

Woodrow Wilson School of Public and International Affairs

Spring 2004

WWS 586c (GEO 586) Earth's Atmosphere: Theory and Practice

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Course Description

This course explores the relation between scientific understanding and public policy on the atmosphere. The course will provide an introduction to the composition, structure, and dynamics of the atmosphere with an emphasis on changes wrought by human activities, the consequences of those changes, and attempts to address them in the policy arena. Expansion of industrial and agricultural activity by a growing human population has caused a progressive extension of the range and persistence of human influence on the atmosphere. The phenomena urban air pollution, long range transport of smog and acidic pollutants (i.e., acid rain), depletion of the stratospheric ozone layer, and global warming demonstrate the progression of human influence from local to regional and global atmospheric scales over the past 2 centuries. They also reflect an increasing persistence of pollution that ranges from days to weeks to centuries to millennia. The exploitation of fossil fuels stands out as a source of several of these problems.

Atmospheric emissions and their effects extend across physical and regulatory boundaries into the marine, fresh water, and terrestrial environments, contributing to changes as diverse as coastal flooding, eutrophication of estuaries, regression of glaciers, early emergence of insects, and bleaching of coral reefs. Key questions to be addressed in the course include:

- Absent government policy, how much and how fast might the atmosphere change in the future?
- What could be the implications for ecosystems and society?
- To what degree can changes, like global warming, be averted?
- What policies might be effective?
- How have scientists, firms, NGO's, and other individuals and institutions influenced policy on the atmosphere?

Scientists and scientific information, the latter often properly applied but sometimes abused, have shaped responses to these problems by the public, private, and non-governmental sectors. In addition to regulatory responses to these problems like the US Clean Air Act, a new regime of international law and regulation is embodied in the Montreal Protocol on Substances that Deplete the Ozone Layer, the UN Framework Convention on Climate Change, and the Kyoto Protocol. The response of the private sector has ranged from opposition to regulation to innovative voluntary efforts by firms to reduce emissions. Environmental non-governmental organizations (NGO's) have also played a critical role in shaping public and private policy responses to problems of the atmosphere.

The course will emphasize a limited number of themes that emerge from the science that delimit the boundaries for policy responses, and can be generalized to many applications beyond issues of the atmosphere. The themes include:

- Defining permissible limits and thresholds for environmental damage
- Assessing risk in the context of uncertainty, learning, and unexpected (surprise) outcomes
- Implications of long time-scales, irreversibility, and lags in physical and biological systems for public policy

The scientific bases of these atmospheric issues will be developed and their policy implications examined concurrently to show the interplay of research findings, public understanding, and government and private responses.

Assignments

Each class will generally be conducted half as an interactive lecture and half as a discussion. Students are expected to prepare to lead and/or participate in the discussion each week. In addition, a brief written paper or problem (not to be graded) will be assigned occasionally.

Exams and Papers

There will be a midterm paper and a final paper. There will be no exams.

Grades

The weighting of the above in the final grade will be

Class participation ... 35%
Midterm paper 25%

Final paper 40%

Readings

Substantial amounts of **REQUIRED** reading from:

Graedel, T. and P. Crutzen: *Atmosphere, Climate, and Change*. Scientific American Library, New York. 1995.

Grubb, Michael, et al., *Kyoto Protocol: A guide and Assessment*, Brookings Institute, 1999

Harvey, L.D.: *Climate and Global Environmental Change*. Prentice Hall, Upper Saddle River, NJ. 2001

Intergovernmental Panel on Climate Change: *Climate Change 2001. Summaries for Policy Makers and Technical Summaries for Working Groups I, II, III*. (Available at www.ipcc.ch)

Benedick, R.: *Ozone Diplomacy*. Harvard U., Cambridge., 1998

The following books are **RECOMMENDED** as interesting background; and in addition, a few sections of them will be required reading.

Claussen, E. ed.: *Climate Change: Science, Strategy, and Solutions*. Brill, Boston. 2001

Graedel, T. and P. Crutzen: *Atmospheric Change: an Earth Systems Perspective*. WH Freeman, New York. 1993.

Jacob, D.J.: *Introduction to Atmospheric Chemistry*, Princeton University Press, 1999

Newell, Peter: *Climate for Change – Non-state Actors and the Global Politics of the Greenhouse*, Cambridge University Press, 2000

Oberthur, S. and H.E. Ott: *The Kyoto Protocol*. Springer, Berlin. 1999.

Oppenheimer, M.: *Dead Heat: The Race Against The Greenhouse Effect*. New Republic Books, NY. 1990.

Social Learning Group: *Learning to Manage Global Environmental Risk*, vols. 1 and 2. MIT, Cambridge. 2001

*Spiro, T. and W. Stigliani: *Chemistry of the Environment*: Prentice Hall, Upper Saddle River, NJ. 1996.

Schneider, Stephen H., et al., *Climate Change Policy/A Survey*, Island Press, 2002

Additional reading on reserve:

Acid Rain and Transported Air Pollutants(Implications for Public Policy), Office of Technology Assessment, Congress of the United States

Agrawala, Shardul and Steinar Andresen *Indispensability and Indefensibility? The United States in the Climate Treaty Negotiations*, *Global Governance* 5 (1999),

Barnola, J.-M., “*Status of the atmospheric CO₂ reconstruction from ice cores analyses*”, *Tellus* **51B**: 1999.

Blair, Tony, Prime Minister/ *M: 'Concerted international effort' necessary to fight climate change* 2/24/03

Bloomfield, Janine, Molly Smith and Nicholas Thompson, *Hot Nights in the City, Global Warming, Sea-Level Rise and the New York Metropolitan Region*, Pages 1-36, Environmental Defense Fund, 1999

Carlson, C., et al., *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*, *Journal of Political Economy*, 2000, Vol. **108**, no. 6 (pgs 1292-1326)

Common Questions About Climate Change, UNEP, WMO

Cook, Elizabeth ,Ed., *Ozone Protection in the United States: Elements of Success*, World Resources Institute, November 1996

Crutzen and Ramanathan, *The Ascent of Atmospheric Sciences*, *Science* **290**, 299 (2000)

Daley, Suzanne, *Europeans Give Bush Plan on Climate Change a Tepid Reception*, *The New York Times INTERNATIONAL* Friday, February 15, 2002, page A6.

deMenocal, Peter B., *Cultural Responses to Climate Change During the Late Holocene*, *Science*, Vol. **292**, (pgs 667-673). www.sciencemag.org

den Elzen, M.G.J. and A.P.G. Moor, *Evaluating the Bonn Agreement and some key issues/RIVM report* 2001

Dotto, L. and H. Schiff: *The Ozone War*. Doubleday, Garden City, NY. 1978

Dovers, Stephen R. and John W. Handmer, *Ignorance, the Precautionary Principle, and Sustainability*, Academy of Sciences 1995

Driscoll, C.T., et al, Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies, *BioScience* **51**(3)180-198 March 2001

Gian-Reto Walther et al, *Ecological responses to recent climate change*, *Nature*- vol. **416**, 28 March 2002/ www.nature.com pgs. 389-395 (Macmillan Magazines Ltd.)

Gollier, Christian, *Precautionary Principle: The economic perspective*, Summary, *Should we be aware of the Precautionary Principle?*, *Economic Policy* October 2001

Ha-Duong, M. *A pro-active stratospheric ozone protection scenario*, *Global Environmental Change*,

Haagen-Smit, A.J. : *Chemistry and Physiology of Los Angeles Smog*. *Journal of Industrial and Engineering Chemistry*, Vol. **44**, No. 6, April 19, 1952

Harte, John: *Consider A Spherical Cow*. *University Science Books*, 1988

Harvey, L.D. Danny, *Global Warming: The Hard Science*, Prentice Hall 2000

Hoffert, Martin I. Et al., *Advanced Technology Paths to Global Climate Stability: Energy for Greenhouse Planet*, *Science*, Vol. **298**, 1 November 2002

Houghton, J., et al, eds. *Climate Change 2001: The Scientific Basis*. *Cambridge U.*, Cambridge, 2001.

Hubbard, R. Glenn, *Realism in Cutting Emissions*, *The New York Times OP-ED Friday*, February 15, 2002

Jacobs, Madeleine, *Don't Confuse Me with the Facts*, *C&EN*, October 9, 1995, pg 5.

Kemp, Renee, *Zero Emission Vehicle Mandate in California. Misguided Policy or Example of Enlightened Leadership?*
(http://meritbbs.unimaas.nl/rkemp/zero_emission.pdf)

Kennedy, Randy, *The Day the Traffic Disappeared*, *The New York Times Magazine*, April 20, 2003

Kerr, Richard A., *It's Official: Humans Are Behind Most of Global Warming*, *Science Magazine*, Vol. **291**, pg 566, Jan. 26, 2001

Krugman, Paul, *Ersatz Climate Policy*, *The New York Times OP-Ed*, Friday, February 15, 2002

Krugman, Paul, *Rejecting the World*, *The New York Times*, Friday, April 18, 2003

Lee, Jennifer, *A Call for Softer, Greener Language*, The New York Times , Sunday, March 2, 2003

Lee, Jennifer 8., *The Warming Is Global but the Legislating, in the U.S. Is All Local*, The New York Times, Wednesday, October 29, 2003

Likens, G. E. and F. H. Bormann, *Acid Rain: A Serious Regional Environmental Problem*, Science **184** pgs 1176-1179, June 1974

McCarthy, J., et al, eds. : *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Cambridge U., Cambridge. 2001

Metz, B., et al, eds. : *Climate Change 2001: Mitigation*. Cambridge U, Cambridge. 2001

National Acid Precipitation Assessment Program Biennial Report to Congress: An Integrated Assessment, National Science and Technology Council, May 1998,
http://www.nnic.noaa.gov/CENR/NAPAP/NAPAP_96.htm

Nordhaus, William D., *Global Warming Economics*, Science, Vol. **294**, pgs 1283-1284, 9 November 2001

Nordhaus, William D., *An Optimal Transition Path for Controlling Greenhouse Gases*, Science ,Vol. **258**, pgs 1315-1319, 20 November 1992

Ogden, Joan, *Hydrogen: The Fuel of the Future*, pgs 69-75 Physic Today-April 2002 (American Institute for Physics).

O'Neill, Brian C. and Michael Oppenheimer, *Dangerous Climate Impacts and the Kyoto Protocol*, Science, Vol. **296**, pgs. 1971-1972, 14 June 2002

Oppenheimer/Commentary/ *Declare war on global warming*, International Herald Tribune, Tuesday, April 8, 2003

Oppenheimer response, *Pondering Greenhouse Policy*, Science, Vol. **259**, pgs 1381-1384, March 1993

Policy Implications of Greenhouse Warming, Committee on Science, Engineering and Public Policy/ National Academy Press, 1992

Revkin, Andrew C., *Bush Offers Plan for Voluntary Measures to Limit Gas Emissions*, The New York Times, INTERNATIONAL Friday, February 15, 2002

Rowland, F. Sherwood, *President's Lecture: The Need for Scientific Communication with the Public*, SCIENCE, Vol. **260**, pages 1571-1576, June 11, 1993.

Schleich, Joachim , et al., *Greenhouse gas reductions in Germany- Lucky strike or hard work?*, *Climate Policy* **1** (2001) 363-380

Schneider, S. and R. Londer: *The Coevolution of Climate and Life*. Sierra Club Books, San Francisco. 1984

Science Magazine, *Global “Claptrap” ?* *SCIENCE* **Vol. 268**, June 1995

Stoddard, J.L. et al, *Regional trends in aquatic recovery from acidification in North America and Europe*, *Nature* **401**(7) 575-578, October 1999

Taubes, Gary, *The Ozone Backlash/ A Fateful Prediction/Stratospheric Chlorine: Blaming It on Nature*, *Science*, Vol. **260**, pp 1580-1583, June 11, 1993

Trenberth, Kevin E., Schneider, Stephen H., Editors, *Introduction to climate modeling*, *Climate System Modeling*, Chapter 1, pages 3-26 Cambridge University Press, 1992

Watson, R. et al, eds. *The Regional Impacts of Climate Change*. Cambridge U., Cambridge. 1998.

World Meteorological Organization: *Scientific Assessment of Ozone Depletion: 1998*. WMO, Geneva. 1999.

World Meteorological Organization: Executive Summary, 23 Aug, 2002 (WMO 2002) www.wmo.ch/web/arep/reports/execsumm.23%20Aug%2002.final.pdf

<http://www.pbs.org/wgbh/nova/kilimanjaro/vanishing.html>

Topics

Week 1.

The atmosphere and the Earth system

- A snapshot of the atmosphere: where it's warm, where it's cold.
- How the air moves: elements of climate and weather.
- The atmosphere and the whole Earth system: the great global cycles.
- Why do we need public policy for the atmosphere?

Week 2.

I. Meet the Media: A Lesson from Antarctica

II. Meet the Molecule: Chemistry of Ozone in the Troposphere

- An episode in malfeasance: articles on climate changes in Antarctica
- Primer in atmospheric chemistry: formation, reaction, and removal.
- Smog and human health.
- A question of thresholds: regulating smog

Reading:

Course Notes #1

Antarctic Packet

Graedel and Crutzen, *Atmosphere, Climate, and Change*, pp. 1-28, 42-47
(Also take a look at Graedel and Crutzen, *Atmospheric Change: An Earth System Perspective*, Figure 5.12)

Harte, J., p.23-27

Jacob, *Introduction to Atmospheric Chemistry*, Ch. 9.

Browse the following:

Air Quality Trends:

<http://www.epa.gov/oar/aqtrnd00/> (follow links)

Visibility:

<http://www.hazecam.net>

Ozone Air Quality Film

<http://www.epa.gov/cgi-bin/airnow.cgi?MapDate=20010803&MapDomain=EA&MapName=east&MapType=8a&MapYear=2002>

Smog Health Effects

<http://www.epa.gov/airnow/health/smog1.html#5>

Simplified Version of Clean Air Act

http://www.epa.gov/oar/oaqps/peg_caa/pegcaa02.html#topic2e

Discussion:

1. How would you evaluate the media's handling of recent scientific findings in regard to Antarctica? How well did the scientists do? Pretend you are an assistant to President Bush's science advisor, and he asked you to summarize the meaning of

these findings in 3 sentences he could relay to the President. What would you say? What overall lesson do you draw for the average citizen trying to make informed judgments about technical subjects?

2. Pretend you are the EPA Administrator. What relative priority would you give to the following factors in deciding how to regulate ozone: ecological impact, aesthetic impact, health effects, cost of regulating precursor pollutants? Consider the tradeoffs among these factors and what information you would want to have in order to decide.

Assignment:

Harte, exercises p. 27

Week 3.

The regionalization of pollution: pollution and solutions spread across borders.

- Long range transport of pollution.
- Effects on regional ecosystems and human health.
- Acid rain: the question of irreversibility.
- Internationalization of pollution control.
- The Clean Air Act of 1990 and trading of emissions.
- The multiple benefits of emission control and shifting views of the problem: what properties should drive regulation?
- Assigning responsibility.

Reading:

Course Notes #2

For historical context:

Likens, G. E. and F. H. Bormann

Acid Rain and Transported Air Pollutants(Implications for Public Policy, Chapter 1 Summary pgs, 3-24, Chapter 4 -The Pollutants of Concern pgs 57-75, Appendix C, pgs 265-299, Appendix D, pgs 300-318.

Overview:

National Acid Precipitation Assessment Program Biennial Report to Congress: An Integrated Assessment,

http://www.nnic.noaa.gov/CENR/NAPAP/NAPAP_96.htm

For recent developments:

<http://www.epa.gov/ord/htm/CAAA-ExecutiveSummary-1-29-03.pdf>

<http://www.nescaum.org/airtopics.html>

(**Optional** : Stoddard, J.L. et al, *Regional trends in aquatic recovery from acidification in North America and Europe*, Nature 401(7) 575-578, October 1999; Driscoll, C.T., et al, *Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies*, BioScience **51**(3)180-198 March 2001)

On emissions trading:

<http://www.epa.gov/airmarkets/arp/overview.html#phases>

<http://www.epa.gov/airmarkets/arp/regs/sec403.html>

Carlson, C., et al (pgs 1292-1326)

Recent Administration proposal for further reductions:

<http://www.whitehouse.gov/news/releases/2002/02/20020214-5.html>

Mercury emissions and effects:

<http://www.epa.gov/ttn/oarpg/t3/reports/volume1.pdf>

Discussion:

A debate--Emissions trading, the pros and cons

Assignment: Pretend you work on the staff of a member of the US Congress. Prepare for the debate by writing a one-page briefing paper on emissions trading for your boss. Read Graedel and Crutzen, *Atmospheric Change: An Earth System Perspective*, p. 149-154; then try problem 16.1 (with figure 16.1, on blackboard)

Week 4.

Ozone Depletion, Part I: Scientists as initiators of policy

- The supersonic transport: a never-ending story.
- Predicting ozone depletion.
- The aerosol spray can ban and the end of innovation.
- The Vienna Convention.

Reading:

Course Notes #3

Chemistry of Ozone in the Stratosphere:

Graedel and Crutzen, Atmosphere, Climate, and Change, pp. 35-42, 48- 49, 108-109, 113-120, 123-127

Graedel and Crutzen, An Earth System Perspective, pp. 141-143

OR: Jacob, 10.1 and 10.2

Effects of ozone depletion:

<http://sedac.ciesin.org/ozone/docs/UNEP98/UNEPtoc.html> (read summaries)

Supersonic Transport:

Dotto, L. and H. Schiff: Chapters 1-3; I highly recommend the rest of the book as well.

Chlorofluorocarbons:

Benedick, R.E., Pages: Chapters 1-5 pgs 1-67, Chronology, pgs 335-340, Appendix A, pp. 341-352

Oppenheimer, M. et al., Dead Heat: Chapter 3, pgs 18-50

Discussion:

- Imagine you were the head of the EPA during the 1974-1985 period. Try your best to ignore subsequent developments (beginning in 1985). What would you have done to regulate ozone-depleting chemicals?
- ***Prepare for a Debate:*** Do you consider the response of governments during the 1974-1985 period to the risk of ozone depletion to have been appropriate, given the evidence at hand at that time?

Assignment:

- Prepare for the debate by writing, ***from today's perspective***, a one-page briefing paper on decisions made with regard to ozone layer protection during 1974-1985, for the EPA Administrator, who is reviewing EPA responses to long term issues. Was there a third feasible option during this period, between an aerosol ban as implemented in 1978 and the full-blown CFC phase-out as implemented later?

Week 5

Ozone Depletion, Part II: The ozone hole

- Surprising chemistry.
- Scientific learning and improving regulation.
- Acceptable risk vs. zero risk; scientific uncertainty and the psychology of surprise.
- The Montreal Protocol and equity concerns of developing countries.
- Backlash in the media.

Reading:

Course Notes #4

Chlorine Chemistry:

Spiro, T. G. and W. M. Stigliani, pages 142-162

Graedel, T.E. and P.J. Crutzen, *Atmospheric Change : An Earth System Perspective*, pages 144-146, 259-262 and 371-374

Graedel, T.E. and P.J. Crutzen, *Atmosphere, Climate, and Change*, Chapter Five: pgs 106-112, Chapter Six: pgs 118-120

OR: Jacob, 10.3 and 10.4

Recent scientific developments:

http://www.wmo.ch/web/arep/reports/ozone_2002/11_q&as.pdf (Twenty Questions & Answers about The Ozone Layer, lead author D.W. Fahey)

replaces: <http://www.wmo.ch/indexflash.html> (search website for pdf file of Executive Summary: Scientific Assessment of Ozone Depletion, 2002)

The Montreal Protocol:

Benedick, R. E., 108-217, pp.239-268 and pp. 353-394

Ha-Duong, M.

The Media/Science Backlash

Rowland, F. S.: *SCIENCE*, **Vol. 260**, pages 1571-1576.

Jacobs, M.

Taubes, Gary

Science Magazine, *Global “Claptrap”* ? SCIENCE Vol. 268, June 1995

Discussion:

- Imagine you were one of the negotiators at Montreal. What would have been the key factors in determining your position. Now consider that it is governments, not individual negotiators, which usually make the decisions. If you were President, what would have been the key factor(s) that determined your instructions to your negotiator at Montreal? *Prepare for a debate:* Was the ozone hole the key factor in bringing about governmental action?
- Consider the changing diplomatic roles of the EU countries, the US, and the developing countries over time. What insights does the ozone experience provide on the chicken-and-egg relation between international instruments and domestic policy?
- Was the “backlash” important? Could/should scientists organize themselves better to deal with contrarianism?

Assignment:

From the graphs shown in class of the amount of ozone at each altitude, estimate how effective smog/ozone is at ameliorating the effects of stratospheric ozone depletion.

Week 6.

Ozone depletion, Part III: Actors

Reading:

Course Notes 4 (if you haven't read them yet)

Oppenheimer and Boyle, *Dead Heat*: Chapter 9 pgs 158-160.

Cook, E.: Chapter 1 (Overview), pgs 1-10

The Social Learning Group: *Learning to Manage Global Environmental Risk*, MIT, Cambridge 2001

Volume 1: Ch. 2: *Acid Rain, Ozone Depletion and Climate Change: An Historical Overview*, pgs 21-55 including appendices

And

Ch.11: Civic Science: America's Encounter with Global Environmental Risks, pp.259-294 including appendices

Volume 2: Ch. 17 *Option Assessment in the Management of Global Environmental Risks* and Ch. 18 *Goal and Strategy Formulation in the Management of Global Environmental Risks*, pgs 49-113

Discussion:

- Looking at the entire history of the ozone issue from SST to today, what role have science and scientists played in goal-setting and policy development and implementation, and could the role be improved? Are there any useful comparisons to be made with the acid rain/smog/long range transport issue?
- What role did the private sector, including firms and NGO's, play? What about the media?
- Does the role of developing countries in the negotiations of the ozone agreements provide a useful precedent, or were the circumstances unique?

Assignment: Term paper due by XXX at Robertson 447A or to omichael@princeton.edu.

Week 7.

A brief history of the Earth from the climate point of view.

- Paleoclimate.
- Recent observations: we live in a changed climate
- Natural and manmade influences on climate
- The carbon cycle

Reading:

Intergovernmental Panel on Climate Change: *Climate Change 2001 The Scientific Basis, Third Assessment, Report of Working Group I, Summary for Policy Makers, p.1-7*
(Available at www.ipcc.ch.)

Harvey, *Climate and Global Environmental Change*, Chapter 1, Chapter 2 sec. 2.1-2.4, 2.10-2.12, Chapter 3, Chapter 4, sec. 4.1-4.4, 4.7, 4.8

Barnola, J.-M.

Graedel, T.E. and P.J. Crutzen, *Atmosphere, Climate, and Change*, Chapter Four

Some recent changes:

Gian-Reto W. et al, www.nature.com

Previous human response:

deMenocal, P. B., www.sciencemag.org

Schneider, S. H., and R. Londer, pages 3-32, figs. 1.1, 1.3

Discussion:

- How resilient are humans and society in the face of climate change? Consider examples, both direct and indirect, of how climate change could affect you.

Assignment:

- It is sometimes asserted that we need trees, which produce oxygen during photosynthesis, to keep atmospheric oxygen at safe levels. If all the trees on earth were cut down and burned, how much would oxygen levels change? What about atmospheric CO₂ levels? Use the appendixes in Harte to obtain estimates of carbon in trees.

Week 8.

The Human Influence on Climate: plausibility and uncertainty

- The greenhouse effect
- Computer climate models
- Proof of the human influence
- Irreversibility, continuity, and lags: framing a policy response

Reading:

Course Notes #5 and #6

Intergovernmental Panel on Climate Change: *The Scientific Basis*, Third Assessment, Report of Working Group I, Summary for Policy Makers, through p.8-18 and *Synthesis Report*, pp. X (Available at www.ipcc.ch).

Harvey, D., *Climate and Global Environmental Change*, Chapter 5 and Chapter 6 (Box 6.1 is very difficult and contains an error!)

Oppenheimer, M., *Global Warming: Projections for the New Millennium*

Schneider, S.H., in Trenberth, ed., Chapter 1, pages 3-26.

Kerr, R. A.,

Common Questions about Climate Change, pgs 9 and 10

Discussion

Prepare for a debate: In what sense has the human influence on climate been “proven”?

Week 9.

Projecting the Future

- Scenarios of future greenhouse gas emissions.
- Projected climate change, sea level rise, and uncertainty.
- Sensitive ecosystems, vulnerable countries.
- Beyond a doubling of CO₂: avoiding catastrophe.
- Uncertainty and lessons from earlier cases.

Reading:

Course Notes #7 and #8

Harvey, L.D. Danny, *Climate and Global Environmental Change*, Chapter 8, Chapter 9 through 9.1 only, Chapter 10.

Bloomfield, J., M. Smith and N. Thompson, Pages 1-36

US Gov't/ US Global Change Research Program 2000, *Impacts of Climate Change on the U.S.*, (available at www.gcrio.org/National) Overview Section

Houghton, J., et al, eds. *Climate Change 2001: Working Group II: Impacts, Adaptation, and Vulnerability Summary for Policy Makers and Technical Summary* Available (at www.ipcc.ch). Also, *Chapter 1* is recommended .Cambridge U., Cambridge 2001.

Intergovernmental Panel on Climate Change: The Regional Impacts of Climate Change/
An Assessment of Vulnerability. *Summary for Policy Makers* pg 1-18.1997/1998

Recommended: Claussen, E., pages 43-81

Assignment for Discussion:

Choose one region, such as sub-Saharan Africa or eastern North America. Based on the various impacts discussed in the assigned reading (including the full bodies of reports for which only summaries were assigned), create your own order-of-significance for potential impacts of climate change for that region. Based on this prioritization, consider which impact(s) should be key determinants of global efforts to reduce emissions, from the regional point of view. Think about how you would make that case at an international negotiation on limits-to-warming. Write it down, at least in outline, and be prepared to discuss in class.

Problem (Optional): Consider Mars, Earth, and Venus. Look up their distances from the sun, and calculate the ratio of the intensity of sunlight reaching the orbit of each planet. Also look up their surface temperatures and calculate their ratios. Using the black-body radiation law, calculate the expected ratio of their top-of-the-atmosphere (or, atmosphere-free) temperatures. How do the two sets of ratios compare? Why?

Week 10.

Technology and other notions of solutions: the end of fossil fuels?

- Adaptation
- Improving energy efficiency.
- Renewable energy: the hydrogen economy.
- Lifestyle changes
- Sequestration and geo-engineering.
- Incentives, markets, and the stimulation of innovation.
- Lesson from the past: the synthetic fuels debacle.
- Multiple benefits, no regrets.

Reading:

Course Notes #10

IPCC (Synthesis Report) pp. 291-354

Hoffert, et al., pgs., 981-987

Ogden, J.

Policy Implications of Greenhouse Warming, Committee on Science, Engineering and Public Policy, Chapter 28, p. 433-464

Reread Oppenheimer, Dead Heat, pp.163-165 and associated end notes

Recommended: Kemp, R., (http://meritbbs.unimaas.nl/rkemp/zero_emission.pdf)

Recommended: Climate Change: Science, Solutions, Strategies, 209-244; 148-175

Discussion: Considering the various alternative approaches to reducing the threat of climate change, what is the appropriate balance among adaptation, emissions reduction, geo-engineering, research, for the near term (10 years) and for the long term (100 years)? Is there any approach that should be ruled out? What criteria would you use for making such judgments?

Assignment: How much surface area of Earth would need to be reforested to capture all projected CO₂ emissions for the next 50 years (use Harte appendix to find the average amount of carbon in a forest)? Given what you know of the land-use tradeoffs, how much forest sequestration do you think is feasible? Hold on to this number and for Class #11, consider how it stacks up against the total reduction required, versus Business-as-Usual, to reach various long term goals, such as 450 ppm, 550 ppm, etc.

Week 11

Implementation: The UN Framework Convention on Climate Change, the Kyoto Protocol

- Optimization vs. Precaution: How Warm is Too Warm?
- Equity and the developing countries: who's responsible?
- Equity among industrial countries: who should bear the greater burden?
- From Rio de Janeiro to Johannesburg: global warming and sustainable development

Reading

RE-READ : COURSE NOTES #5; Global Warming: Key Scientific and Political Events

The Kyoto Protocol

Course Notes #9 and #11

Grubb: The Kyoto Protocol: pp. XXX

Nordhaus, W. D., *Global Warming Economics*

Decision frameworks: The economic view, the precautionary view

Nordhaus, W. D., *An Optimal Transition Path for Controlling Greenhouse Gases*,

Oppenheimer response, *Pondering Greenhouse Policy*

Gollier, C., Pages 303-327,

Dovers, S. R. and J. W. Handmer, pgs 92-97

Intergovernmental Panel on Climate Change: *Climate Change 2001, Synthesis Report*,
Working Group III-Mitigation, section 10, pages 349-354, Cambridge University Press,
2001

Policy Implications of Greenhouse Warming, Committee on Science,
Engineering and Public Policy, Chapters 4-9 pgs. 29-83

Schneider, S. H. et al./*Climate Change Policy*: Appendix A,

Recommended: Oberthur and Ott: pp. XXX

Recommended: Schneider, S. H. et al./*Climate Change Policy*, chapters 14 and 15

Recommended: Newell, P. , Conclusion: states, NGOs, chapter 7

Recommended: den Elzen, M.G.J. and A.P.G. Moor, pages 1-34.

Recommended: Schleich, J., et al.,

Discussion:

The Kyoto Protocol has several faults and many detractors. Some argue that its implementation would be too complex, its scope too ambitious, others that it would do too little, still others that it cost too much, and that it is unfair to the US. Be prepared to discuss your own views on the Protocol. **Debate:** We will divide the class into “pro-Kyoto” and “against-Kyoto” groups for the sake of discussion.

Week 12.

Whither US Policy?

Reading:

Agrawala, S. and S. Andresen

Blair, T., Prime Minister

Krugman, P., *Ersatz*

Krugman, P., *Rejecting the World*

Hubbard, R. G.

Revkin, Andrew C (2 articles)

Daley, S.

Kennedy, R.

Lee, J., *A Call for Softer, Greener Language*

Lee, J., *The Warming Is Global but the Legislating in the U.S. Is All Local*, The New York, Times, Wednesday, October 29, 2003

O'Neill & Oppenheimer

Oppenheimer, *Declare war on global warming*

Discussion: Imagine the world in 2020. What do you think industrial countries will have achieved with respect to mitigation of global warming? Developing countries? Will the Kyoto Protocol have been implemented? Altogether abandoned? Superseded? Regarded as a failure? A success?