SESSION OUTLINES

Thursday, June 19th, 2003: Millennial-scale climate variability and rapid climate change: what's going on?

Moderator: Chris Bretherton

Speakers: Eric Steig, Gerard Roe, Martin Visbeck (Columbia and Lamont)

Several different lines of evidence suggest that extremely rapid climate changes occurred during the last ice age. Changes of 15C in annual mean temperature in the space of not more than 30 years are thought to have happened in Greenland on several occasions, and it is argued that these events have a global scale. This represents a major challenge to our understanding of the basic physical mechanisms of climate. We do not understand how such large and rapid changes are possible, nor why there appears to be a characteristic 1500-yr time scale to the events. We will review the data, and explore the relative roles that the atmosphere, oceans and ice sheets may have played in the size, timing and communication of these events throughout the climate system.

Key issues:

1. Is it possible to warm up the high latitudes by 10°C to 15°C in 50 years?

2. Is it possible for surges of ice from ice sheets to disrupt the thermohaline circulation sufficiently to cause the observed changes?

3. Are rapid changes in the current climate possible? And what do we mean by rapid anyway?

4. What controls the timescales of variability in the climate system?

Specific Questions:

Data:

- What do the proxy records really tell us about?
- How large and fast are the warmings?
- How extensive is the signal?
- What other records, besides the temperature records in the ice cores show the warmings, and what do those records reflect?
- Is there a connection to the southern hemisphere (during the rapid events or otherwise)?

Atmosphere:

- Why look to the tropics as governing global variability?
- Can atmospheric teleconnection patterns be reconciled to the paleorecords?
- Is their evidence of two different atmospheric tropical states, Dave, from models or otherwise? What is its physics?

- How sensitive is annual mean temperature at high latitudes to different patterns of tropical SSTs?

Ocean:

- Can thermohaline circulation changes cause the observed rapid changes/variability in Greenland?
- Can thermohaline circulation cause change climate outside of the North Atlantic region? Does it have to?

Other:

- Are the rapid change events separate from the rest of the variability at millennial timescales?
- What sets the intervals between rapid change events?

Proposed mechanisms:
Bi-polar see-saw. Great Salt Oscillator. Stochastic resonance. Two state tropics (midwinter minimum or El-Niño switch).

Are there any practical ways of discriminating between these competing theories? Do they have critical aspects which make concrete predictions that can be evaluated?

Suggested Papers:
Bond et al., 2001. Persistent solar influence on North Atlantic climate during the Holocene. Science, 294, 2130-2136.

Stocker, T. F. and Marchal, O. 2000. Abrupt climate change in the computer: Is it real?, PNAS, 97, 1362-1365.

Steig, E. J. and Alley, R. B. 2002. Phase relationships between Antarctic and Greenland climate records. Annals of Glaciology, 35, 451- 456 .

Processes That Cause Abrupt Climate Change. Chapter 3 in Abrupt Climate Change: Inevitable Surprises, 2002,. Committee on Abrupt Climate Change, National Research Council, 73-106).

Pierrehumbert, R. T. 2000. Climate change and the tropical Pacific: The sleeping dragon wakes. PNAS, 97(4), 1355-1358.

Friday, June 20th, 2003: Issues in regional climate modeling and evaluating impacts

---

Moderator: Amy Snover

Perhaps the main motivation to study climate change is because of its impact on the land surface, and the resulting consequences for ecosystems and societies. To evaluate this to any degree requires understanding the mechanisms and sensitivities to change of natural

systems and societies. This is a considerable scientific challenge: in many ways such systems are more complex and unpredictable than climate itself. In addition, they tend to be most vulnerable to extreme climate events (e.g., droughts or floods), which are hardest to predict. We will explore our ability to understand the consequences of climate changes at a regional scale, and discuss how to most effectively use scenarios from global scale models to predict regional scale changes.

Speaker: Dennis Lettenmeier
Modeling regional consequences of climate variability and change

- As we look at records of stream flow in the 20th century, can we distinguish between human-caused and natural variability?
- Can we separate climate influences from human (land use change) influences on the hydrologic cycle? Example: timber harvesting influencing frequency of flooding.

Assessing impacts:

- How does one determine the sensitivities and vulnerabilities of water resource systems to climate change?
- What do you need from climate models (with what spatial/temporal resolution) to project the impacts of climate change on hydrology? On water resources? What would water resource managers need?
- On what timeline/under what circumstances do socioeconomic changes matter for climate impacts projections?
- How do you deal with physics of processes that must inevitably be heavily parameterized? Is there a different research strategy for different kinds of questions?
- What do such uncertainties mean in terms of interpreting the results of regional-scale impacts models?
- Water resource issues outside of the Northwest, what are the differences?

Themes: issues in employing information based on downscaling to regional scales and attribution of observed variability and/or trends.

Speaker: Phil Mote
Downscaling from global climate models

- What information can/cannot global climate models provide? What can and can't climate models be used for?
- On what kinds of time and space scale do future socioeconomic changes (socioeconomic decisions) matter for climate change projections?
- What do you need to know in order to model regional climate change?
- What are issues in downscaling? What regional climate change information is/is not available?
- What are the ultimate limitations on climate models to predict different kinds of things that matter to impacts scientists and/or society? e.g., regional (vs. global) temperature changes, seasonal climate changes precipitation patterns, storm tracks, upwelling,winds...

Speaker: Don Mckenzie

Ecosystems

- How does climate influence forests?
- How is this known?
- How does this vary across different regions? Different species?
- Why does the history/timeline of a forest matter?
- What do you need from climate models to project climate impacts on forest ecosystems? On forest management?
- What would forest managers need?

Speaker: Amy Snover
Impacts and Policy

- What sort of information do people who do impacts studies want?
- How do they use that information when they get it? (understand limiting factors of a system and mgmt/instit/pol/soc/econ context)
- Frame importance (social relevance) of climate change research: The question does it matter immediately requires answering for what? and to whom?
- Test case of a better forecast of the PDO - how could that be used? (Would a perfect climate forecast necessarily be useful for impacts work/adaptation?)
- For what kinds of problems will better understanding of climate likely help?
- And for what kinds of problems will it not (maybe because we have no control, or because climate is not the largest uncertainty)

PCC core questions:

- What research needs to be done in order to provide policy makers with more reliable projections?
- How do natural and human induced climate changes impact ecosystems and societies?
- How serious are the risks of catastrophic impacts?
- Based on assessment of these risks, are costly measures warranted to reduce the rate of gw?
- To what extent can the adverse impacts of climate change be alleviated if long range planning is informed by long range climate projections?
- To what extent are the climate trends of the past few decades induced by human activities?

Suggested papers:

Top 3:

Pielke, R. A., Jr. and D. Sarewitz. 2003. Wanted: Scientific leadership on climate. Issues in Science and Technology, Winter,(27-30).

McKenzie, D, D.W. Peterson and D.L. Peterson, Modeling conifer species distributions in mountain forest of Washington State, 2003, The Forestry Chronicle, 79, 2.

Lettenmaier, D.P., A.W. Wood, R.N. Palmer, E. Wood, and E.Z. Stakhiv. 1999. Water

Resources Implications of Global Warming: A U.S. Regional Perspective. Climate Change 43, 537-579

Others:
Kirschbaum, M. U. F. and A. Fischlin. 1996. Climate Change Impacts on Forests. Chapter 1 in Part II of Climate Change1995: Impacts, Adaptations and Mitigation of Climate Change, Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. R. T. Watson, M. C. Zinyowera and R. H. Moss, eds. New York, New York, Cambridge University Press.

Whitlock, C. 1992. Vegetational and climatic history of the Pacific Northwest during the last 20,000 years: implications for understanding present-day biodiversity. The Northwest Environmental Journal 8:5-28.

Bartlein, P.J., C. Whitlock, S.L. Shafer, 1997: Future Climate in the Yellowstone National Park Region and Its Potential Impact on Vegetation.Conservation Biology, 11(3).