Ocean Biogeochemical Cycles- Spring 2022

Professors:
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This course will focus on two big questions:

Learning goal 1. What can we learn about how the planet functions

a.) physical circulation
b.) distributions and rates of biological cycling
c.) rates and ratios of chemical addition and removal

from the distributions of chemical tracers in the ocean and sediments? We'll examine a whole range of tracers, including those affected by biological cycling, as well as tracers involved in hydrothermal processes.

Learning goal 2. How do we use models to make quantitative interpretations of these distributions?
a.) Box models
b.) Advection-diffusion-reaction models
c.) Simple biological-ecological models
d.) Model construction: For many aspects of chemical oceanography the "storytelling" process of making models involves making choices about how to tell the story. One of the things I want you to recognize is this process of making choices- how do we reduce complex systems to something we can solve? How does this process work?

Learning goal 3: Learn to use a programming language to answer these questions.

We'll also use the Matlab programming environment to understand these problems. No previous knowledge is needed to do this- my goal is to teach you what you need to know. You will not need to get Matlab in order to do your work (it is available on campus computers) but it will be helpful. (It is also free to obtain under a site license).

Grading for this course will consist of
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Problem Sets: We aim to hand out problem sets will be handed out over the term. You may consult with your classmates on these but we will expect you to write them up separately. *Each problem set will be 10% of the grade*. If you get behind on this it will be serious!

Exams: There will be a midterm, accounting for 12% of the final grade and a final accounting for 24%. (Note- we will consider whether to do final projects rather than a final exam, final decision hasn't been made yet)

Class participation: Habitual absence will be penalized.

Grading philosophy: We are looking for you 1. Show that you have engaged the material-that you understand the basic concepts. 2. Show that this engagement has enabled you to think critically and scientifically about the material. There are no grade quotas in this class.

Text**:** Emerson and Hedges: Chemical oceanography and the marine carbon cycle

https://www.amazon.com/Chemical-Oceanography-Marine-Carbon-Cycle-ebook/dp/B001AGTD06

Fine to buy used!

What to do if you have issues with the course: Come and talk with us. I can work with you up to a certain point, but only if you let us know. If the issue is episodic (you have an interview on a given day) just give us a heads up. 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). 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.eduor visit the websitehttps://studentaffairs.jhu.edu/disabilities

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 theirservices. The Counseling Center is located at 3003 NorthCharles Street in Suite S-200 and can be reached at 410-516-8278 and online at http://studentaffairs.jhu.edu/counselingcenter/

Academic honesty: A major purpose of this class is to give you a window into how science is actually done. Science only works if we can trust each other to be honest about what we've done and how we've done it. 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.

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 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, I invite you to share directly with me or the TAs. I 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 (Sabine Stanley, sabine@jhu.edu), the Director of Undergraduate Studies (Kevin Lewis, klewis@jhu.edu), the Assistant Dean for Diversity and Inclusion (Araceli Frias, 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)

Preliminary lecture list

January 24, Lecture 1: A tracer-based view of the ocean. Introduction to Matlab. (Chapter 1)-Gnanadesikan

January 26, Lecture 2: Conservative tracers, watermasses, density and circulation-Gnanadesikan

January 28, Lecture 3: Transient tracers and biology-Gnanadesikan

January 31, Lecture 4: Ocean circulation- a large scale introduction-Haine

February 2, Lecture 5 One box model of ocean chemistry- residence time (Chapter 2) Haine

February 4,Lecture 6: What can we learn from different elemental distributions? Haine

February 7, Lecture 7: Deep removal mechanisms (hydrothermal)-using tracers to construct a balance Haine

February 9, Lecture 8: Calcium carbonate system- calculating the pH of seawater (Chapter 4) Haine

February 11, Lecture 9: Processes controlling the alkalinity of seawater, Haine

February 14: Lecture 10: Ocean circulation and the three-dimensional distribution of alkalinity.

February 16: Lecture 11: Stable isotopes (Chapter 5)

February 18, Lecture 12: Radioisotopes and dating, global overturning

February 21: Lecture 13: Estimating global export (Chapter 6.1)

February 23, Lecture 14: Stoichiometry and carbon export (Chapter 6.2)

February 25, Lecture 15: Remineralization and oxygen utilization (Section 6.4)

February 28: Lecture 16: Diffusion and gas exchange (Chapters 9,10) Haine

March 2: Lecture 17: Estimating gas exchange (Chapter 10) Haine

March 4: Lecture 18: Anthropogenic carbon dioxide-carbon chemistry (Chapter 11.1) Haine

March 7: Lecture 19: Estimating anthropogenic carbon dioxide in the ocean (Chapter 11.3)-Haine

March 9: Review

March 11: **Midterm**

March 20: Lecture 20-Nitrogen cycling in the global ocean

March 22: Lecture 21-Proximate vs. ultimate limiting nutrients for biological uptake, Tyrell

March 24: Lecture 22-Nutrient limitation- Michaelis Menten kinetics. Metals limitation.

March 28: Lecture 23-Biological modeling, functional groups, nutrient limitation

March 30: Lecture 24: Biological modeling, light and light limitation

April 1: Lecture 25: Biological modeling, how do we think about loss terms?

April 4: Lecture 26: Ecosystem structure and export

April 6: Lecture 27: What genomics tells us about biology and the problem of the plankton (Louca et al.)

April 8: Lecture 28: Dissolved organic matter (Chapter 8)

April 11: Lecture 29: The ice ages and paleoclimatology (Chapter 7) Haine

April 13: Lecture 30: Abrupt climate change (7.3) Haine

April 15: Lecture 31 Carbon pumps and glacial-interglacial CO2 change. Haine (Chapter 11.2)

April 18: Lecture 32- Hypoxia and oceanic dead zones (shadow zones)-Haine

April 20: Lecture 33- Coastal hypoxia and nutrients, Chesapeake Bay.

April 22: Lecture 34- Sulfur cycling

April 25: Lecture 35- Lower trophic levels marine viruses

April 27: Lecture 36- upper trophic levels and fisheries

April 29: Lecture 37-more on upper trophic levels and fisheries

Final Exam will be scheduled at the time determined by the Registrar (not currently available).