Click to view movie of sun (5 mb).
Right click to download movie of carbon dioxide for past 400,000 years (30 mb).
Right click to download movie of paleogeographic reconstructions from 740 MA to present (29 mb).
Right click to download movie of surface temperatures from 1870 to present with major volcanic eruptions (355 mb).
Right click to download GIS-climate model (147 mb).
Right click to download movie of precipitation, 2005 (May-Nov) (69 mb).

Climate System Modeling 2007: From a Global to a Regional Perspective*

Tim Killeen[1]

Search and Discovery Article #70061 (2009)
Posted February 20, 2009

*Adapted from oral presentation at AAPG Annual Convention, San Antonio, Texas, April 20-23, 2008

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Abstract

The ability of the scientific community to model climate system dynamics has markedly improved over the past decade, with major increases in available computer power, coupled with systematic improvements in the sophistication of the mathematical treatment of the interacting components of the earth system. The Intergovernmental Panel on Climate Change (IPCC) Working Group I report, published in 2007, provided a comprehensive assessment of the peer-reviewed literature and summarized the results from more than 15 modeling centers worldwide. The IPCC assessment stated that warming of the climate system is "unequivocal." The models predict further systematic and significant warming of the planet over the coming decades. The next generation of climate system models will have greater spatial resolution and can be tailored to address decision-making needs at the regional level and for specific economic sectors. This talk will summarize recent developments in climate system modeling at the regional level, with special emphasis on results from the Community Climate System Model (CCSM) and implications for the oil- and gas-generating regions of the world. The CCSM was one of the models used within the IPCC assessment and has been developed under the long-term sponsorship from the National Science Foundation and the U.S. Department of Energy. The CCSM is managed by the National Center for Atmospheric Research.

References

Lawrence, D.M., and A.G. Slater, 2006, A projection of severe near-surface permafrost degradation during the 21st century; Reply: Geophysical Research Letters, v. 33/21, p. L21504.

Seager, R., et al., 2007, Model projections of an imminent transition to a more arid climate in southwestern North America: Science, v. 316/5828, p. 1181–1184.

Stephens, B.B., et al., 2007, Weak northern and strong tropical land carbon uptake from vertical profiles of atmospheric CO_2: Science, v. 316/5832, p. 1732–1735.

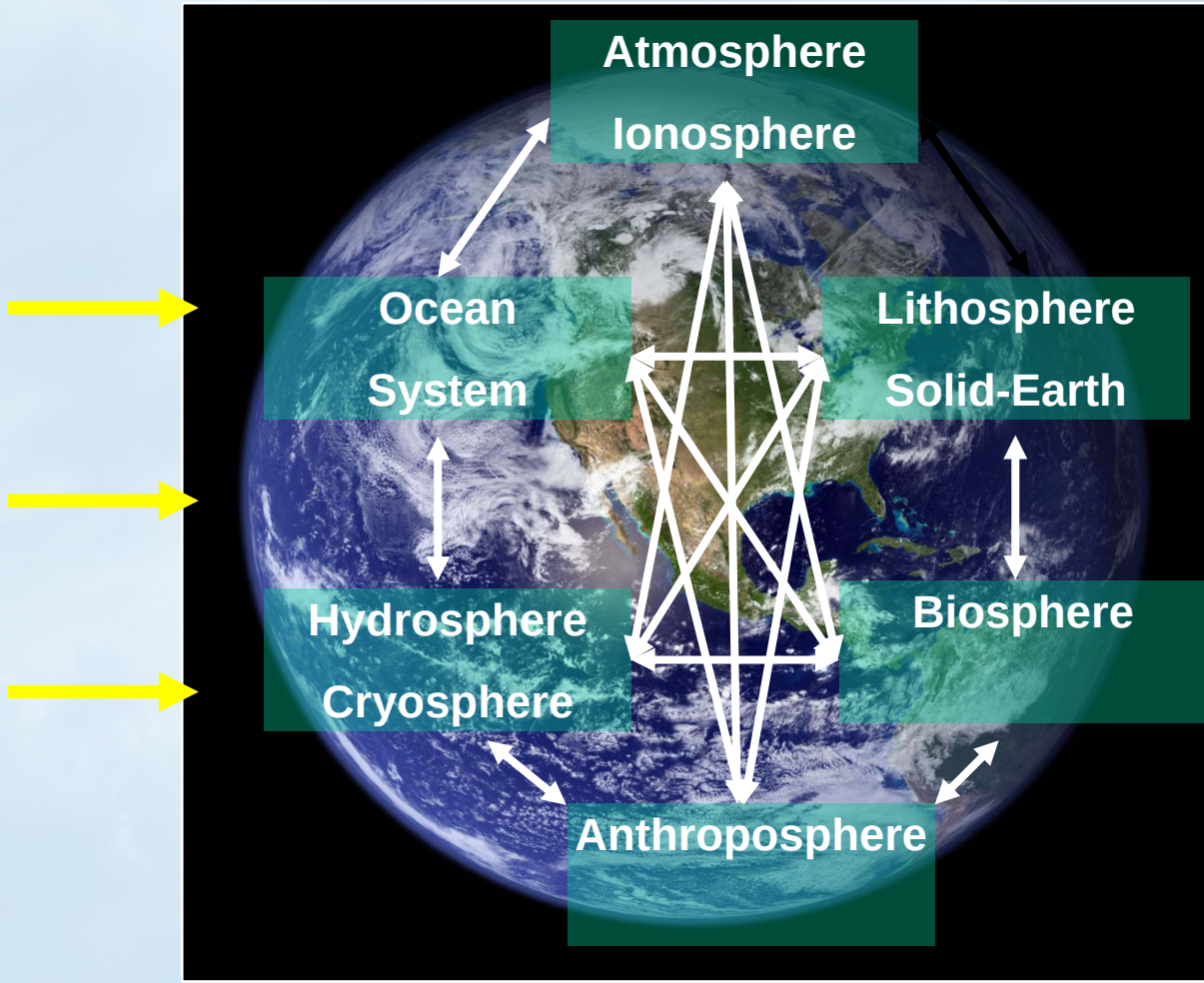
Climate System Modeling: From a Global to a Regional Perspective

Tim Killeen
Director, National Center for Atmospheric Research
President, American Geophysical Union

AAPG, San Antonio
April 21, 2008

The Sun-Earth System

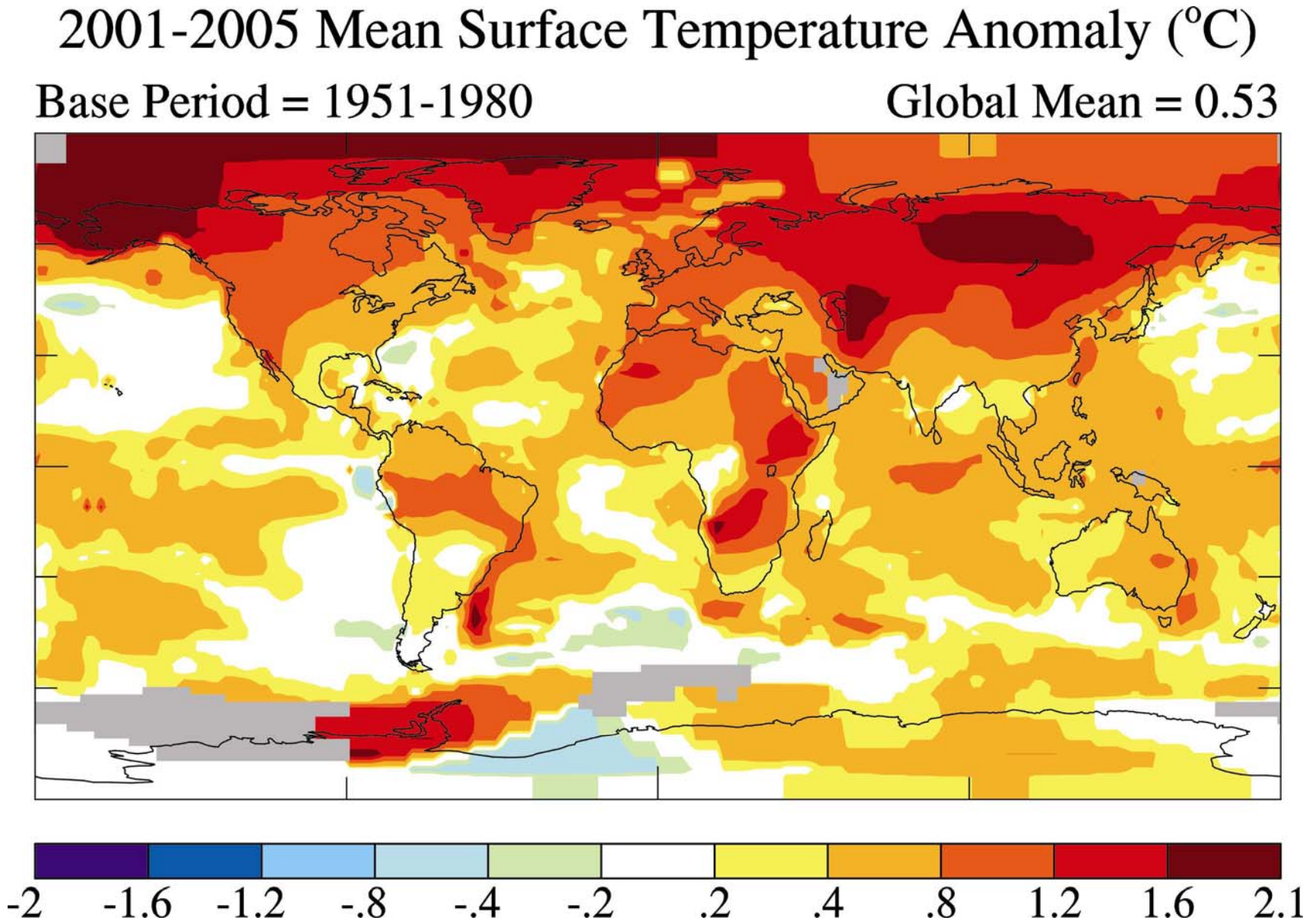
See movie of sun.



The Earth’s constant is change… …but that change is not constant .

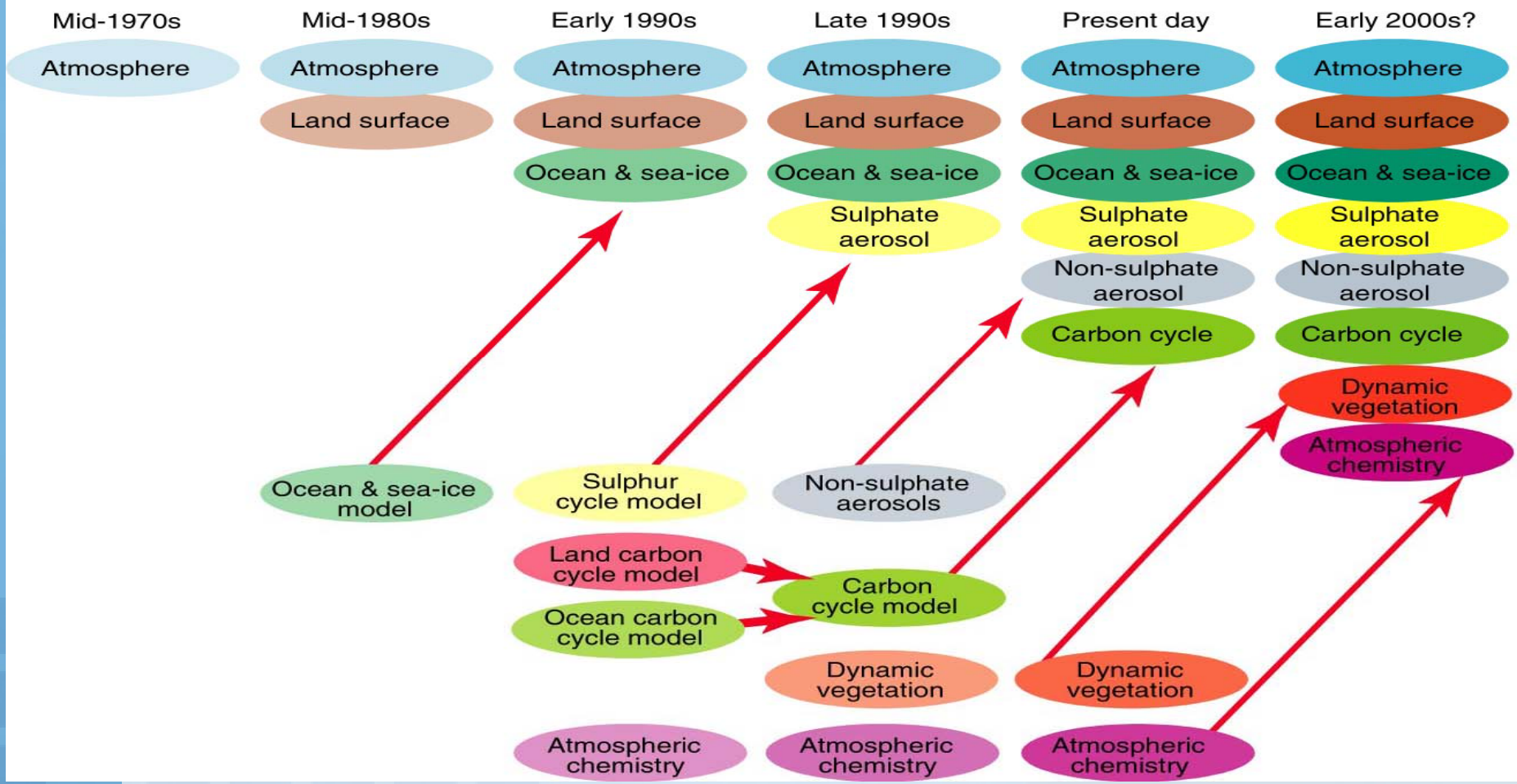
See movie (or download movie - 30mb) on Carbon Dioxide with time.
See movie (or download movie - 29mb) showing paleogeographic reconstructions.

A Warming World…



NASA

The Development of Climate models, Past, Present and Future



The IPCC and AGU Sequence……

IPCC (1990) Broad overview of climate change science, discussion of uncertainties and evidence for warming.

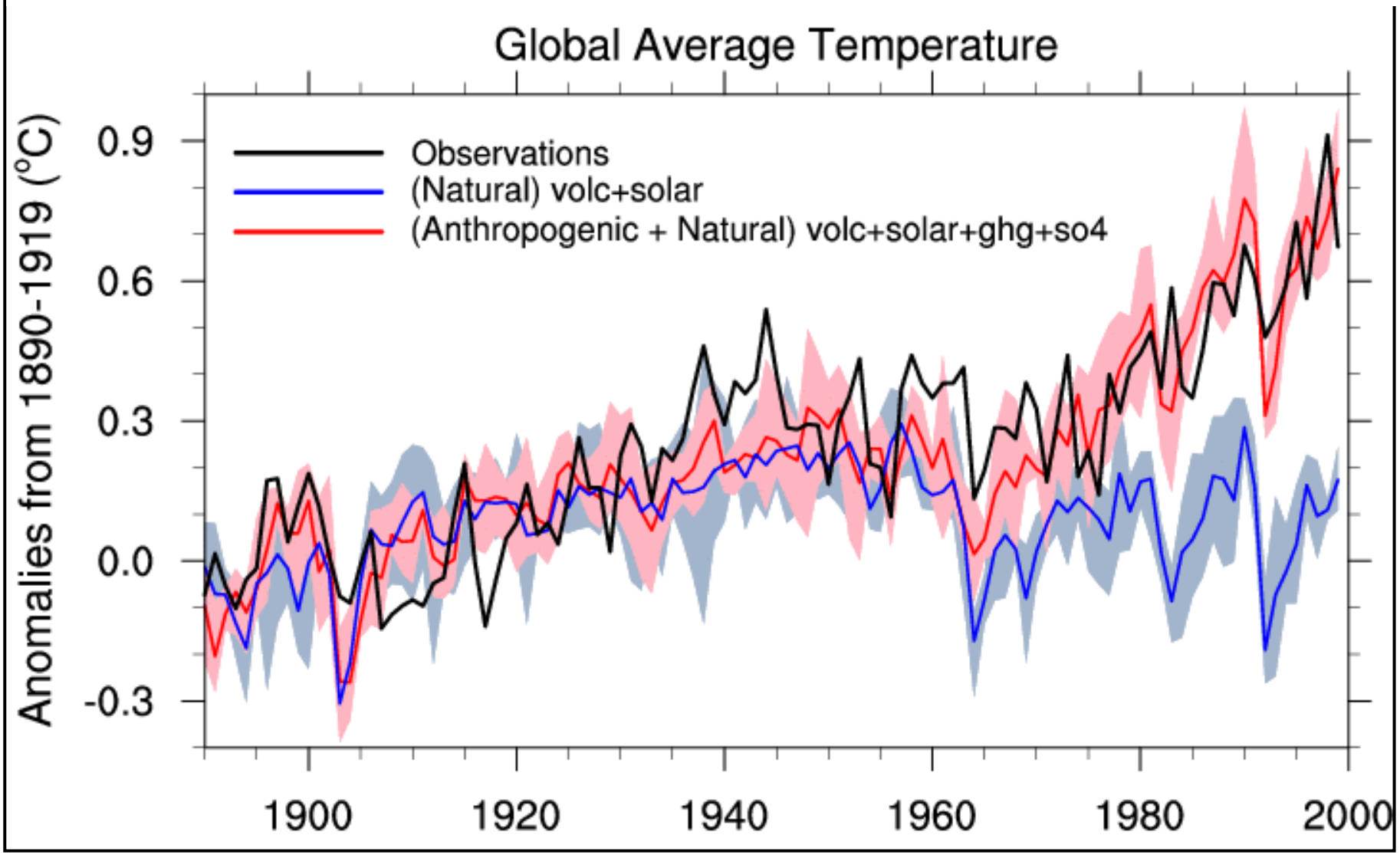
IPCC (1995) "The balance of evidence suggests a discernible human influence on global climate."

IPCC (2001) "Most of the warming of the past 50 years is likely (>66%) to be attributable to human activities."

IPCC (2007) "Warming is unequivocal, and most of the warming of the past 50 years is very likely (>90%) due to increases in greenhouse gases."

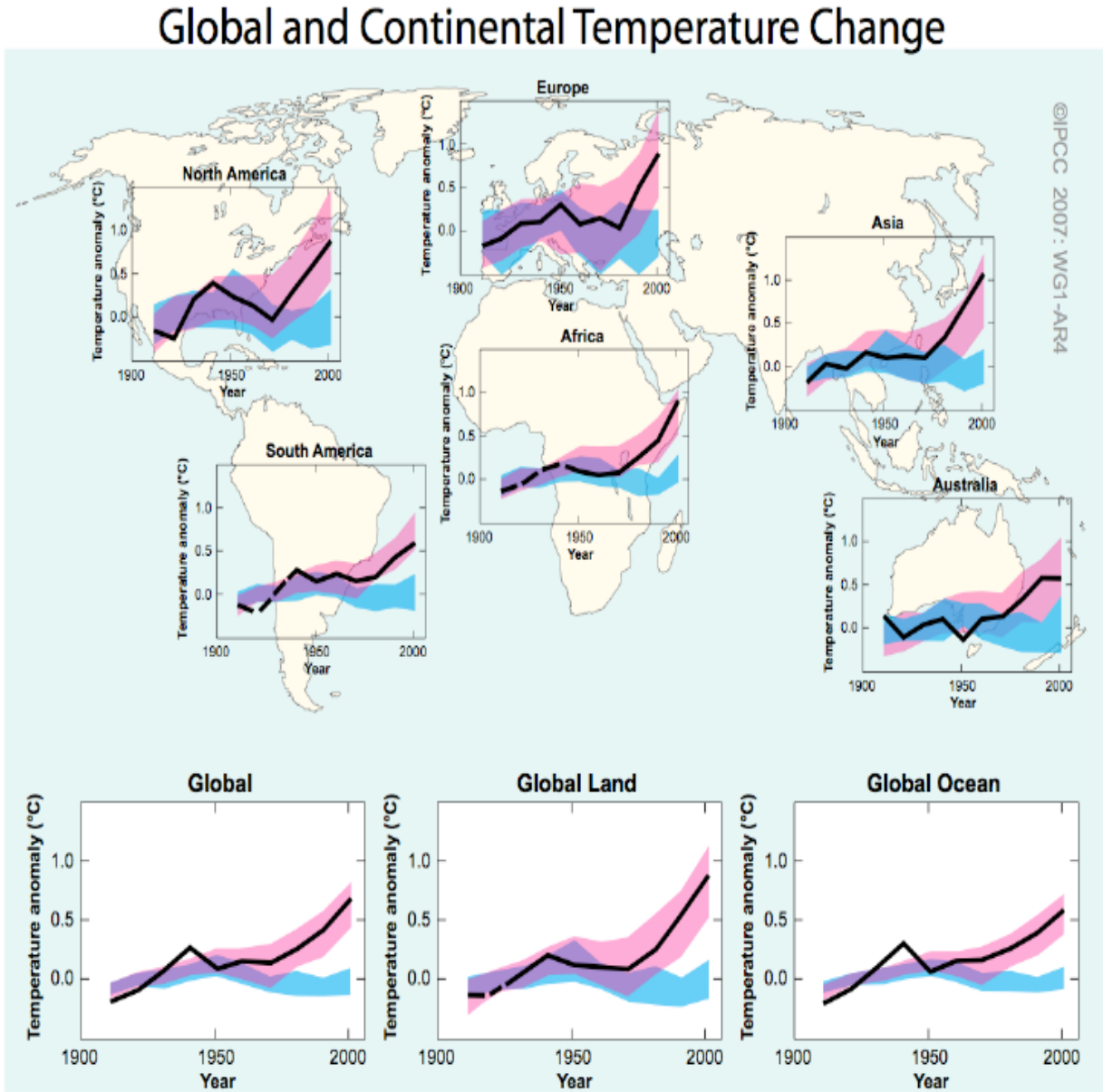
AGU (2008): "The Earth's climate is now clearly out of balance and is warming"

Modern climate models can reproduce the climate of the past century only if greenhouse gases are included



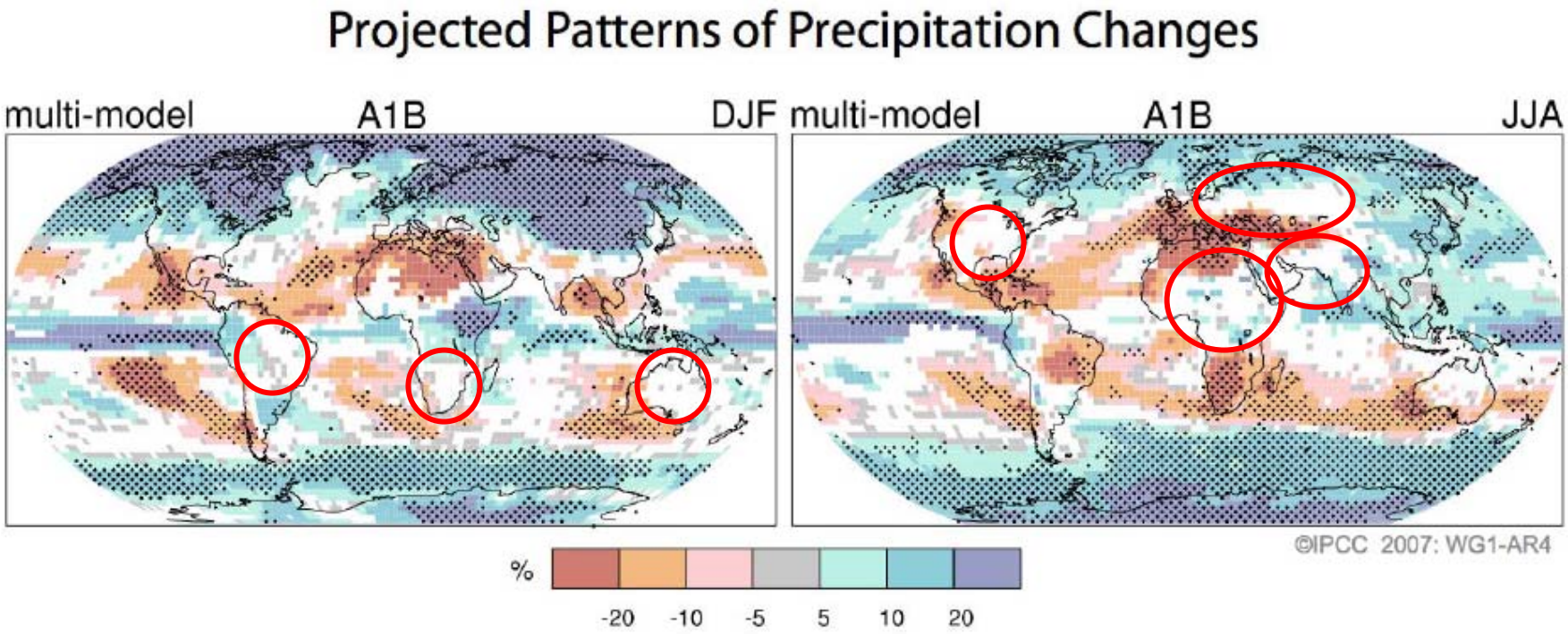
NCAR

Temperatures are rising all over the world - on all continents, on land and over the ocean.



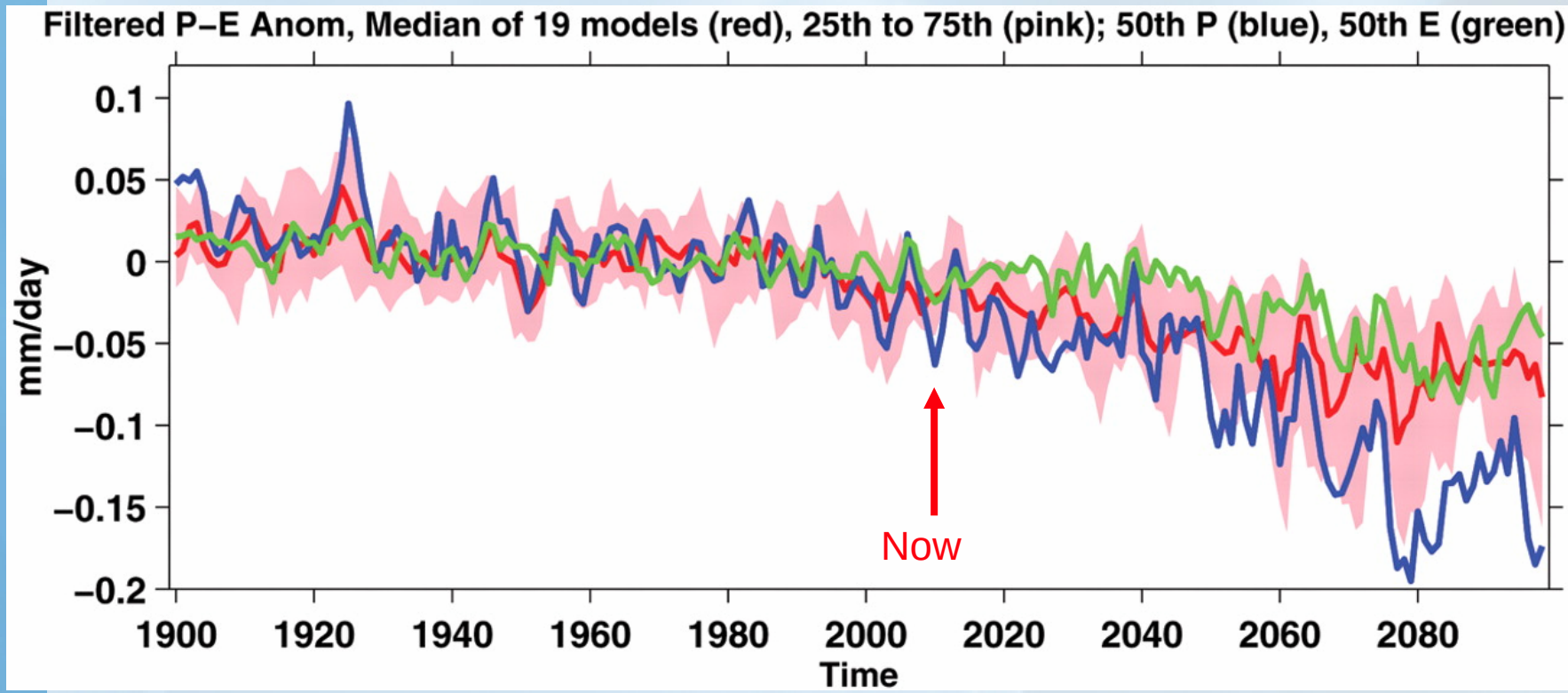
IPCC 4th Assessment Summary for Policy Makers, 2007

IPCC ***Projected precipitation changes*** in global climate models over regions where people live (+/- 50 latitude) mostly show low confidence (less that 66% of the models agree on the sign of the precipitation change, white region).



IPCC model projected changes in SW US water budget

Water balance

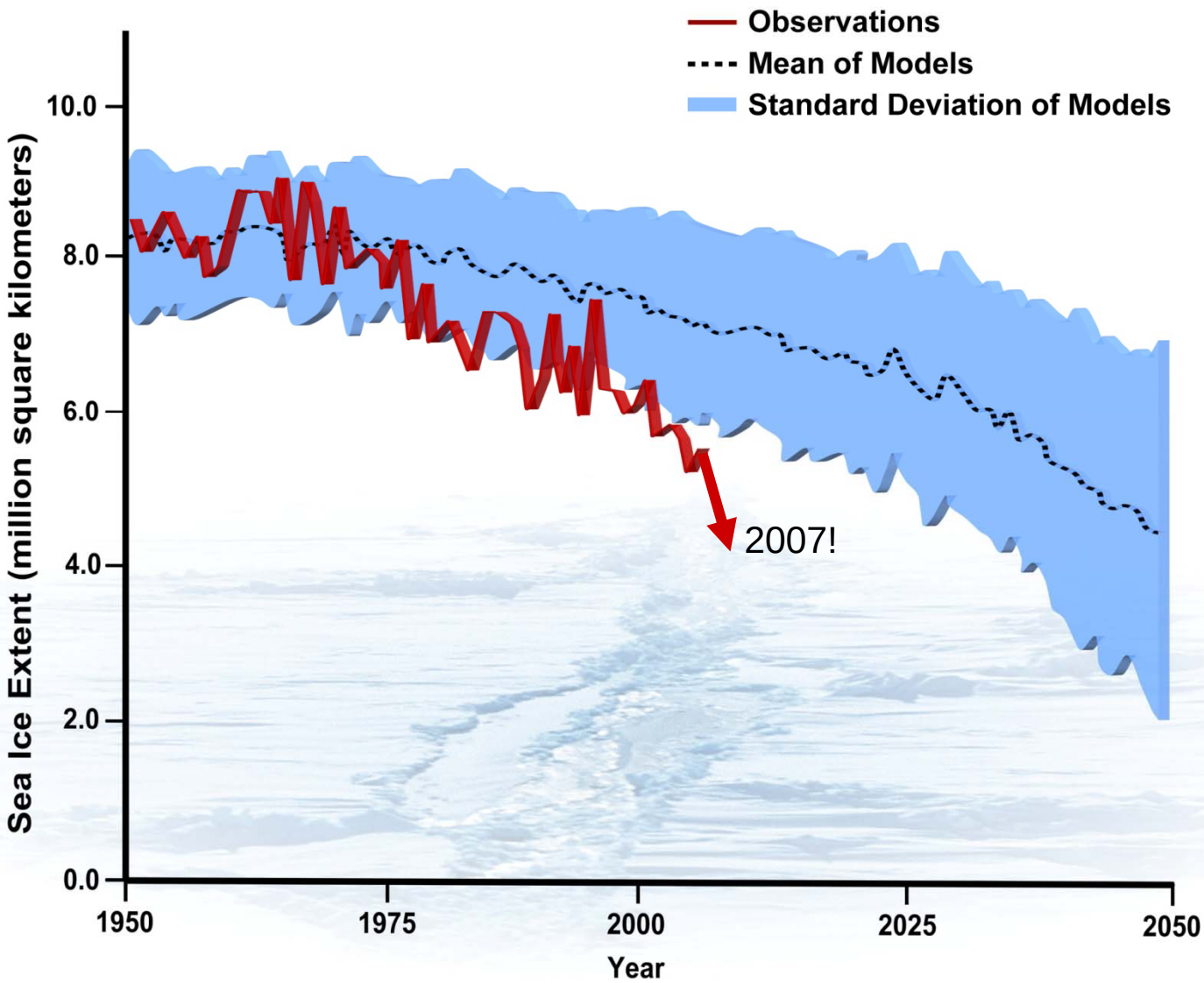


Time

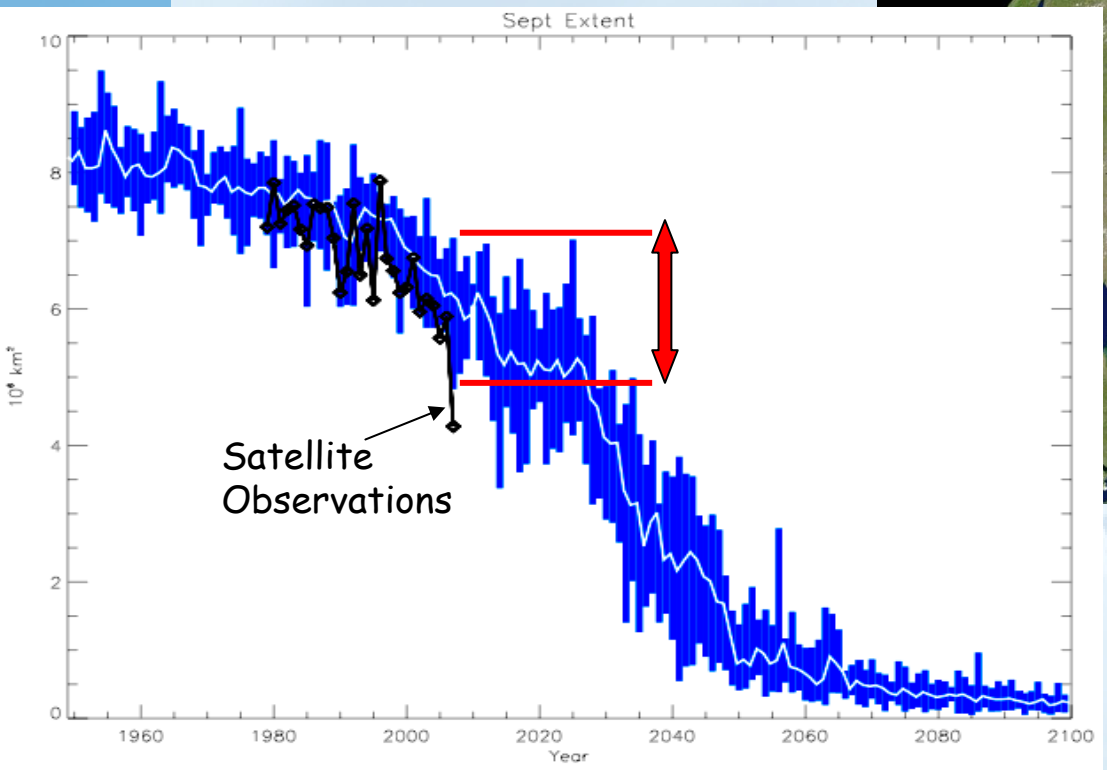
Seager *et al. Science* 2007

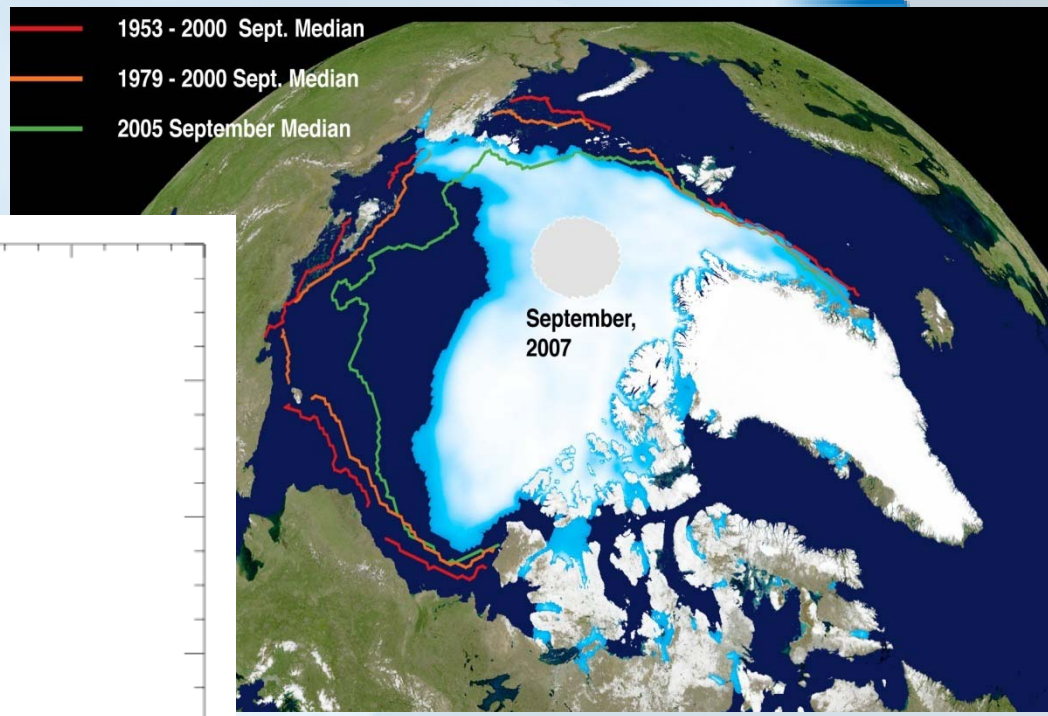
- See movie (or download movie - 355mb) of surface temperature with catastrophic volcanic eruptions from 1870 onward.

Arctic September Sea Ice Extent: Observations and Model Runs



Importance of Natural Variability





Some models are generally consistent with observed loss

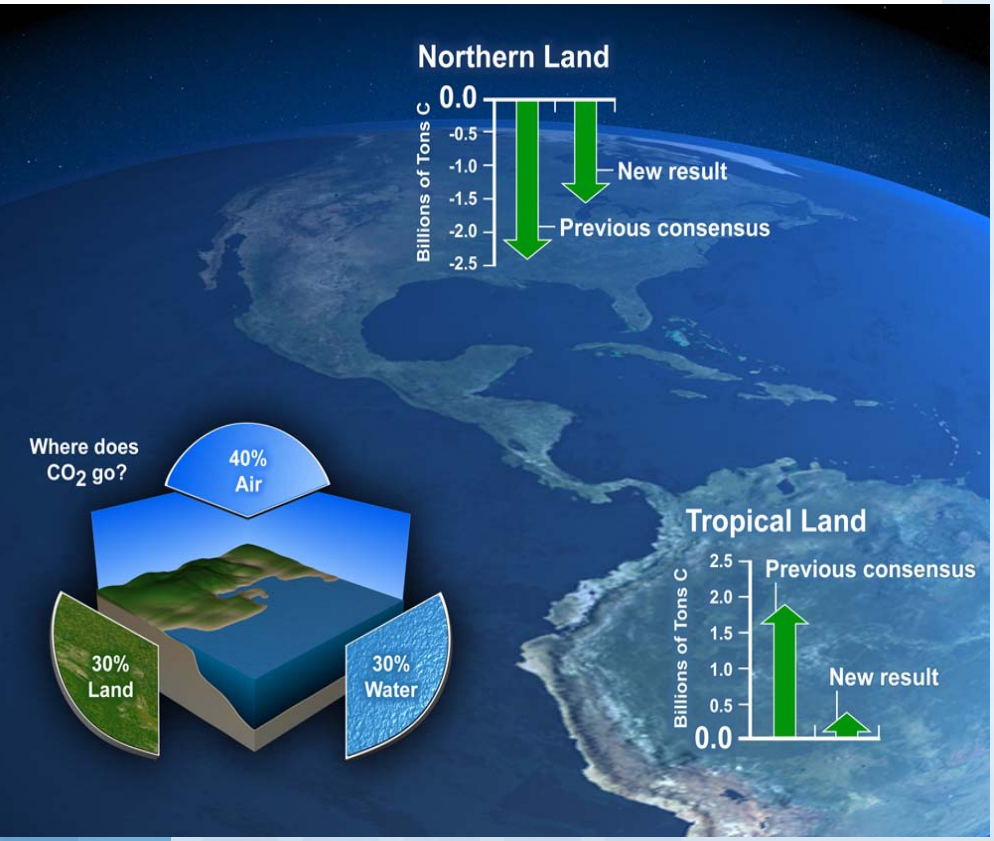
Even these models do not obtain 2007-like conditions until 2013

However simulated natural variability is considerable

Aircraft CO_2 Observations and the Missing Carbon Sink

NCAR

Weak Northern and Strong Tropical Land Carbon Uptake from Vertical Profiles of Atmospheric CO_2



Britt Stephens et al. Science (2007)

Airborne CO_2 measurements indicate:

- Northern forests, including U.S. and Europe, are taking up much less CO_2 than previously thought
- Intact tropical forests are strong carbon sinks and are playing a major role in offsetting carbon emissions

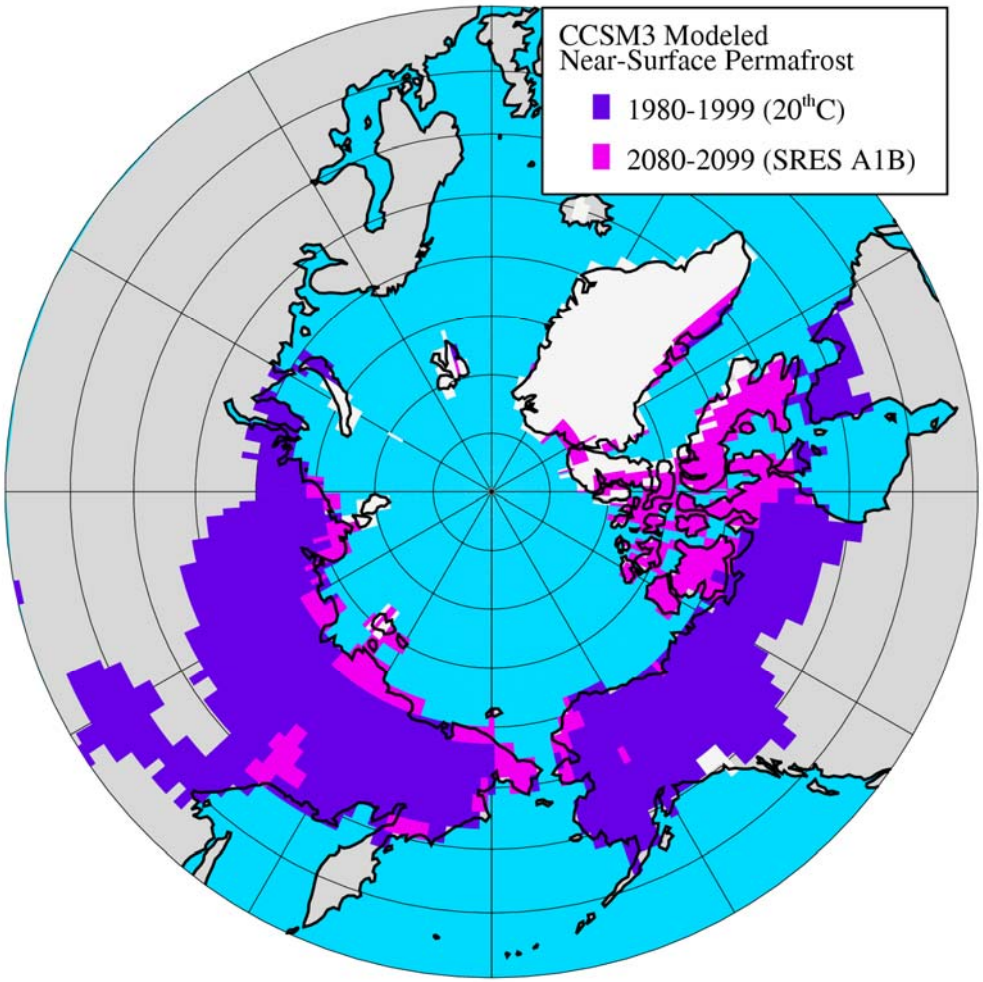
Implications of this work:

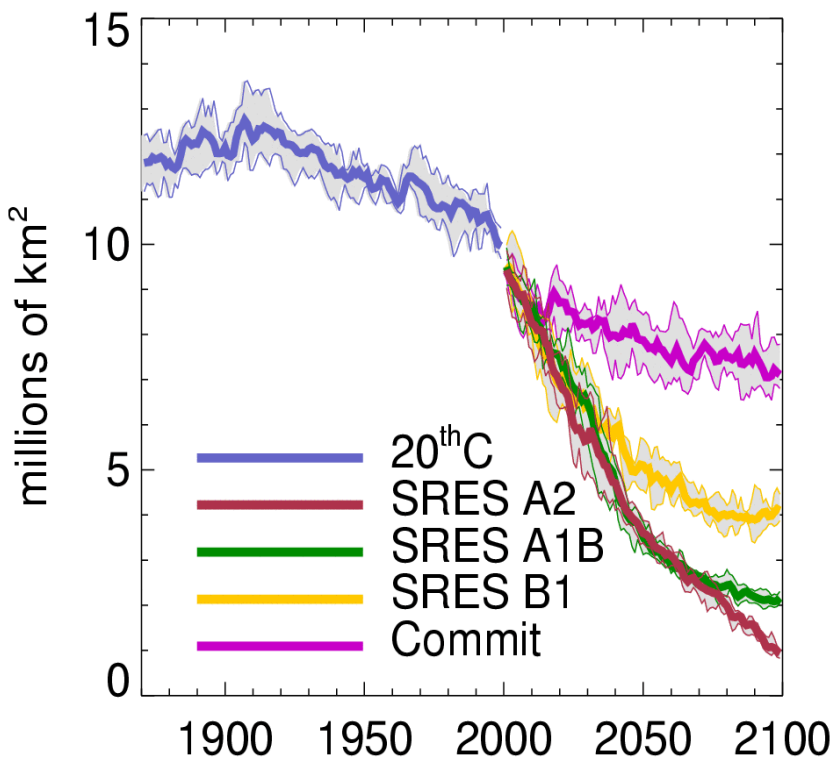
- Helps to resolve a major environmental mystery of the past two decades

  → Northern "missing carbon sink" has not been found because it is not there

- Improved understanding of processes responsible for carbon uptake will improve predictions of climate change and assessment of mitigation strategies

Projections of Degradation of Near-Surface Permafrost

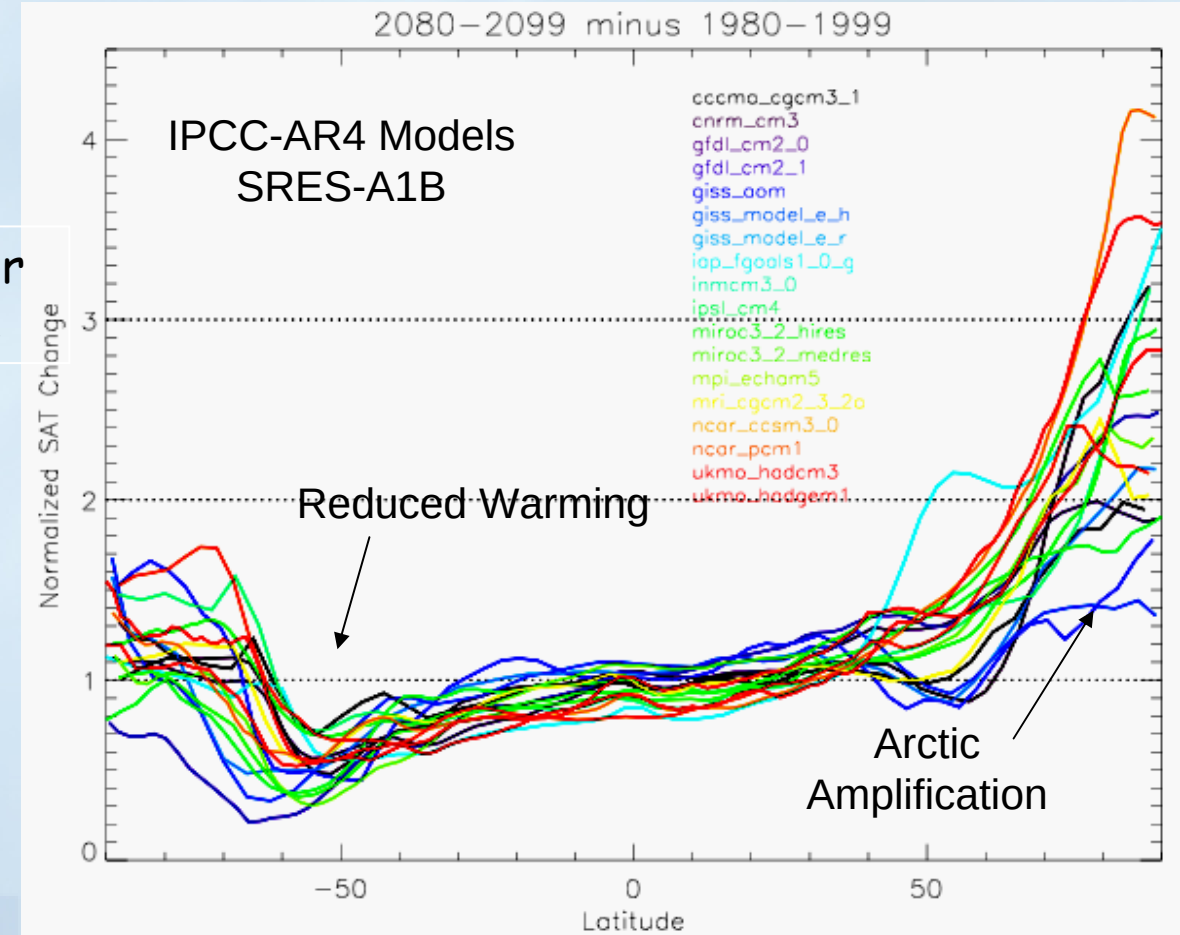




Lawrence and Slater, 2005

Consistency among models

Zonally Avg Air Temp Change



All models simulate that the Arctic will experience:

Shrinking ice cover, largest warming on globe, similar annual cycle of warming

Senate Commerce, Science, and Transportation, February, 2007:

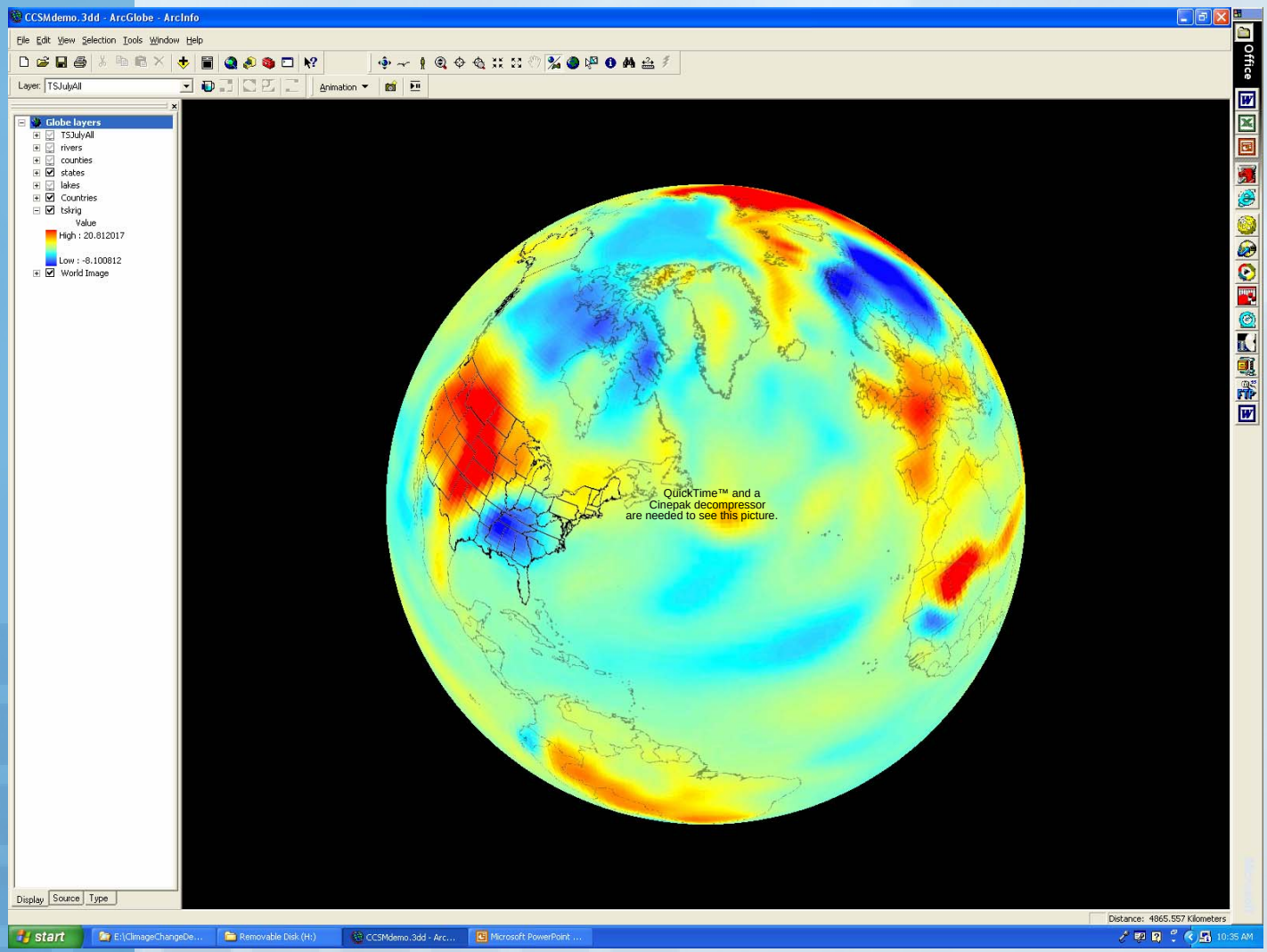
But, professor, what do we do about it?

House select committee on energy independence and global warming, visit to NCAR, October 2007:

How to manage and monitor a carbon cap and trade economy in the U.S?

GIS-Based Climate Services

See movie (or dowload movie - 147 mb)



e.g.,
100 year (2000-2099) change in mean July surface temperature

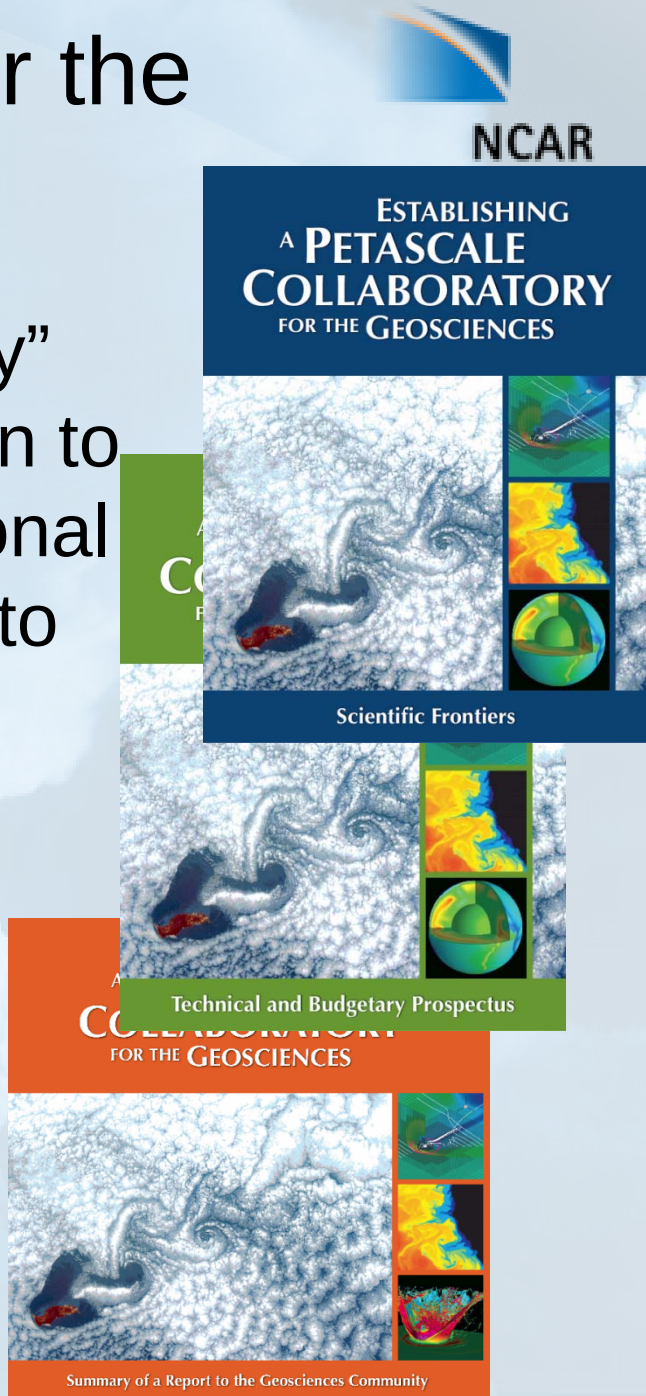
NCAR

Towards comprehensive Earth-system models that assimilate observations to provide a quantitative depiction of the Earth system and that make testable predictions of Earth's future

See movie (or download movie- 69mb) of precipitation, 2005 (May – Nov)

A Computational Vision for the Geosciences

- Establish a “Petascale Collaboratory” for the Geosciences with the mission to provide leadership class computational resources that will make it possible to address, and minimize the time to solution of, the most challenging problems facing the geosciences.



Closing Comments

(personal thoughts)

Scientific Progress in understanding the Earth as a System has proceeded steadily and is poised to accelerate dramatically with new computational and observational infrastructure

New decision tools exist or can be developed to support industrial decision making, by issue, by region and by economic sector

Uncertainties remain: e.g., future precipitation rates, the role of nitrogen, ice shelf stability, methane release rates, etc.