

SYLLABUS

Spring 2018

ENVR 575: Global Climate Change: Science, Impacts, Solutions

Class meets: Tuesdays & Thursdays 12:30-1:45, McGavran-Greenberg 2305

Instructor: Jason West

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Office Hours: After class Tuesdays & Thursdays, 1:45-3

Course Description and Goals

Climate change is a difficult, contentious, and important issue. It will perhaps be the defining environmental issue of the 21st century. This course aims to address the whole complexity of climate change as an issue, by bringing together the science, impacts, economics, abatement technologies, and policy solutions into one course. Through this course, we will address several important questions. What is the scientific basis for our understanding of climate change, and in what ways is that scientific basis uncertain? What changes in climate might we expect over the coming centuries? What would be the impacts of these changes in climate for human well-being and the natural world? What are the sources of emissions of greenhouse gases? What technologies exist or might be developed to allow us to slow climate change, and what international policy solutions might be necessary or preferred?

Students will be expected to show mastery of relevant concepts drawn from the Earth sciences, chemistry, physics, engineering, economics, and political science, and be able to explain the relevance of these concepts for our present understanding of human-caused climate change and for the viability of different proposed solutions. By the end of this course, students will be able to:

- Explain and evaluate the evidence for human-caused climate change, in the context of historical climate change, as well as the relevant scientific uncertainties and possible evidence to the contrary.
- Explain and quantify the impacts of climate change on human well-being and the natural world, and evaluate means by which these impacts can be reduced (adaptation).
- Explain the human causes of climate change, including the sources of greenhouse gas emissions. Because energy consumption is central to greenhouse gas emissions, students will understand the global energy infrastructure in a historical context and evaluate technological options for reducing emissions.
- Apply quantitative analysis of concepts relevant for climate change, drawn from chemistry, physics, and economics, through homework problems.
- Evaluate the successes and failures of past national and international efforts to address climate change, and evaluate prospects for future management of climate change.
- Evaluate the issue of climate change from the perspective of individual nations.

- Assess the communication of science and policy for climate change, as a successful or unsuccessful example of how science and policy can and should inform one another.

In completing this course, students will improve their abilities to read and understand research papers from several disciplines addressing climate change, and to apply concepts quantitatively. Students will also improve their abilities to communicate through in-class presentations, and to develop and test hypotheses through an individual research paper.

Prerequisites

This is a graduate level course. Advanced undergraduates will be admitted to the course only with permission of the instructor. Students must have

- had at least one undergraduate course in chemistry.
- had at least one undergraduate course in physics.
- competence in math.
- an open mind.

Course Requirements and Evaluation

Class participation	10%
In-class exams	20%
Homework assignments	25%
Group presentation 1 – impacts of climate change	9%
Group presentation 2 – perspectives of different nations	9%
Individual research paper	27%
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	100%

There is no final exam, so that students can focus on the individual research paper.

Homeworks are expected to be turned in on time. Late homeworks will lose 10% for each day late, except for very exceptional circumstances and the prior approval of the instructor. You are encouraged to work in groups for your homeworks (and for the group presentations). However, each student is responsible for writing up and turning in their own results for their homework. If you work with others, you are required to include a note on your homework with the names of the people you work with (working with others does not count against you, but you will lose a point if you fail to acknowledge them). Handing in homework identical to another student's is not acceptable.

Homeworks should be written up to explain completely the methods used to solve problems. If Excel spreadsheets or other tools are used to solve, those files should also be submitted (for example, by email). Many homeworks will require some writing in addition to solving problems, and this interpretation of what the results mean is important for the overall exercise. Please try to write these responses in a way that is clear and well organized. Homeworks can be submitted on paper in class or in my mailbox, or electronically by email.

Readings

Because understanding of climate change is moving rapidly, this course will make use of recent and primary sources in the literature, drawing heavily from some of the key articles in journals like Science and Nature. We will also use all 3 volumes of the Intergovernmental Panel on Climate Change Fifth Assessment Report, which assesses our current understanding of climate change. Individual articles will be posted on the sakai site. There is one required text:

John Houghton, Global Warming: The Complete Briefing, 5th Edition, 2015, Cambridge Univ. Press.

Useful resources

We will read significant portions of the Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5), published in 2013. The IPCC received a share of the 2007 Nobel Peace Prize for the Fourth Assessment (AR4). The report is in four volumes:

1. Science
2. Impacts
3. Abatement
4. The Synthesis Report

Full text of these reports are available online at www.ipcc.ch. You should consider buying one or more of these volumes if you plan to continue working in climate change.

The US National Climate Assessment (nca2014.globalchange.gov/), and the 2017 Climate Science Special Report (<https://science2017.globalchange.gov/>). Also older reports are available from the US Global Change Research Program, including the “Synthesis and Assessment Products” on various topics, which can be downloaded for free (www.globalchange.gov/engage/process-products/sap-summary).

Useful websites and news

The Discovery of Global Warming website (companion to the book by Spencer Weart) – www.aip.org/history/climate/

Real Climate - www.realclimate.org – a blog on climate science that debunks the debunkers.

New York Times – www.nytimes.com – click on “Times Topics” and then “Global Warming”.

Science – www.sciencemag.org – good news and summaries of research articles up front.

Pew Center on Global Climate Change – www.pewclimate.org – good commentaries on climate policy.

International Energy Agency – www.iea.org – a good source for statistics on energy.

US Energy Information Administration – www.eia.doe.gov – lots of global energy statistics.

United Nations Framework Convention on Climate Change – www.unfccc.org – the international body under which the Kyoto Protocol was negotiated, and the sites lists reports from individual nations.

Course Schedule (subject to updates)

Please read the readings **before** each class.

Additional readings from the IPCC and more journal articles will be posted on the sakai site.

- 1 Thurs., Jan. 11 Introduction to class, Climate change science: early discoveries, energy balance model
(Note: the energy balance model in the first several lectures on the are based on D. Jacob, Introduction to Atmospheric Chemistry, Chapter 7, which is available free online at <http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html> - it is not required)
- 2 Tues., Jan. 16 Climate change science: early discoveries, energy balance model with GHGs
Readings: Houghton, Chapter 1
- 3 Thurs., Jan. 18 Greenhouse gases, radiative forcing, and a first estimate of climate sensitivity
Readings: Houghton, Chapter 2
Karl and Trenberth (2003) Science
- 4 Tues., Jan. 23 Radiative transfer, an improved estimate of climate sensitivity
- 5 Thurs., Jan. 25 Greenhouse gases
Readings: Houghton, Chapter 3
- 6 Tues., Jan. 30 Discuss research papers
More greenhouse gases
- 7 Thurs., Feb. 1 The global carbon cycle – biogeochemistry
- 8 Tues., Feb. 6 Introduction to Impacts – Impacts, adaptation, and vulnerability
Readings: Houghton, Chapter 7
IPCC WG2 – Summary for Policymakers,
also skim the Technical Summary
- 9 Thurs., Feb. 8 Aerosol Radiative Forcing
The observational record of modern climate change
Readings: Houghton, Chapter 4 (only p. 56-64)
- 10 Tues., Feb. 13 Paleoclimate – what can we learn from the past?
Readings: Houghton, Chapter 4 (only p. 64-75)
- 11 Thurs., Feb. 15 Global atmospheric circulation
Climate modeling and climate change feedbacks: linking atmosphere, oceans, biosphere, and cryosphere
Readings: Houghton, Chapter 5
** Individual Research Paper – submit one page on proposed topics

12 Tues., Feb. 20 Climate modeling continued

Readings: Mahlman (1997) Science

13 Thurs., Feb. 22 Inferring climate sensitivity from the modern record

Detection and attribution of climate change – are there fingerprints?

Readings: Andreae et al. (2005) Nature

14 Tues., Feb. 27 Scientific consensus and uncertainty, the IPCC science assessment

Projection of future scenarios

Readings: Houghton, Chapter 6

15 Thurs., Mar. 1 EXAM 1

16 Tues., Mar. 6 NO CLASS

17 Thurs., Mar. 8 IMPACTS of climate change

Student-led presentation & discussion

1. Freshwater Resources

2. Terrestrial and Inland Water Systems (Ecosystems)

Readings: Read the Executive Summary and Frequently Asked Questions for each IPCC impacts chapter presented.

SPRING BREAK

18 Tues., Mar. 20 IMPACTS of climate change

Student-led presentation & discussion

3. Ocean Systems

4. Food Security and Food Production

19 Tues., Mar. 22 IMPACTS of climate change

Student-led presentation & discussion

5. Key Economic Sectors and Services

6. Human Health

20 Tues., Mar. 27 IMPACTS of climate change

Student-led presentation & discussion

7. Human Security; Livelihoods & Poverty

Impacts review

- 21 Thurs., Mar. 29 The global energy infrastructure and GHG emissions
 Future technologies: carbon sequestration, biofuels, hydrogen, geoengineering
 Readings: Houghton, Chapter 11
 Hoffert et al. (2002) Science
 Socolow et al. (2005) Scientific American
 ** Individual Research Paper – submit outline (2 pages)
- 22 Tues., Apr. 3 Stabilization wedges
 Readings: IPCC WG3, Summary for Policymakers
 Pacala and Socolow (2004) Science (you might also look at Socolow and
 Pacala (2006) Scientific American, which covers the same material)
- 23 Thurs., Apr. 5 International Agreements: the United Nations Framework Convention on
 Climate Change, Kyoto Protocol, Paris Agreement
 Interpreting “Dangerous Anthropogenic Interference”
 Emissions trading and the Global Warming Potential
 Readings: Houghton, Chapter 10
 O’Neill (2002) Science
- 24 Tues., Apr. 10 Should we abate? Cost-benefit views of the climate problem
 Discounting
 Readings: Stern Report, Introduction and Summary of Conclusions
 Nordhaus (2007) Science
 Stern and Taylor (2007) Science
 ** Individual Research Paper – Draft papers due to receive comments
- 25 Thurs., Apr. 12 Integrated Assessment, Decisions under uncertainty
 Abate now, or delay?
- 26 Tues., Apr. 17 Integrated Assessment, Decisions under uncertainty
 Emissions budgets
- 27 Thurs., Apr. 19 EXAM 2
- 28 Tues., Apr. 24 Climate change from national perspectives
 Student-led presentations and discussion
- 29 Thurs., Apr. 26 Climate change from national perspectives
 Student-led presentations and discussion
- Fri. May 4, noon – final exam period, we will use for the final “nations” presentations.
 ** Individual Research Papers due