Climate Change

(GARP 0206-001, CRN 31454, 3 credits, WF 13:40 – 14:55, Wilson 130)

The United Nations Framework Convention on Climate Change (UNFCCC, signed and ratified by the U.S.) defined 'Climate Change' in 1992 as:

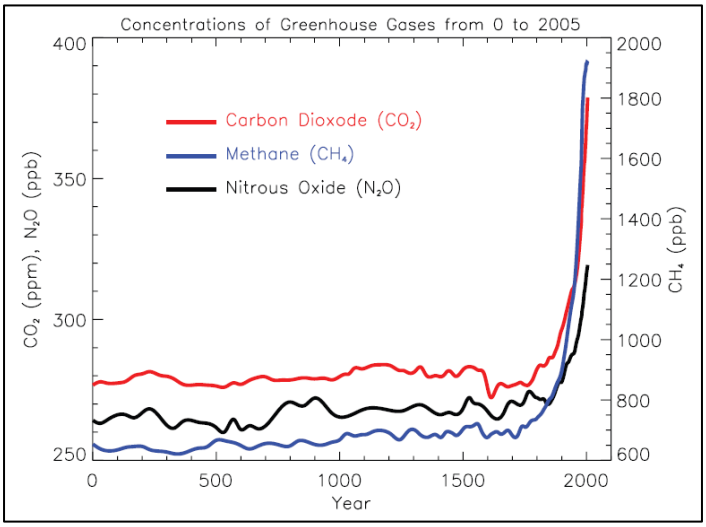
> *"…a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."*

Article 2 of the UNFCCC then calls for the:

> *"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."*

➔ **What is a 'dangerous anthropogenic interference' with the climate system?**
➔ **What is a 'safe' anthropogenic interference' with the climate system?**

In this course, we will explore climate change from a variety of angles. We begin by investigating the basics of our climate system, including the physics of the greenhouse effect and mechanisms (= forcings), both natural and human, of climate change.



The second part of the course focuses on climate change observed in the past, today, and in the future, including methods of (past) climate reconstruction and (future) climate prediction.

In the third part of the course we will extend our discussions beyond the scientific basis and into questions of impacts, vulnerabilities, and suitable adaptation and mitigation strategies. Each of the three parts includes a relevant 'focus theme' designed to emphasize a certain theme or question:

Focus Theme 1:	An Inconvenient Truth
Focus Theme 2:	What caused the Ice Ages?
Focus Theme 3:	Sustainable Energy

➔ **This course requires continuous active participation through reading, writing, in-class discussions, and presentations.**

Learning Goals

The fundamental objective of this course is to separate scientific facts from personal opinion and scientific uncertainty from political, moral, or ethical bias. About two-thirds of the course focuses directly on the scientific aspects of climate change and 'Global Warming', including issues of uncertainty, especially with respect to predictions of future climate change. The last part explores more controversial topics, such as local, regional, and global impacts of climate change and associated natural and societal vulnerabilities/responsibilities. Finally, the course explores the 'So what?' or 'Now what?' questions, and discusses adaptation and mitigation strategies, especially those related to sustainable energy sources beyond fossil fuels.

1) Knowledge and Geographic Literacy

- Facts and concepts of the climate system, paleoclimate, and climate change.
- Systems thinking, processes, interactions, and feedbacks as related to the changing climate system.
- Natural and anthropogenic influences on the climate system and their interplay.

2) Skills and Critical Thinking

- Application of geographic knowledge and spatial analysis to the changing climate system.
- Intellectual inquiry using the scientific method.
- Effective scientific communication (as a scientific research paper).

3) Perspective and Implications

- Space and change as relevant global concepts.
- Interactions between human and environmental systems.
- Interplay between science, public policy, values, and ethical considerations.

Your Instructor

Dr. Carsten Braun cbraun@wsc.ma.edu 413.572.5595 Bates 217
Office Hours: MWF 12:15 to 13:15 (or anytime by appointment)

The basic objective of this course is to untangle scientific facts from personal opinions and scientific uncertainty from political, moral, or ethical bias. Does uncertainty justify inaction? How much uncertainty justifies inaction? What types of action are justified or necessary today?

The public discourse about climate change and 'Global Warming' is highly polarized and thus often fails to foster pragmatic, 'no-regrets' approaches and solutions. This course cannot offer simple answers, but we will separate scientific facts from personal/religious/special-interest opinion and engage in nuanced and informed discussions of what we can/should/must do/not do about these climate change.

➔ If you feel that you are not progressing as well as you hoped, please feel free to talk to me during my office hours or a mutually convenient time – the sooner the better!

Required Textbooks

- John Houghton: *Global Warming: The Complete Briefing*. Cambridge University Press; fourth edition (April 27, 2009), ISBN-13: 978-0521709163, 456 pages, $49.86.
- Spencer T. Weart: *The Discovery of Global Warming: Revised and Expanded Edition*. Harvard University Press (October 31, 2008), ISBN-13: 978-0674031890, 240 pages, $12.20.

Assessment

1. Six to eight homework assignments and/or data analysis exercises (30 percent of grade). These assignments/exercises are designed to formalize the readings and to lay the foundation for in-class discussions. Assignments typically involve writing in connection with the assigned weekly reading, but will also include quantitative problem solving.

2. Two take-home tests (20 percent of grade).
   The tests will cover a selection of several pre-defined topics. You will have about one week to complete each test.

3. Review Paper (20 percent of grade).
   This review paper is essentially a summary of the Spencer Weart textbook *The Discovery of Global Warming: Revised and Expanded Edition.* Detailed instructions will be provided; for due dates and deadlines see the course schedule.

4. Research Project (30 percent). Here you get choose your own topic (see below), conduct the research, and formalize your research as a professional scientific paper.

   - About 15 pages text (figures, tables, and bibliography extra).
   - The proposal and draft are mandatory and part of the overall project evaluation.
   - Topics: Anything related to climate change (with prior approval).
   - Detailed instruction and support will be provided.

Letter	Points	Letter	Points	Letter	Points
A	93 to 100	B–	80 to 82	D+	67 to 69
A–	90 to 92	C+	77 to 79	D	60 to 66
B+	87 to 89	C	73 to 76	F	< 59
B	83 to 86	C–	70 to 72		

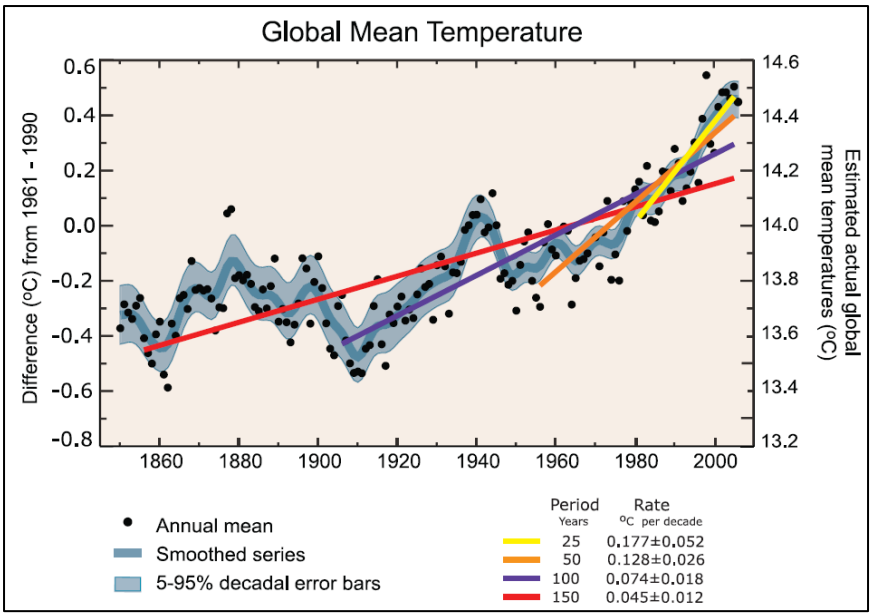
Course Schedule GARP 0206 (Spring 2010)			
	Theme/Topic	**Reading**	**Comments**
Week 1 (01/20, 01/22)	Course Overview Climate Change vs. Global Warming	Houghton: Preface and Ch. 1	
Week 2 (01/27, 01/29)	**Focus Theme 1** An Inconvenient Truth	Hand-outs	
Week 3 (02/03, 02/05)	The Basics of the Climate System: Atmosphere, Temperature, Wind, etc.	Houghton: Ch. 2	
Week 4 (02/10, 02/12)	The Physics of the Greenhouse Effect: Radiation and Greenhouse Gases	Houghton: Ch. 3	
Week 5 (02/17, 02/19)	Mechanisms of Climate Change: Forcings, Feedbacks, and Tipping Points		*Review paper draft is due*
Week 6 (02/24, 02/26)	**Focus Theme 2** What caused the Ice Ages?	Hand-outs	
Week 7 (03/03, 03/05)	Studying Past Climates: Methods of Paleoclimatology	Houghton: Ch. 4	*Test #1*
Week 8 (03/10, 03/12)	Climates Change in the Past: The last 1,000,000 years	Houghton: Ch. 4	*Review paper is due*
Week 9 (03/17, 03/19)	*No Classes!* *Spring Break!*		
Week 10 (03/24, 03/26)	Climates Change Today: The last 1,000 years	Houghton: Ch. 5	*Research paper proposal is due*
Week 11 (03/31, 04/02)	Climates Change in the Future: The future according to models	Houghton: Ch. 6	
Week 12 (04/07, 04/09)	Climate Change Today: Impacts, Vulnerability, Adaptation, Mitigation	Houghton: Ch. 7	*Work on your research paper*
Week 13 (04/14, 04/16)	*No classes!* *CB at conference*		*Work on your research paper*
Week 14 (04/21, 04/23)	Climate Change Today: Climate Neutrality and Sustainability	Houghton: Ch. 9, Ch. 10	*Research paper draft is due*
Week 15 (04/28, 04/30)	**Focus Theme 3** Sustainable Energy	Houghton: Ch. 11	
Week 16 (05/07)	Semester Wrap-up	Houghton: Ch. 12	*Test #2*

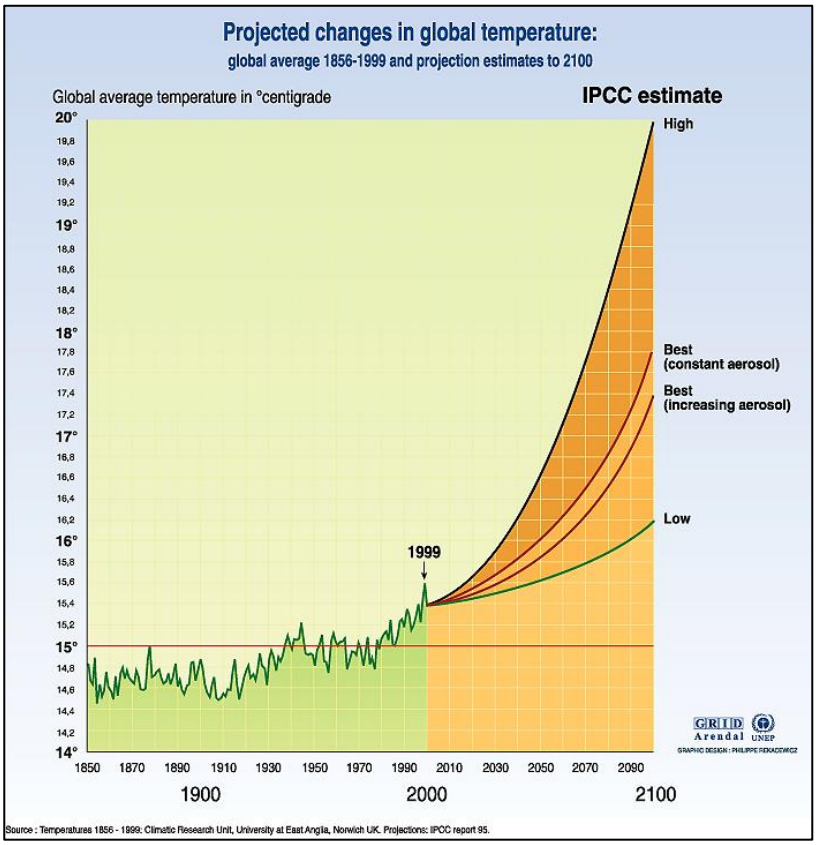
Notes on the schedule

- Test 2 and the research paper are due on 14 May 2009 at 12:00 noon.
- No classes on 04/14, 04/16, and 05/05 – use the time to work on your research project.
- Adjustments to the course schedule may be necessary to account for unforeseeable or unavoidable situations during the semester.
- Attendance is mandatory. If you have to miss a class, please inform me in advance.
- It is your responsibility to keep up with the course material, hand-outs, assignments, due dates, projects, etc. over the course of the semester.
- It is your responsibility to seek additional help and support as needed.
- Late tests/assignments/papers: minus 10 points for each day late; 'skipped' = zero.

Annual global mean observed temperatures (black dots) along with simple fits to the data. Linear trend fits to the last 25 (yellow), 50 (orange), 100 (purple) and 150 years (red) are shown. Note that for shorter recent periods, the slope is greater, indicating accelerated warming.

(Source: IPCC 2007 WG I FAQ)





Projected global mean temperature changes relative to 1990 calculated up to 2100. The topmost curve is for IS92e, assuming constant aerosol concentrations beyond 1990 and high climate sensitivity of 4.5°C. The lowest curve is for IS92c and assumes constant aerosol concentrations beyond 1990 and a low climate sensitivity of 1.5°C.

The two middle curves show the results for IS92a with 'best estimate' of climate sensitivity of 2.5°C: the upper curve assumes a constant aerosol concentration beyond 1990, and the lower one includes changes in aerosol concentration beyond 1990. (It is assumed that the Greenhouse effect is reduced with increased aerosols.)

(Source: http://www.grida.no/publications/vg/climate/page/3076.aspx)

Figure on Page 1: Atmospheric concentrations of greenhouse gases over the last 2,000 years. Increases since ~1750 are attributed to human activities (IPCC 2007 WG I FAQ).