EAS 4803/6672: Ocean Dynamics

Monday/Wednesday, 11:00-12:15

Instructor Information

Instructor	Email	Drop-in Hours & Location
Professor Lily Dove	dove@gatech.edu	TBD

General Course Information

Description

This course introduces the fundamental processes that govern how the ocean moves and evolves, with a primary focus on physical oceanography. Students will explore how winds, heat, Earth's rotation, and differences in temperature and salinity drive currents ranging from small-scale turbulence to basin-wide circulation. Students will build an intuitive understanding of ocean behavior through descriptive examples while also developing the mathematical basis needed to describe these phenomena quantitatively. Students will derive and apply key relationships that explain ocean motion, making connections between theory, observations, and real-world ocean systems. The course is designed to show not only how the ocean works, but additionally why it matters for climate, ecosystems, and human activities.

Prerequisites

Multivariable calculus - Students will use multivariable calculus to describe how ocean properties vary in three dimensions and to formulate the equations that govern fluid motion.

Physics I (calculus-based mechanics): Students will draw on concepts from calculus-based mechanics to understand and mathematically describe what drives ocean currents and water movement.

Course Goals and Learning Outcomes

Upon successful completion of this course, you should be able to:

- Apply the governing equations of rotating, stratified fluids to derive and interpret key oceanographic balances.
- Use scaling analysis and nondimensional numbers to evaluate which physical processes dominate in different ocean regimes.
- Analyze and interpret oceanographic observations using dynamical frameworks.
- Explain and quantitatively describe major ocean circulation features.

Course Requirements & Grading

Assignment/Assessment Type	Number	Weight
Problem sets	6	5% each (30% total)
Exams	3	15% each (45% total)
In-class activity participation	12 (~weekly)	10%
In-class presentation	1	15%

UG/G Section Differentiation

Expectations for the course assessments are differentiated between those enrolled in the undergraduate and graduate sections. In problem sets, some more challenging problems will be required for the graduate section and offered as extra credit for the undergraduate section. Graduate students will be expected to take on more challenging or detailed topics for the final presentation (discussed with instructor) and give a longer in-class presentation.

Description of Graded Components

Problem sets: There will be bi-weekly problem sets (6 total) throughout the semester. Individual due dates for problem sets will be posted on Canvas. These problem sets focus on connecting your mathematical calculations with your oceanographic intuition and may involve some data analysis and visualization, which can be done in program of your choice. I strive to return problem sets to you as soon as possible to maximize your learning.

Exams: There will be three exams throughout the semester (see the Course Schedule for more details). These exams will happen during class time and will be done on paper.

In-class activity participation: There will be quasi-weekly activities that are meant to cement your understanding of new principles. This part of the final grade is based on participation in the activities rather than correctness and are graded on a scale as follows: 1 = full participation; 0.5 = poor or distracted participation; 0 = did not attend or participate.

In-class presentation: In Week 15, each student will give a 10-minute presentation on a physical oceanography topic of their choice. Students will provide a brief set of slides to support their presentation. Presentations will be assessed based on clarity of explanation, accuracy and depth of content, organization, and effective communication with the audience (including appropriate pacing and engagement).

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Course Materials

Course Text

Introduction to Physical Oceanography (Robert Stewart, 2008) – PDF will be provided

Descriptive Physical Oceanography: An Introduction (Lynne Talley and coauthors, 2011) – PDF will be provided

Additional Materials/Resources

Ocean Dynamics and the Carbon Cycle (Richard G. Williams and Michael J. Follows)

Course Website

We will use Canvas as the central management system for course materials and announcements.

Course Policies, Expectations, & Guidelines

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarizing on an exam or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations. See the "Use of Generative AI" section for details regarding misconduct with AI-based information.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter.

Attendance
While attendance is not formally required, this course is not structured for asynchronous participation. Most lectures will be delivered on the board, and key explanations and examples may not be fully captured in posted materials. You are therefore responsible for attending class regularly if you wish to stay current with the course content.

There will also be quasi-weekly in-class assignments that count for 15% of your final grade. These assignments are intended to be completed during class time and cannot generally be made up after the fact.

Exceptions will be made for institute-excused absences or when you communicate with me in advance about an absence. In these cases, we can work together to determine appropriate accommodations.

Collaboration Policy
While collaboration is allowed on the problem sets, each student must submit their own write-up in their own words. Each student must complete exams independently.

Use of Generative AI

In this class, we treat AI-based information (*e.g.* that produced by ChatGPT, Gemini, or other AI-based assistants) the same way we treat other forms of collaboration. You may talk about your ideas and assignments with other people as well as with AI-based assistants. However, all work you submit for a grade in this class must be your own. All sources, including AI-based assistants, must be properly cited. Use of AI products beyond the accepted use case above will be treated as academic misconduct and reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations. Large Language Models (LLMs) are created by learning patterns and relationships in massive volumes of data, primarily from the internet. LLMs can demonstrate bias and provide inaccurate information. Part of your training as a scientist is learning how to validate information with cross-referencing and recognizing the limitations of tools and methods, including LLMs and AI.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams
Life happens! If you anticipate needing an extension on an assignment, please reach out as early as possible, ideally before the deadline. In most cases, extensions can be granted when there is clear, advance communication. Problem sets submitted after the deadline without prior communication will be subject to a 10% daily penalty per day late.

Re-scheduled exams will be offered only in cases of institute-excused absences or when you have communicated with me in advance about a conflict. Whenever possible, arrangements should be made prior to the scheduled exam time. Unexcused missed exams may not be eligible for a make-up.

Digital Learning Days
In the case of inclement weather or an unsafe campus, we may proceed with class on Zoom. This information will be provided as far as advance as possible through a course announcement on Canvas.

Student-Faculty Expectations Agreement
At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Student Use of Phones, Tablets, and Laptops during Class
Everyone takes notes, processes information, and engages with course material differently. To support this, the use of phones, tablets, and laptops is permitted during class, and some in-class activities will require a laptop or tablet to complete. However, if device use becomes distracting to you or others, I reserve the right to modify this policy and restrict their use.

Campus Resources for Students

Undergraduate Student Academic Success Resources: A list of resources for undergraduate students' academic success and information about advising can be found at Success at Tech.

Graduate Student Academic and Professional Success Resources: A list of resources for graduate students is given on the Office of Graduate and Postdoctoral Education website.

Student Well-Being

I recognize that many of you are balancing multiple courses, research responsibilities, jobs, and commitments outside the classroom. This course is important, but it is not the only demand on your time, and I want to support you in managing those competing priorities as effectively as possible.

If something arises that may affect your ability to participate in class, complete assignments, or perform at your best, the most important thing you can do is communicate with me early. I am generally able to offer flexibility or help you make a plan, but I can only do so if I am aware of the situation.

You do not need to share more detail than you are comfortable with and simply letting me know that you are facing a challenge is enough. My goal is to create an environment where you can succeed academically while also taking care of your well-being. Georgia Tech has also compiled a list of wellness related resources which is available here.

Course Schedule

Date	Topic	
Week 1 **8/24 & 8/26**	Governing equations & scaling analysis	
Week 2 **8/31 & 9/2**	Equation of state, buoyancy, & energetics	Problem set 1 due
Week 3 **9/7 (no class) & 9/9**	Geostrophic & hydrostatic balance	
Week 4 **9/14 & 9/16**	Potential vorticity	Problem set 2 due
Week 5 **9/21 & 9/23**	Review & synthesis	Exam 1 (covers weeks 1-4)
Week 6 **9/28 & 9/30**	Ekman dynamics & boundary layers	
Week 7 **10/5 (no class) & 10/7**	Sverdrup balance & gyre theory	Problem set 3 due
Week 8 **10/12 & 10/14**	Western boundary currents	
Week 9 **10/19 & 10/21**	Barotropic & baroclinic structure	Problem set 4 due
Week 10 **10/26 & 10/28**	Review & synthesis	Exam 2 (covers weeks 5-9)
Week 11	Rossby waves	

Date	Topic	
11/2 & 11/4		
Week 12 **11/9 & 11/11**	Gravity & internal waves	Problem set 5 due
Week 13 **11/16 & 11/18**	Instabilities & eddy dynamics	
Week 14 **11/23 & 11/25 (no class)**	Turbulence & mixing	Problem set 6 due
Week 15 **11/30 & 12/2**	Special topics	In-class presentations
Week 16 **12/7**	Course wrap-up & reflection	
Final time slot		Exam 3 (covers weeks 10-15)