Climate Change: The Move to Action
(AOSS 605 (480) // NRE 501.076)

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Winter 2007
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Class News

- There will be a ctools site by Friday
- Plan for a “community” web site to support the class with RSS link and infrastructure to support our class as a community
  - Want to start a wiki book

- First Readings: Spencer Weart’s *The Discovery of Global Warming*
  http://www.aip.org/history/climate/index.html

  - And in particular two subsections
    - Carbon dioxide greenhouse effect: http://www.aip.org/history/climate/co2.htm
    - Simple climate models http://www.aip.org/history/climate/simple.htm

- Other references:
  - Glossary of climate and weather jargon (overkill, but might be useful) http://www.wrcc.dri.edu/ams/glossary.html
  - Link to the United States Climate Prediction Center (this is NOT climate change, but demonstrates the type of real problems people worry about impacting people) http://www.cpc.ncep.noaa.gov/

Outline of lecture

- Who am I?
- Course Description Overview
- Glimpse in the Climate Change Problem
- More detailed Course Description
  - Subjects to be addressed
  - Project description
- Science-Mitigation-Adaptation Framework

Who Am I?

http://aoss.engin.umich.edu/go/?id1=10&id2=1&id3=48

- Scientist at NASA publishing in ozone modeling, climate modeling, physically-based analysis of observations
  - Current interest intersection of weather and climate
- Manager at NASA, modeling, data analysis, and high-performance computing
- Participant in national and international assessments of ozone depletion and environmental impact of aircraft
- Advocate and developer of multi-agency programs in the U.S. to address climate change problems
  - Detailed to Office of Science and Technology Policy
- Participant in the development of U.S. high-performance computing policy

Who Am I?

- At U o' Michigan taught Climate Change: The Intersection of Science, Policy, and Economics Winter 2006
  - New course, unique course that brings together many of the communities with an interest of climate change,
  - Projects that took a hard look at a number of complex problems and tried to make recommendations … or at least evaluate the impact.
- At U o' Michigan teach geophysical fluid dynamics of the atmosphere.
- Projects from the Winter 2006 class
  - Carbon emissions trading and their role in climate change
  - Fuel taxes and the reduction of carbon emissions
  - Great Lakes fisheries and climate change
  - New Orleans (2 projects)
    - Sea level rise
    - Public health, petroleum industry infrastructure.

Last years website

- http://aoss.engin.umich.edu/class/aoss605/

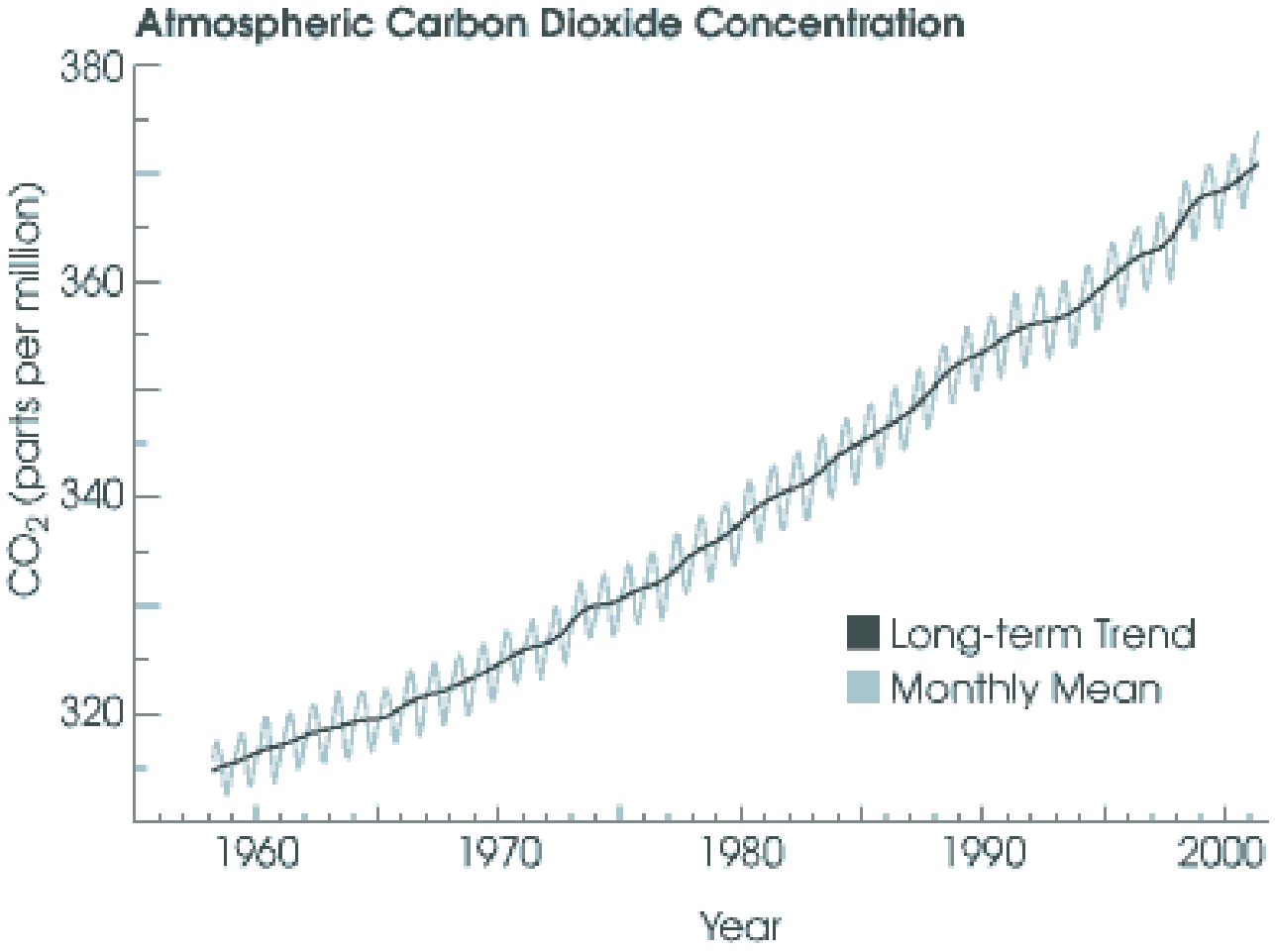
From Course Description

- Identify the important elements of science, policy, economics, public health, etc.
  - Where should we pay attention?
  - What do we know versus what do we believe?
- Identify and map the interactions between these elements and connections to other external elements
  - How big is the problem?
- How is all of this changing?

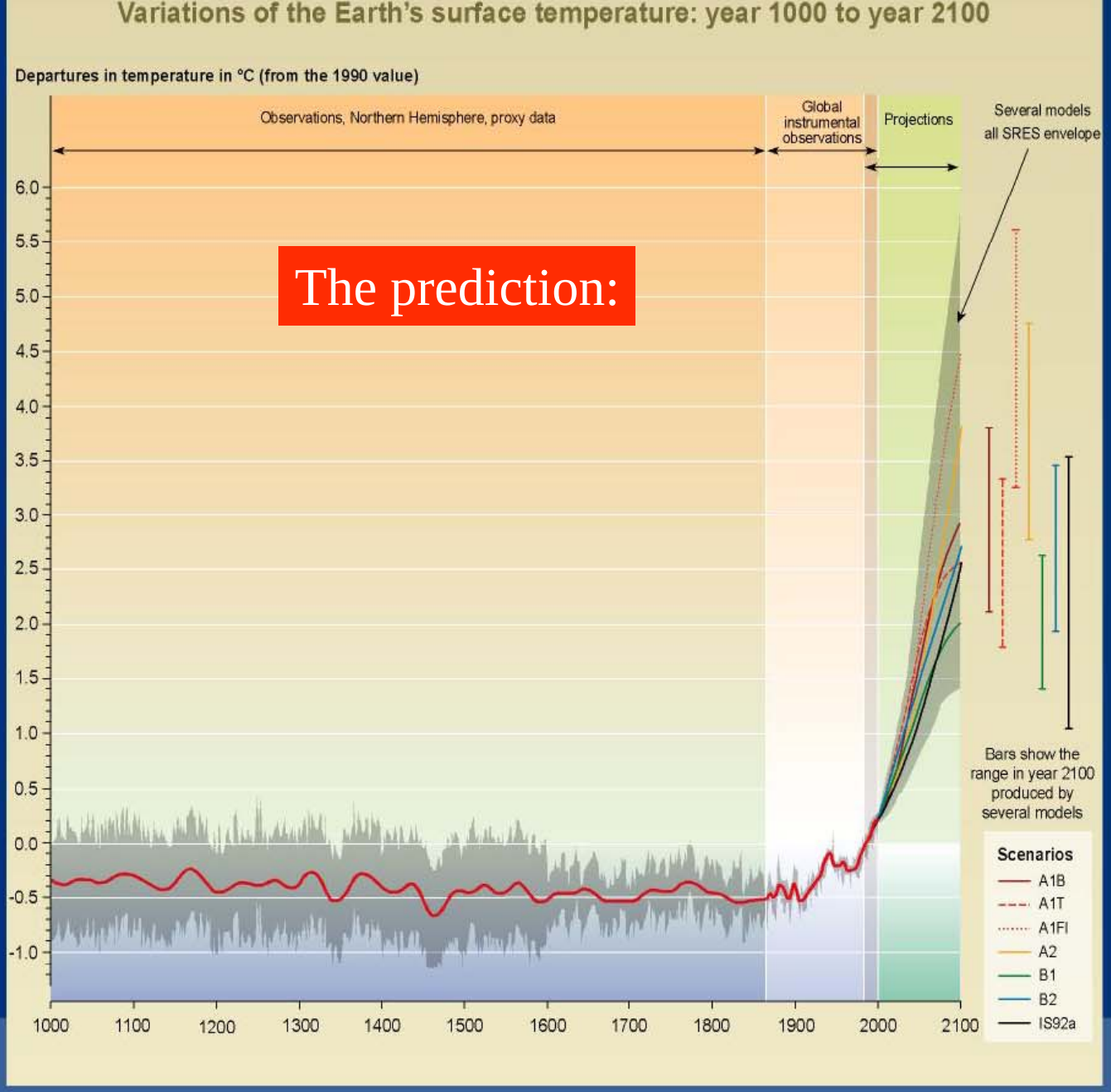
Glimpse into the issues of Climate Change

- Some global climate predictions
- Some responses to climate change
- Climate change and Michigan
- What are the ethical questions?

The motivator: Increase of CO_2 (Keeling et al., 1996)



Basic physics of temperature increase is very simple, non-controversial.

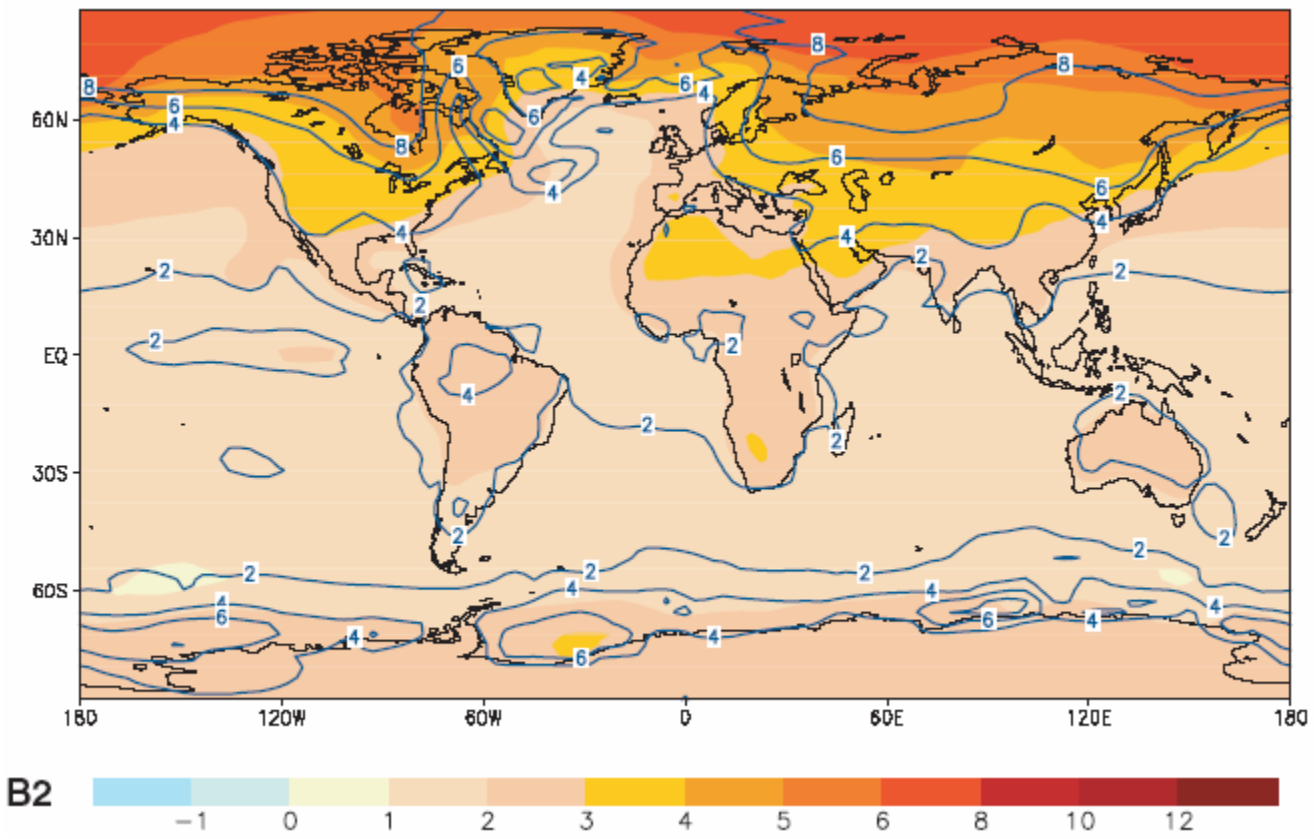


Note: There i consistency from many models, man scenarios, that there wil be warming. (1.5 – 5.5 C)

Also, it's still going up in 2100!

SYR - FIGURE 9-1b

Projected Global Temperature Trends

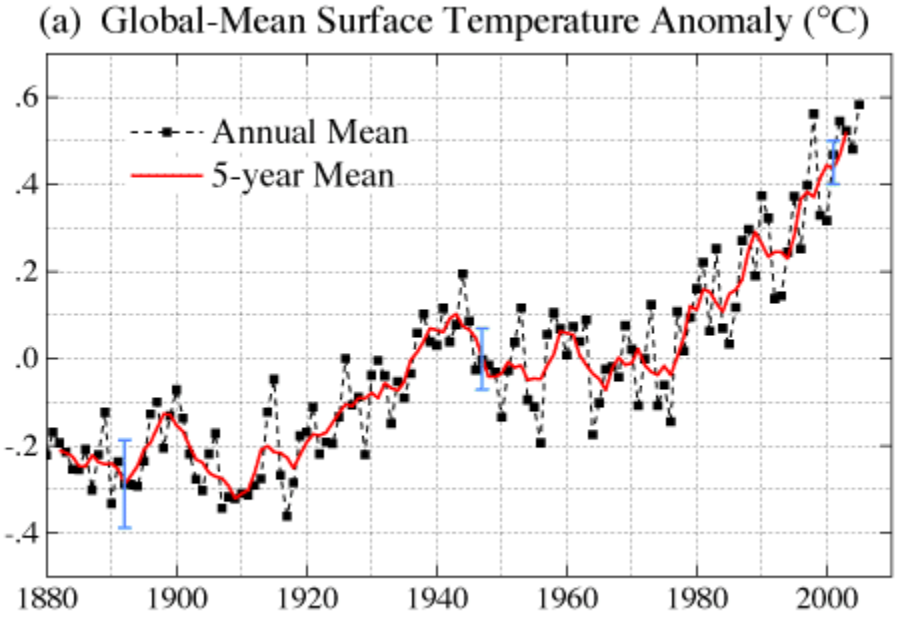


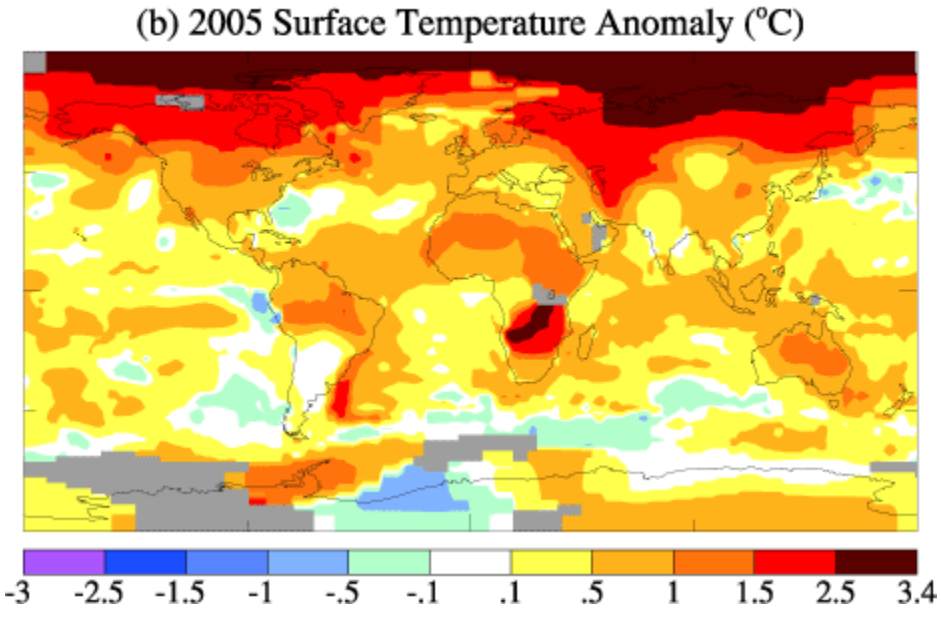
2071-2100 temperatures relative to 1961-1990.
Special Report on Emissions Scenarios Storyline B2 (middle of the road warming).

IPCC ‘01

Observed Temperature Anomaly in 2005

http://data.giss.nasa.gov/gistemp/2005/





See Also: Osborn et al., The Spatial Extent of 20th-Century Warmth in the Context of the Past 1200 Years, Science, 311, 841-844, 2006

What parameters/events do we care about?

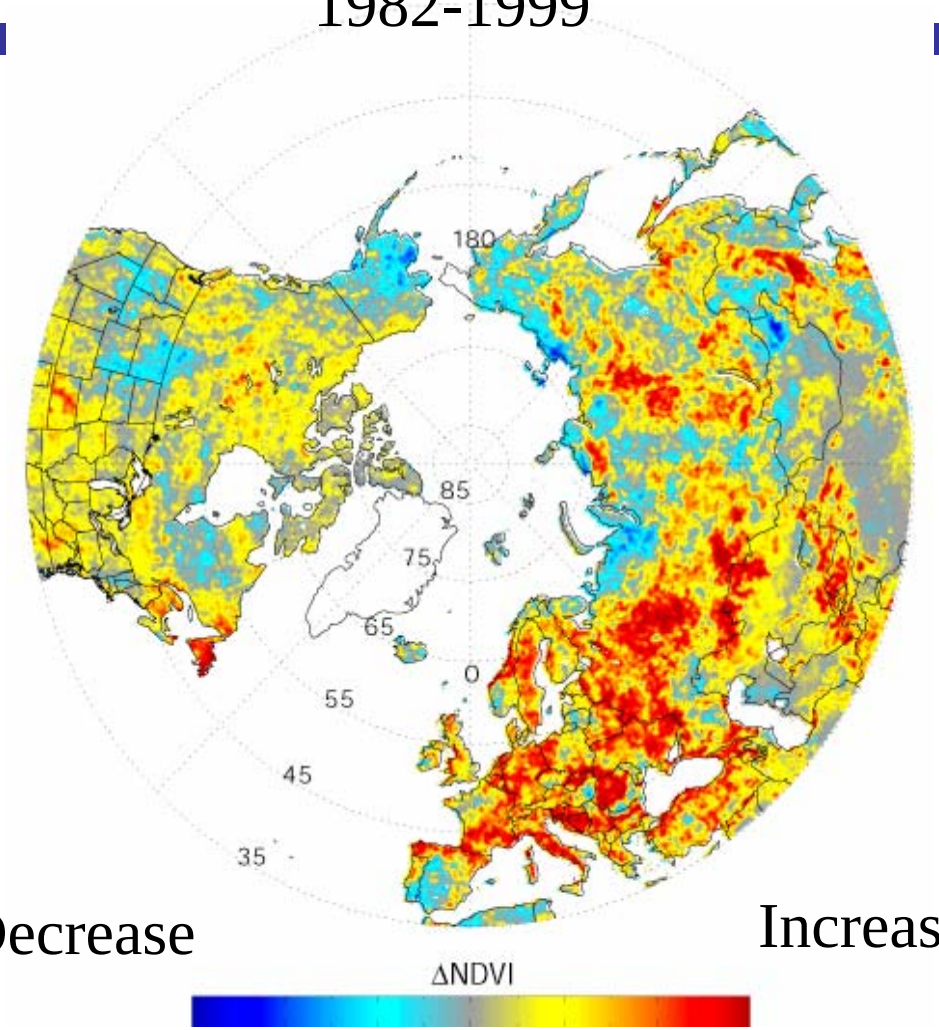
- Temperature
- Water
  - Precipitation
  - Evaporation
  - Humidity
- Air Composition
  - Air quality
  - Aerosols
  - Carbon dioxide
- Winds
- Clouds / Sunlight
- Droughts
- Floods
- Extreme Weather

Ecosystems

The Response

Northern Hemisphere May-September Vegetation Changes

1982-1999



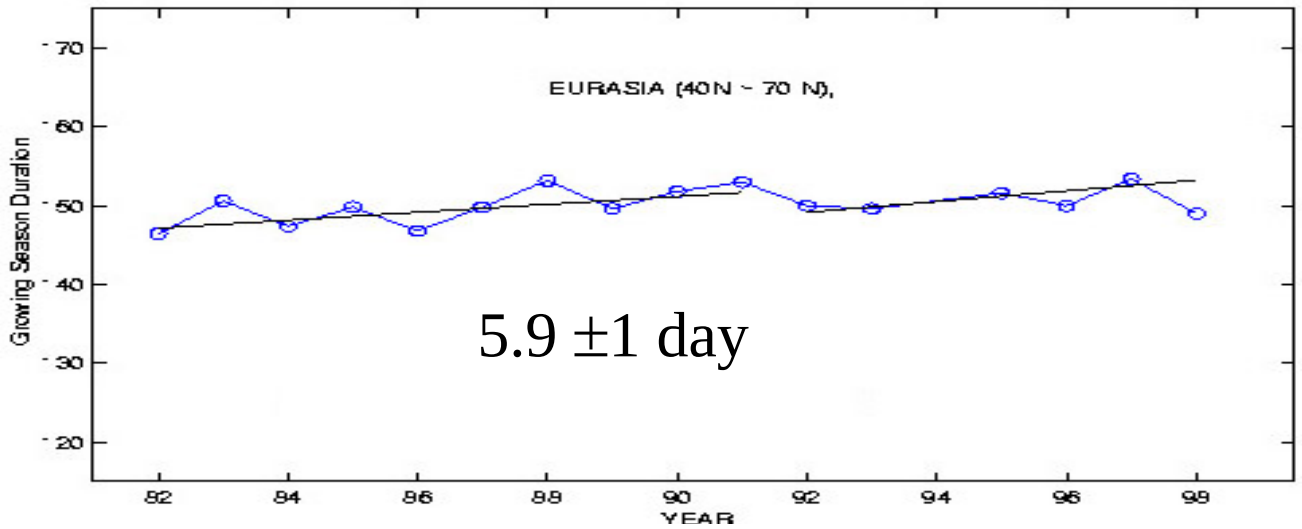
Decrease

Increase

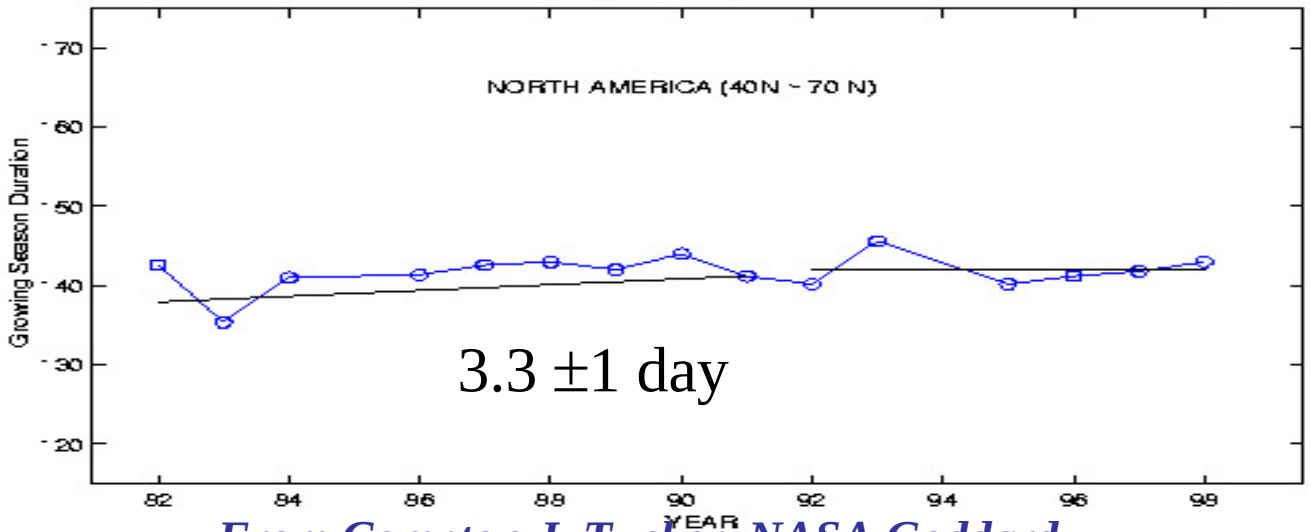
From Compton J. Tucker, NASA Goddard

Warmer Earth Greener North

Longer Growing Seasons



Longer Growing Seasons



From Compton J. Tucker, NASA Goddard

Systematic Look

- Freeze-free periods are getting longer
- Snow cover decreasing
- Growing season longer
- Spring is earlier
- CO2 annual cycle is getting larger
- Sea ice is decreasing
- Mountain glaciers are decreasing
- Mountain ecosystems are changing

Regional issues identified in assessments

- **Reduction in water level of the Great Lakes (1-5 feet)**
  - **Temperature rise (20th Century and predicted)**
  - **Precipitation increase (20th Century and predicted)**
- **Human health in cities**
  - **Heat waves / Reduced extreme cold**
  - **Air quality worse in heat**
- **Agriculture and forestry**
  - **Soil moisture decrease, more drought**
  - **Growing season longer**
  - **Changes in insects, disease, fire …**
- **Ecosystem – water and air quality**
  - **Lower stream flows, punctuated with floods**
  - **Changes in flora and fauna (land and water) due to temperature**
  - **Invasive species**
- **<u>External factors from other regions</u>**
  - **Water for western half of U.S.**
    - **Great Recycling and Northern Development Canal (James Bay in Canada)**
  - **Water for eastern half of the U.S.**
  - **Hydroelectric facilities**
  - **Pollution from/to other regions**

Ice reduced, shoreline damage decreased, less snow removal, more land, …

What are the ethical issues?

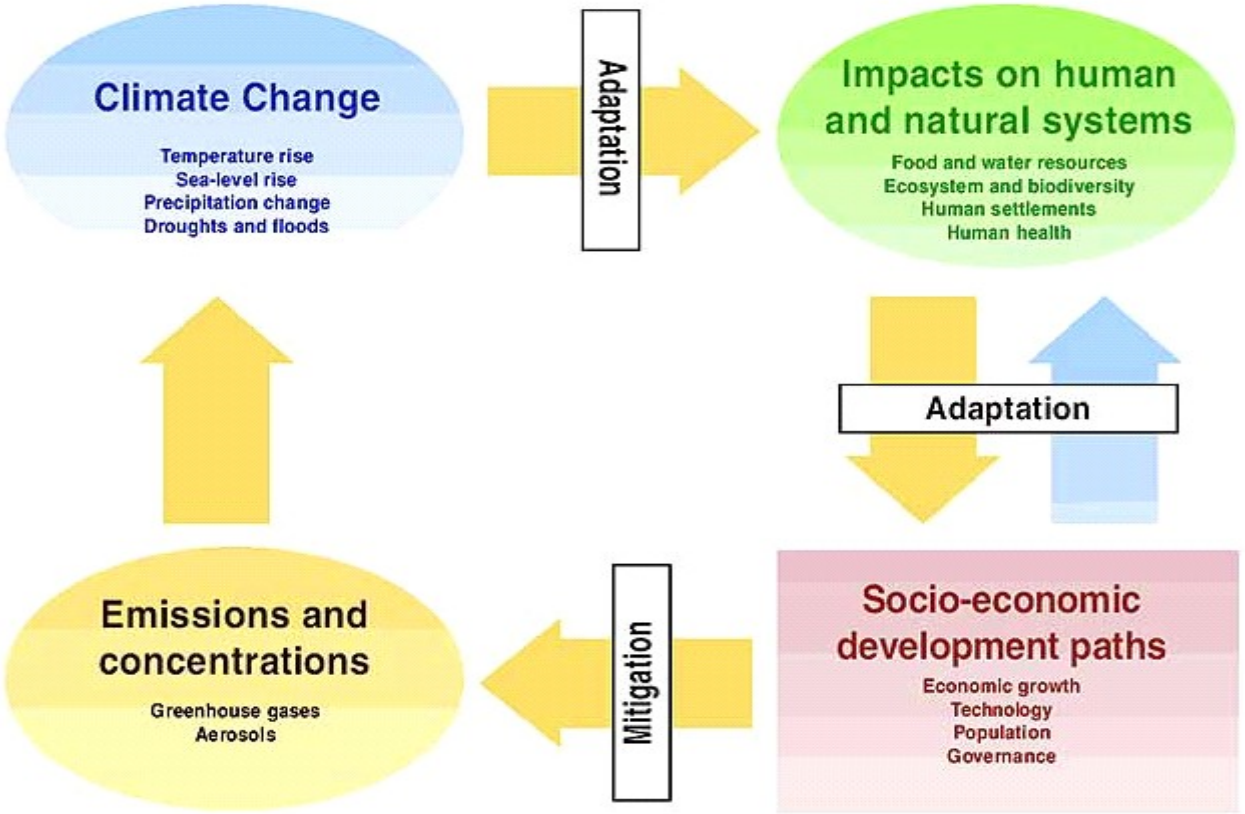
Climate and Energy

- Carbon increase directly correlated to use of energy
- Energy use directly correlated to success of economy
- Energy use directly correlated with personal behavior
- Energy use directly correlated with wealth
- Ann Arbor is wealthy …

Fundamental Ethical Questions

- Contrast between rich and poor, haves and have nots.
- Those who use energy are not those most impacted by climate change.
- Those with wealth are more resilient, more adaptable.
- Winners and losers in climate change?
- Climate change versus the other challenges we face.
- Our use of knowledge

Science, Mitigation, Adaptation Framework



Questions for you

- Which of these parameters are important to you?
- How do you imagine adapting to climate change?
- Are you concerned about your children’s future? Their children.

Questions

- When some one asks you about global warming, or you hear about global warming, what is your first reaction?
- Do you think that the planet is warming?
- Is this warming consequential?
- Is this warming manmade?
- Can we do something about it?
- What are the questions you want answered in this course?
  - Is it bogus science?

Approximate Course Outline

- Week 1: Description of course and course goals. Scientific investigation of climate – how is it done? What is climate variability? What are the fundamental balances of energy and how might these change? (Conservation principle.) What's the relation between weather and climate?
- Week 2: What are the elements of the climate system? What are the roles of these elements? Where can we expect the unexpected? Incremental versus abrupt climate change.
- Week 3: How is the climate variability measured? What are the sources of observations and how reliable are these observations? How do we build modern climate data records from weather data?

Approximate Course Outline

- Week 4: What are the components of modern climate models? How well do these models represent the fundamental balances and the observed variability? Why are the model predictions controversial? What do the models tell us about the observations, and what do the observations tell us about the model? How do we determine cause and effect, the attribution of observed signals to specific mechanisms?
- Week 5: Coherent and Convergent Evidence of Climate Change. What are the signals of climate change and how do these stack up against theory and predictions? Physical climate, ecosystems, coastal societies.
- Week 6: Social and Ethical Considerations: What are the potential social issues and ethical ramifications for mitigation and adaptation associated, primarily, with changes in energy sources, production, and use? Climate change in wealthy countries versus not so wealthy countries.

Approximate Course Outline

- Week 7: Global/International Policy Response: What are the strategy, role, impact and future direction of Global and International Multi/Bi/Unilateral and Sectoral Climate Regimes? How does the United States play in the international arean?
- Week 8: Sub-National Policy Response: What are the strategy, role and impact of, Sub-National Climate Regimes? Are bottom-up approaches more promising than top-down? What are U.S. states and communities doing? Will it impact federal policy?
- Week 9: Impact of Climate Change on Public Health: Are there health risks (advantages) associated with climate change? Emerging diseases. Heat waves. Air quality and climate change.

Approximate Course Outline

- Week 10: Private Sector Perception and Response: What issues are seen by the business community? How does this change from sector to sector? What is the role of liability risk? Business and policy: the need for national policy. Opportunity, competitiveness, risk.
- Week 11: Economics, Markets, and Trading: How is the value of the climate integrated into our economies? Carbon market and carbon trading, is this the strategy for controlling emissions through cost? What is the role of taxes and incentives?
- Week 12-13: Adapting to Climate Change: Vulnerability, resilience and adaptive capacity. When do societies adapt to climate change? Who pays? What is the best scale for measuring, implementing and monitoring adaptation options? Who gains, who loses? What are the strategies for integrating and mainstreaming climate change into the fabric and practices of society (planning, management and policy making)? What is the role of geo-engineering? Finally, how does the prospect of abrupt climate change influence these questions?
- Week 14: Project presentations.

Course Project

- Reflective of workplace …
  - “Complex Problems with no Known Solutions.”
- Groups of individuals with varied expertise
- Responsive to “news”
  - Relationship of news to science
- Project will provide recommendations, a strategy for addressing the complex problem.
  - What are first steps?
  - What do we need to look out for as these steps are taken?
- Monitor progress // briefing during the course
  - Use of community web page
  - Development of wiki book
  - Possible publication on widely accessed web site.
- Presentation at end of course
  - Nomination for student prize

Questions, Discussion

- I want this course to include discussion, questions, unification, and expansion of ideas.
  - But to avoid “group think”

- Please suggest topics you are especially interested in.

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