Climate Change

(GARP 0239, 3 credits, Tu/Th 14:15 – 15:30, Wilson 130)

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

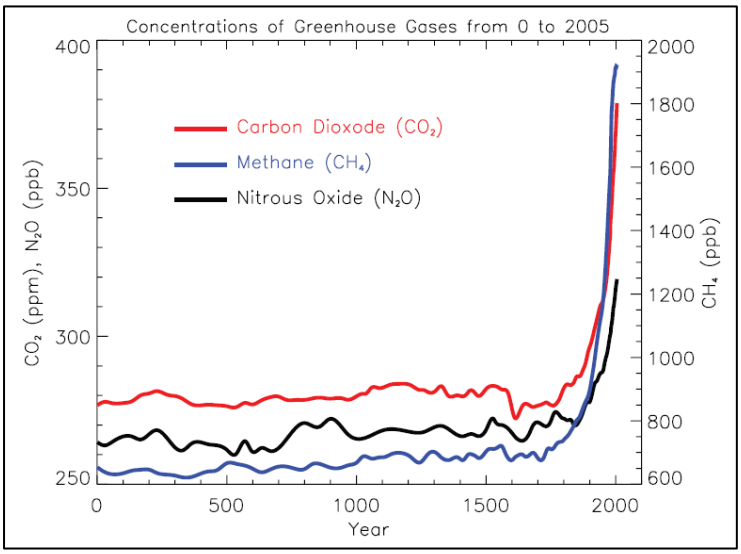
> *"…a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."*

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."*[1]

➔ **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:	Energy beyond Carbon

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

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

Your Instructor

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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 Textbook

- Archer, D., 2007, Global Warming – Understanding the Forecast. Blackwell Publishing, ISBN 978-1-40514093-3, 194 pp., ~$50. (http://forecast.uchicago.edu/)

Assessment

1. Three tests (30 percent combined). The tests will be either take-home format and/or short paper format (~5 pages) with a selection of several pre-defined topics. You will have about one week to complete each test. Test #3 is due 05/07/2008 at 12:00 during the Final Exam period.

2. Six to eight reading assignments and/or data analysis exercises (20 percent combined). 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.

3. Semester-long individual research project (40 percent). Here you get choose your own topic (see below), conduct the research, and formalize your research as a scientific paper.

    - About 15 pages text (figures, tables, and bibliography extra).
    - Follow the scientific method as appropriate and the standard scientific paper structure.
    - The project proposal and project draft are mandatory and part of the overall project evaluation.
    - We will meet individually in Week 12 to improve your paper.
    - Topics: Anything related to alternative energy and carbon neutrality.

4. Organization and participation in Green Day events (04/22/2008)/

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		

➔ **More detailed and specific instructions will be provided over the course of the semester.**

Course Schedule GARP 0239 (Spring 2009)			
	Theme/Topic	**Reading**	**Comments**
Week 1 (01/20, 01/22)	Course Overview Climate Change vs. Global Warming	Archer Ch.1 Hand-out	
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.	Archer Ch.6	
Week 4 (02/10, 02/12)	The Physics of the Greenhouse Effect: Radiation and Greenhouse Gases	Archer Ch.2/3/4	Research Project Proposal due
Week 5 (Th, 02/19)	Mechanisms of Climate Change: Forcings, Feedback, and Tipping Points	Archer Ch.7	Test #1 out
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	Hand-outs	Research Project Draft due
Week 8 (03/10, 03/12)	Climates Change in the Past: The last 1,000,000 years	Hand-outs	
Week 9 (03/17, 03/219)	**Spring Break**		
Week 10 (03/24, 03/26)	Climates Change Today: The last 1,000 years	Archer Ch.11	
Week 11 (03/31, 04/02)	Climates Change in the Future: The next 100 years according to GCMs	Archer Ch.12	Test #2 out
Week 12 (04/07, 04/09)	Climate Change Today: Impacts and Vulnerability	Archer Ch.13	Meetings about Research Project
Week 13 (04/14, 04/16)	Climate Change Today Mitigation and Adaptation Strategies	Archer Ch.8 Archer Ch.9	
Week 14 (04/21, 04/23)	Climate Change: Climate Neutrality and Sustainability	Hand-outs	Research Project due
Week 15 (04/28, 04/30)	**Focus Theme 3** Energy Beyond Carbon	Hand-outs	Test #3 out

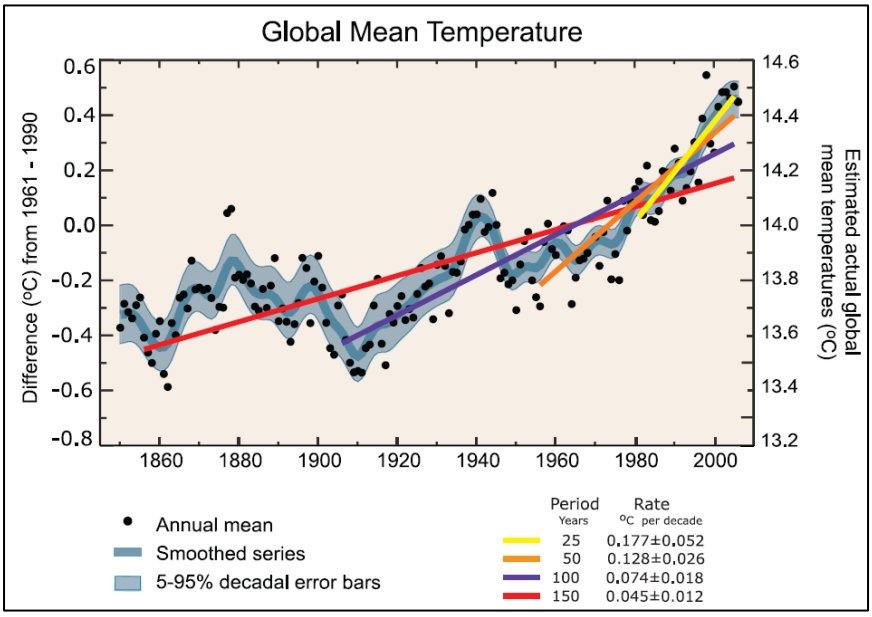
Notes

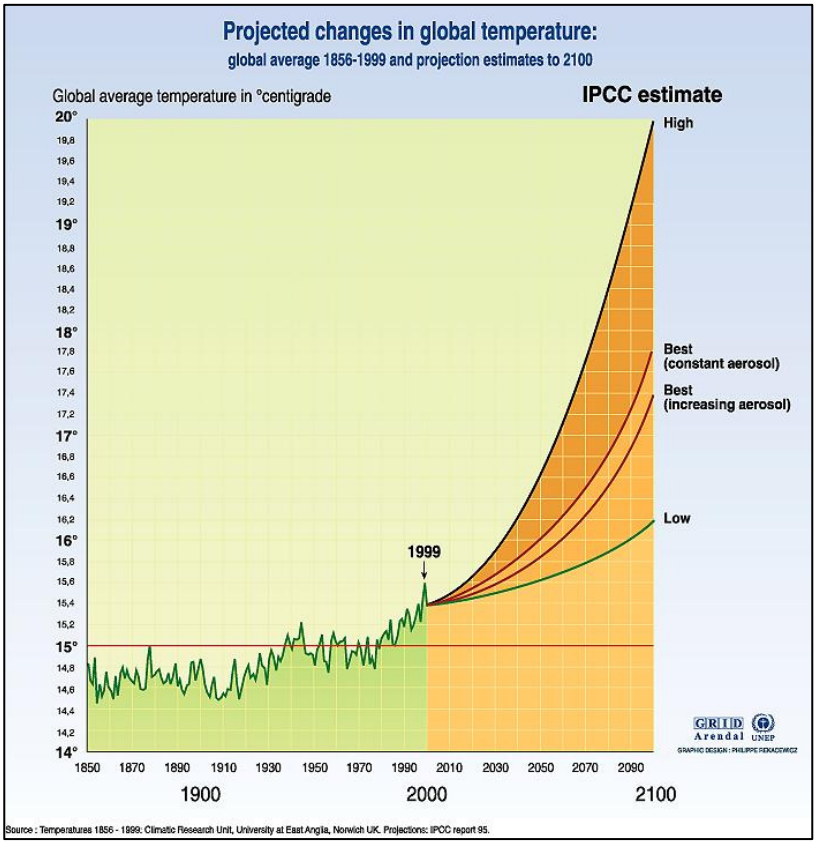
Tuesday (01/20/2009) No class
Wednesday (04/22/2009) Earth Day

- Adjustments to the course schedule may be necessary to account for unforeseeable or unavoidable situations during the semester.
- I will try to invite guest speakers at appropriate times during the semester. The precise dates also depend on their schedule and may require some adjustments.
- Attendance is mandatory. If you have to miss a class…inform me in advance.
- It is your responsibility to keep up with the material, hand-outs, 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/project: 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)