

Syllabus

EES 2110: Introduction to Climate Change

Jonathan Gilligan
Vanderbilt University

Spring 2023

1 Nuts and Bolts

1.1 Class Meetings

MWF 9:05–9:55 Stevenson 6740

1.2 Professor

Jonathan Gilligan
The Alexander Heard Distinguished Service Professor,
Associate Professor of Earth & Environmental Sciences,
Associate Professor of Civil & Environmental Engineering
Stevenson 5735
`jonathan.gilligan@vanderbilt.edu`
Office Hours: TBA or by appointment.

1.3 Email

If you want to communicate with Professor Gilligan be sure to begin the subject line of your email with “EES 2110”. This helps assure that I will see your message quickly and respond to it.

I have set my email reader to flag all messages like this as important, so I will read them first. This also assures that I do not mistake your email for spam. I typically receive over 100 emails per day, so if you do not follow these instructions I may not notice your email.

2 Course Description

2.1 Catalog Description

EES 2110 Introduction to Climate Change Science, policy, history, and causes of climate change on Earth in the last 2 million years; evidence of human impacts on climate since 1850; future climate change and its economic, social, and ecological consequences; economic, technological, and public policy responses. Not open to students who have earned credit for EES 3310 without permission. [3] (MNS)

2.2 Narrative Description

This course will provide an introduction to the scientific principles of earth's climate, the causes of climate change, and scientific knowledge about the way climate has changed throughout our planet's history, with an emphasis on the last two million years, and especially on recent history. We will study:

- Determinants of climate: What factors affect climate, how do we know this, and how certain are we?
- Scientific evidence about past climates: What do we know, how do we know it, and how certain are we?
- Natural climate change in earth's history.
- Effects of human activity on global climate in the last 200 years.
- What do we know about future climate change and how will it affect the quality of people's lives?
- What can we do to mitigate future global climate change or adapt to life in a different climate?
- What is happening politically, both in the U.S. and internationally, to respond to climate change?

The course will make extensive use of algebra, but does not expect calculus or advanced math.

2.3 Goals for the Course

My goals for this course are that at the end of the semester:

- You will have a solid quantitative understanding of the basic physical and chemical principles that control the system and be able to apply that knowledge to reasoning about the climate system and its response to disturbances.
- You will have a solid scientific understanding of what scientists know, what they don't know, and how they know what they know about how climate works, how and why it has changed in the past, and how it may change in the future.
- You will be able to evaluate the evidence for and against the idea that human activity is warming the planet and assess for yourself whether the evidence is persuasive.

- You will have the tools and knowledge to make informed decisions about what climate policies you support or oppose.

When you leave this course, you will not be qualified to work as a climate scientist, but you will be able to follow and critically evaluate news reporting about climate change and climate policy, debate intelligently and knowledgeably, and be an informed voter.

I do not care whether you agree with me politically. I respect people who think for themselves. **What counts is whether you can present your own position clearly and support it with solid evidence and reasoned argument.**

3 Important Dates:

Many of you have athletic and other commitments during the term and may travel for personal reasons. As you plan for your semester, particularly if you are purchasing nonrefundable airplane tickets, consult the syllabus.

If you have away games that require you to miss a scheduled test or in-class activity, let me know well in advance.

- There are in-class tests on **Wednesday, February 8, Wednesday, March 8, and Wednesday, April 12,**
- The take-home final exam is due at **11:00 am Saturday, May 9.** You will submit the final exam on Brightspace, so you do not need to be on campus for this.

4 Structure of the Course:

I divide the semester into two parts:

1. **Scientific Principles of Climate:** For the first half of the semester, we will focus on the scientific principles of climate and natural climate change in earth's past. This will be very mathematical, using basic algebra. We do not use calculus or other advanced math in this class, but you should be comfortable with simple algebraic equations. We will then look at climate change in the last two centuries and what might happen over the next several centuries. We will emphasize examining the scientific evidence to understand what it can and cannot tell us.
2. **Human Dimensions of Climate Change:** For the second half of the semester, we will focus on the ways that climate change is likely to affect people's lives over the rest of this century and what technological responses are being considered to reduce harmful impacts.

4.1 Reading Material

There are three required textbooks. Supplementary reading on the Internet or in handouts will also be assigned during the term and posted on Brightspace.

REQUIRED READING MATERIALS

- David Archer, *Global Warming: Understanding the Forecast*, 2nd ed. (Wiley, 2011; ISBN 978-0-470-94341-0). Be sure you get the second edition because it is significantly different from the first.
- William Nordhaus, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World* (Yale, 2013; ISBN 978-0-300-21264-8)
- Roger A. Pielke, Jr., *The Climate Fix* (Basic Books, 2010; ISBN 978-0-465-02519-0)

There is a companion web site to Understanding the Forecast at climatemodels.uchicago.edu which includes interactive online computer models that we will use for homework exercises. You can also access that site at climatemodels.jgilligan.org

OVERVIEW OF READING MATERIALS

Understanding the Forecast is an excellent introduction to climate science, written by one of the leading climate scientists in the world for students who are not science majors, but want to understand what science knows about climate change.

Science aims to give correct answers to scientific questions, but there are not right or wrong answers to questions of what is the best way to assess the economic costs of climate change or the best policy with which to respond to climate change, so I have chosen books and other reading material that present different points of view on the political and economic aspects.

4.2 Class Web Site

In addition to the Brightspace web site, I have set up a server at ees2110.jgilligan.org where I post the detailed reading and homework assignments, slides from lectures, and other helpful material.

4.3 Graded Work

BASIS FOR GRADING

Class participation & in-class exercises	5%
Homework	30%
In-class tests	45%
Final exam	20%

4.4 Overview of reading assignments

I have posted detailed reading assignments on the course web site, which give specific pages to read for each class and notes on important things you should understand. **I expect you to complete the reading before you come to class on the day for which the reading is assigned**, so you can participate in discussions of the assigned material and ask questions if there are things you don't understand.

4.5 Homework Assignments

I have posted homework assignments on the course web site. Turn in homework assignments on Brightspace. Homework assignments are due at the time specified in the Brightspace assignment, which is usually at the start of class on the day they are due.

Late homework will be penalized 5% for each day, or part of a day, it is late until I post the solutions (a week after it is due). After I have posted the solutions, late homework will receive up to 50% credit, so no matter how late it is, it will still be worth finishing.

4.6 Tests and Exams

There will be three tests during the semester and a take-home final exam. The in-class tests will test you on the material we have studied. The first two will cover the science and the third will cover responses to climate change.

I will provide you with a list of relevant physical constants and important equations. For the most part, I do not expect you to memorize equations and numbers, but there are a few numbers, such as the equilibrium climate sensitivity and the concentration of carbon dioxide in the atmosphere that I do expect you to know by heart. Reading assignments will clearly state what numbers I expect you to memorize.

The final exam will be an open-book, open-notes take-home exam. It will be cumulative over all the material covered during the term. It will not ask you to solve scientific problems, but will ask open-ended questions about the big ideas we have covered during the semester.

The in-class tests will take place on NA, NA, and NA.

The take-home final exam is due at **11:00 am Saturday, May 9.**

5 Honor Code:

This course, like all courses at Vanderbilt, is conducted under the Honor Code.

I encourage you to seek help from me, from Mr. Belanger, or from other classmates or friends in your studying. I also encourage working together on homework assignments: you may talk with your friends and classmates about homework assignments, compare notes on how you are working a problem, and you may look at your classmates' work on homework assignments. But you must work through the problems yourself in the work you turn in: **Even if you have discussed the solution with others you must work through the steps yourself and express the answers in your own words. You may not simply copy someone else's answer.**

Tests are different from homework: **all work on tests and exams must be entirely your own. You may not work together with anyone or receive any help from anyone but me on exams and tests (this includes take-home exams and tests).**

If you ever have questions about how the Honor Code applies to your work in this course, please ask me. **Uncertainty about the Honor Code does not excuse a violation.**

6 Final Note:

I have made every effort to plan a busy, exciting, and instructive semester. I may find during the term that I need to revise the syllabus to give more time to some subjects or to pass more quickly over others rather than covering them in depth. Many topics we will cover are

frequently in the news. Breaking news may warrant a detour from the schedule presented on the following pages. Thus, while I will attempt to follow this syllabus as closely as I can, you should realize that it is subject to change during the semester.

7 Meet Your Professor

Jonathan Gilligan has worked in many areas of science and public policy. His past research includes work on laser physics, quantum optics, laser surgery, electrical properties of the heart, using modified spy planes to study the ozone layer in the stratosphere, and connections between religion and care for the environment.

Professor Gilligan is the Alexander Heard Distinguished Service Professor, Associate Professor of Earth & Environmental Sciences, Associate Professor of Civil & Environmental Engineering, and the director of the Vanderbilt Climate and Society Grand Challenge Initiative, which is working to integrate research, teaching, and public outreach about climate change across the natural sciences, social sciences, and humanities. He co-chaired the committee that designed the new Climate Studies major at Vanderbilt and he is currently serving on the faculty committee that is redesigning Vanderbilt's undergraduate Arts and Science curriculum.

His current research investigates the role of individual and household behavior in greenhouse gas emissions in the United States; how “smart cities” can use technology to reduce environmental footprints and promote health and citizen empowerment; water conservation policies in American cities; vulnerability and resilience to environmental stress in South Asia; and developing new directions for climate policy in the US.

Professor Gilligan and Professor Michael Vandenberg won the 2017 Morrison Prize for the highest-impact paper of the year on sustainability law and policy. Gilligan and Vandenberg's book, *Beyond Politics: The Private Governance Approach to Climate Change* (Cambridge University Press, 2017), was named by *Environmental Forum* as one of the most important books on the environment of the last 50 years.

Apart from his academic work, Professor Gilligan dabbles in writing for the theater. His stage adaptation of Nathaniel Hawthorne's *The Scarlet Letter*, co-written with his mother Carol Gilligan, has been staged at The Culture Project in New York City, starring Marisa Tomei, Ron Cephas Jones, and Bobby Cannavale, and was later performed at Prime Stage Theatre, Pittsburgh and in a touring production by The National Players. Most recently, it was performed as the principal fall 2019 production of the Fullerton College Classic Dramatic Series in Fullerton CA, directed by Michael Mueller, and was also chosen by the Classic Repertory Company in Watertown, MA, for its 2019-2020 repertory season.

Prof. Gilligan and Carol Gilligan also wrote the libretto for an opera, *Pearl*, in collaboration with composer Amy Scurria, and producer/conductor Sara Jobin, which was performed at Shakespeare & Company in Lenox MA, starring Maureen O'Flynn, John Bellemer, Marnie Breckenridge, John Cheek, and Michael Corvino, and in Shanghai China, starring Li Xin, Wang Yang, John Bellemer, and Lin Shu.

Schedule of Classes (Subject to Change)

IMPORTANT NOTE: This schedule gives a rough indication of the reading for each day. See the assignment sheets posted on Brightspace for the detailed daily assignments.

Date	Topic	Reading
Mon., Jan. 9	Introduction	No reading
Wed., Jan. 11	What is Climate Change?	<i>Forecast</i> Ch. 1, <i>Casino</i> Ch. 1-2
Fri., Jan. 13	Energy Balance and Climate	<i>Forecast</i> Ch. 2-3 pp. 9-23
Mon., Jan. 16	MARTIN LUTHER KING, JR. DAY	
Wed., Jan. 18	Greenhouse Effect	<i>Forecast</i> Ch. 3 pp. 23-26
Fri., Jan. 20	Greenhouse Gases	<i>Forecast</i> Ch. 4 Read the whole chapter, but concentrate on pp. 29-34
Mon., Jan. 23	Spectrum of Atmospheric Radiation	<i>Forecast</i> Ch. 4 pp. 34-40
Wed., Jan. 25	Vertical Structure of the Atmosphere	<i>Forecast</i> Ch. 5 Read the whole chapter, but focus on pp. 43-50
Fri., Jan. 27	Atmospheric Convection	<i>Forecast</i> Ch. 5 pp. 50-55
Mon., Jan. 30	Review of Greenhouse Effect	No reading
Wed., Feb. 1	Weather and Climate	<i>Forecast</i> 6
Fri., Feb. 3	Feedbacks	<i>Forecast</i> 7 pp. 73-81
Mon., Feb. 6	Ocean and Biosphere Feedbacks	<i>Forecast</i> 7 81-84
Wed., Feb. 8	TEST #1	
Fri., Feb. 10	The Carbon Cycle: Ocean and Biosphere	<i>Forecast</i> 8 pp. 89-97
Mon., Feb. 13	The Carbon Cycle: Mineral Weathering	<i>Forecast</i> 8 pp. 95-101
Wed., Feb. 15	Perturbing the Carbon Cycle	<i>Forecast</i> 10
Fri., Feb. 17	Ocean Acidification	<i>Forecast</i> 10
Mon., Feb. 20	Isotopes	Handouts (on Brightspace)
Wed., Feb. 22	Climates of the Past	<i>Forecast</i> 11
Fri., Feb. 24	The Pleistocene Ice Ages	<i>Forecast</i> 7, <i>Forecast</i> 8, <i>Forecast</i> 11
Mon., Feb. 27	Human Impact on Climate: The Evidence	<i>Forecast</i> 11
Wed., Mar. 1	Review of Carbon Cycle and Paleoclimates	No reading

Date	Topic	Reading
Fri., Mar. 3	Identifying Fallacies about Climate Change	"23 Ways to Mislead"
Mon., Mar. 6	Climate Fallacies Game	"A History of FLICC"
Wed., Mar. 8	TEST #2	
Fri., Mar. 10	Climate Models	<i>Casino</i> Ch. 3-4, <i>Casino</i> 3-4
Mon., Mar. 13	SPRING BREAK	
Wed., Mar. 15		
Fri., Mar. 17		
Mon., Mar. 20	Future Climate Change	<i>Forecast</i> Ch. 12 pp. 153-164, <i>Casino</i> Ch. 5
Wed., Mar. 22	Uncertainty about Future Climates	<i>Forecast</i> Ch. 12 pp. 164-166, <i>Casino</i> Ch. 24, <i>Climate Fix</i> Ch. 1 pp. 1-24
Fri., Mar. 24	Policy Myths	<i>Climate Fix</i> 2, <i>Casino</i> Ch. 25
Mon., Mar. 27	The Kaya Identity	<i>Climate Fix</i> Ch. 3, <i>Casino</i> Ch. 14
Wed., Mar. 29	Future Emission Scenarios	TBA
Fri., Mar. 31	Renewable Energy	Handouts (on Brightspace)
Mon., Apr. 3	Nuclear Energy	Handouts (on Brightspace)
Wed., Apr. 5	Geoengineering: Solar Radiation Management	TBA
Fri., Apr. 7	Geoengineering: Carbon Dioxide Management	TBA
Mon., Apr. 10	Review of Impacts and Responses to Climate Change	No reading
Wed., Apr. 12	TEST #3	
Fri., Apr. 14	Climate Change, Agriculture, and Health	<i>Casino</i> 6-8
Mon., Apr. 17	Climate and Oceans: Hurricanes, Sea-level, etc.	<i>Casino</i> 9-10, 12
Wed., Apr. 19	Climate Justice	Handouts (on Brightspace)
Fri., Apr. 21	History of Climate Policy	TBA
Mon., Apr. 24	Future Possibilities	TBA
Thu., May. 4	TAKE-HOME FINAL EXAM DUE	