270.225 OCEANS AND ATMOSPHERES

Spring 2025

Monday, Wednesday, Friday 1:30–2:20, 304 Olin Hall

FACULTY: Prof. Thomas Haine, 329 Olin Hall, Thomas.Haine@jhu.edu
Prof. Darryn Waugh, 320 Olin Hall, waugh@jhu.edu
TA: Cara Williams, cwill353@jh.edu

FORMAT: The course will be taught in person and online as three 50-minute lectures each week. Class materials will be posted to the class Canvas site.

COURSE DESCRIPTION

This course is a broad survey course of the Earth's oceans and atmosphere, and their role in climate. Topics covered include ocean and atmosphere circulation, weather systems, hurricanes, El Nino, and climate change. This is a Natural Sciences class. There are no pre-requisites for this class. This does not mean that we expect you to know nothing! Instead, it means that you are not required to have taken other classes. Taking freshman physics and chemistry is an advantage, however, and a few concepts taught in those classes will be used here without exhaustive explanation. Some students may need to do additional reading to fully grasp all aspects of this class (see below). In terms of intellectual challenge, this class is similar to freshman physics or chemistry. The class is designed for freshman and sophomore science/engineering students. If you do not fit these categories, you should probably take another class in marine and/or atmospheric science (ask the professors).

LEARNING GOALS

By the end of the course, students should be able to:

1. Describe the structure and general circulation of Earth's atmosphere and oceans.
2. Explain the greenhouse effect and Earth's energy balance.
3. Describe geostrophic and Ekman flows, and use them to explain the winds and ocean currents in the extra-tropics.
4. Discuss the roles the ocean plays in the Earth's climate system.
5. List causes of climate change, and use them to interpret the observed changes in climate over the last century.
6. Explain the causes of ocean pollution, ocean acidification, stratospheric ozone depletion and air pollution.

BOOKS

We will be using material out of two textbooks:

• "Essentials of Oceanography" by T. Garrison, Brooks/Cole Cengage Learning, ISBN-9780840061553, 6th edition.

• "Essentials of Meteorology" by D. Ahrens, Brooks/Cole Cengage Learning, ISBN-9781285462363, 7th edition.

These are not the latest editions, but contents change very little between editions and we advise you to consider any editions of these texts (although be aware that occasionally the chapter order differs). These texts are in the $150 range new, but used versions, rentals, or e-books are available for $20–$30. E.g., www.cengage.com. These books are recommended, but not required. They're available at the bookstore and on reserve at the library.

These related books are also available at the library:

- "Oceanography: A view of the Earth" by Gross and Gross [GC11.2.G76 QUARTO]
- "Oceanography" by Summerhayes and Thorpe. [QG11.2.O22]
- "Introduction to Ocean Sciences" by Segar. [QG11.2.S443 QUARTO]
- "Meteorology Today" by C. D. Ahrens, 2008 [QC861.3.A47 2009 QUARTO]
- "The Atmosphere" by Lutgens and Tarbuck. [QC861.2.L87]
- "Meteorology: The atmosphere ..." by Moran and Morgan. [QC861.2.M625]

Almost all of the material in the class texts is also contained in these other books (among others). The class text covers most, but not all the material you will need to learn. In particular, there are some quantitative aspects of the class which are not covered in the books (and the books are not 100% free of errors). As always, the primary source of your information should be your own notes and the fruits of your own initiative

ASSESSMENT

There will be **two exams** – a mid-term and a final – and **four homework** assignments. The midterm and final are each worth 20% of the final grade, each homework is worth 10%, and 10% for participation in the live class. Homework handed in late without an acceptable reason will be penalized, or returned un-marked, at the instructors' discretion. Please inform the instructors before the homework deadline if you anticipate a delay in submitting your work.

The policy for homework and tests is to set questions with a range of difficulty. Some questions will require quantitative answers and careful thinking about basic (physical, chemical) principles. Some homework questions may require some straightforward research (e.g., online searching). Students very rarely score 100% in homework or tests, so you should not expect to either.

In previous years, about 1/3 of students earned an A or A- grade. Our expectation is that the grade distribution should be similar, but we will not be enforcing quotas (if 70% of the class gets over 90%, then 70% get an A). Among the few students who scored a D or worse in the last decade or so, the average attendance in class was 34% and the average rate of submission of homeworks and tests was 50%. So, if you don't want a poor grade, come to class and hand in written work! In addition, students are expected to read independently on the topics being taught in class. The relevant sections of the course text are indicated in the schedule below.

The professors and TA are available to answer specific questions on course material, but will not give explicit solutions to homework problems. Please approach us at the end of class or send an email to arrange an appointment.

ETHICS

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. In addition, the specific ethics guidelines for this course are:

1) Homework assignments must be completed without any collaboration with anyone else. All printed and online information source, other than the Garrison and Ahrens texts should be accurately cited.

2) Tests must be completed without any collaboration with anyone else with strict adherence to the rubric of the test.

Report any violations you witness to the instructor. For more information, see the Homewood Student Affairs site on academic ethics: (https://studentaffairs.jhu.edu/policies-guidelines/undergrad-ethics/ and studentconduct@jhu.edu)

ANXIETY AND MENTAL HEALTH

If you are struggling with anxiety, stress, depression or other mental health related concerns, please consider visiting the JHU Counseling Center. If you are concerned about a friend, please encourage that person to seek out their services. The Counseling Center is located at 3003 North Charles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/.

DIVERSITY AND INCLUSION

Johns Hopkins University values diversity and inclusion. We are committed to providing welcoming, equitable, and accessible educational experiences for all students. Students with disabilities (including those with psychological conditions, medical conditions and temporary disabilities) can request accommodations for this course by providing an Accommodation Letter issued by Student Disability Services (SDS). at 103 Shaffer, 410-516-4720, studentdisabilityservices@jhu.edu. Please request accommodations for this course as early as possible to provide time for effective communication and arrangements.

For further information or to start the process of requesting accommodations, please contact Student Disability Services at Homewood Campus, Shaffer Hall #101, call: 410-516-4720 and email: studentdisabilityservices@jhu.edu or visit https://studentaffairs.jhu.edu/disabilities.

CLASSROOM CLIMATE

We are committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. We believe fostering an inclusive climate is important because research and our experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join us in creating a welcoming and vibrant classroom climate. Note

that you should expect to be challenged intellectually by us, the TA, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, we invite you to share directly with us or the TA. We promise that we will take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the department chair department chair (Ben Zaitchik, zaitchik@jhu.edu), the Director of Graduate Studies (Emmy Smith, efsmith@jhu.edu), the Assistant Dean for Diversity and Inclusion (Araceli Frias-Ohane, afrias3@jhu.edu) or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g., sexual harassment).

Part 1: Introduction, Vertical processes in oceans and atmospheres
1/22, Lecture 1: (Haine) Geography of the Earth (Ahrens, Appendix)
1/24, Lecture 2: (Haine) Atmospheric pressure. Ideal gas law Hydrostatic relationship (Ahrens, Chapters 1 and 2 up to section on Radiation)

1/27 Lecture 3: (Waugh) Composition of the atmosphere and ocean, relationship between composition and density (Garrison, Chapter 6)
1/29, Lecture 4: (Waugh) Vertical structure of the atmosphere and ocean. Potential temperatures and density. Boundary layers
1/31, Lecture 5: (Waugh) Impact of the water cycle on atmospheric and oceanic structure (Ahrens, Chapter 4)

2/3, Lecture 6: (Waugh) Radiation, energy balance, seasonal cycling (Ahrens, remainder of Chapters 2, 3)
2/5, Lecture 7: (Waugh) Seasons, temperature
2/7, Lecture 8: (Waugh) Ice and phase changes of water, Heat transport and vertical stability

Part 2: Horizontal circulations
2/10, Lecture 9: (Haine) Air pressure and winds (Ahrens, Chapter 8, Garrison Chapter 8; Chapter 7 is also useful)
2/12, Lecture 10: (Haine) Air pressure and winds continued
2/14, Lecture 11: (Haine) Coriolis force and geostrophic winds

2/17, Lecture 12: (Haine) Coriolis force and geostrophic winds continued. Rotating table Experiment 1
2/19, Lecture 13: (Haine) More on Weather
2/21, Lecture 14: (Haine) Global winds and jet streams (Ahrens, Chapter 7)

2/24, Lecture 15: (Haine) Ocean circulation: Phenomenology. Rotating table Experiment 2

2/26, Lecture 16: (Haine) Ocean circulation: Subtropical gyres
2/28, Lecture 17: (Haine) Ocean circulation: Deep circulation

3/3, Lecture 18: (Haine) Catch up as necessary
3/5, Lecture 19: (Haine/Waugh) Review of first half,
3/7, Lecture 20: MIDTERM TEST

Part 3: Climate and natural hazards
3/10, Lecture 21: (Waugh) Tropical cyclones, phenomenology (Ahrens, Chapter 15, Hurricanes)
3/12, Lecture 22: (Waugh) Controls on tropical cyclone intensity
3/14, Lecture 23: (Waugh) Long gravity waves, storm surge

3/17-3/21 SPRING BREAK WEEK

3/24, Lecture 24: (Waugh) Anthropogenic climate change: Observations (IPCC AR6 SPM)
3/26, Lecture 25: (Waugh) Anthropogenic climate change: Processes
3/28, Lecture 26: (Waugh) Anthropogenic climate change: Future Projections

3/31, Lecture 27: (Haine) Carbon cycle
4/2 Lecture 28: (Haine) Ocean carbon
4/4 Lecture 29: (Haine) Ocean ecosystems, coastal pollution and hypoxia

4/7: Lecture 30 (Haine) Oceanic biomes and climate
4/9 Lecture 31: (Haine) Terrestrial biomes and climate
4/11, Lecture 32: (Haine) Atlantic Meridional Overturning Circulation

4/14, Lecture 33: (Waugh) Atmospheric pollution
4/16, Lecture 34: (Waugh) Ozone depletion
4/18, Lecture 35: (Waugh) Ozone depletion

Part 4: Variability
4/21 Lecture 36: (Waugh) El Nino (Garrison chapter 10, Ocean circulation)
4/22 Lecture 37: (Waugh) El Nino, variability
4/25, Lecture 38: (Waugh) Other modes of climate variability

4/28 Lecture 39: (Haine) Milankovitch and the ice ages. (Additional reading provided)

DROP DEADLINE:	Friday 28 February
FINAL REVIEW:	TBA
FINAL EXAM:	Monday May 12, 6–9pm