

L&S 70B: GLOBAL WARMING
Instructors: Profs. John Chiang & Nathan Sayre
4 LeConte, Tuesday-Thursday 11:00-12:30
6/19/07

1: Introduction – Climate & Society	Jan 16 th
2: History of Climate Science	Jan 18 th
3: The Greenhouse Effect	Jan 23 rd
4: Greenhouse gases and radiative forcing	Jan 25 th
5: Fossil Fuels – Industrial Revolution	Jan 30
6: Fossil Fuels – 2 nd Industrial Revolution	Feb 1 st
7: Carbon Cycle	Feb 6 th
8: Fossil Fuels – Agriculture	Feb 8 th
9: Fossil Fuels – Transportation	Feb 13 th
10: Essentials of Climate I	Feb 15 th
11: Essentials of Climate II	Feb 20 th
12: Climate feedbacks	Feb 22 nd
13: Sociology of Climate Science Today	Feb 27 th
14: Climate Models	March 1 st
15: Past Climate Change	March 6 th
16: Detection and Attribution	March 8 th
17: Midterm	March 13 th
18: Projections	March 15 th
19: Impacts: Biodiversity	March 20 th
20: Impacts: Public Health	March 22 nd
21: Impacts: California – Precipitation & Drought	April 3 rd
22: Impacts: Hurricanes	April 5 th
23: Impacts: Oceans	April 10 th
24: Regulation: Local-Regional Initiatives	April 12 th
25: What do we do from here?	April 17 th
26: Economics of Climate Change	April 19 th
27: Regulation: Global commons	April 24 th
28: Mitigation/adaptation	April 26 th
29: Carbon sequestration	May 1 st
30: Review	May 3 rd
31: Review	May 8 th

LECTURE 1: Introduction - Climate and Society (NS & JC)

January 16th

Themes/Questions:

How do you know climate change is occurring? Is human activity causing this?

How did we get to the point where individuals, cities, entire nations, are mobilizing against it?

The roles and convergence of science, politics, and policy.

Motivation for this course

LECTURE 2: History of Climate Science (NS)

January 18th

Roots in studying ice ages

Global climate monitoring

Relation to Cold War science and technology

Scientific method, contingency and convergence

Required:

-Weart, S. 2003. *The Discovery of Global Warming*. Cambridge: Harvard University Press. (Chapters 1-4)

-Crutzen, P. 2002. "The Geology of Mankind." *Nature* 415: 23. **CR**

LECTURE 3: The greenhouse effect (JC)

January 23rd

What is the greenhouse effect?

A: How does a planet get its temperature? Planetary energy balance and blackbody radiation

B: A simple model for the greenhouse effect

Required:

-Houghton, Chapter 2, "The Greenhouse Effect".

- Kump, Kasting & Crane. First half of Chapter 3, "Global Energy Balance". *The Earth System*. Pearson Prentice Hall. 2004. (Details about blackbody radiation) **CR p19-28**

LECTURE 4: Greenhouse gases and radiative forcing (JC)

January 25th

What are the important greenhouse gases, and what makes them so? Where are the sources and sinks of these gases?

Are there factors (natural or anthropogenic) other than greenhouse gases that force climate change?

How do we understand their relative importance in forcing the climate? The concept of radiative forcing.

Required:

- Houghton, Chapter 3, "The Greenhouse Gases". pp 42-53. (section about other greenhouse gases and radiative forcing)
- Kump Kasting & Crane. Chapter 3 (Details on greenhouse gases) **CR p29-34**

LECTURE 5: Fossil Fuels in Modern Society – The Industrial Revolution (NS)

January 30th

*What were the origins of the Industrial Revolution? What were its social and ecological ramifications?
Why did it happen when and where it did? Why did it then spread to other areas?
Fossil fuels as cross-scale subsidy*

Required:

- Freese, B. 2003. *Coal: A Human History*. Cambridge: Perseus. Chapters 3-4 ("Launching a Revolution" & "Full Steam Ahead" pp 43-102) **CR**
- Marx, Karl. 1867 (1977). "Machinery and Modern Industry". *Capital* Vol I. New York: Vintage. (pp 492-508) **CR**
- Aldhous, P., 2005: China's burning ambition. *Nature*, 435: 1152-1154. **CR**

LECTURE 6: Fossil Fuels in Modern Society – 2nd Industrial Revolution (NS)

February 1st

*To understand the breadth of developments known as the Second Industrial Revolution
To discuss the release of the Fourth IPCC Assessment on Friday and the importance of probability in the IPCC's work
To examine the distribution of GHG emissions in the US from 1990 to 2004*

Required:

- Shah, S. 2004. *Crude: The Story of Oil*. NY: Seven Stories Press. Chapters 1 -2 ("The Eclipse of Coal" & "Exile from Tethys") **CR**
- Environmental Protection Agency. 2006. "The U.S. Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2004: Fast Facts." (Tables) **CR**
- McKibben, B. 2005. "The Great Leap: Scenes from China's Industrial Revolution". *Harper's* 311: 42-52. **CR**

LECTURE 7: Carbon cycle (JC)

February 6th

How is the concentration of CO₂ in the atmosphere naturally determined? The concept of the carbon cycle

How is the anthropogenic emissions of carbon dioxide affecting atmospheric carbon dioxide levels, and the carbon cycle in general?

Required:

- Botkin and Keller, Chapter 4 (an introduction to biogeochemical cycles, which includes the carbon cycle) **CR pp155-179**
- Kump Kasting & Crane, Chapter 16, pp 317-324 (for the perturbed carbon cycle) **CR 68-75**

LECTURE 8: Fossil Fuels in Modern Society – Agriculture (NS)

February 6th

What role do fossil fuels play in agriculture?

How have changes in agriculture due to fossil fuels affected overall GHG emissions?

What are the environmental and economic processes associated with these interactions?

Required:

- Pollan, M. 2006. “There Goes the Sun” in *The Omnivore’s Dilemma*. New York: Penguin. pp 41-47. **CR**
- Pimentel, D. et al. 2005. “Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems”. *BioScience* 55: 573-582. **CR**
- Weart, Chapter 5

LECTURE 9: Fossil Fuels in Modern Society – Transportation (NS)

February 13th

How did internal combustion engine-powered automobiles come to dominate transportation?

How have automobiles affected patterns of land use and the economy?

What trends are evident in transportation and GHG emissions?

Required:

- Flink, J. 1988. “The Triumph of the Automobile” in *The Automobile Age*. Cambridge: MIT Press. pp 358-375. **CR**
- Bureau of Transportation Statistics. 2001. “Highlights of the NHTS” & “Daily Travel Quick Facts”. From the *National Household Travel Survey*. **CR**
- Volti, R. 1990. “Why Internal Combustion?” *Invention & Technology Magazine*, Fall 1990. Vol 6: 42-47. **CR**
- Weart, Chapter 6

LECTURE 10: Essentials of Climate I (JC)

February 15th

What are the essentials of earth’s (circulation) climate as seen by climate physics?

Energy transports

Large-scale atmospheric motions: Hadley circulation, transient and stationary eddies
Forces on an air parcel
Effects of continents: stationary eddies; ocean basin circulations; land-ocean contrasts

Required:

- Kump, Kastings, Crane Chapter 4 (pp 55-81) **CR pp 40-67** (Note: you can ignore the inset box p42 of the CR, about the ideal gas law)

LECTURE 11: Essentials of Climate II (JC)

February 20th

What are the essentials of earth's climate as matters to humans?

Weather

Moist processes in climate

Climate variability

Required:

-Hyndman & Hyndman, Chapter 10 (pp 245-267) CR (you can skip the first 6 pages; cover pp 251-267, which corresponds to CR pp.225-241)

- Lippsett, L. 2000. "Beyond El Niño". *Scientific American* 11: 77-83. **CR pp243-249**

LECTURE 12: Climate feedbacks (JC)

February 22nd

What is a climate feedback, and why is it important for the regulation of climate?

What are the major climate feedbacks that matter for global warming?

Required:

Kump, Kastings and Crane Ch2 ("Daisyworld") - CR pp. 3-17

Kump, Kastings, and Crane part of Ch3 on "Intro to Climate modeling" and "Climate feedbacks" - CR pp.35-38

LECTURE 13: Sociology of Climate Science Today (NS)

February 27th

How does GW science work, both internally and in relation to society at large?

How do science and politics interrelate?

How has the IPCC handled these issues in building both knowledge and authority?

What are the strengths and limitations of climate models (GCMs)?

Required:

-Weart, S. *Discovery of Global Warming* Chapters 7-8.

-Dessler, A. & Parson E. 2006. *The Science & Politics of Global Climate Change*. Cambridge Univ. Press. (Chapter 2 -"Science, politics, and science in politics" pp 18-46) **CR**

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-Oreskes, N. 2004. "The Scientific Consensus on Climate Change". *Science* 306: 1686. **CR**

LECTURE 14: Climate Models (Guest lecture: Inez Fung)

March 1st

Our projections of future climate are based on climate models. What are they, and how well do they work? How much can we trust them to produce the forecasts of future climate?

Required:

-Chapter 5, Houghton

LECTURE 15: Past Climate Change (JC)

March 6th

*How did climate change in the past?
How do we infer past climate changes?
Abrupt climate change
How have these past climate changes impacted humans?
What lessons do they hold for our future climate?*

Required:

-Houghton, Chapter 4

-Alley, R. 2004. "Abrupt Climate Change." *Scientific American*, November: 62-69. **CR**

-Kolbert, E. 2005. "The Climate of Man -- II (Babylon)". *The New Yorker* 81. **CR**

LECTURE 16: Detection and attribution of climate changes (JC)

March 8th

*"Climate change is already happening". How do we know this? What are the difficulties inherent in detecting climate change?
Given that we have detected climate change, what do we attribute it to?*

Required:

-National Research Council. 2001. "Climate Change Science: An Analysis of Some Key Questions." Washington, DC: National Academy Press. **CR 303-329**

-Intergovernmental Panel on Climate Change 2007. WG1 Executive Summary for Policy Makers". **Bspace**

SESSION 17: Midterm

March 13th

LECTURE 18: Future climate change: projections and implications (JC)

March 15th

*What is the value of projecting future climate?
How does the IPCC project climate into the future?
What are the up to date projections by the IPCC?
Are we underestimating climate change?*

Required:

- KKC section on climate change, b-space under 'Resources/Required Readings'
- IPCC AR4 SPM pp.10-14 - these are the most current projections by the IPCC
- Pittock, A (2006) "Are scientists underestimating climate change?" EOS, 22 August. CR2, pp21-22

LECTURE 19: Impacts – Biodiversity (NS)

March 20th

*What effects is global warming having on ecosystems now?
What may be expected in the future?
How does climate interact with ecosystems?
How do these effects relate to biological diversity?*

Required:

- Houghton pp.143-145 and 170-176
- Kolbert "Butterfly Lessons."

LECTURE 20: Impacts – Public Health / Disease (Guest Speaker Bob Gould)

March 22nd

Required

- Patz et al. 2005. "Impact of Regional Climate Change on Human Health". Nature 438: 310-317. CR

LECTURE 21: Impacts – California: Water, Drought, Fire (NS)

April 5th

*How do scientists make regional projections of global climate change?
What difference can action to reduce GHG emissions now make on future impacts?
What are the projected effects of climate change in California?*

Required

- Our Changing Climate: assessing the risks to California. A summary report from the California Climate Change Center. **B-Space**

LECTURE 22: Impacts – Hurricanes (JC)

April 3rd

What are hurricanes, how do they form and evolve, and what damage do they cause? Can they be forecast?

How is global warming thought to affect hurricanes? Have we detected changes in hurricane behavior in the recent past?

The current scientific debate and policy implications

Required:

- “Hurricane Basics”, a publication from the National Oceanic and Atmospheric Administration (May 1999) **CR2 pp. 65-82**
- Witze, A. “Bad Weather Ahead”. *Nature* (2006). **CR2 pp. 83-85**
- Pielke, R.A., et al. “Hurricanes and Global Warming” *Bulletin of the American Meteorological Society*, Nov 2005. **CR2 pp. 86-89-** for this reading, you can just skim the first section titled ‘Event risk’ as the main points of that are summarized in Witze; focus on the 2nd and last sections (‘Vulnerability and outcome risk’; and ‘conclusions’).

LECTURE 23: Impacts – Oceans: Sea Level Rise (JC)

April 10th

What is the physics of sea level rise, and what is contributing to it now and the future?

What are some impacts of ocean warming and sea level rise?

Required:

- Houghton, Chapter 7: pp145-155
- Schneider, D. 1998. “The rising seas”. *Scientific American* special issue, pp 28-35. **CR pp107-109** (for this, just read the section on “Antarctic Uncertainties”).
- Ruttimann, J. 2006. “Sick Seas”. *Nature* 442: 978-980. **CR.** (NOTE: the material on ocean acidity is not required for the final exam)

LECTURE 24: Regulation - Regional initiatives (Guest Speaker Michael Armstrong)

April 12th

Required:

- Fisher, B. and R. Costanza. 2005. "Regional commitment to reducing emissions". *Nature* 438: 301-302. **CR2 pp. 127-128**
- Bailey, J. 2007. "Lessons from the Pioneers: Tackling Global Warming at the Local Level". Institute for Local Self Reliance. **CR2 pp. 129-145**

LECTURE 25: What do we do from here? (JC)

April 17th

*What are the various issues that factor in as we decide what to do with global warming?
What are the requirements of stabilizing CO₂ concentrations, and how does it that influence
mitigation strategies?*

Adaptation as a strategy

Required:

- Houghton Ch 9
- Broecker (2007), "CO₂ Arithmetic". **B-space**
- Pielke et al. (2007), "Lifting the taboo on adaptation". **B-space**
- Pacala and Socolow (2005) **CR2 pp227-231**

LECTURE 26: Economics of climate change (Guest – Max Auffhammer)

April 19th

How do economists think about climate change?

Required:

-The Stern Review on the Economics of Climate Change. "Executive Summary". Treasury Dept of the United Kingdom. 2006. **Bspace**

LECTURE 27: Regulation: Global Commons (NS)

April 24th

The Kyoto Protocol; Developed, Developing and Underdeveloped: Are Equitable Standards Possible?

The Montreal Protocol and Ozone Depletion

Governing the global commons

Required:

- Handmer, J., S. Dovers & T. Downing. 1999. "Societal Vulnerability to Climate Change and Variability". *Mitigation and Adaptation Strategies for Global Change*. 4: 267-281. **CR**
- Brander, L. 2003. "The Kyoto mechanisms and the economics of their design". In *Climate Change and the Kyoto Protocol*, ed: M. Faure, J. Gupta, & A. Nentjes. Northampton: Edward Elgar. **CR**
- Kintisch, E. 2006. "Along the Road from Kyoto". *Science* 311: 1702-03. **CR**
- Bastiononi, S., F. Pulselli, & E. Tiezzi. 2004. "The problem of assigning responsibility for greenhouse gas emissions". *Ecological Economics* 49: 253-257. **CR**

LECTURE 28: Mitigation/Adaptation (NS & JC)

April 26th

Carbon mitigation strategies: Emissions Controls, Carbon Sequestration, Carbon Credit Trading, Stabilization wedges, new technologies. Strategies, opportunities, and impediments to adaptation

Required:

- Kolbert, E. 2005. "The Climate of Man -- III". *The New Yorker* 81. **CR**
- Pacala, S. & R. Socolow. 2004. "Stabilization Wedges: Solving the Climate Problem for the next 50 years with Current Technologies". *Science* 305: 968 – 972. **CR**
- Woodward, C. 2004. "Europe: Planning Ahead" in *Feeling the Heat: Dispatches from the frontlines of climate change*. Routledge. **CR**

LECTURE 29: Mitigation - Carbon Sequestration (NS; Guest speaker: Joel Brown)

May 1st

Themes/Questions:

*Can carbon be effectively and economically sequestered to mitigate global warming?
What are the scientific, political and economic obstacles to such a strategy?*

Required:

- Socolow, R. 2005. "Can we bury global warming?" *Scientific American*, July: 49-55. **CR**
- Broad, W. 2006. "How to Cool a Planet (Maybe)". *The New York Times*, June 27. **CR**
- Houghton, Chapter 11, selections: pp 289-314

Suggested/Supplementary:

- Schiermeier, Q. 2006. "The Hundred Billion Tonne Challenge". *Nature* 442: 620-623.

Bspace

- Marris, E. 2006. "Black is the New Green". *Nature* 442: 624-626. **Bspace**