

**GEOL 157L**  
**The Logic of Climate Change: from Data to Deeds**  
Julien Emile-Geay  
Spring 2018

**General Information**

*Where/When* Class meets Mon/Wed/Fri, 11:00–11:50 in SAL101.  
Lab section meets in ZHS 130. Remember to register separately for lab and class!

*Instructors*

Professor:	Julien Emile-Geay	ZHS 275	<a href="mailto:julieneg@usc.edu">julieneg@usc.edu</a>
Teaching Assistants:	TBD	TBD	<a href="mailto:tbd@usc.edu">tbd@usc.edu</a>

*Office Hours* MWF 10-11 in ZHS 275, or by appointment.

**Course Description**

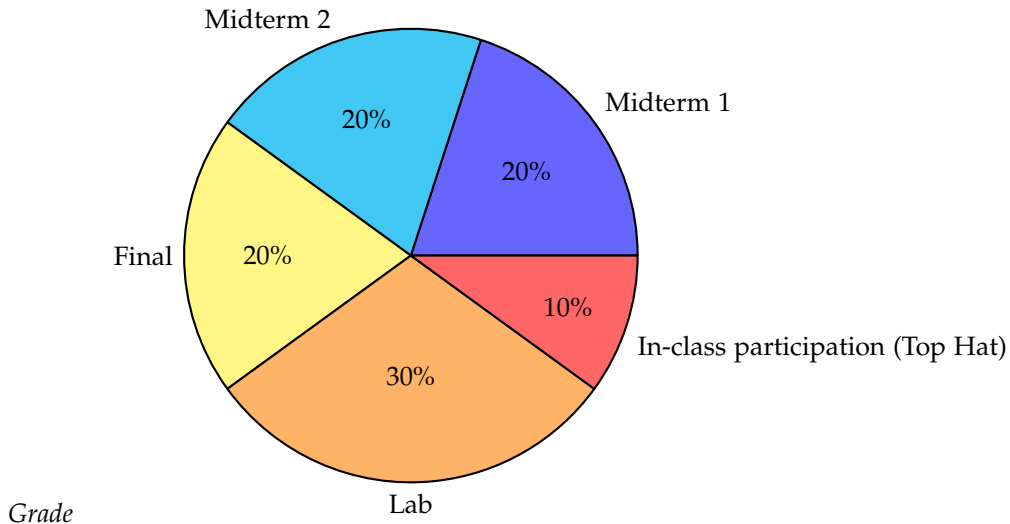
*Synopsis* Climate science offers many puzzles, not least of which is the gap between scientific and public opinion: there is a near-total scientific consensus that human activities are warming the planet, yet poll after poll reveals that the American public perceives a much weaker consensus, and consequently, a much lower level of risk. This class (GE-Category F) will walk you through the logic of climate change. Through lectures and Python-based data science labs, we will explore questions such as: How can scientists say for sure that climate is warming? What are the logical steps between quantitative observations of climate and the conclusion that humans are driving its current warming? What are the logical and moral implications of a man-made climate, both for human civilization and for other species? Finally, what explains the gap between scientific and public perceptions of climate risk, and how can we close this gap to formulate meaningful responses to the crisis?

*Learning Objectives* Students will learn the evidentiary basis of global environmental change. They will learn to: empirically analyze climate data; understand the logical structure of the case for anthropogenic climate change; deconstruct common logical fallacies used by denialists. One innovation of this class is that it will leverage [Jupyter Notebooks](#) to teach students fundamental data science skills so they can: perform elementary analysis and visualization of climate data; debunk pseudoscientific claims that deny the human causes of climate change; run elementary climate models; explore the climate's sensitivity to various forcings.

*Requirements* This class will teach elementary notions of physics, chemistry, statistics & computer programming. A high-school level science background is desirable. A personal computer with Python 3 installed<sup>1</sup> is helpful, but not required.

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<sup>1</sup><https://www.continuum.io/downloads>



The class is worth 4 units, which means that it requires substantial work. Lab attendance is mandatory. Labs are graded weekly and administered by Teaching Assistants (see separate lab syllabus). Exams are all multiple choice questions. The final (2h) is cumulative.

Table 1: Numeric to letter grade conversion (cutoffs)

< 60	60	64	67	70	74	77	80	84	87	90	≥ 94
F	D-	D	D+	C-	C	C+	B-	B	B+	A-	A

### Extra credit

*JEP* One way to boost your grade is participating in the [Joint Educational Project](#), worth up to 1/3 of a grade (3.33%) (e.g. from B+ to A-). Sign up early or forever hold your peace.

*Discussions* Another way to participate is via BlackBoard discussions. Throughout the semester we will post 6 discussion boards with assigned multimedia content, which are a great way to explore deeper topics and use your writing skills. You will be graded on the substance of the posts, out of 10. A 10 will be worth a boost of 1/3 on your final grade (e.g. from B+ to A-). Discussions may be accessed on Blackboard via the Assignments tab, or via Tools>Discussions. Deadlines will be announced via the calendar.

Extra credit opportunities are cumulative; doing both will earn you a *maximum* grade boost of 5% (assuming perfect scores in both).

*Rules* There aren't many rules, but they're all important. First, read the syllabus (if you've gotten this far, you're on the right track). Second, check BlackBoard. Third, ask questions when you don't understand things; chances are you're not alone. Fourth, don't miss class or lab. Fifth, please do not email the instructor with questions whose answer is in the syllabus. Sixth, under no circumstance should you ever even think of haggling for your grade. Seventh, read the syllabus once more. Just in case.

*Exams* We believe in making exams a learning experience. Each exam will take place in two phases. First, you will sit the exam as a group, open-book style, and wrestle with hard problems for an hour. A few days later, you will sit the same exam again, closed book. Since you will have already had a chance to think about the problems and review the relevant material, you should do great. And these important questions stick with you for a while.

## Reading

### Main book

Dessler, A., *Introduction to Modern Climate Change, 2nd Ed.*, Cambridge University Press, 2014.  
[URL](#).

### Relevant Books

- Weart, S., *The Discovery of Global Warming*, [URL](#).
- Emanuel, K., *What we know about climate change*, [URL](#).
- Edwards, P.N., *A vast machine*, [URL](#)

## Schedule

### I IS CLIMATE CHANGING?

What is climate? And how do we know that it is changing?

#### Week 1 — 01/08/18— What is climate?

**Lectures** The climate change roadmap; A tale of three planets; climate system overview

**Reading:** Dessler, Chapter 1

#### Week 2 — 01/15/18— A changing atmosphere

**Lectures** (Monday: MLK day). atmospheric structure and composition. Surface & satellite observations.

**Reading** Dessler, Chapter 2

#### Week 3 — 01/22/18— Statistics: from measurement to thermodynamics

**Lectures** Measurement error. Gaussian distribution. Kinetic theory of gases. First principle of thermodynamics.

**Lab #1** Introduction to data science in Python .

**Reading** A primer on statistical mechanics

## II WHY IS CLIMATE CHANGING?

### **Week 4 — 01/29/18— Energy & Radiation**

**Lectures** Energy types & conversions; laws of radiation; Greenhouse effect;

**Lab #2** The temperature record

**Reading** Dessler, Chapter 3

### **Week 5 — 02/05/18— Elementary Climate models**

**Lectures** A 0D climate model; planetary energy balance. 1D climate models.

**Reading** Dessler, Chapter 4

**Assignments** Lab #2 report due

### **Week 6 — 02/12/18— Fluid flow**

**Lectures** ocean & atmospheric circulation. storage, transport of heat and carbon.

**Lab #3** The greenhouse effect & planetary energy balance

### **Week 7 — 02/19/18— The Carbon Cycle**

**Lectures** Monday: no class (President's Day). The long- and short-term carbon cycle.

**Reading** Dessler, Chapter 5

**Assignments** Lab #3 report due

### **Week 8 — 02/26/18— Forcings & Feedbacks**

**Lecture** Forcings, Feedbacks & Climate Sensitivity. Midterm 1: group & individual

**Lab #4** Radiative-convective equilibrium

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## III NOT ALL CHANGES ARE MAN-MADE: NATURAL CLIMATE VARIABILITY

How has the climate system behaved over recent and geologic history?

### **Week 9 — 03/05/18— Timescales of Climate Change**

**Lectures** Seasonal variability (monsoons); interannual var. (El Niño); decadal var. (the “Hiatus”);

**Reading** Dessler, Chapter 6,7

**Assignments** Lab #4 report due

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## **SPRING RECESS : March 11 – 18**

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**Week 10 — 03/19/18— Lessons from Earth’s past**

**Lectures** Paleoclimate proxies; The Hockey Stick Controversy;  
The biggest control knob: Carbon through the eons.

**Reading** Dessler, Chapter 5

**Assignments** Lab #4 report due

**Week 11 — 03/26/18—Midterm 2**

The Anthropocene. Midterm 2 (group & individual)

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**IV ATTRIBUTING CLIMATE CHANGE**

We now quantitatively prove that most of the current warming is man-made, and explore the reasons why this fact is not more widely accepted by the public.

**Week 12 — 04/02/18— Climate Models**

**Lectures** Climate Modeling: from Fourier to Global Climate Models. Detection and Attribution of climate change

**Lab #5:** Exploring climate models

**Reading** *Schmidt: the physics that we know*. Dessler, Chapter 8

**Week 13 — 04/09/18— Climate Denial**

**Lectures** Merchants of Doubt; Climate change in the media; The “logic” of climate denial

**Assignments** Lab #5 report due

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**V THE CONSEQUENCES OF CLIMATE CHANGE**

In this last section, we explore the logical consequences of man-made warming: from our responsibilities to other species or the less fortunate members of our own, to the implications for economics, policy, and lifestyle choices.

**Week 14 — 04/16/18— Climate Futures**

**Lectures** The Greenhouse Future; Impacts of climate change; Energy Systems.

**Lab #6:** Debunking Climate Myths

**Reading** Dessler, Chapter 10, 11, 12. Discussion #5 due

**Week 15 — 04/23/18— Climate Decisions**

**Lectures** Climate Options; The Economics of Climate Change; Geoengineering;

**Reading** Dessler, Chapter 9, 13, 14.

**Lab** Group final; Lab#6 report due

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**Monday May 8(?)—Final Exam – 8-10am**

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**VI PARTICIPATION**

Class participation is a critical aspect of this course. The first way to participate in class is to come to class. I somehow make it to class every day – it requires no superhuman powers. However, just parking in the classroom and checking Facebook is a waste of your time and your parents’ money, so *active participation* is what we’re after: ask questions. Offer comments. You are not required to know much science to take this class, so there is no such thing as a stupid question; also, we will encounter many controversial topics, in which your opinion

matters – it would be too bad to keep it for yourself. In addition, I will ask you to answer some questions during every lecture via a polling software called **Top Hat** (see corresponding section). Some polls will be informal, only aimed at getting your personal opinion on a climate-related question; those will be anonymous. Other questions will not be. You will not be graded based on correctness to these questions; only participation. In-class participation represents 10% of the final grade. To obtain these 10 points, you need to maintain an average participation rate of at least 80%.

## VII TECHNOLOGY

### **Blackboard**

BlackBoard is our primary medium of communication outside the classroom. It is where I post class notes, announcements, and assignments. It is where you access that content, participate in discussions, and check your grades. **It is your responsibility to ensure that you receive BlackBoard announcements.** Make sure you enable email notifications, and importantly, make sure your inbox is not full; every year I get emails bounced from students too neglectful to clean up their inbox. If you have a doubt about when an assignment is due, go check it on BlackBoard. Also note that BlackBoard messages are richer than the email notifications they generate. Frequently, the announcements I'll send will have links to content archived on BlackBoard – those links will not appear in the emails. If the email digest you read does not make sense, please check it on BlackBoard; it might have the answer you need over there. If it still doesn't, please email me.

### **Top Hat**

The tool we will use to gather live, in-class feedback is called **Top Hat**. You may submit your responses in one of three ways: Text messages, a Smartphone App, or a Web browser. In case you have not received an invitation to join the course on Top Hat, here's how to **get started**.

The economics are as follows: \$20 for a semester-long license or \$38 for a 5-year license (unlimited number of classes). **Purchase of a license is required to get in-class discussion points (10% of the grade).** The course code is \_.

### **Email etiquette**

Email is a relatively new advent in the world of education. It allows an unparalleled level of access to professors, which has both pros and cons. In some cases you will spot a mistake of mine in an assignment or a grade, and pointing it out will save everyone a lot of time. In many cases, however, emails unnecessarily clog my inbox. Here are some rules to use email wisely:

- Check BlackBoard before you type. Chances are the answer you seek is already there.
- Direct all lab-related queries to your TA.
- Direct all Top Hat issues to [support@tophat.com](mailto:support@tophat.com), unless they tell you to contact me.
- Do not expect an immediate answer. I have a life too.
- Write exactly as if you were speaking to me in person. Not more, not less formally.

Emails that break any one of these rules will not receive an answer. If you can spare the time, please come to office hours or see me after class. I'd much rather talk to a human than a computer, and I have yet to bite a student. Other email etiquette tips may be found [here](#).

## Laptops & Tablets

Laptops and tablets look way cool, but they have proven far less effective than good old pen&paper at information retention. Moreover, their use in the classroom can be disruptive to you and (more importantly) people around you if you use them for activities unrelated to the class. Please exercise best judgment and be considerate of others around you.

## VIII ACADEMIC CONDUCT

### Plagiarism

Presenting someone else's ideas as your own, either verbatim or recast in your own words, is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in [SCampus](#) in Section 11, [Behavior Violating University Standards](#). Other forms of academic dishonesty are equally unacceptable. See additional information in [SCampus](#) and university policies on [scientific misconduct](#).

### Discrimination

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the [Office of Equity and Diversity](#) or to the [Department of Public Safety](#). This is important for the safety whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The [Center for Women and Men](#) provides 24/7 confidential support, and the [sexual assault resource center webpage](#) describes reporting options and other resources.

### Support Systems

**Student Counseling Services (SCS)** (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

<https://engemannshc.usc.edu/counseling/>

**National Suicide Prevention Lifeline** –1-800-273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

<http://www.suicidepreventionlifeline.org>

**Relationship & Sexual Violence Prevention Services (RSVP)** – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

<https://engemannshc.usc.edu/rsvp/>

**Sexual Assault Resource Center** For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

**Office of Equity and Diversity (OED)** (Title IX compliance) – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

**Bias Assessment Response and Support** Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. <https://studentaffairs.usc.edu/bias-assessment-response-support/>

**Student Support & Advocacy** – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic.

<https://studentaffairs.usc.edu/ssa/>

**Diversity at USC** Tabs for Events, Programs and Training, Task Force (including representatives for each school), Chronology, Participate, Resources for Students.

<https://diversity.usc.edu/>

## **GradeBuddy**

The following is a reminder from Academic Policies memo 11/25:

*Any student selling or distributing notes taken in a classroom is in violation of the University's Academic Integrity policy and is subject to university sanctions. This policy is clearly stated in Section 11.12 of the student handbook, **SCampus**, which identifies the following as violations of community standards:*

- Acquisition of term papers or other assignments from any source and the subsequent presentation of those materials as the student's own work, or providing term papers or assignments that another student submits as his/her own work.*
- Distribution or use of notes or recordings based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes, but is not limited to, providing materials for distribution by services publishing class notes. This restriction on unauthorized use also applies to all information which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the Internet or via any other media. (See Section C.1 Class Notes Policy.)*
- Recording a university class without the express permission of the instructor and announcement to the class. Recording can inhibit future free discussion and thus infringe on the academic freedom of other students as well as the instructor.*