbes (1977)

*Introduction to Modern Climate Change 2<sup>nd</sup> Edition* by Dessler (2016)

*The North Atlantic Oscillation* edited by Hurrell et al. (2003)

*El Nino Southern Oscillation and Climate Variability* by Allen, Lindesay and Parker (1996)

### **Course Overview:**

This class introduces you to the dominant patterns of climate variability that we see in the world today, and the underlying responsible processes. The focus of this course is not on theoretical fluid dynamics, but rather starts with observations of the climate system, and builds your knowledge of the underlying theory to better understand the observations. Homework problem sets will reinforce these concepts and underpinning theory, frequently using climate reanalysis data. We will explore the signature and causes of regional-scale ocean-atmosphere variability including the El Nino-Southern Oscillation, monsoons, and the North Atlantic Oscillation. We will rely heavily on the peer-reviewed literature to explore hypotheses about their nature and driving forces. We will explore the signature and mechanisms of how these climate modes are influenced by external forces such as solar and volcanic variability, how they interact with the surface ocean and sea ice, and how they influence regional weather patterns. Abstract writing exercises are aimed at improving your literature comprehension and writing skills. The course will culminate in a final research project on a topic of your choice that includes an extensive literature review and analyses incorporating climate reanalysis data, climate model data, remotely sensed climate data, or instrumental climate data.

### **Course Requirements and Grading:**

***Homeworks and In-class Assignments (20% of grade):*** We will complete some problems in class and some for homework throughout the term. These assignments will allow you to work through concepts that we discuss in class, and will also introduce you to web-based platforms for working with climate reanalysis datasets.

***Abstracts (20% of grade):*** We will read many journal articles in this class, and you will write abstracts for several of them. The abstracts will be in the very specific format specified by Nature magazine (which is not the journal in which they were originally published).

**Midterm Exam (20% of grade):** During class in Week 5

**Final Project (40% of grade):** During the second half of the course, you will conduct a research project on a topic of your choice. The project will include an extensive literature review and analysis of climate reanalysis data culminating in a written document and ~10 minute class presentation. Ideally this should be on a topic related to a research project of yours or something that you find intrinsically interesting about the climate system. Possible topics ideas include: ENSO/NAO interactions and/or controls on US weather; mechanisms and/or signature of solar/volcanic forcing of ENSO/NAO/monsoons/ITCZ; Seasonal signature and mechanisms of polar amplification; Investigating the warming pauses during the 1950's and 2000's; projections of future ENSO/NAO/monsoon state under different climate scenarios; among many others. Discuss your ideas for this project with me before the Midterm exam.

**Late Assignments:** 10% will be deducted for each day that an assignment is late unless you discuss the situation with me prior to the original due date. If you are unable to complete an assignment on time due to illness or other personal reasons, you may be eligible to have this penalty waived. You are encouraged to talk to me as soon as possible, and if necessary, meet with your Dean to discuss your situation.

**Planned Absences:** If you know ahead of time that you will be absent (e.g. for a college-affiliated extra-curricular activity, job interview, etc.), particularly during an exam, speak with me about it as soon as you know so that accommodations can be made. My policy is to allow students to take an exam early for a planned absence, but not to take it late unless there are special circumstances.

**Disability-Related Accommodations:** Students with disabilities who may need disability-related academic adjustments and services for this course are encouraged to see me privately as early in the term as possible. Students requiring disability-related academic adjustments and services must consult the Student Accessibility Services office (Carson Hall, Suite 125, 646-9900, [student.accessibility.services@dartmouth.edu](mailto:student.accessibility.services@dartmouth.edu)). Once SAS has authorized services, students must show the originally signed SAS Services and Consent Form and/or a letter on SAS letterhead to me. As a first step, if students have questions about whether they qualify to receive academic adjustments and services, they should contact the SAS office. All inquiries and discussions will remain confidential.

**Statement on Mental Health:** The academic environment at Dartmouth is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including:

- Your undergraduate dean (<http://www.dartmouth.edu/~upperde/>),
- Counseling and Human Development (<http://www.dartmouth.edu/~chd/>), and
- The Student Wellness Center (<http://www.dartmouth.edu/~healthed/>).

**Religious Observances:** Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

**Academic Honor Principle:** You should be aware of and conform to the Dartmouth Honor Principle as expressed in the ORC. For this course, this means:

**Abstracts:** The published papers for which you will be writing abstracts have existing abstracts as published. The papers as you receive them from me will have the abstracts removed, but you can easily find them online. You are expected not to do so. If you come across the published abstract and feel that you would like a different paper to work on, please see me.

**Exams:** The midterm exam is a closed-book exam with no notes allowed. All work on the exam is your own.

### Course Outline

Lecture#	Date	Topics	Reading	Assignment Due
1	Tu 1/7	Course overview		
2	Th 1/9	Water Vapor & Clausius-Clapeyron	M&P Ch. 1; Wentz et al., 2007	Wentz Abstract due
3	Tu 1/14	Simple Greenhouse Effect Model 1	M&P Ch. 2; Hart. Ch. 2	
4	Th 1/16	Simple Greenhouse Effect Model 2 and Energy Balance	M&P Ch. 2; Hart. Ch. 2	HW #1 due
5	Tu 1/21	Radiative Forcing and Feedbacks	Hart Ch 10; Soden et al., 2002	Soden Abstract due
6	Th 1/23	Climate sensitivity	Hart Ch 10; IPCC	
7	Tu 1/28	Large-scale atmospheric circulation 1	Hart Ch 6; M&P Ch 8	HW #2 due
8	Th 1/30	Large-scale atmospheric circulation 2	Hart Ch 6; M&P Ch 8	Final Project Idea/Outline due
	Tu 2/4	MIDTERM EXAM		
9	Th 2/6	Thermohaline circulation	Hart Ch 7; M&P Ch. 9, 11	
10	Tu 2/11	AMO and ENSO	Hart Ch 8; M&P Ch. 12; papers	Caesar or Thornalley Abstract due
11	Th 2/13	ENSO and the PDO	Hart Ch 8; M&P Ch. 12; papers	
12	Tu 2/18	Arctic Oscillation and North Atlantic Oscillation	Papers	HW #3 due
13	Th 2/20	Monsoons and the ITCZ	Papers	Seager Abstract due
14	Tu 2/25	Natural climate forcing mechanisms	Hart. Ch. 11; Papers	
15	Th 2/27	Mid-latitude weather, polar jet, and climate change	Papers	
10	Tu 3/3	Final project presentations		Final Project Due
10	Th 3/5	Final project presentations		