Ocean Circulation and Climate: Ocean 423

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Office hours: by appointment or just stop by (not right before class).

In this class, we will ask the question: what do we need to understand about the ocean in order to predict future climate change? We will focus on ocean storage and transport of heat and freshwater. We will first develop understanding of how the ocean is set into motion and how it stores and transports temperature and fresh water. Through readings of contemporary papers and excepts of the recent IPCC report we will then answer the following questions:

Should we worry about global warming leading to the next ice-age?
What ocean measurements should be made to monitor climate change?
What is causing regional changes in the ocean?
Is sea-ice extent change tied to ocean circulation?
Prerequisite: PHYS 123; MATH 125; recommended: OCEAN 210

I will be gone Tuesday April 7th, and will have an in class exercise prepared that will be led by graduate student Jimmy Booth. I will also not arrive to class until 10:00 on April 16th.

There is no textbook. I will provide as much of my notes as possible, including figures from lectures.

Schedule

Week 1-2: Some ocean and climate basics
The Earth's climate
Heat and fresh water budgets
Seawater properties
Atmosphere circulation
Structure of the oceans

Week 3: Methods of data analysis for climate variability
EOFs

Week 4-5: Wind-driven ocean circulation
Geostrophic currents and thermal wind
Ekman transport and pumping
Sverdrup circulation
Western boundary currents (e.g., Gulf Stream)
Temporal response: Rossby waves and Kelvin waves

Week 6: Subduction and water mass formation and the vertical structure of the ocean
SST re-emergence
Thermohaline circulation
Deep water formation regions
The structure of the ocean temperature and salinity fields: intermediate, deep and bottom waters
What forces the meridional overturning circulation?

Week 7: Climate Change and the oceans
The sluggish response of the ocean to atmospheric noise
The oceans and the commitment to climate change
Climate sensitivity and ocean heat content
Ocean climate modeling

Week 8-10 :Presentations and discussion of papers
Possible topics

1. Regional climate variability: Pacific, PDO
2. Regional climate variability: Atlantic, NOA/AO
3. Tropical Atlantic Variability
4. AMO and hurricanes
5. Arctic change and sea-ice extent
6. Antarctic and deep ocean changes
7. North Atlantic Thermohaline Circulation changes
8. Consequences of fresh water perturbations to the climate system
9. Sea level rise and Upper ocean heat content changes
10. Salinity changes
11. Other future ocean changes

Assignments

Grades will be based on five written assignments (45%). You will also prepare a brief summary (1-2 pages) of a paper related to one of the topics listed above. You will also prepare a presentation on that topic for class and be ready to lead a discussion (40%). All of the other students on your day of presentation will read one short paper on the topic and prepare two questions based on what they read and participate in the discussion on these topics (15%). There will be no midterm or final exam.

Each of you should give me an ordered list of the topics they are interested in by next class, and I will assign the topics. If you one that you are interested in that is not on the list, let me know.

On the day you are responsible for your topic, you will

(1) Reading a set of papers that will be decided ahead of time by me with input from you. You will run into terms that are unfamiliar! Ask me...I am available as a general resource to you in understanding these research papers.

(2) Summarizing one paper in written form (This will be 20% of your grade)

(3) Make a short presentation to the class about the topic as a whole (about 15 minutes, 15% of the grade). I will prepare a summary of the questions that the other students will send to me the day before your presentation. I will help you to guide the discussion based on these questions (5% of the grade). Often there will be overlaps with other topics, so pay attention to what other people have presented.

People not presenting:

The day before the discussion on a given topic, I'd like you to email me (and cc the discussion leader) with a question or comment related to a short paper that you will read in preparation for the discussion. This will count toward the participation component of your final class grade, and will guide the discussion after the presentation.

Goals of Course

When you are done with the course, I would like you to be able to do the following things:

State clearly and with quantitative information to back you up why the understanding the dynamics and thermodynamics of the ocean is important to be able to predict climate.

Determine the degree of certainty we know the ocean's role in climate.

Have an expert's knowledge on one topic relevant to the ocean's role in climate. You should be able to explain to your family and friends the importance of this topic.

Find the information that you need to explain the other topics in the class to your family and friends.

Be able to evaluate popular news items about the ocean's role in climate. To do this, you must also be able to read and evaluate the primary literature on which statements in popular media are based.

Extra credit: Bring to class current news article about the ocean's role in climate. This must be related to the dynamics and thermodynamics of the climate system, not the carbon cycle.