Outline

Who am I and what are my qualifications to teach this course?

Questionnaire

Global Warming Survey

Syllabus, mechanics, etc

“Earth System” graph
Who am I?

Primarily, a research scientist
• Aerosol particles, climate forcing, atmospheric chemistry
• An experimentalist with interest/concern for “integration”

As a teacher
• Taught this course in 1997
• Love the subject (all its facets)
• Deep interest in conveying the nature of science to non-scientists
• Very aware of the challenge of learning new concepts (new ways of thinking)
Outline

Announcements

Earth as a “Coupled System”
   Stockholm Earth-science meeting, Jan 2002

Is global CO2 increasing?

Is global temperature increasing?
Announcements:

Writing requirement – instructor does this on grading form

Amy’s office hours: 9-10:15 Tues, Wed, Room 329
2:30-3:30 Fri, Room 425

Extra credit and upcoming talks:
“weather discussion”: every Tues, 12:30-1:00 Rm 610 ATG

“Forbidden Climate Forcings” by Tad Anderson
3:30 pm Thurs Jan 9
Physics Astronomy Auditorium Room A118

For extra credit, attend a climate-related talk, write up a one paragraph description of the talk and of the questions that it raised for you. Up to 10 points each. Max 100 points for the quarter. (10% of grade)
Earth as a “coupled system”

Textbook takes a “top-down approach to the natural sciences” (p. ix)

p.1: “Earth is changing faster today than it has throughout most of its 4.6 billion year history. Indeed, it may be changing faster than it ever has, except perhaps in the aftermath of giant meteorite impacts.”

“Anthropogenic” (formerly, “man-made”): caused by humans
  high-tech examples:
  low-tech examples:
Earth as a “coupled system”

What is this figure trying to show?
In what ways is it misleading?
How else could the same information be presented?
EARTH SYSTEM: Current Understanding  
(International Geosphere-Biosphere Program)

Five scientific findings of the past decade

1. The biosphere is an active, controlling part of the earth system.

2. Global change is much more than climate change - there are direct effects occurring now on a global scale.

3. Global change is not a simple cause-effect problem. The human enterprise drives multiple, interacting effects that cascade through the earth system in complex ways.

4. Earth dynamics are characterized by critical thresholds and abrupt changes.

5. The earth system is now operating in a "no analog" state.
Outline

Announcements/questions
Survey results (Amy)
Forcing-response
Is global CO2 increasing?
Is global surface temperature increasing?
Announcements:

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Homework coming tomorrow

Questions?
“top-down approach”

Start with intuitive grasp, then develop details. (Details make sense because they have a context.)

Earth as a “coupled system”

**Forcing**

(p.3-4): “One of our goals is to show how the different components of the Earth system interact in response to various internal and external influences, or *forcings*.”

Distinguish “Forcing-response” from “cause-effect”

“Forcing”: an imposed change on one or more components of the Earth system. Examples?
Three major global-scale issues

- **ozone hole**
- loss of **biodiversity**
- **global warming**

Exercise 1: define each problem in 1-2 sentences

Exercise 2: give a timescale for each problem

Exercise 3: rank these in order of importance
Outline

Announcements/questions
Three big problems: timescales
Is global CO2 increasing?
Is global surface temperature increasing?
Weather vs Climate
Aerosols vs Greenhouse Gases
Intro to Tad’s talk
Announcements:

Friday is usually a regular lecture

Upcoming talks:
  “Forbidden Climate Forcings” by Tad Anderson
  3:30 pm TODAY
  Physics Astronomy Auditorium Room A118
Three major global-scale issues

- **ozone hole**
- loss of **biodiversity**
- **global warming**

Time scales:
- Effects
- Solution
Is global CO2 increasing?

**Parts per million (ppm)** unit of atmospheric concentration
Figure 1 The 420,000 year Vostok ice core record, showing variations in the concentrations of CO₂, CH₄, and Cl⁻.
FIGURE 2-4
The globally averaged temperature history from 1850 to 1996, showing the 0.5°C (1°F) cooling associated with the eruption of Mt. Pinatubo in 1991. Anomalies are defined as deviations from the 1951–1980 mean. (From R.W. Christopherson, Geosystems: An Introduction to Physical Geography, 3/e, 1997. Reprinted by permission of Prentice Hall, Upper Saddle River, N.J.)
Weather vs Climate
Aerosols vs Greenhouse Gases
Current global-warming paradigm

1. Positive forcing from GHG’s

2. Climate models predict warming
Current global-warming paradigm

Surface temperature record:

3. warming has been detected, and …
4. … the warming has been attributed to humans
Current global-warming paradigm

Summarizing…

Warming of the Earth’s surface…
• Is predicted by climate models forced with GHG’s
• Has in fact been detected
• Match between prediction and observation is sufficiently good that attribution has been claimed

Conceptual framework for this paradigm:

\[ \Delta T = \lambda \Delta F \]  
(Eq. 6.1 of IPCC, 2001)

\( \Delta F \): externally imposed change in energy balance (W/m^2)
\( \Delta T \): resulting change in surface temperature (K)
\( \lambda \): climate sensitivity
We submit that the attribution argument relies on three, interconnected premises:

1. $\Delta F$ is dominated by GHG’s and, thus, is positive and of substantial magnitude.

2. $\Delta T$ is outside the range of natural variability.

3. $\Delta T^*$ is consistent with current knowledge of $\Delta F$ and of the forcing/response relationship as embodied in climate models.

* and its spatio-temporal patterns

Do we know Premise 1 is true? Strangely, it has hardly been examined.
The global mean radiative forcing of the climate system for the year 2000, relative to 1750.

Figure 3: Many external factors force climate change.
Outline

Announcements/questions
Wrapping up Chap 1
Fun and Games
Intro to Chap 2
Announcements/questions

Need homework? (due Wednesday)

Missing students

Repeat: Friday is regular lecture
Wrapping up Chap 1 (handout)