ES297B: Climate geoengineering -- evaluating strategies to sequester CO2

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3 credits
M,T,W,R 1:00-2:50 pm
Keyes 102
Office hours by appointment
Prerequisite: CH141 or CH/GE121 and 100-level geology, ES, or biology course

Course description

Human emissions of carbon dioxide and other greenhouse gases are causing Earth's climate to change more rapidly than at any other time in our history. Impacts such as sea level rise, changing precipitation patterns, ocean acidification, and heat waves are altering terrestrial and natural ecosystems and impacting human populations. As the global community struggles to reduce greenhouse gas emissions, increased attention has focused on ways to actively remove atmospheric carbon dioxide and sequester it in terrestrial and marine environments. Such approaches carry significant ethical and technical risks, as well as potential costs and benefits that must be carefully evaluated if we are to make informed decisions about their use in the future. This course will review proposed geoengineering approaches to carbon dioxide removal, including technical and biogeochemical bases and potential financial costs. We will consider the risks of action and inaction, as well as governance structures that could regulate geoengineering activities.

Learning goals

1) review human impacts on global carbon cycle and attendant climate effects
2) understand the range of proposed approaches for large-scale carbon dioxide sequestration, including technical basis, potential impacts, economic costs, and ecological/environmental risks
3) understand existing global regulatory structures relevant to geoengineering approaches
4) develop ability to read and interpret primary literature and synthesize scientific and policy information
5) improve skills in scientific writing and public speaking
6) prepare students to critically evaluate possible proactive responses to changing global carbon cycle

Course materials

All course materials, including readings and lecture slides, will be provided via a Google Shared Drive. There is not a textbook for the course, but there are a number of recent reports prepared by the British Royal Society and the US National Academy of Sciences that provide useful overviews of geoengineering. Parts of these will be assigned as class readings, but the full reports are also available on the class drive for reference in the 'overview reading' folder:

1. The Royal Society. 2009. Geoengineering the climate: Science, governance and uncertainty. 98p.
2. Lenton and Vaughan (eds). 2013. Geoengineering responses to climate change. 199p.
3. National Academy of Sciences. 2015. Climate intervention: Carbon dioxide removal and reliable sequestration. 154p.

4. National Academy of Sciences. 2019. Negative emissions technologies and reliable sequestration: A research agenda. 510p.
5. GESAMP Working Group 41. 2019. High level review of a wide range of proposed marine geoengineering techniques. 143p.

Learning assessment

General participation in class discussions: 20%
Lead discussion on primary literature (2 papers): 20%
Written summary and critique of public perception of geoengineering: 20%
Oral presentation of geoengineering approach: 15%
Final paper evaluating and advocating for an approach to geoengineering: 25%

Course format and expectations

This will be a small, discussion-based class covering a timely, pressing, multifaceted topic. There are technical, scientific, policy, economic, and ethical dimensions to all of the geoengineering topics, and no one is expected to be an expert in any or all of them. We will be grappling with critical questions that do not have easy or straightforward answers. We encourage all class participants to arrive each day prepared to contribute thoughts, perspectives, questions, and concerns.

Class meetings will typically start with a lecture (25-45min) followed by a discussion of public perception and coverage of the topic (20min), during which students will share observations from independent online research. There will be a short (5min) break. The second half of the class meeting will focus on discussion of papers and primary literature, or a presentation and discussion with an invited speaker.

Course schedule

Date	Topic	Guest/Activity
1/11/21	The problem: global climate change	
1/12/21	Global carbon cycle and mitigation efforts	
1/13/21	Overview and history of geoengineering efforts	Dr. Jim Fleming, Colby College
1/14/21	Direct capture of CO2 from air and emissions	
1/18/21	Land-use management and soil improvement	Dr. Dorn Cox, Wolfe Neck Center
1/19/21	Ocean upwelling and nutrient fertilization	
1/20/21	Ocean iron fertilization	Dr. Ken Buesseler, Woods Hole Oceanographic
1/21/21	Enhanced chemical weathering	
1/25/21	Permaculture, blue carbon, and Maine's	Dr. Nichole Price, Bigelow

	Climate Plan	Laboratory
1/26/21	Ocean alkalinity enhancement	
1/27/21	Comparing financial costs and market opportunities	
1/28/21	Governance and policy frameworks	Dr. Wil Burns, American University
2/1/21	Equity, social acceptance, and public perception	Dr. Whitney King, Colby College
2/2/21	Student presentations	
2/3/21	Summary/wrap-up	

Academic Integrity

Academic honesty is very important. Taking credit for ideas or work that is not your own constitutes academic dishonesty. Not only does this practice effectively steal from another person, it also cheats you out of your education. Be sure to cite the sources of information and ideas, and any quotations, that you use in your assignments. Please contact us if you have any questions about how to best acknowledge help received or how to cite sources appropriately.

Plagiarism includes verbatim copying, paraphrasing (changing a few words here and there), and structural plagiarism (borrowing the structure or outline of somebody else's work without acknowledgement). Students are subject to College policies on attendance and academic dishonesty found in the College Catalogue and the Student Handbook.

Attendance

Attendance is required at all classes and is uniquely important for this short, fast-paced class. Please contact the professor if you must miss a class. Remote participation in classes will be enabled via Zoom when required. Unexcused absences will be reflected in the class participation portion of your grade.

Disabilities and Religious Observances Accommodations

Students who may need academic accommodations for learning disabilities or differences are encouraged to see one of us privately as early as possible in the term. If you have a religious observance that impacts your participation in the course, please meet with us well beforehand to discuss accommodations.

Electronic Device Policy

We expect appropriate use of electronic devices in the classroom. You may use your devices to access readings, participate in in-class activities, and take notes, but please do not check social media or surf the web during class. Please be considerate of your peers.