

CORE 103
The Process of Change in Science
THE DISCOVERY OF GLOBAL WARMING
Fall 2020

Course Description

Synopsis Today there is a quasi-absolute scientific consensus that human activities are warming the planet. How did we go from the idea that Earth was too vast and powerful for humans to possibly change, even comprehend, to the recognition that Earth's surface is a collection of fragile systems that humanity must manage and preserve for its own survival? This class will survey the discovery of global warming, whose 200-year history mirrors the fundamental progress of science: quantum physics, electromagnetism, fluid dynamics, biogeochemistry, radioisotope chemistry, chaos theory, ecology, supercomputing, state estimation, and the theory of complex adaptive systems. The journey will teach us much about the nature of scientific inquiry, the culture of "organized skepticism" at the root of scientific progress, and the emergence of scientific consensus based on a confluence of evidence involving theory, direct and indirect observations, as well as experiments *in silico*.

Requirements An open mind

General Information

Instructors

Professor:	Julien Emile-Geay	ZHS 275	julieneg@usc.edu
Teaching Assistant:	Alexander James	ZHS 275	akjames@usc.edu

Connectivity

Blackboard: announcements, assignments, course materials, link to lectures.

Access at <https://blackboard.usc.edu>.

Zoom: recorded lectures and live discussions. Zoom links will be posted on Blackboard, and should be good throughout the semester.

Slack: I created an optional Slack channel in the [USC Dornsife workspace](#). This may be used for asynchronous discussions with everyone in the class, at your discretion. Standard, commonsense rules of respectful online behavior apply, naturally. Enrolled students will receive an invitation the first week of class.

Office Hours M-W 13:30-15:00 or by appointment, on [Zoom](#).

Where/When

Class meets Mon/Wed, 10:00–11:50 on Zoom ([LINK GOES HERE](#)).

Discussions meet Fri at 9:00 or 10:00 on Zoom (register separately).

Special events Wed evenings, time TBD.

All contact hours will be highly interactive. A recorded Keynote presentation will be posted at least 24h prior to each Monday or Wednesday class period. The latter will be used to clarify aspects that need to be, or delve deeper into topics of interest to you. As such, it is strongly recommended that you watch each video (90min max) prior to those sessions. Friday's discussion sections will be highly interactive group discussions, based on assigned readings. A short written assignment pertaining to this reading will be due each Friday at class time.

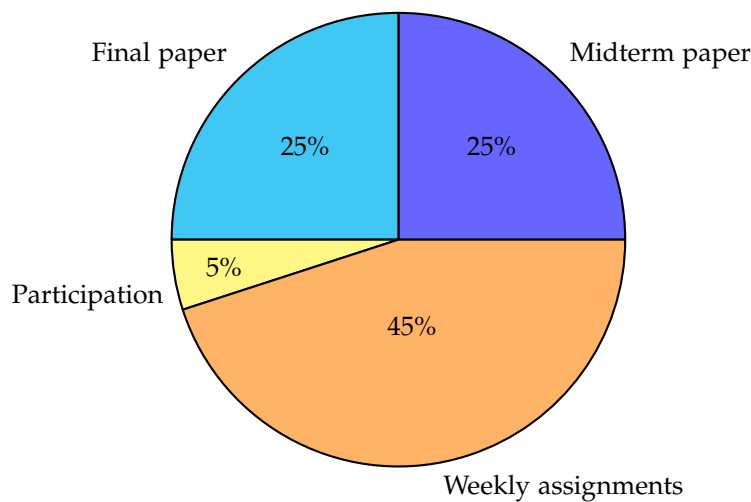
Books

Required Books

- Weart, Spencer R., *The Discovery of Global Warming*, 2nd edition, ISBN:978-0674031890. [URL](#)
- Archer, D. and Pierrehumbert, R., *The Warming Papers: The Scientific Foundation for the Climate Change Forecast*. ISBN: 978-1405196161. [URL](#) (hereafter, “WP”)

Supplemental Reading

- Oreskes, N. & Conway, E., *The Collapse of Western Civilization: A View from the Future*, [URL](#)
- Edwards, P.N., *A vast machine: Computer Models, Climate Data, and the Politics of Global Warming*, ISBN: 978-0262013925 [URL](#).



Grade

The class is worth 4 units, which means that it requires assiduous and substantial work. Attendance to discussion sections is mandatory (register separately, please). You will write two papers: a midterm and a final. At each week’s discussion (12 total), short written assignments will be given and graded. The remaining 10% of the grade will be based on participation.

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

Schedule

I LIGHT & MATTER

Week 1 — 08/17/20— Foundations

Reading: [Weart, Chapter 1](#).

Monday A brief history of global warming. Climate's Three Big Questions.

Wednesday Earth's temperature: Fourier's Footing and Forays

Friday No discussion (starts in week 2).

Week 2 — 08/24/20— Thermodynamics

Reading: WP, Chapter 1 + Pierrehumbert, [2004].

Monday Energy and Entropy

Wednesday "The kind of motion we call heat". Statistical mechanics and atomism.

Friday Discussion: The temperature of the celestial sphere.

Week 3 — 08/31/20— Radiant Energy

Reading WP, Chapters 2 & 3. [Simple Climate, Arrhenius](#). [Pierrehumbert \[2011\]](#). WP, Chap 4; [The CO₂ theory of Gilbert Plass](#).

Monday Light and Matter

Wednesday The Greenhouse Effect

Friday Discussion: By the Light of the Silvery Moon.

Week 4 — 09/07/20— Taking Earth's temperature

Reading WP, Chapter 12. [A vast Machine, Chap 1](#). [The modern temperature record](#)

Monday No class (Labor Day)

Wednesday Taking Earth's temperature

Friday Discussion: The Callendar Effect

Week 5 — 09/14/20— Monitoring Earth

Reading WP, Chapter 13. [Simple Climate: Suess; Broecker; Keeling](#).

Monday The Keeling Curve

Wednesday Eyes on Earth

Friday Discussion: The Carbon Cycle.

II FROM ATOMS TO PLANETS

Week 6 — 09/21/20— Atomic Science, Cold War Science

Reading: [Atoms in trees](#); [World's loneliest tree records the Anthropocene](#); [The age of the Earth](#); [Simple Climate, Dansgaard](#)

Monday Cold War Science (guest)

Wednesday Nuclear Physics: isotopes and atomic bombs

Friday Discussion: Atoms for Earth.

Week 7 — 09/28/20— Climate modeling

Reading WP, Chapter 5 (Manabe & Wetherald 1967). **Schmidt: the physics that we know; Simple Climate: Manabe; Weart: GCMs**

Wednesday Richardson’s “Forecast Factory”. The Attribution of Climate Change.

Assignment Midterm Paper due.

Friday no Discussion

Week 8 — 10/05/20— Paleoclimatology

Reading: **Weart: Ice Age Cycles; Simple Climate: Milankovitch; Broecker, part II.**

Monday Quaternary Ice Ages

Wednesday Abrupt climate change

Friday Discussion: paleoclimates

Week 9 — 10/12/20— Space and Time

Reading **Weart: Venus & Mars; The Sixth Extinction**

Monday A journey in space: Mars, Earth, Venus and the solar system.

Wednesday A journey in time: from the Big Bang to the Anthropocene (F. Corsetti)

Friday Discussion: Mass Extinctions

Week 10 — 10/19/20— Chaos and Order

Reading WP, pp 241–254. (Charney Report). **What is Chaos Theory?. Weart, "Chaos".**

Monday Laplace and Lorenz: living on a butterfly’s wings

Wednesday Weather vs Climate Prediction

Friday Discussion: Predicting Climate

Week 11 — 10/26/20— Experiments *in silico*

Reading Oreskes & Conway: The Collapse of Western Civilization; **Weart: Impacts**

Monday Climate Projections

Wednesday Uncertainties: clouds, chaos and climate sensitivity.

Friday Discussion: Human and ecosystem impacts of climate change.

III SCIENCE: FROM WAR WINNER TO CULTURE WAR

Week 12 — 11/02/20— Consensus and Denial

Reading **How do you know a paper is legit?;** Schermer: Why Climate Skeptics Are Wrong.

Monday Scientific progress & consensus

Wednesday Deception: The American Denial of Global Warming

Friday Discussion: Consensus & Denial

Week 13 — 11/09/20— Climate Narratives

Assignments Podcast: [tribal psychology](#); Hoffmann: [Climate Science as Culture War](#);

Monday Denial: motivated reasoning, confirmation bias, identify-protective cognition.

Wednesday Dueling narratives: Climate vs Capitalism, People, Planet & Profit.

Friday Discussion: Tribal Psychology

Nov 24 – Final Paper due

IV PARTICIPATION

Class participation is a critical aspect of this course. The first way to participate in class is to come to class. However, *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.

V FINAL PAPER

Develop your own topic, or choose from one of the following: *From Stasis to Crisis*; *From Biosphere to Noosphere*; *Science & Agnotology*; *Civilization as a geosystem*; *Natural Laws vs Human Nature*; *Anthropocentrism & Anthropocene*; *Revolutions in Earth Science*;

VI 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 contain 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. If it still doesn't, please email me.

Email etiquette

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 people around you if you use them for activities unrelated to the class. Please exercise best judgment and be considerate of others around you.

VII 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

Trojans Care For Trojans (TC4T)

An initiative within the Office of Campus Wellbeing and Crisis Intervention that empowers USC students, faculty and staff to take action when they are concerned about a fellow Trojan challenged with personal difficulties.

A [private and anonymous request form](#) provides an opportunity for Trojans to help a member of our Trojan Family.

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/>