



CLIMATE GEOENGINEERING

SSCI385-01 ■ Fall 2020 ■ Th. – 5:40-7:40pm ■ Online: Synchronous & Asynchronous

Dr. Wil Burns

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Office Hours: I can always meet prior to class, or after, or on the phone or Zoom or Skype. I can usually accommodate other requests with advanced notice.

Course Overview

Climate change is the keystone environmental issue of this generation, and most likely for many generations to come. While the world community and individual countries have formulated policies to address climate change, these policies are almost universally recognized as being wholly inadequate to effectuate the objective of the Paris Agreement to hold global temperatures to well below 2°C above pre-industrial levels, and pursue efforts to limit increases to 1.5°C. This has led to increasing calls for research and development, and potential deployment, of so-called “climate geoengineering” options, defined as “deliberate large-scale intervention in the Earth’s natural systems to counteract climate change.”

This course will assess to examine the case for climate geoengineering as a third component to address climate change, alongside mitigation and adaptation, as well as the potential effectiveness and risks of the most widely discussed approaches. We will also discuss aspects of governance and public deliberation. Moreover, I will also seek to help students develop critical skills of analysis, public speaking, and writing.

Learning Objectives

After taking this course you should be able to:

- Identify the exigencies driving increasing impetus for geoengineering responses to climate change;
- Identify key provisions of international treaty regimes and national legislation that might govern research and/or deployment of climate geoengineering options;
- Assess the potential risks and benefits of discrete geoengineering approaches.

Course Readings

The readings for the course will be derived from the following sources, designated in the class schedule with the icons listed below:

-  **Electronic readings**, which are available on the Blackboard site for this course. On the Blackboard site, click on the “Files” link and look for the “Readings” folder.
-  **Online Hyperlinks**, which must be accessed via the online version of the Syllabus on the Blackboard site for this course. See the “Syllabus” folder under the File’s link on the course’s Blackboard site.

Course Grading Matrix

Course Component	Percentage of Grade	Due Date
Class Participation	15	Ongoing
Mid-Term Take-Home Exam	25	October 17
Special Topics Presentations	10	Ongoing
Term Paper	50	December 8

Brief Description of Assignments

Class Participation [15% of grade]

Class participation assessment will be comprised of your participation during lectures, and in the numerous small-group treaty analysis exercises conducted during the course.

Special Topics Presentations [10% of grade]

Students will work in groups of 2-3 to prepare 10-minute presentations for class on assigned topics. Please see the “Assignment Guidelines” folder under the Folders link in Blackboard for further instruction.

Mid-Term Take Home Examination [25% of grade]

The mid-term examination will be a 48-hour take-home. Students will have the option of beginning the examination at any point after 9:00 am on 10/15. The deadline for submission all of examinations is 9.00am on October 17.

Term Paper [50% of grade]

Each student will prepare a 12-page term paper, conforming to the guidelines set forth in the “Term Paper Guidelines” document, in the “Term Papers” folder on the course’s Blackboard site. Each student will also prepare a presentation for class on their preliminary findings. Students in the course will provide feedback on the paper, including suggestions.

Policy on Attendance

- Come to class ***on time*** and ***prepared***.
- Regular attendance and participation in class are required of everyone.
- If you miss class for reasons beyond your control—such as illness or family emergency—your absence will be excused if you inform the professor in a timely manner. Verification may be required, at the professor’s discretion.
- Absences that result in missed assignments or presentations will require written verification before a make-up will be considered.
- **More than three unexcused absences will result in an automatic reduction of one letter grade from your final course grade.** For example, if you earn a B for all graded work and have 3 unexcused absences, you will get a C for the class.

- Regardless of the reason for an absence, the student is always responsible for all material, work, announcements and assignments, and for meeting all scheduled deadlines.

University Policies

IIT Code of Academic Honesty

In the portions most pertinent to this course, the IIT Code of Academic Honesty provides:

Illinois Tech expects students to maintain high standards of academic integrity. Students preparing for the practice of a profession are expected to conform to a code of integrity and ethical standards commensurate with the high expectations society places upon the practitioners of a learned profession. No student may seek to gain an unfair advantage over another.

It shall be a violation of this Code of Academic Honesty for a student to engage in conduct that violates the established standards of his or her major academic discipline, the established standards of the academic discipline in which she or he is engaged, the established standards of the profession of which she or he is training, or the standards of Illinois Tech set forth herein. In addition, it is a violation of this Code of Academic Honesty for a student, whether or not currently enrolled at Illinois Tech, knowingly to engage or attempt to engage in the following or to engage or to attempt to engage in a course of action that would cause a reasonable student to conclude a violation of any of the following would be the likely result:

- *The misrepresentation of any work submitted for credit or otherwise as the product of a student's sole independent effort, such as using the ideas of others without attribution and other forms of plagiarism;*
- *The use of any unauthorized assistance in taking quizzes, tests or examinations;*
- *The acquisition, without permission, of tests, answers sheets, problem solutions or other academic material when such material has been withheld from distribution by the instructor;*

Should you have any questions about any of these categories, please contact me.

Plagiarism is a particularly pervasive phenomenon in contemporary classrooms. Software also makes it very easy for professors to detect, so it's both an unethical and dumb thing to do given the potential ramifications at IIT, which can include a reduction in grade or expulsion from a course. I recommend working through the materials on the site listed below, including its very good quiz on plagiarism:
<http://www.lib.usm.edu/legacy/plag/plagiarismtutorial.php>.

Also, should you have any doubts about whether any of your writing might cross this line, don't hesitate to discuss this with me via email, or during office hours.

Accommodations for Students with Disabilities

Reasonable accommodations are available for students who have a documented disability. The procedures for assessment and determination of reasonable accommodations can be found at: <https://web.iit.edu/cdr/services/reasonable-accommodations>.

COURSE SCHEDULE	
8/27	Course Overview <ul style="list-style-type: none"> ▪ Instructor/Student Introductions ▪ Syllabus Review, including assignments
SECTION 1	The Science of Climate Change
9/3	Overview of Climate Change Science
	READINGS: <ul style="list-style-type: none"> ▪  IPCC, <i>Climate Change 2013: The Physical Science Basis, Summary for Policymakers</i> 1-27 (2013) ▪  Australian Academy of Science, The Science of Climate Change 1-32 (2015)
SECTION 2	International Climate Institutions Pertinent to Geoengineering

9/10



READINGS:

- [Text of the Paris Agreement](#) (2015)
- Hale, “All Hands on Deck”: *The Paris Agreement and Nonstate Climate Action*, 16(3) GLOBAL ENVIRONMENTAL POLITICS 12-22 (2016)
- Keohane & Oppenheimer, *Paris: Beyond the Climate Dead End through Pledge and Review?*, 4(3) POLICY & GOVERNANCE 142-151 (2016)

STUDENT LEARNING EXERCISE:

Please print out a copy of the **Paris Agreement Interpretation Exercise** in the “Treaty Interpretation Exercises” folder on the Blackboard site for the course and bring it to class, or have it available on your laptop for class.

SECTION 3

Solar Radiation Management Approaches

9/17



Sulfur Aerosol Injection & Marine Cloud Brightening

READINGS:

- U.S. National Academies of Science, *Climate Intervention: Reflecting Sunlight to Cool Earth* 66-90 (2015)
- Asayama, *Beyond solutionist science for the Anthropocene: To navigate the contentious atmosphere of solar engineering*, 6(1-2) THE ANTHROPOCENE REVIEW 19-37 (2019)
- Morton, *Great White Hope*, 458 NATURE 1097-1100 (2009)
- [Text of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques](#) (1976) and its [Understandings](#)

STUDENT LEARNING EXERCISE:

Please print out a copy of the **Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques Treaty Interpretation Exercise** in the “Treaty Interpretation Exercises” folder on the Blackboard site for the course and bring it to class, or have it available on your laptop for class.

9/24



Space-Based Options, and Questions of SRM Governance

READINGS:

- Schrogl & Summerer, *Climate engineering and space*, 129 ACTA ASTRONAUTICA 121-29 (2016)
- Parson & Keith, *End the Deadlock on Governance of Geoengineering Research*, 339 SCIENCE 1278-79 (2013)

-  Nicholson, Jinnah & Gillespie, *Solar radiation management: a proposal for immediate polycentric governance*, 18(3) CLIMATE POLICY 322-334 (2018)
-  Szerszynski, et al., *Why solar radiation management geoengineering and democracy won't mix*, 45 ENVIRONMENT AND PLANNING 2809-2816 (2013)

STUDENT PRESENTATIONS:

- **Topic: Cirrus Cloud Thinning**
 - Fayemi
 - Singh
 - Moureni
- **Ocean Bubbles**
 - Shiflet
 - Conlon
 - Cao

SECTION 4

Carbon Dioxide Removal Options

10/1

Bioenergy and Carbon Capture with Storage, Part 1: Bioenergy Feedstocks



READINGS:

-  Field, *Robust paths to net greenhouse gas mitigation and negative emissions via advanced biofuels*, PNAS 1-10 (2020)
-  Bhave, *Screening and techno-economic assessment of biomass-based power generation with CCS technologies to meet 2050 CO2 targets*, 190 APPLIED ENERGY 481-89 (2017)
-  Burns, *Human Rights Dimensions of Bioenergy with Carbon Capture and Storage: A Framework for Climate Justice in the Realm of Climate Geoengineering*, CLIMATE JUSTICE: CASE STUDIES IN GLOBAL AND REGIONAL GOVERNANCE CHALLENGES 150-70 (2016)
-  Amos, *Bioenergy Carbon Capture and Storage in Global Climate Policy: Examining the Issues*, 4 CCLR 187-93 (2016)

STUDENT PRESENTATIONS:

- **Topic: Algae-based BECCS**
 - Mei
 - Gomez, Nathan
 - Bhattacharya

10/8

Bioenergy and Carbon Capture with Storage, Part 2: Carbon Capture with Storage (CCS)



READINGS:

-  Haszeldine, et al., *Negative emissions technologies and carbon capture and storage to*

achieve the Paris Agreement commitments, 376 PHILOSOPHICAL TRANSACTIONS A 1-23 (2018)

- **E** Edwards & Celia, *Infrastructure to enable deployment of carbon capture, utilization, and storage in the United States*, 115(38) PNAS 8815-24 (2018)
- **E** Turner, *The global overlap of bioenergy and carbon sequestration potential*, 148(1) CLIMATIC CHANGE 1-10 (2018)

STUDENT PRESENTATIONS:

- **Topic: Mineral Carbonation to Permanently Store Carbon**
 - Fu
 - Russell
 - Kindernay
- **Topic: Ocean-Based CCS:**
 - Thomas-Turner
 - Gomez, Brandon
 - Rubenstein

10/15

MID-TERM EXAMINATION



- 48-hour take-home examination, posted on course website at 9:00am on 10/15, must be completed within a 48-hour period by 9:00am on 10/17.
- This is an “open-book” exam. As such, students may use any materials that they wish to complete the examination, including lecture materials, course readings, and outside materials. However, any outside materials used in completing the examination should be properly attributed using footnotes or endnotes.

10/22

“Natural Climate Solutions”: Forest and Soil Carbon Sequestration



READINGS:

- **E** Rumpel, et al., *Put more carbon in soils to meet Paris climate pledges*, 564 NATURE 32-4 (2018)
- **E** Houghton & Nassikas, *Negative emissions from stopping deforestation and forest degradation, globally*, 24 GLOBAL CHANGE BIOLOGY 350-59 (2017)
- **E** Krause, *Large uncertainty in carbon uptake potential of land-based climate-change mitigation efforts*, 8 GLOBAL CHANGE BIOLOGY 3025-38 (2018)
- **E** Anderson, *Natural climate solutions are not enough*, 363 SCIENCE 933-34 (2019)
- **O** Harvey, [*Earth Stopped Getting Greener 20 Years Ago*](#), Scientific American, E&E News, Aug. 15, 2019

STUDENT PRESENTATIONS:

- **Topic: Biochar**
 - Narine
 - Marou

	<ul style="list-style-type: none"> ▪ Topic: Agroforestry <ul style="list-style-type: none"> ○ Lockard ○ Kartheiser ○ Georgopoulos
<p>10/29</p>	<p>Domestic Regulation of Carbon Dioxide Removal Options</p>
<p></p>	<p>Guest Speaker (via Skype): Professor Tracy Hester, University of Houston Law Center</p> <p>READINGS:</p> <p>To Be Announced</p>
<p>11/5</p>	<p>Enhanced Terrestrial Mineral Weathering and Direct Air Capture CDR Options</p>
<p></p>	<p>READINGS:</p> <ul style="list-style-type: none"> ▪  Beerling, et al., <i>Farming with crops and rocks to address global climate, food and soil security</i>, 4 NATURE PLANTS 138-47 (2018) ▪  Lackner, <i>The Use of Artificial Trees</i>, 38 ISSUES IN SCIENCE & TECHNOLOGY, GEOENGINEERING OF THE CLIMATE SYSTEM 80-104 (2014) ▪  Jacobson, <i>The health and climate impacts of carbon capture and direct air capture</i>, 12 ENERGY ENVIRON. SCI. 3567-74 (2019)
<p>11/12</p>	<p>Ocean-Based CDR Geoengineering Options</p>
<p></p>	<p>READINGS:</p> <ul style="list-style-type: none"> ▪  KELLER, <i>Marine Climate Engineering</i>, HANDBOOK ON MARINE ENVIRONMENTAL PROTECTION 261-76 (2018) ▪  McDonald, McGee, Brent & Burns, <i>Governing Geoengineering for the Great Barrier Reef</i>, 19 CLIMATE POLICY 801-11 (2019) ▪  Renforth, et al., <i>Engineering challenges of ocean liming</i>, 60 ENERGY 442-52 (2013) ▪  London Convention, <u>Annex 4, Resolution LP.4(8) on the Amendment to the London Protocol to Regulate the Placement of Matter for Ocean Fertilization and Other Marine Geoengineering Activities</u> (2013) <p>STUDENT LEARNING EXERCISE:</p>

	<p>Please print out a copy of the London Convention, Annex 4, Resolution LP.4(8) Treaty Interpretation Exercise in the “Treaty Interpretation Exercises” folder on the Blackboard site for the course and bring it to class, or have it available on your laptop for class.</p> <p>STUDENT PRESENTATIONS:</p> <ul style="list-style-type: none"> ▪ Topic: Ocean Upwelling/Downwelling <ul style="list-style-type: none"> ○ Mehta ○ Paredes Garcia ▪ Topic: “Blue Carbon” <ul style="list-style-type: none"> ○ Honda ○ Pacer
SECTION 6	Student Presentations on Research Papers
11/19	Student Presentations, Part 1
	<ul style="list-style-type: none"> ▪ Fayemi ▪ Singh ▪ Moureni ▪ Shiflet ▪ Conlon ▪ Cao ▪ Mei ▪ Gomez, Nathan ▪ Bhattacharya ▪ Fu ▪ Russell
11/26	NO CLASS: THANKSGIVING
12/3	Student Presentations, Part 2
	<ul style="list-style-type: none"> ▪ Kindernay ▪ Thomas-Turner ▪ Gomez, Brandon ▪ Rubenstein ▪ Narine ▪ Marou ▪ Lockard ▪ Kartheiser ▪ Georgopoulos ▪ Mehta ▪ Paredes Garcia ▪ Honda ▪ Pacer
12/8	TERM PAPERS DUE



- Submission via Blackboard digital dropbox