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Climate Change and the Future of the American  
West: Exploring the Legal and Policy  
Dimensions (Summer Conference, June 7-9)

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2006

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### SLIDES: Present and Future Status of Climate Change Computer Models

Warren M. Washington

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Warren M. Washington, *Present and Future Status of Climate Change Computer Models*, in *CLIMATE CHANGE AND THE FUTURE OF THE AMERICAN WEST: EXPLORING THE LEGAL AND POLICY DIMENSIONS* (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 2006).

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Title: Present and Future Status of Climate Change Computer Models

Abstract: A presentation will be given on the present and future status of climate change models. The evolution from simple climate models to fully complex Earth system models has led to an improved understanding of the causes of climate change and the impacts on the environment.

# Present and Future Status of Climate Change Computer Models

Warren M. Washington  
National Center for Atmospheric Research

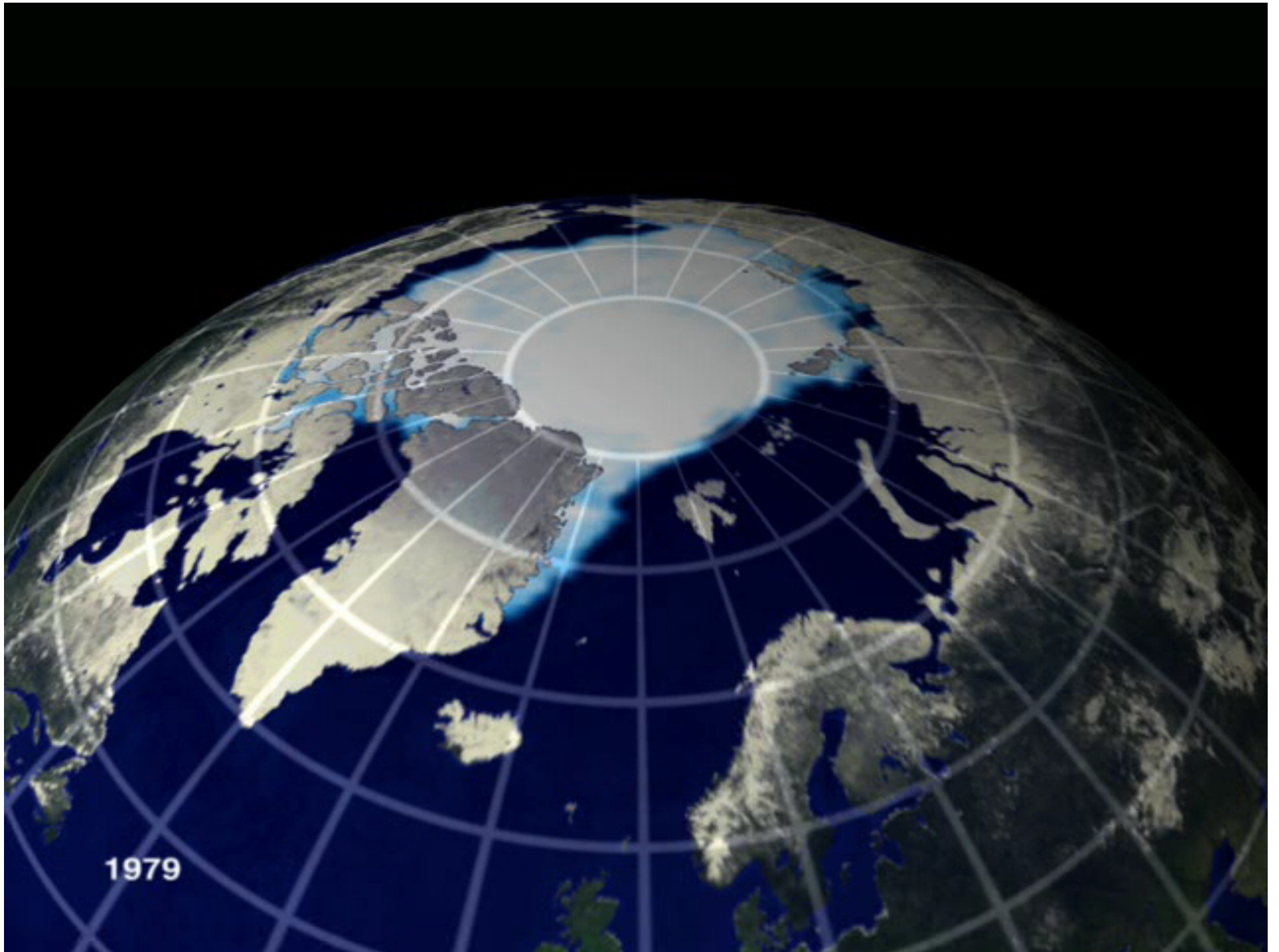
June 2006



NCAR

# Overview

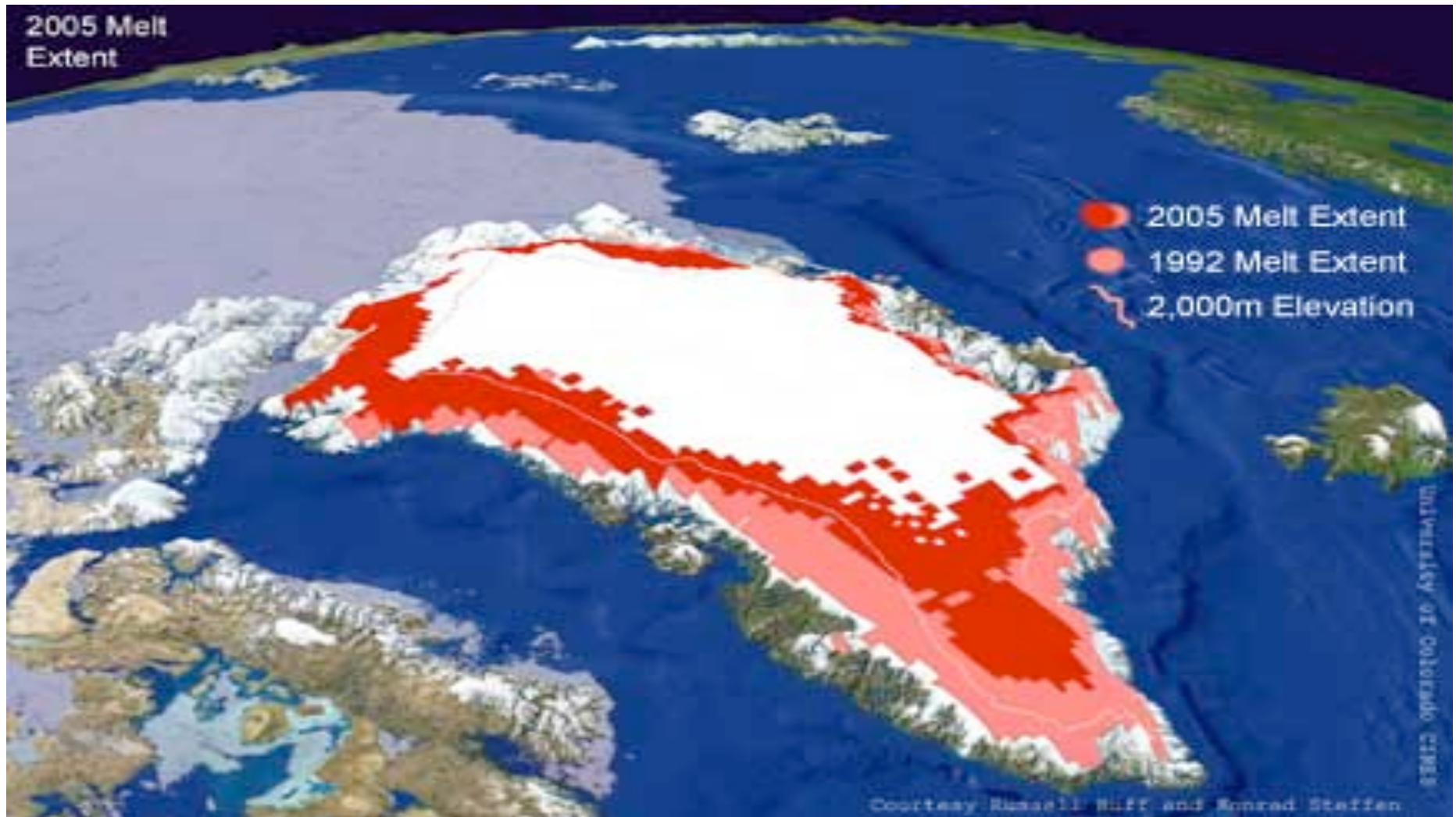
- What is in climate models
- Verification of climate models
- Model projections of past and future climates
- Mitigation versus adaptation
- Computer models as a tool for geoengineering the climate system



1979



University of Colorado: Cooperative Institute for  
Research in Environmental Science, NOAA, NASA  
Konrad Steffen's group uses QuickSCAT data

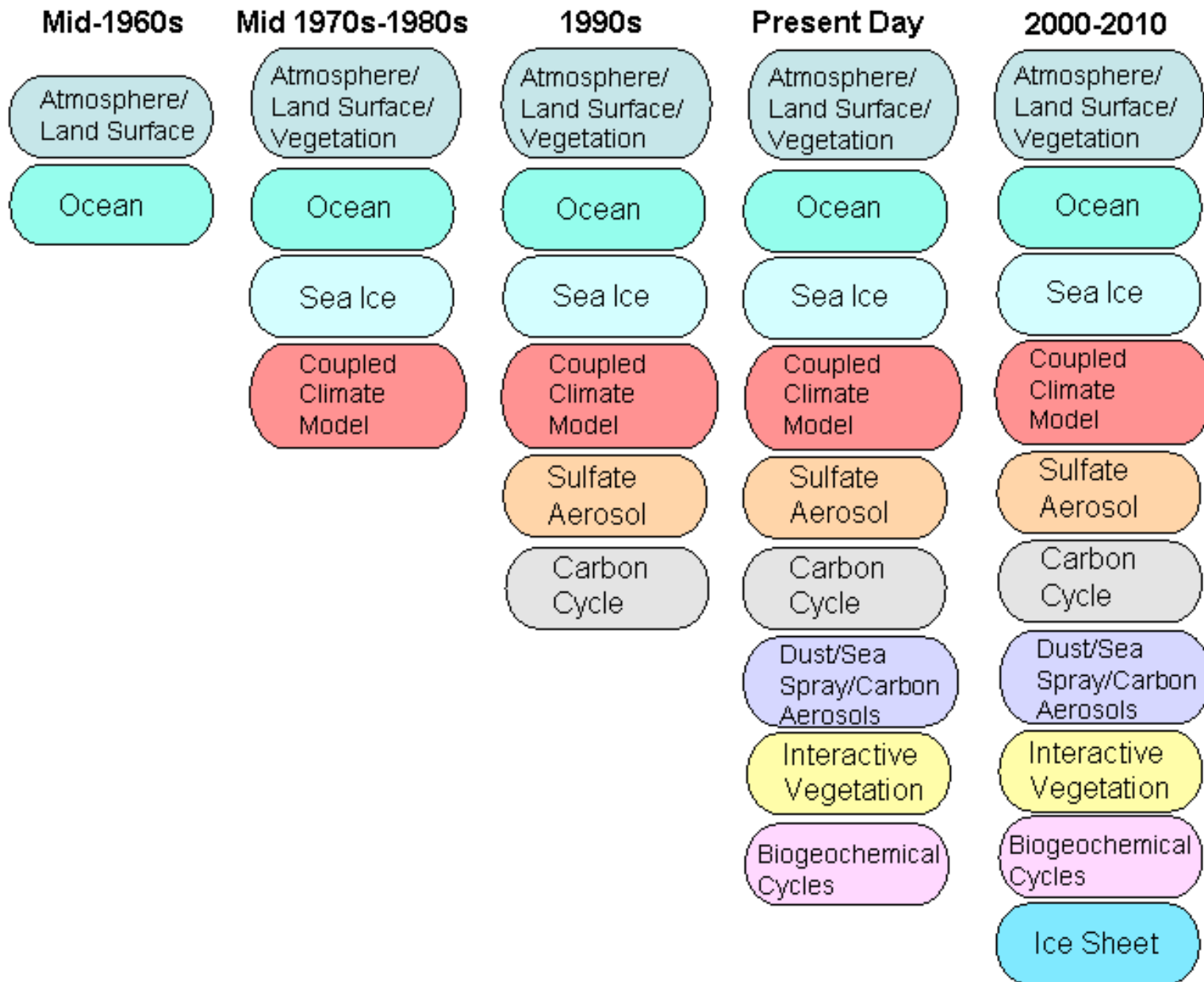


What is the status of  
state-of-the-art climate  
models and their  
transition to earth  
system models?

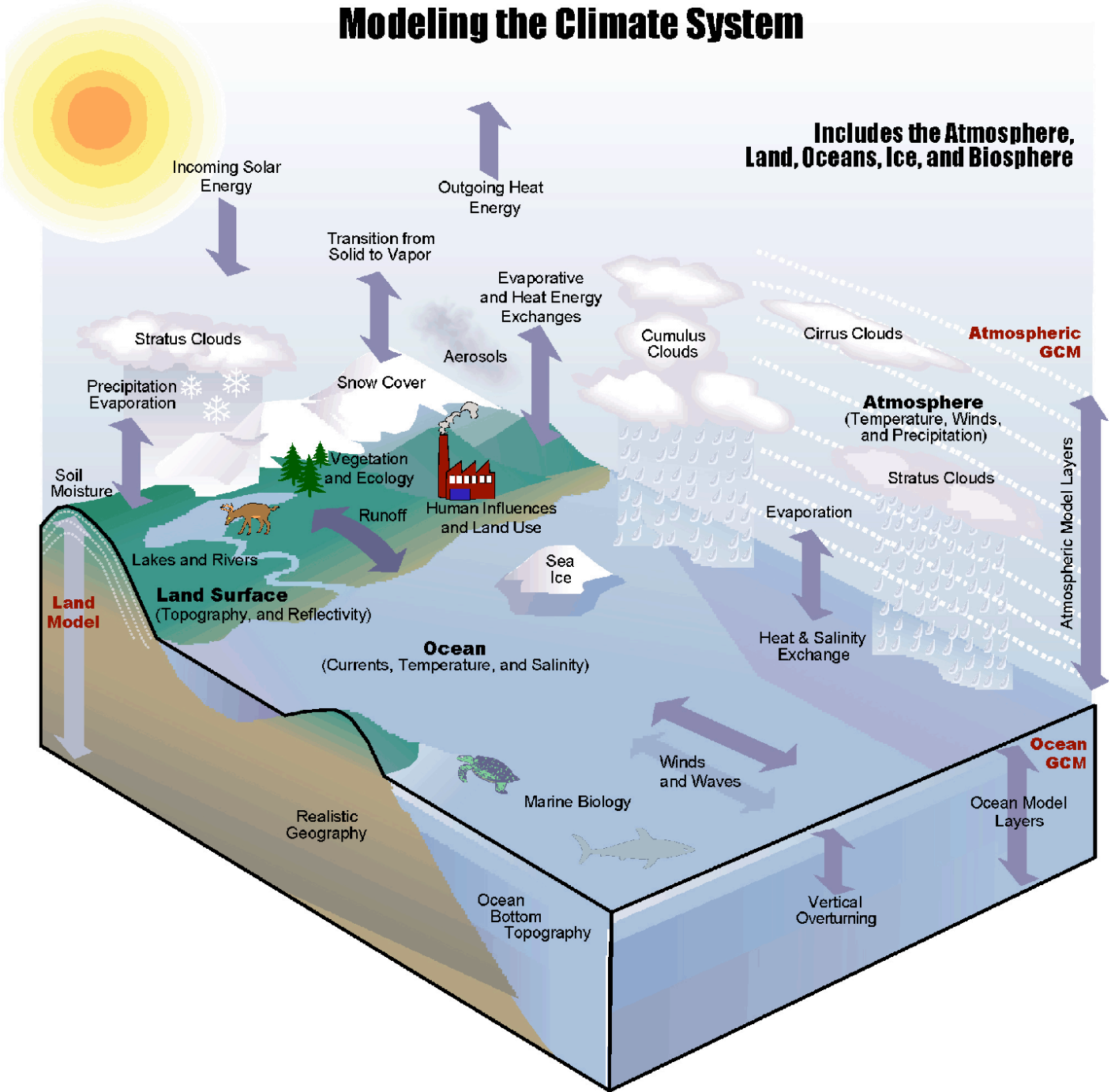




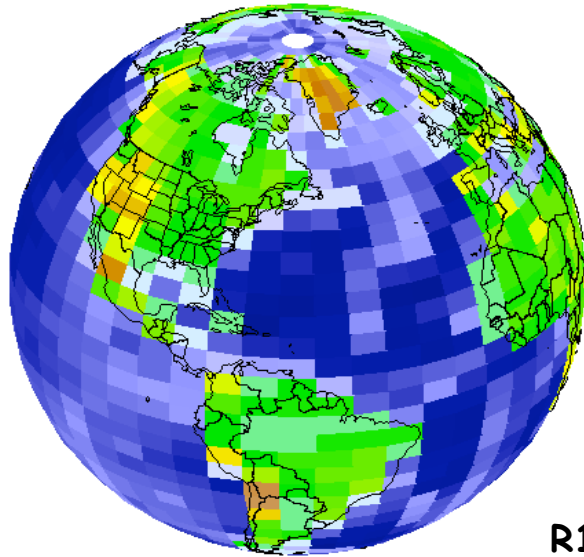
# Timeline of Climate Model Development



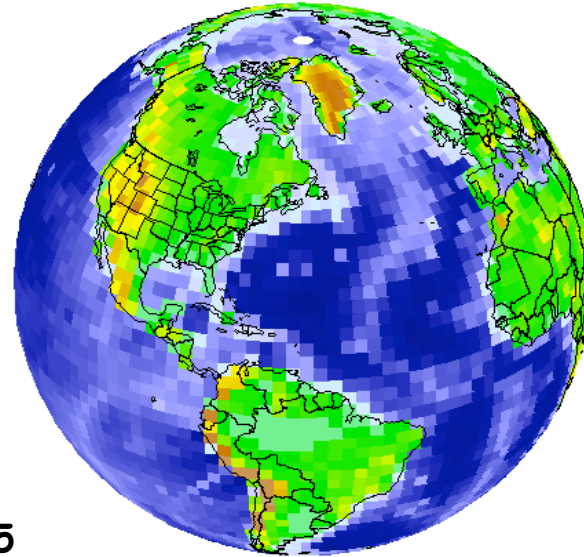
# Modeling the Climate System



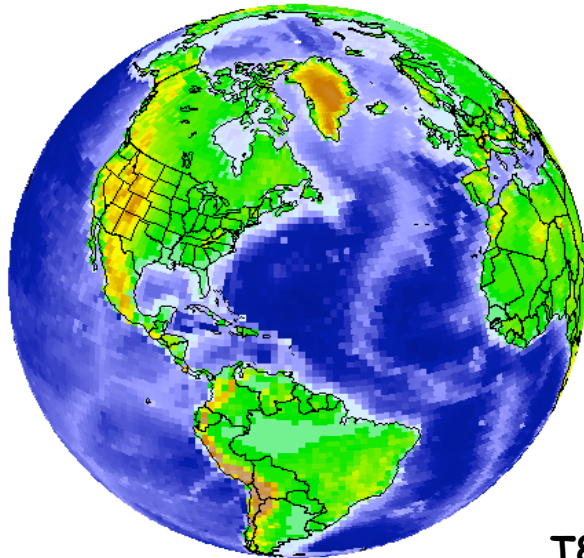
# Model Resolutions



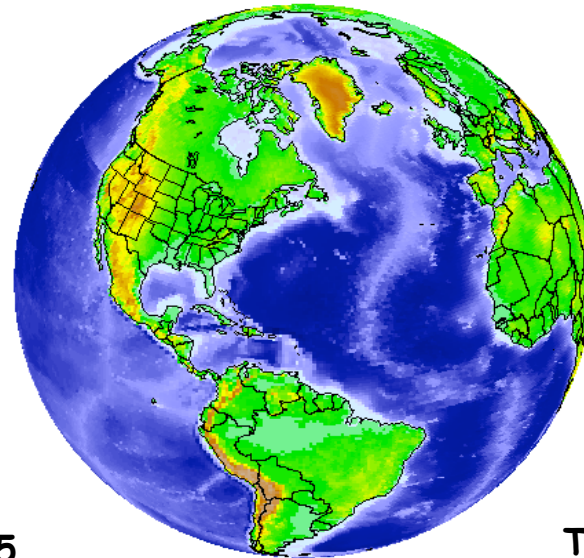
R15



T42

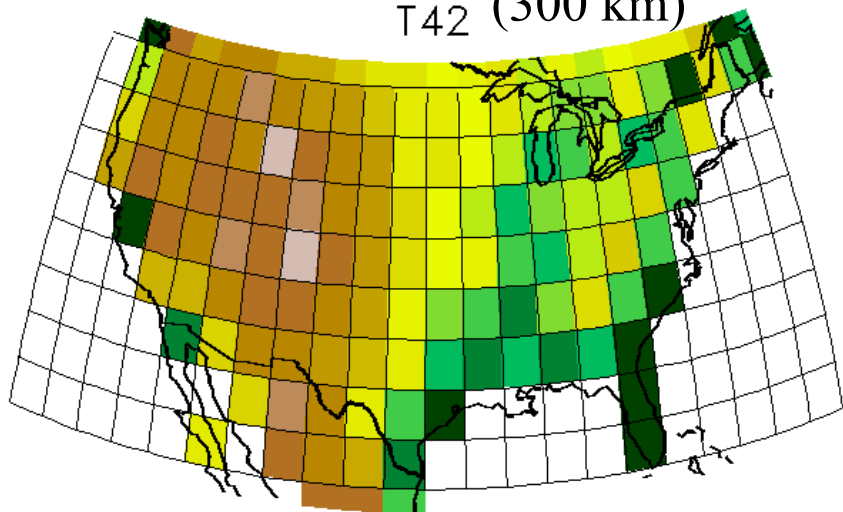


T85

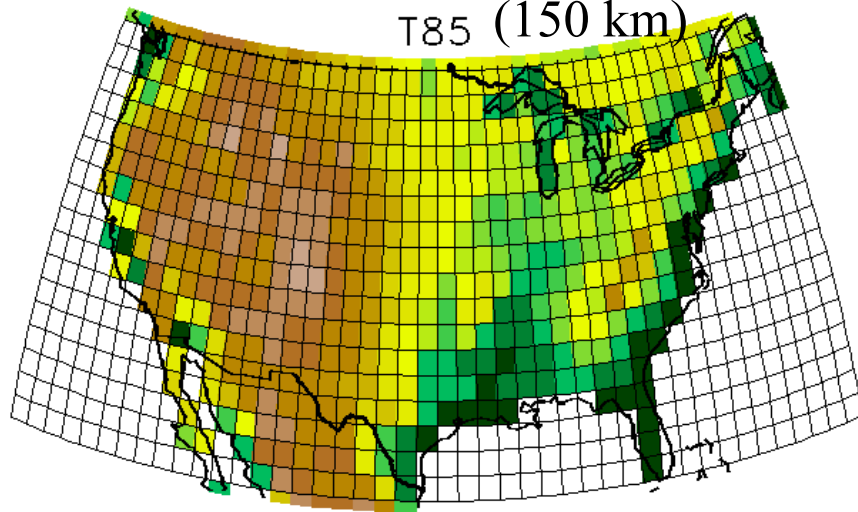


T170

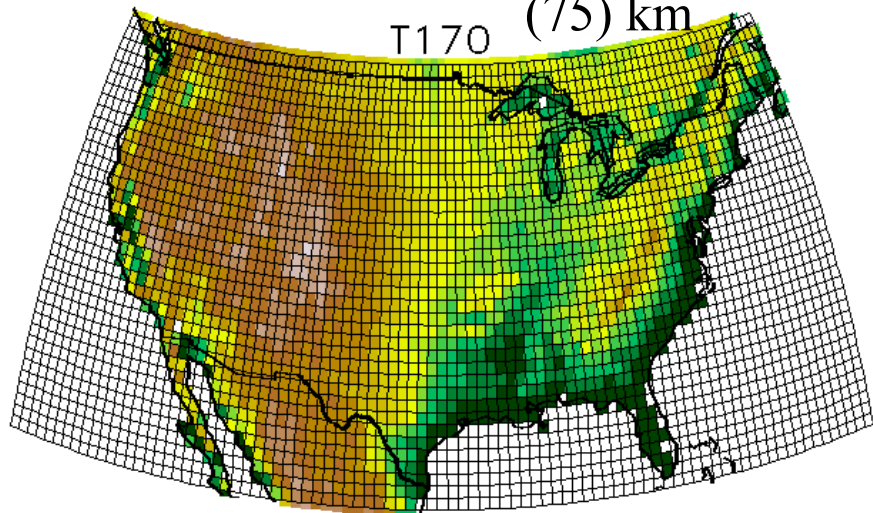
T42 (300 km)



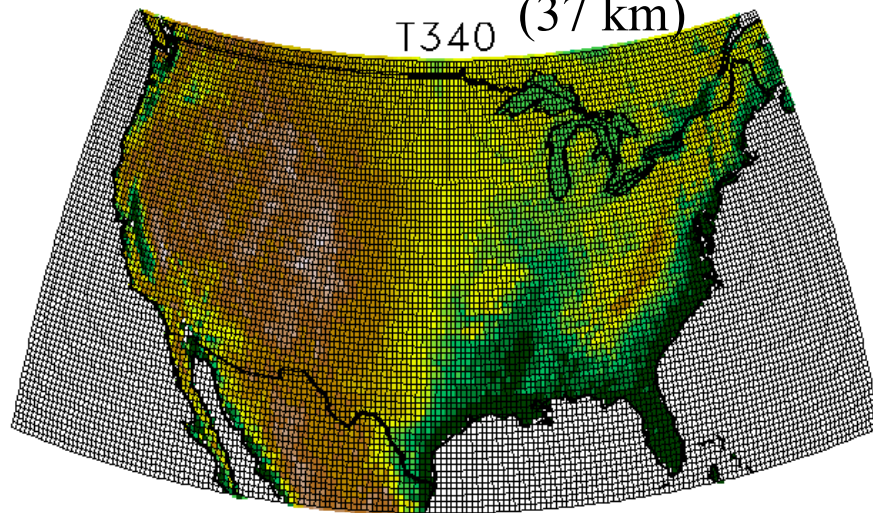
T85 (150 km)



T170 (75 km)

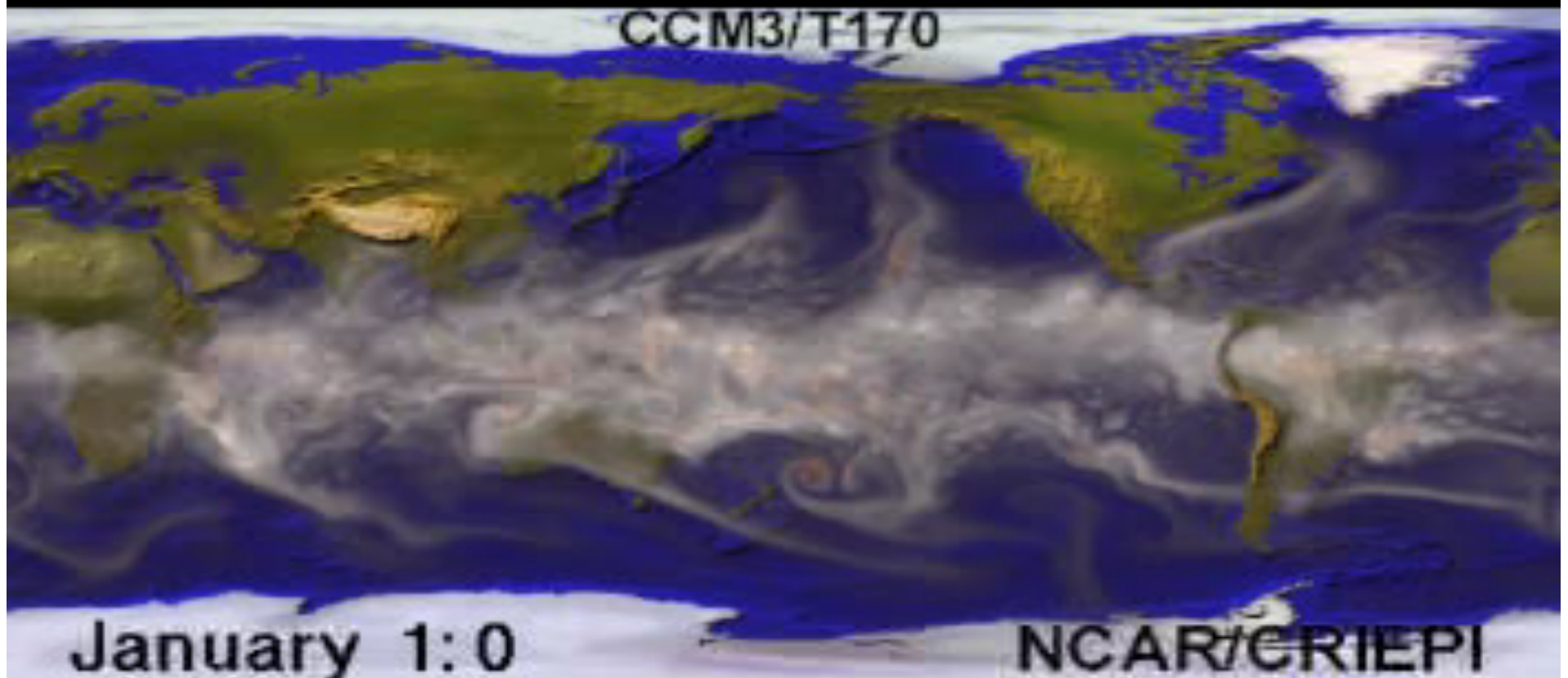


T340 (37 km)

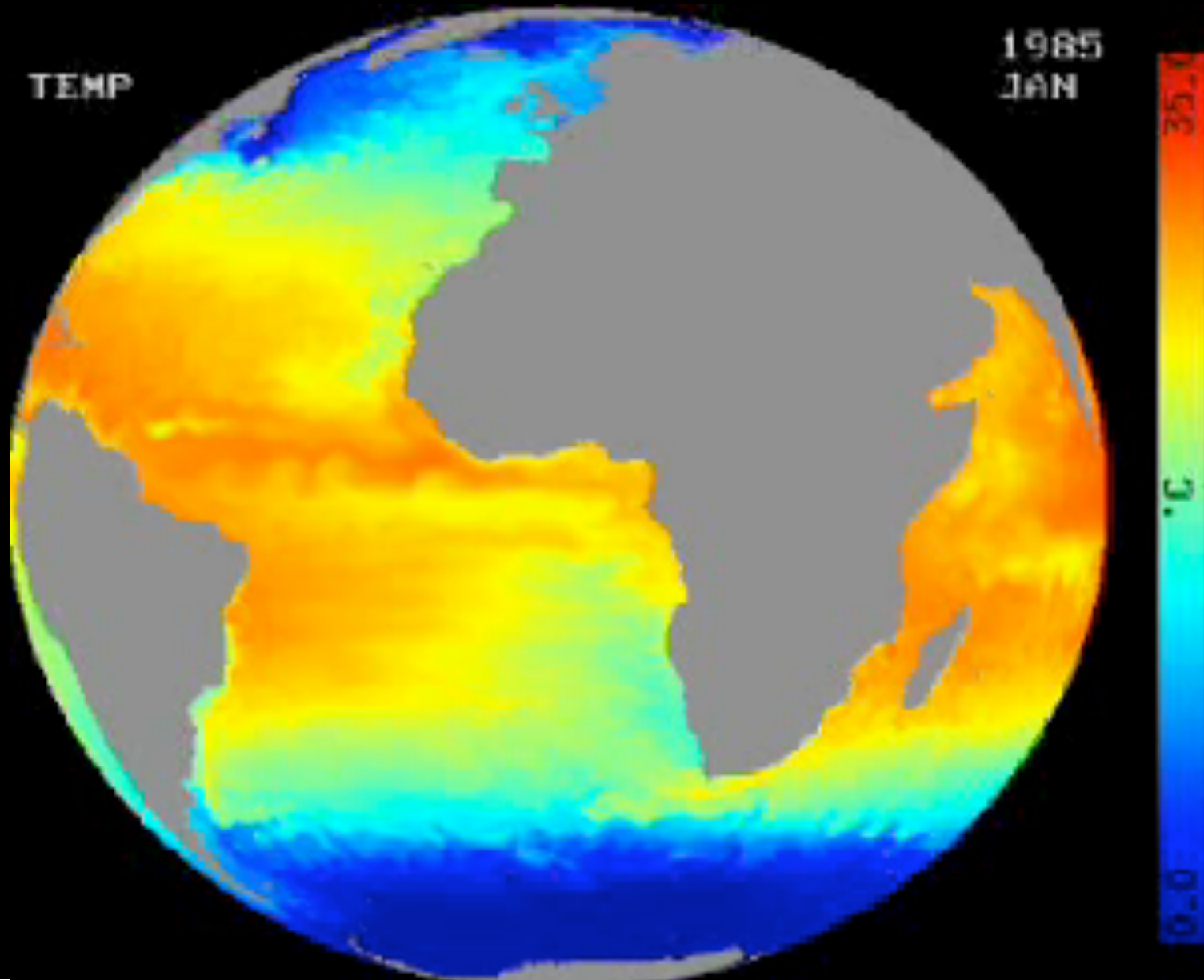




# Global Atmosphere



# Global Sea Surface Temperature



# Global and Regional Climate Aspects Using a Climate Model

- El Niño/La Niña
- Monsoons
- North Atlantic Oscillation
- Arctic Oscillation





Mt Pinatubo eruption in the Philippines, June 15, 1991. Gases and solids injected 20 km into the stratosphere.

From Church, White, & Arblaster



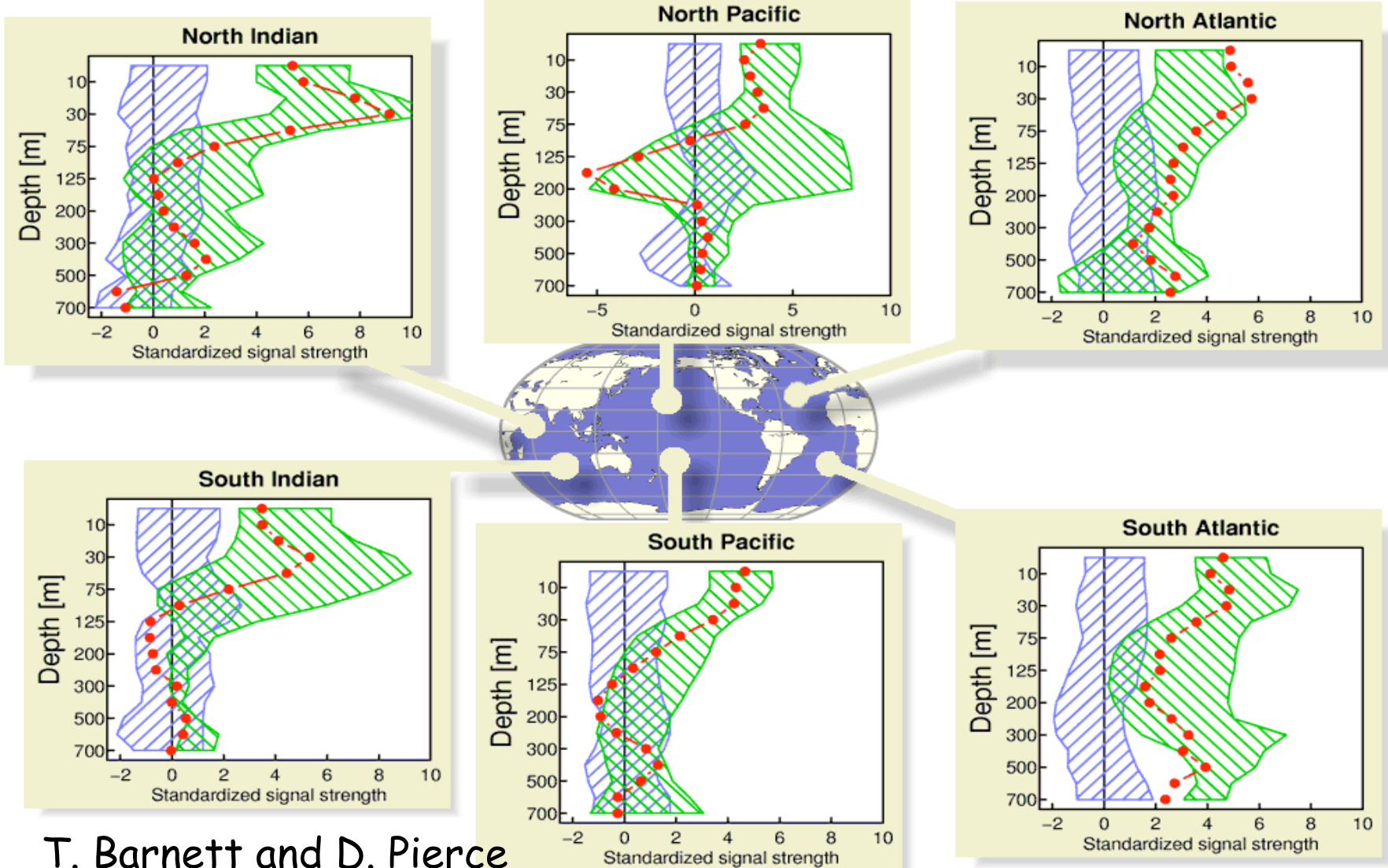
Source: World Resources 2000-2001

Time Magazine - 9 April 2001



# Penetration of Ocean Warming Signal (1955–1999)

Red=Observed    Green=Parallel Climate Model (PCM)    Blue=PCM control run



T. Barnett and D. Pierce  
of SIO

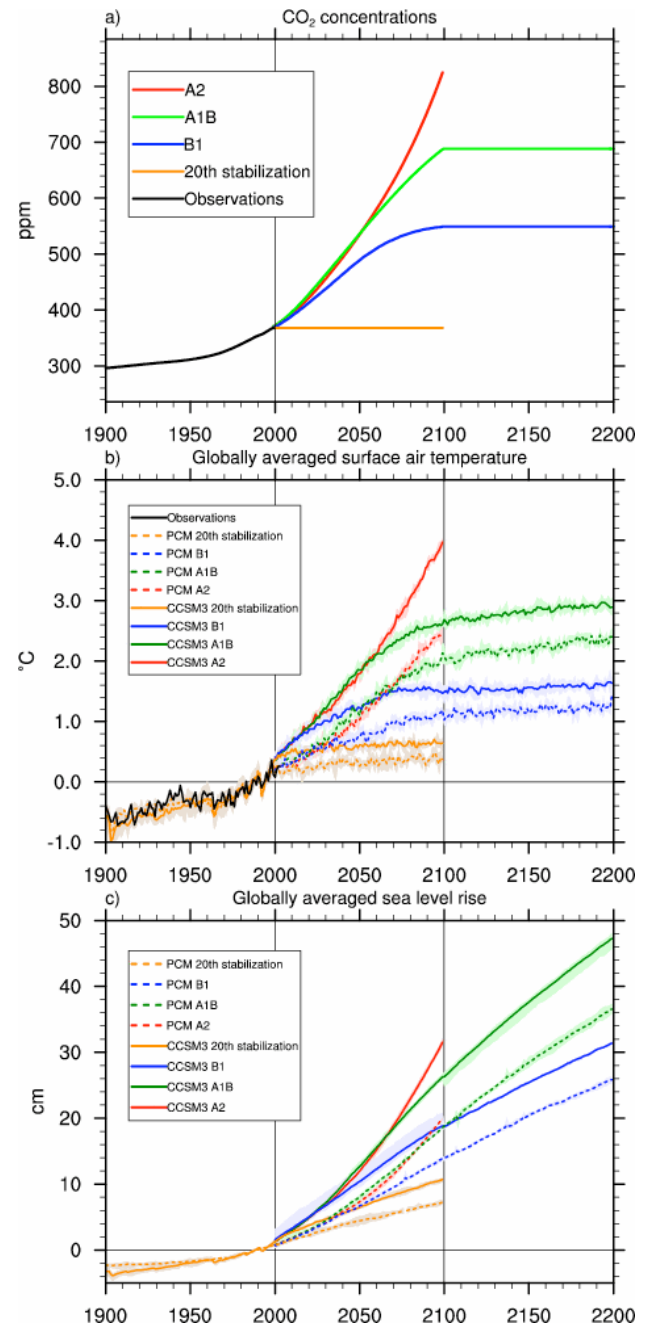
# Climate Change Scenarios:

At any point in time, we are committed to additional warming and sea level rise from the radiative forcing already in the system.

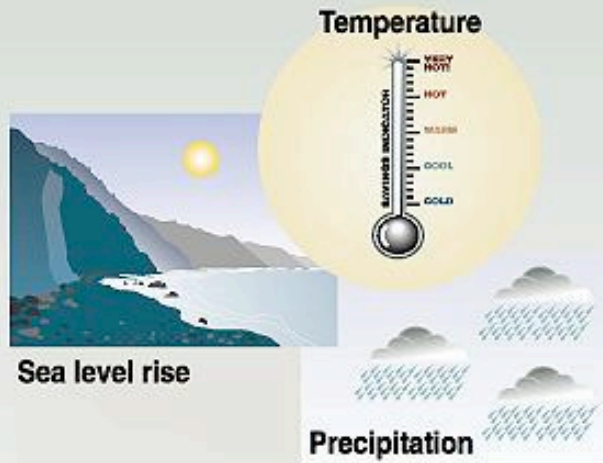
Warming stabilizes after several decades, but sea level from thermal expansion continues to rise for centuries.

Each emission scenario has a warming impact.

(Meehl et al., 2005: How much more warming and sea level rise? *Science*, 307, 1769-1772)



# Potential climate changes impact



## Impacts on...

### Health



Weather-related mortality  
Infectious diseases  
Air-quality respiratory illnesses

### Agriculture



Crop yields  
Irrigation demands

### Forest



Forest composition  
Geographic range of forest  
Forest health and productivity

### Water resources



Water supply  
Water quality  
Competition for water

### coastal areas



Erosion of beaches  
Inundation of coastal lands  
additional costs to protect coastal communities

### Species and natural areas



Loss of habitat and species  
Cryosphere:  
diminishing glaciers

# Global Warming Effects on Hurricanes

- Several studies show more intense hurricanes and less frequent

# Ongoing and Future Climate Model Developments

- Higher resolution, especially important near mountains, river flow, and coast lines
- Full hydrological coupling including ice sheets...important for sea level changes
- Continued improvement in clouds and aerosol effects including solar dimming
- Better vegetation and land surface treatments with ecological interactions
- Carbon and other biogeochemical cycles



# Future Changes That Affect Sustainable Resources

- Warmer, more moist, heavier rainfall events
- Jet stream move further poleward and weaker
- Storm systems moving slower but more intense rainfall events
- Significant regional changes e.g. subtropics

# Should We Consider Geoengineering the Climate?

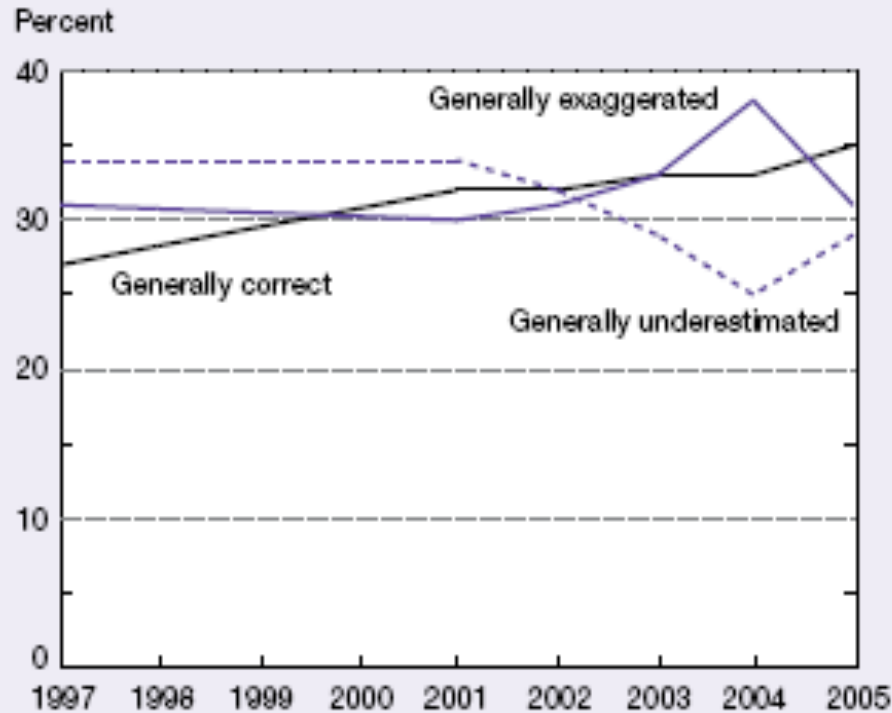
## What are the Legal and Ethical Issues?

What if we find ourselves in a situation where the global temperature increase is  $0.6^{\circ}\text{C}/\text{decade}$ ?

# Proposed schemes for geoengineering can be tested with climates e.g.:

- Dimming the earth with dust
- Shields in space
- Putting iron in the ocean
- Weather modification storm and hurricane systems

Figure 7-12  
Perceptions about news coverage of global warming: 1997–2005



NOTE: Responses to: *Thinking about what is said in the news, in your view is the seriousness of global warming generally exaggerated, generally correct, or is it generally underestimated?*

SOURCE: L. Saad, Public's environmental outlook grows more negative, *Gallup Poll News Service* (21 April 2005), <http://www.gallup.com/poll/content/?ci=15961&pg=1>.

*Science and Engineering Indicators 2006*

## Public Attitude About News Coverage on Global Warming

Google S&E Indicators

Chapter 7. Science and Technology:  
Public Attitudes and Understanding

# Future Climate Change Policy Debate is here



NASA

The End