

An aerial photograph of a coastal region. The image shows a large body of dark water on the right side, with a prominent peninsula extending into it. The land is covered in dense, brownish-green vegetation, likely a forest or scrubland. The overall scene is captured from a high angle, showing the intricate patterns of the terrain and the coastline.

Climate Change and Natural Resources

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Rutgers University

An aerial photograph of a coastal region, likely a river delta, showing a network of waterways and surrounding land. The land is a mix of brown and green, indicating different types of vegetation or soil. The water is dark, and the overall scene is viewed from a high angle.

Earth System Science
Greenhouse Effect
Modeling Climate Change
Sea Ice and the Arctic
Sea Level Rise
Impacts on Natural Resources

An aerial photograph showing a complex network of waterways. A large, dark, irregularly shaped body of water is the central focus, surrounded by a dense network of smaller, branching channels and streams. The surrounding land is a mix of brown and green, suggesting a natural, possibly forested or agricultural, environment. The overall scene illustrates a complex system of water flow and land interaction.

What is a System?

What are components of earth system?



An aerial photograph of a coastal landscape. A large, dark blue body of water occupies the right side of the frame. A narrow peninsula or isthmus connects the land to the water. The land is covered in dense, brownish-green vegetation. The overall scene is a natural, undisturbed coastal environment.

What are components of earth system?

Atmosphere

Hydrosphere

Geosphere

Biosphere



Air



Water



Land



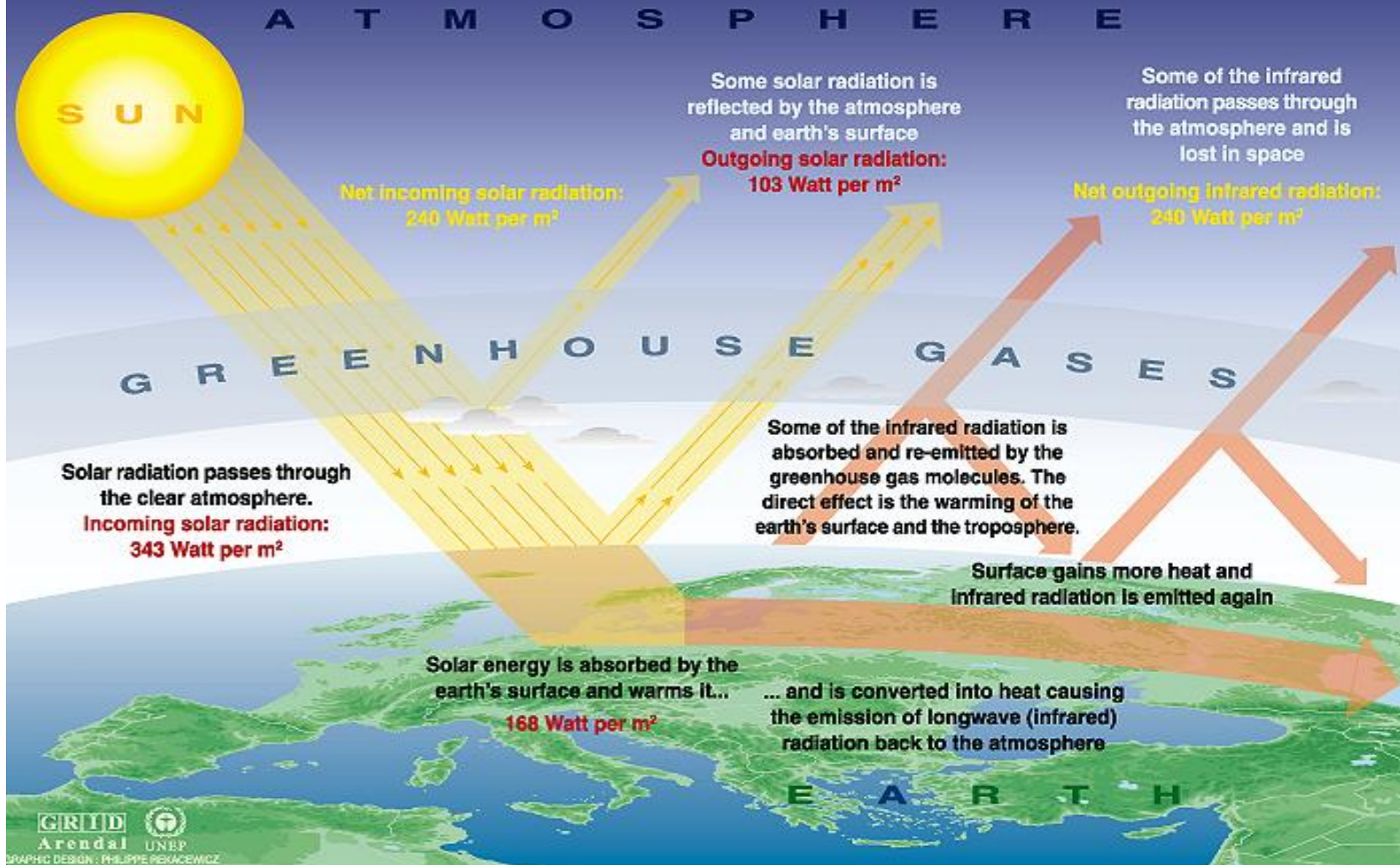
Life



What is the Greenhouse Effect?

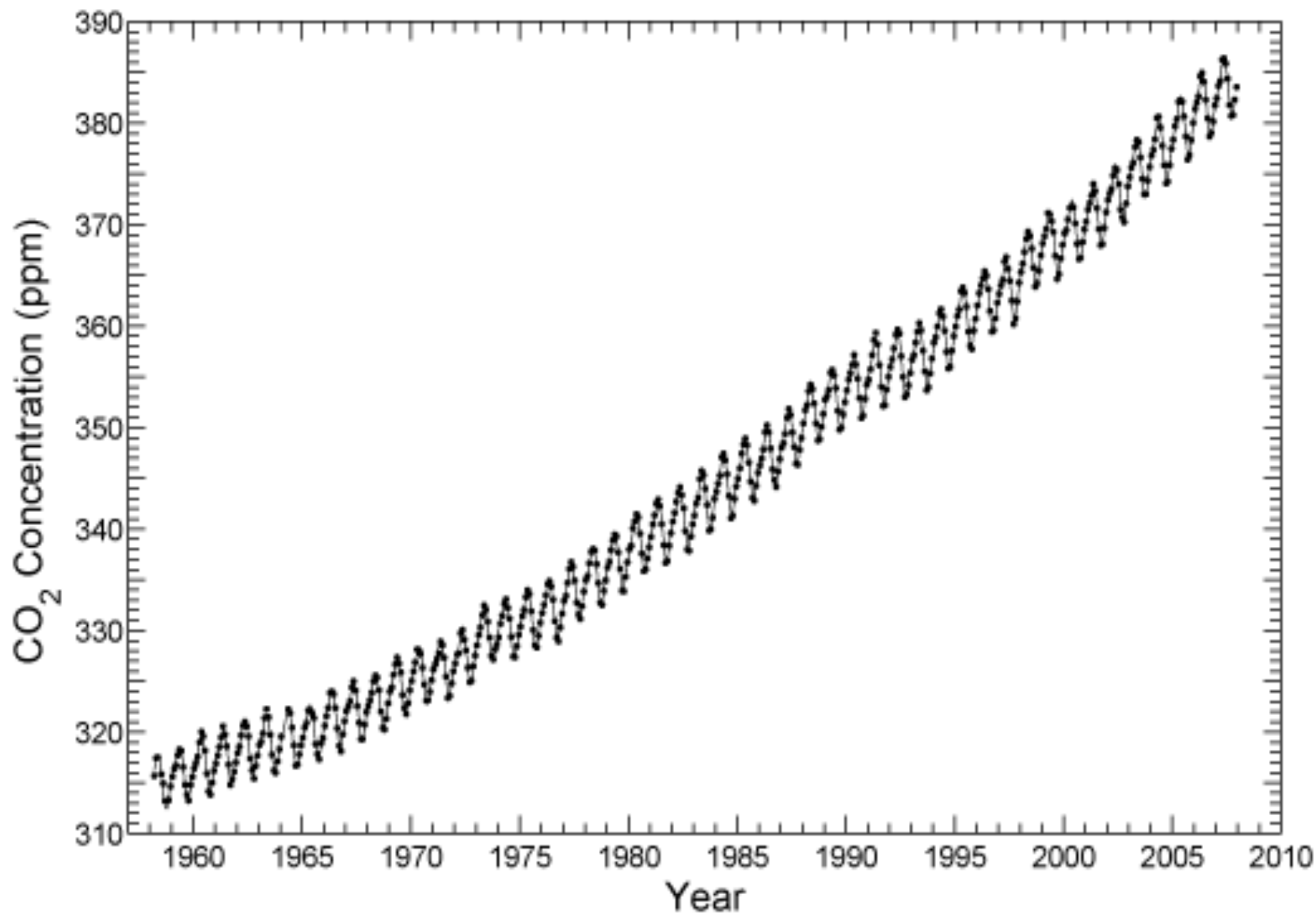


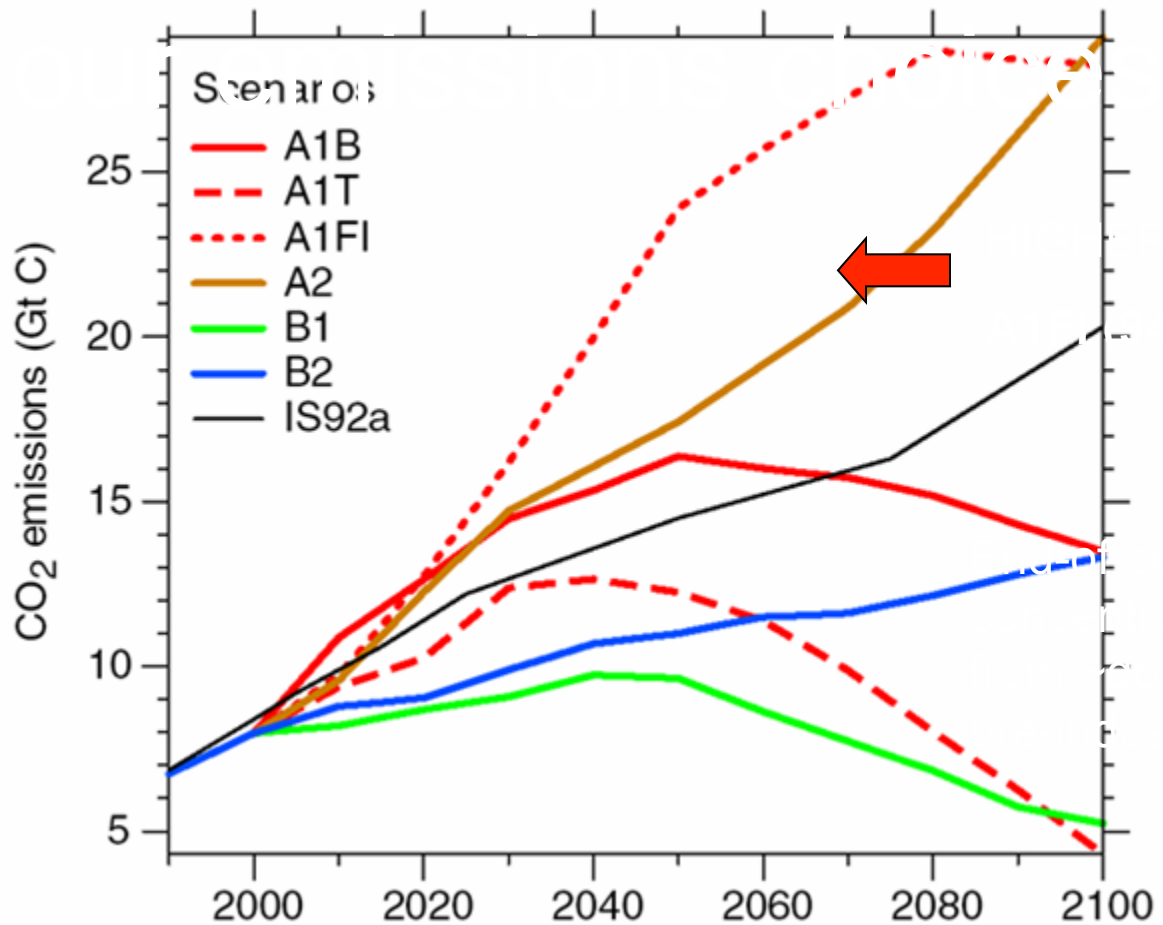
The Greenhouse effect



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Mauna Loa Record



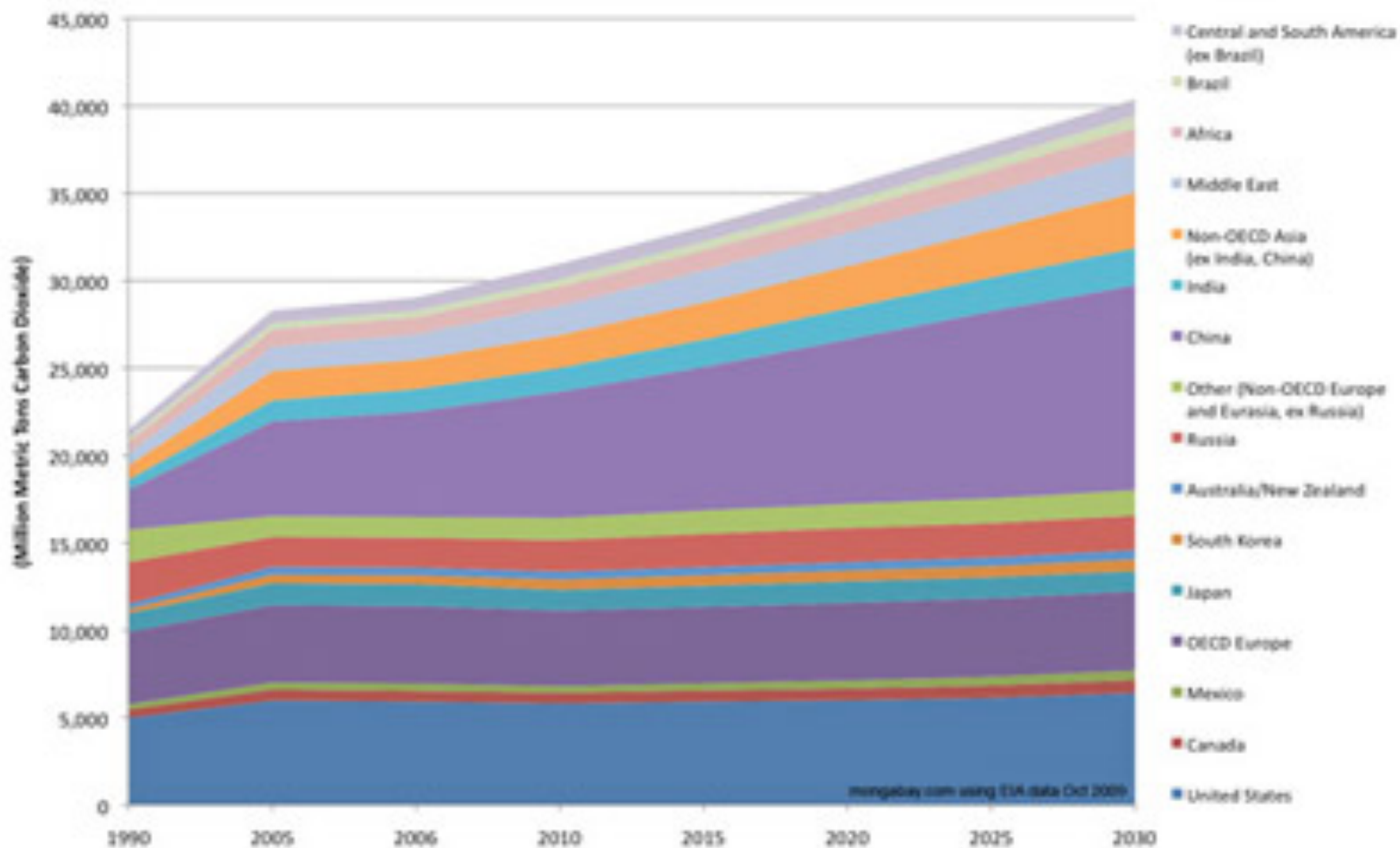


www.climatechoices.org/ne/

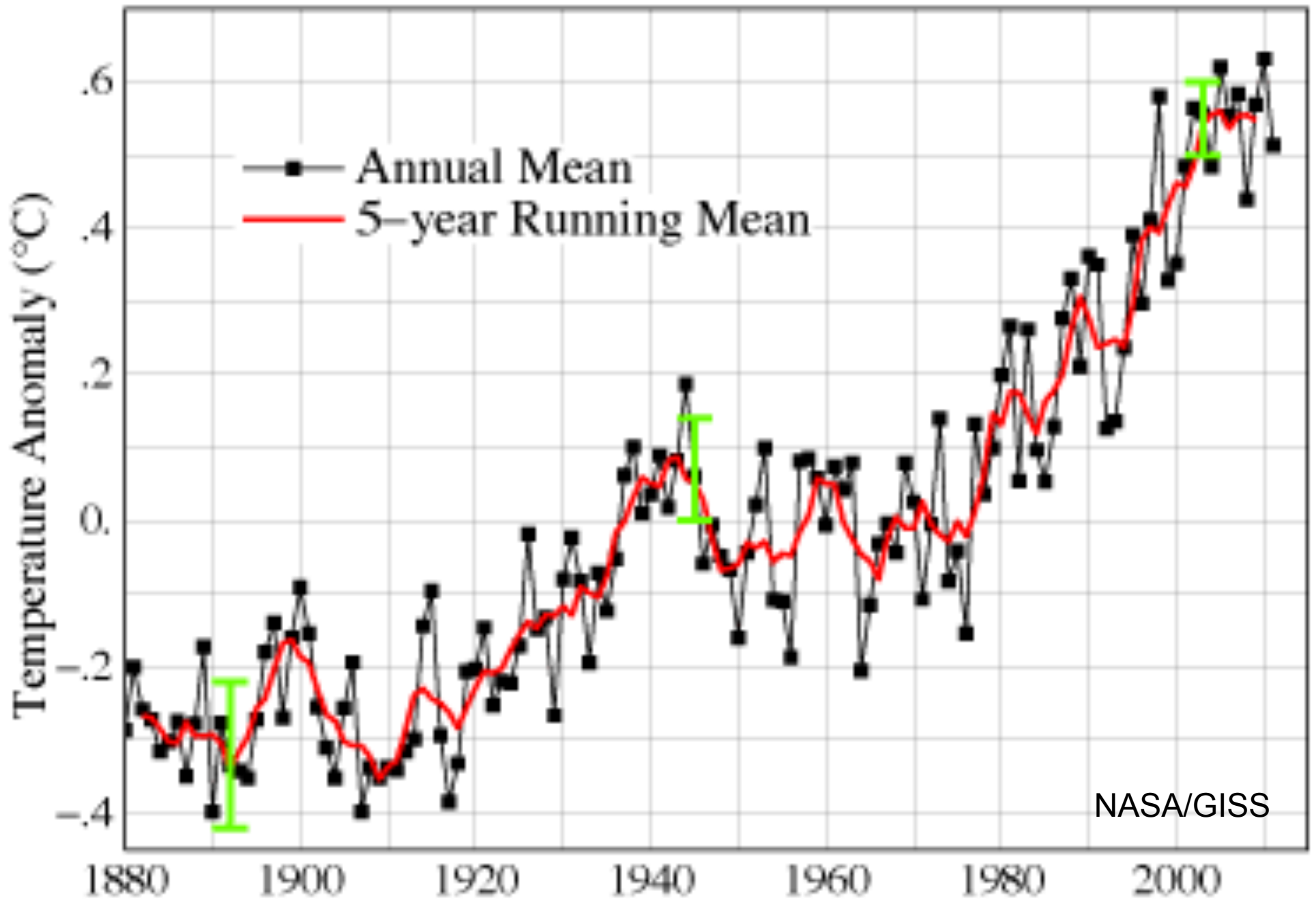
B1 (550 ppm)

Source: IPCC 2001

World Carbon Dioxide Emissions by Region, Reference Case, 1990-2030

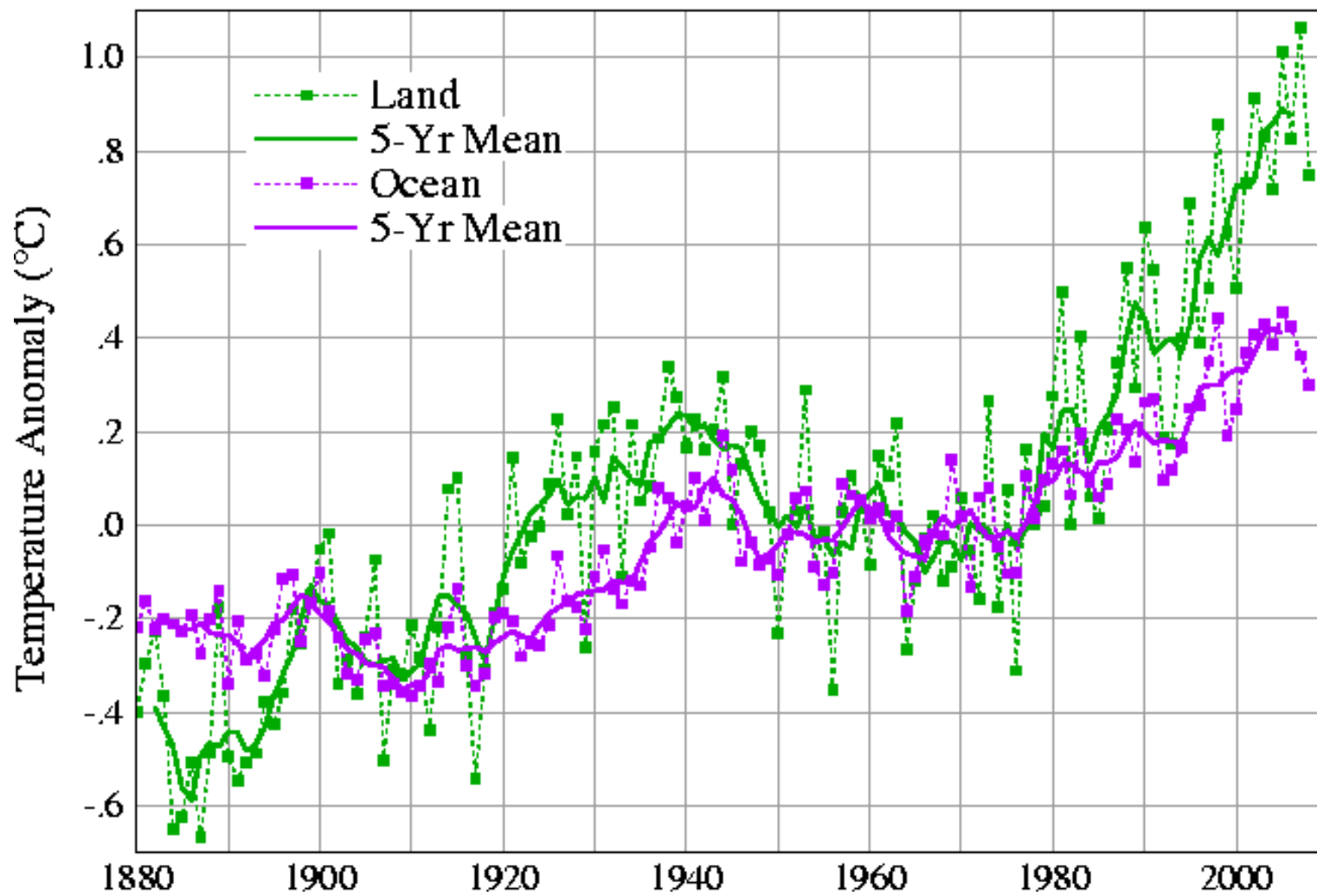


Global Land–Ocean Temperature Index



NASA/GISS

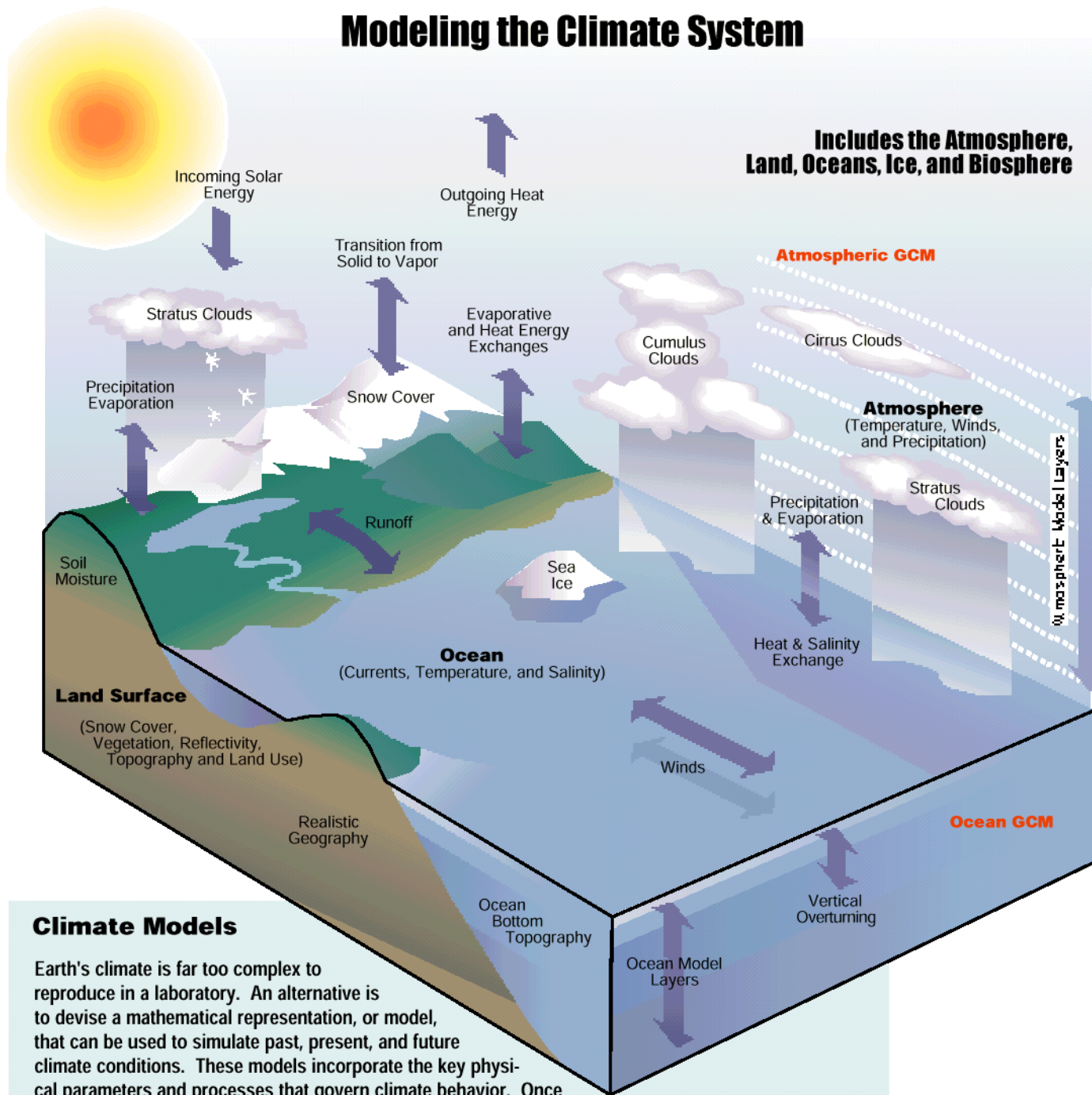
Land and Ocean Temperature Changes



What is a Model?



Modeling the Climate System



**Includes the Atmosphere,
Land, Oceans, Ice, and Biosphere**

Atmospheric GCM

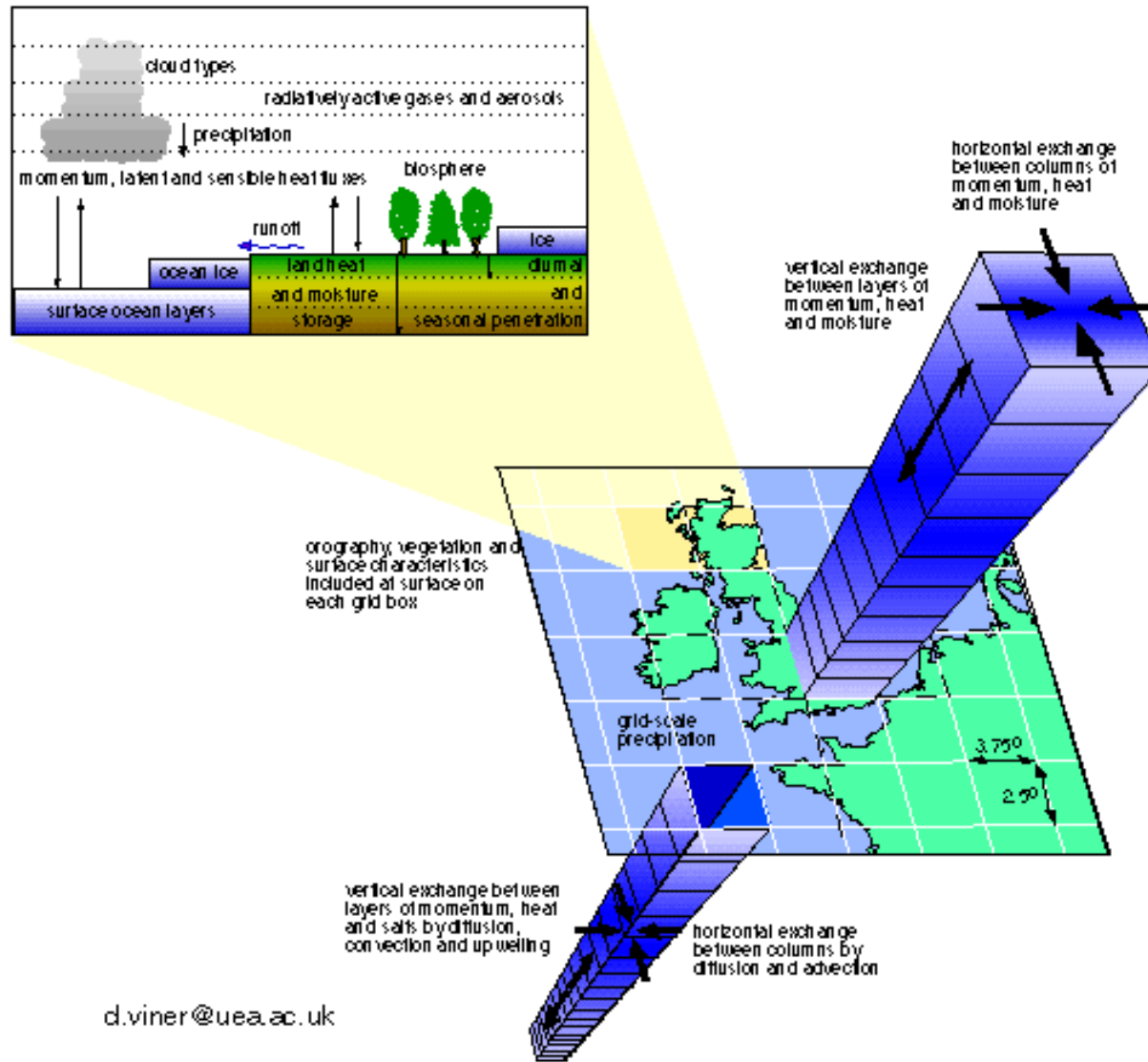
Atmosphere
(Temperature, Winds,
and Precipitation)

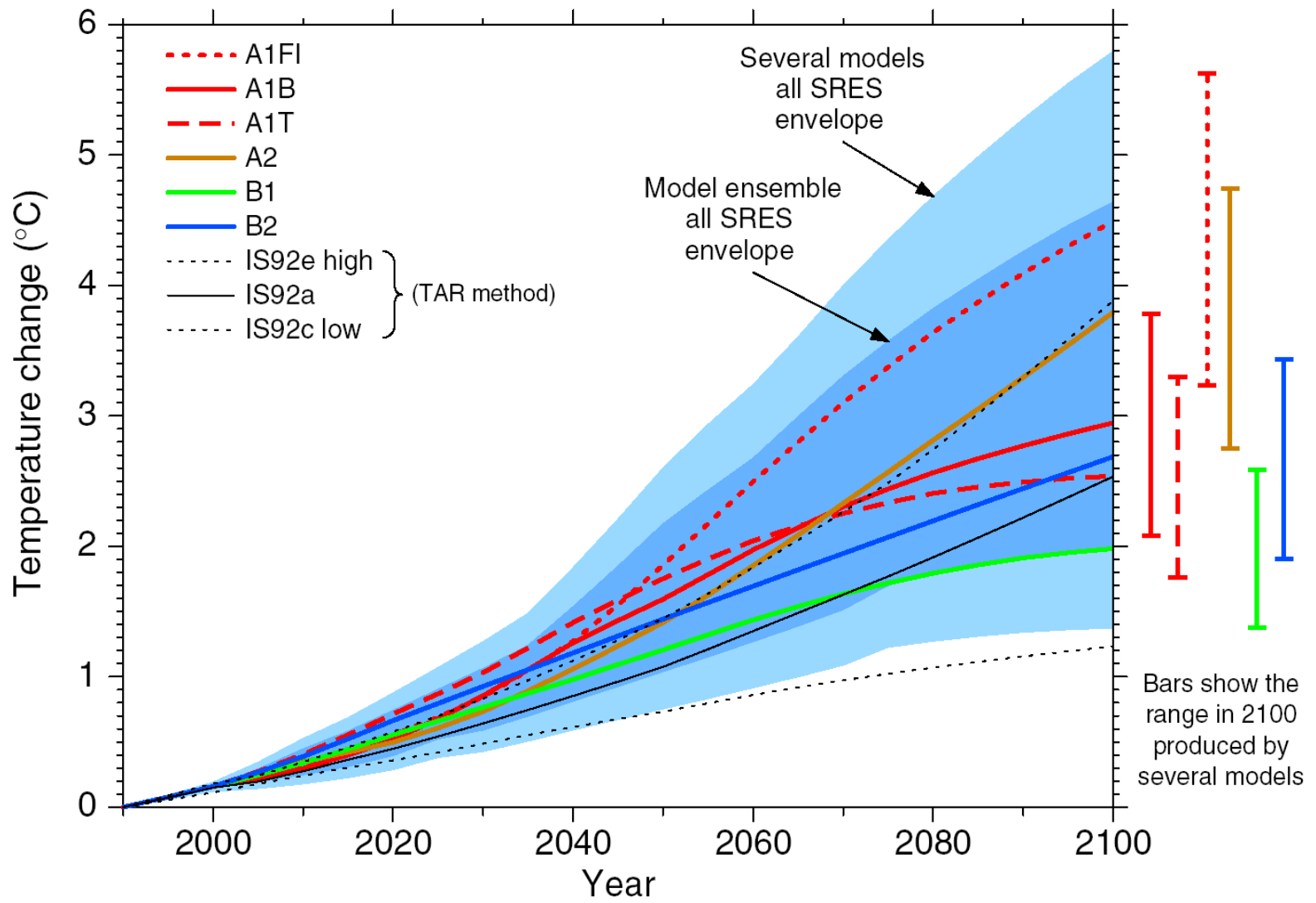
Ocean GCM

Climate Models

Earth's climate is far too complex to reproduce in a laboratory. An alternative is to devise a mathematical representation, or model, that can be used to simulate past, present, and future climate conditions. These models incorporate the key physical parameters and processes that govern climate behavior. Once constructed, they can be used to investigate how a change in green

Coupled Climate Model Schematic



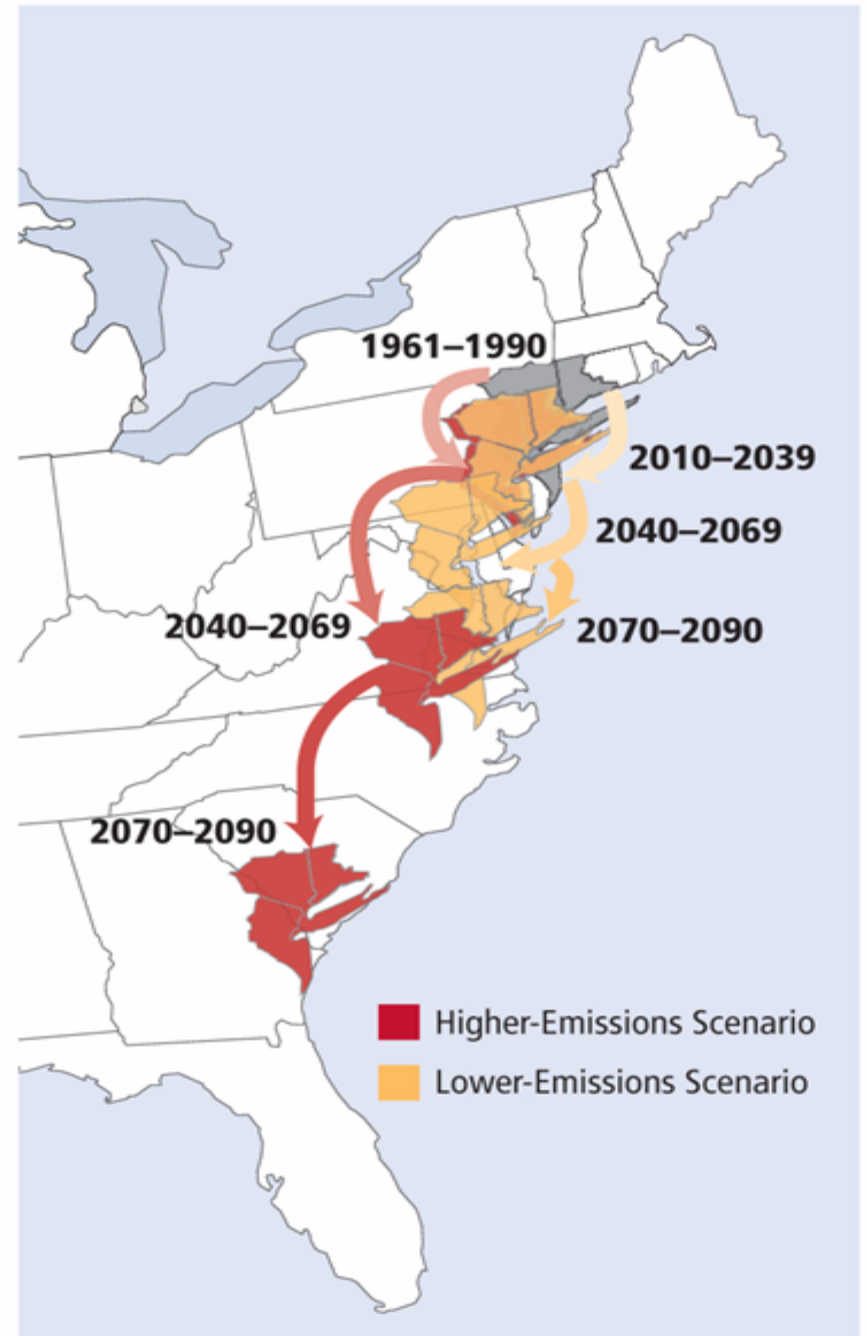


Heat index:
how summers could “feel”



Photo: Michael Kim

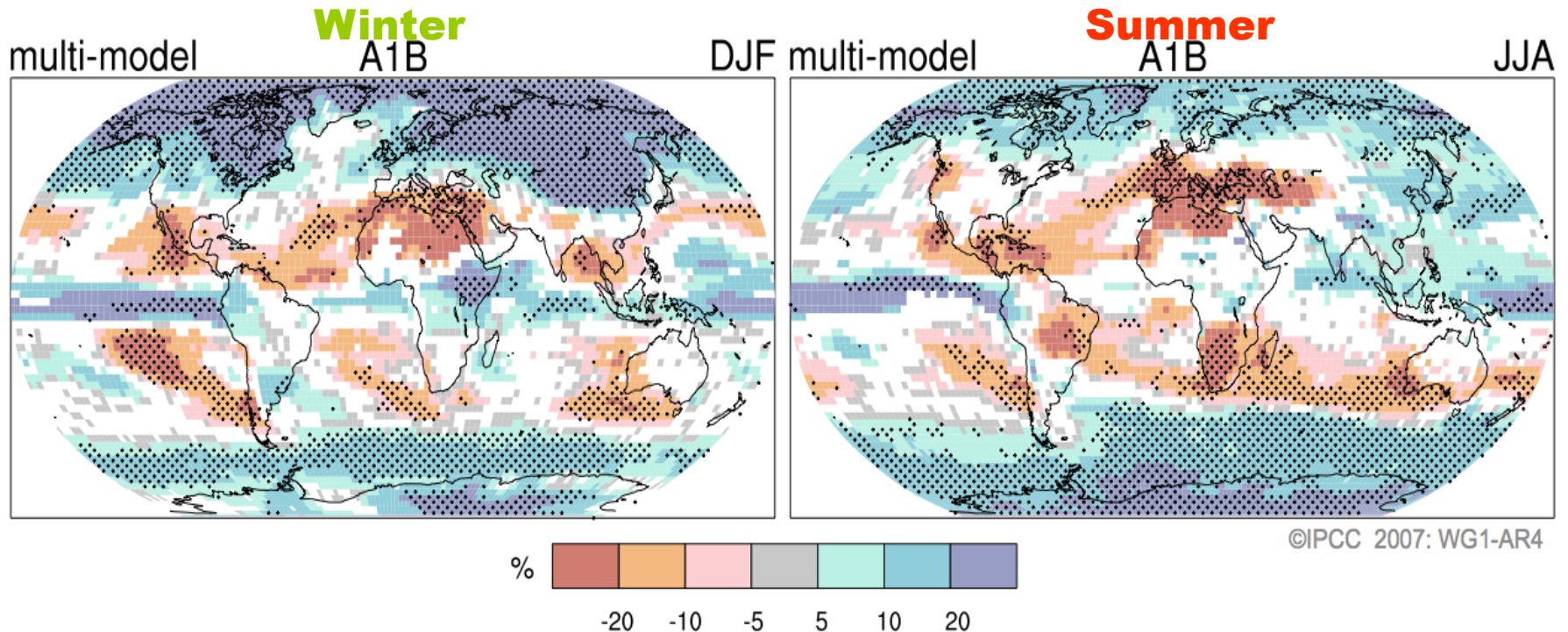
NYC Tri-State Region



Source: NECA/UCS, 2007 (see: www.climatechoices.org/ne/)

Projections of Precipitation Change

Projected Patterns of Precipitation Changes

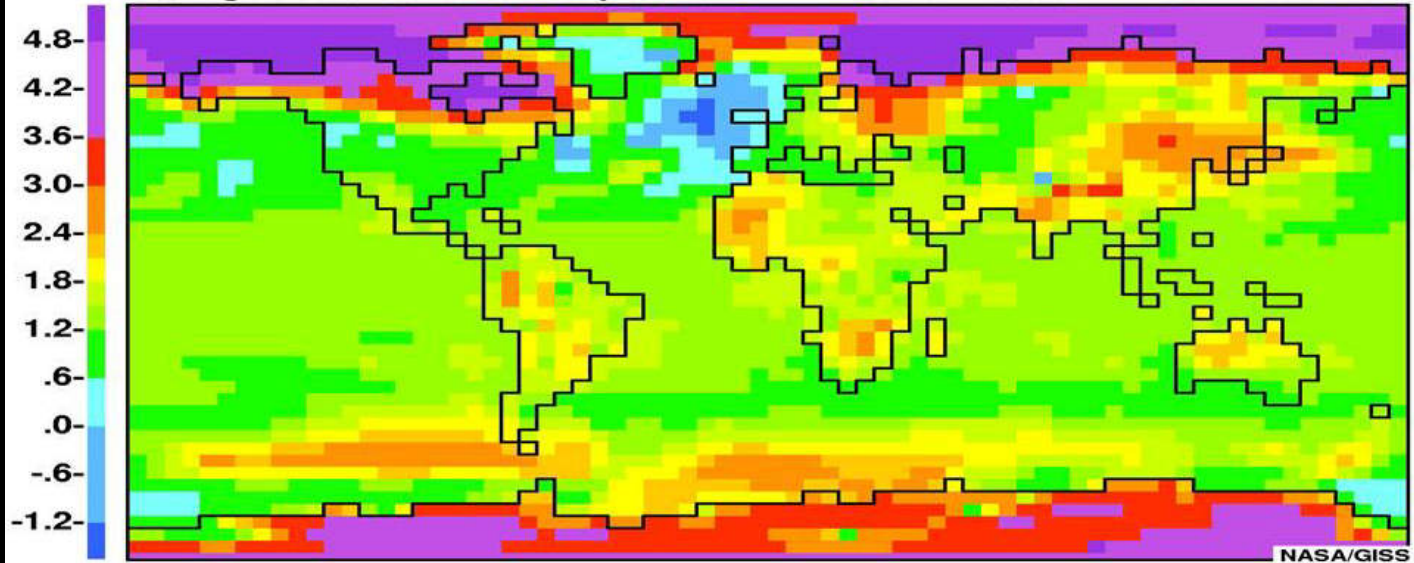


Precipitation increases *very likely* in high latitudes
Decreases *likely* in most subtropical land regions

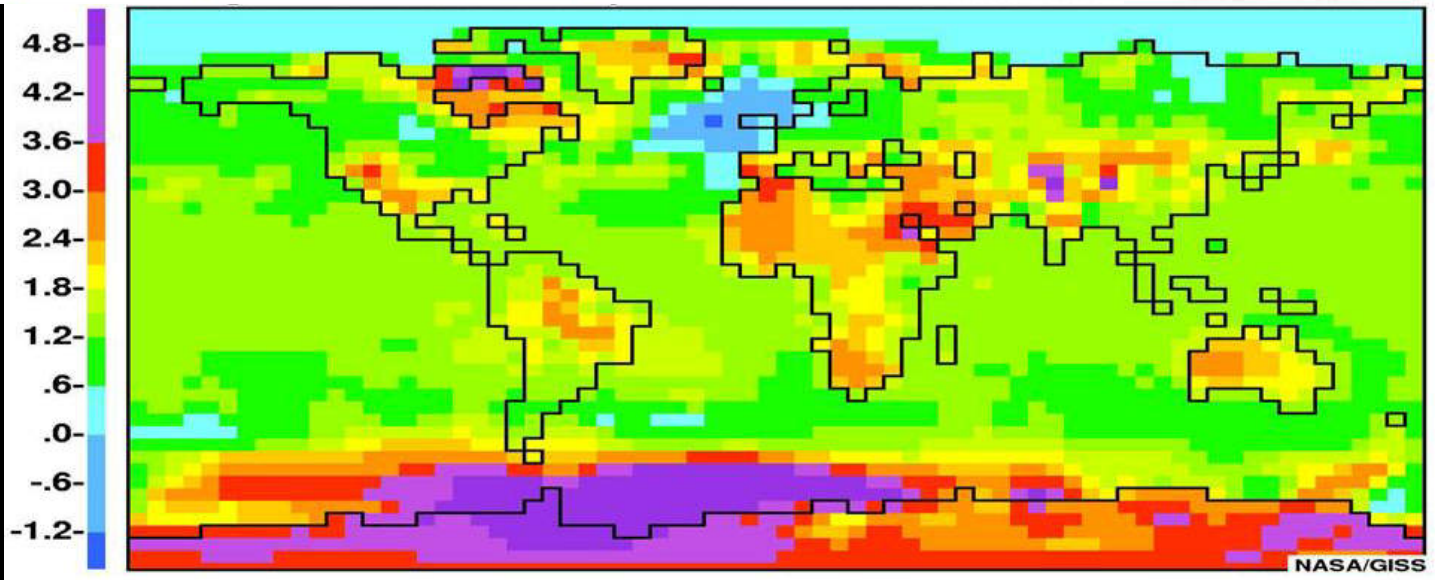
Arctic Cloud and Water Vapor Feedbacks

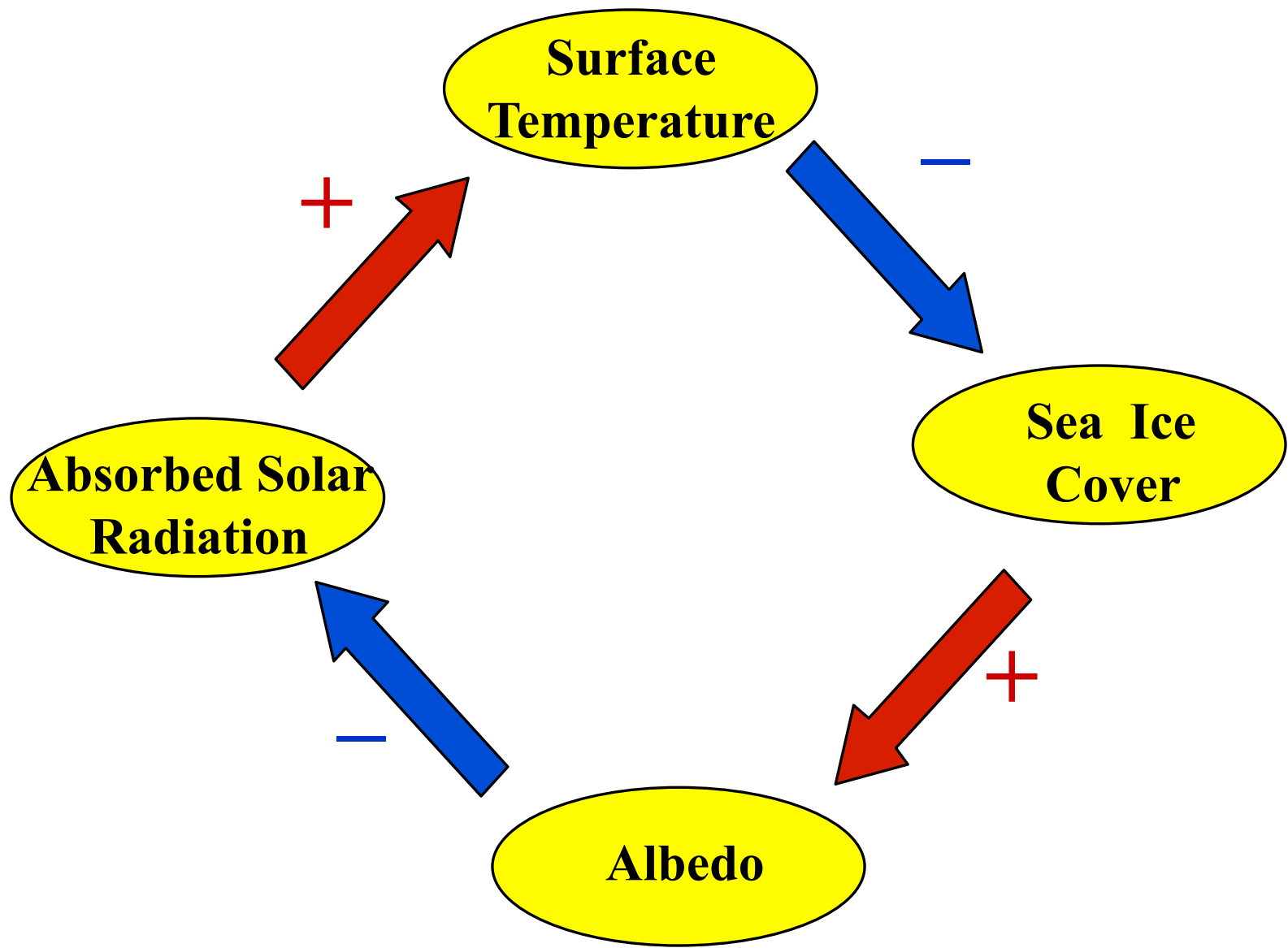


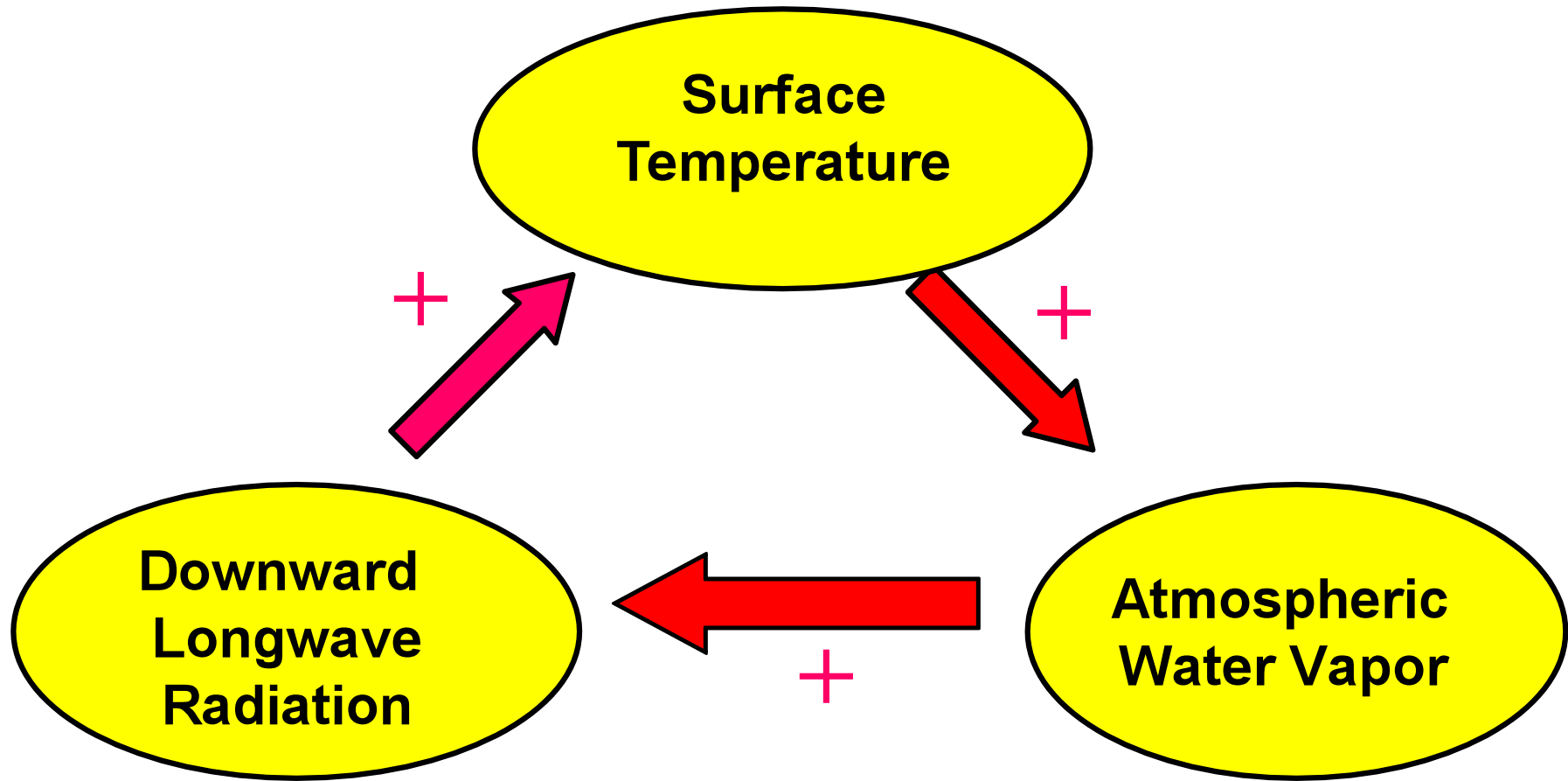
Change in Surface Air Temperature GHG1 - Con1 2050-2099 Jan

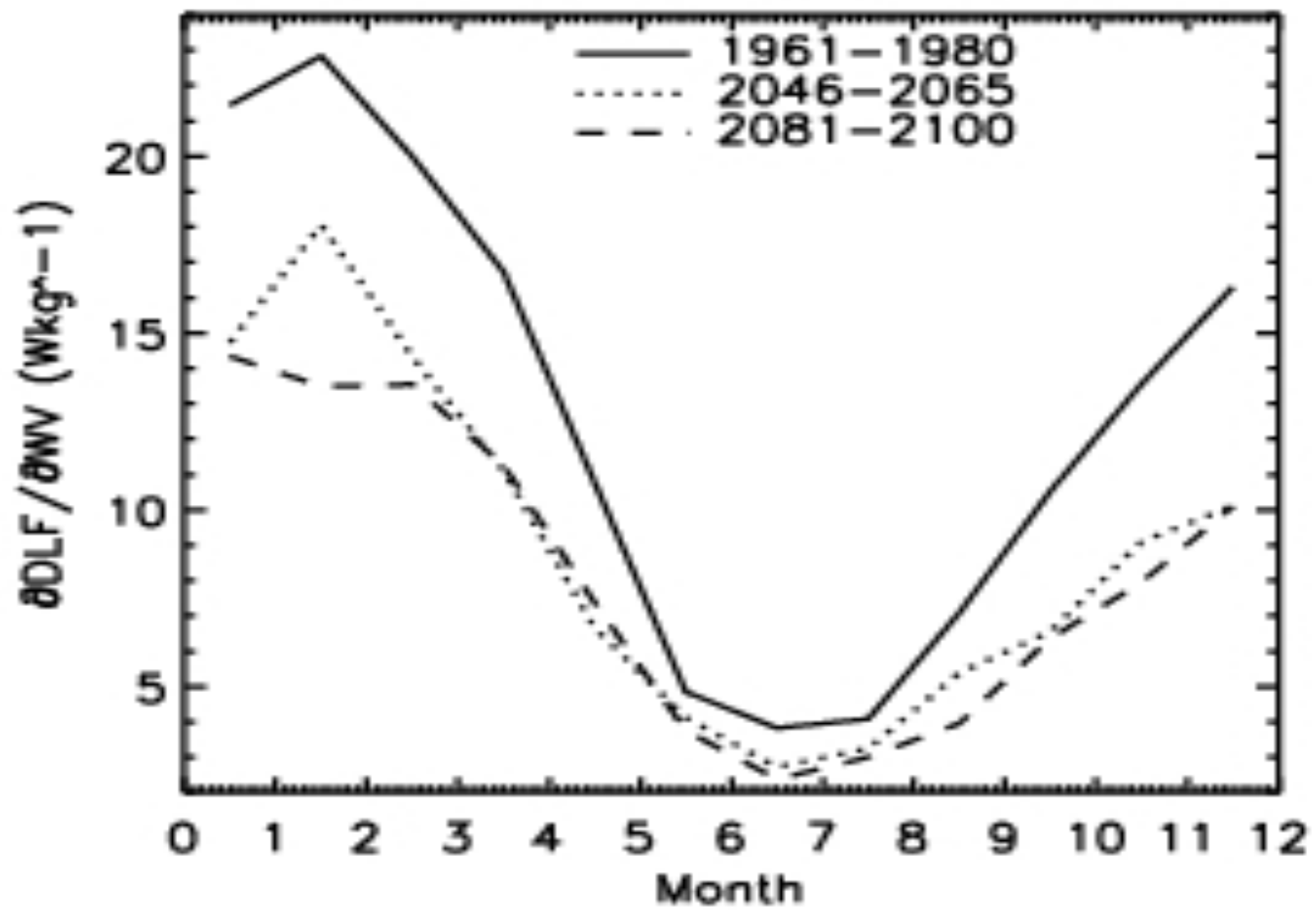


2050-2099 Jul

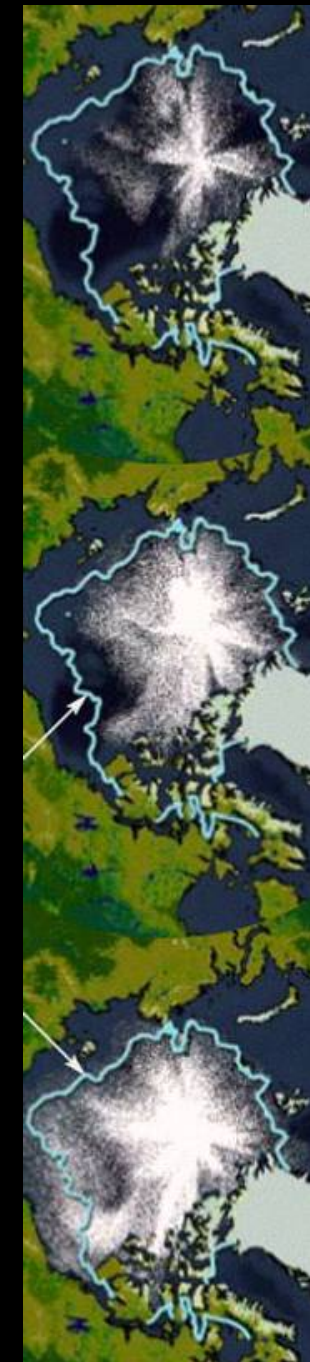
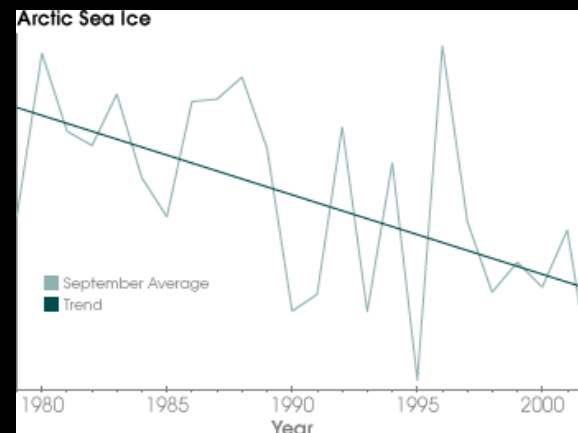
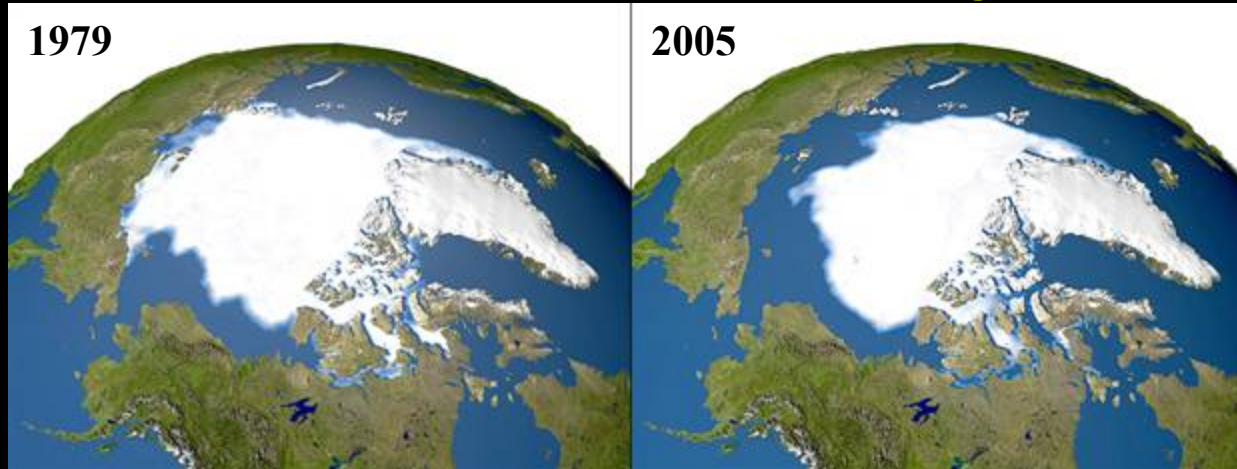






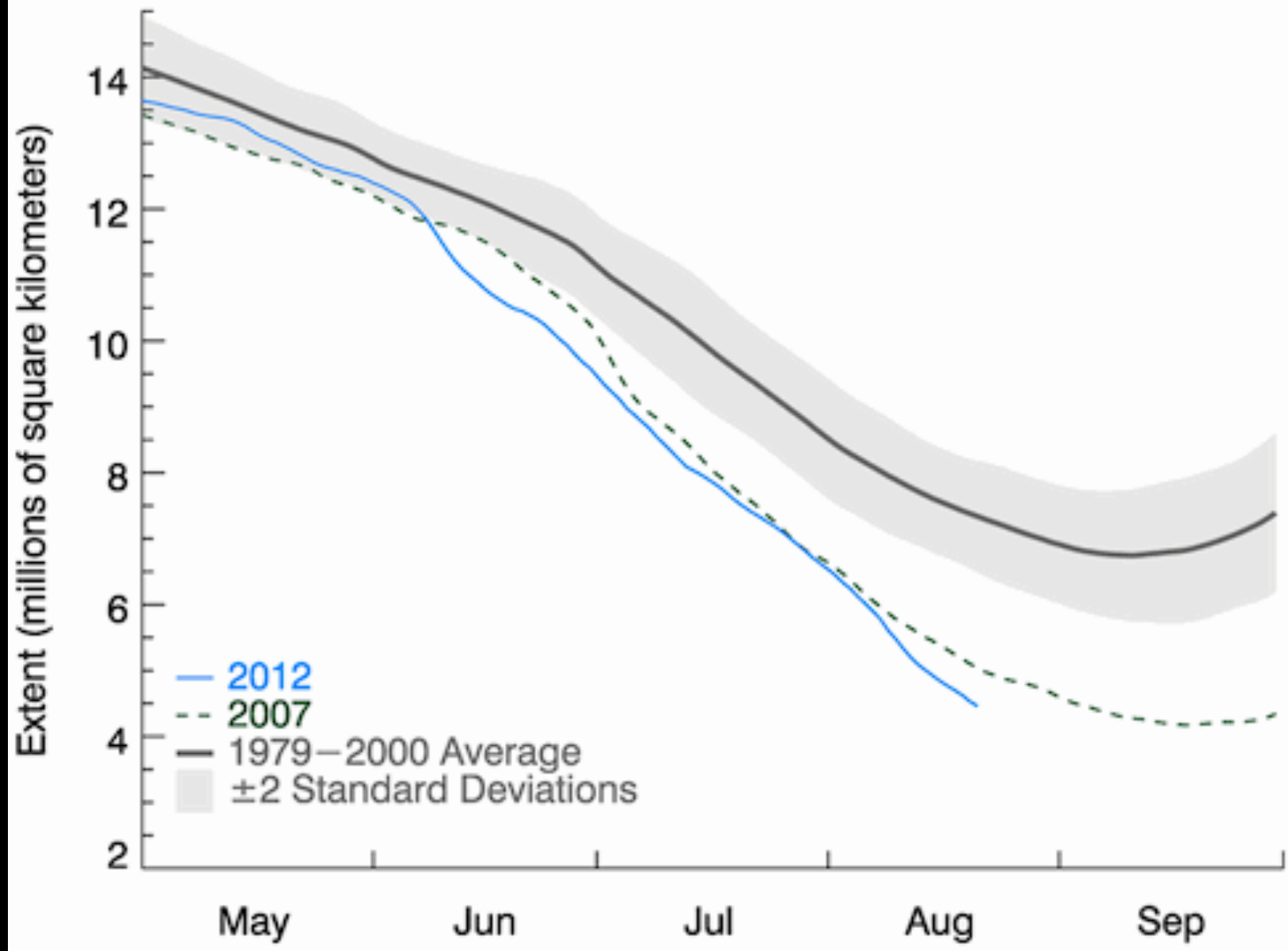


Polar Amplification of Global Warming



Francis et al.

Arctic Sea Ice Extent (Area of ocean with at least 15% sea ice)

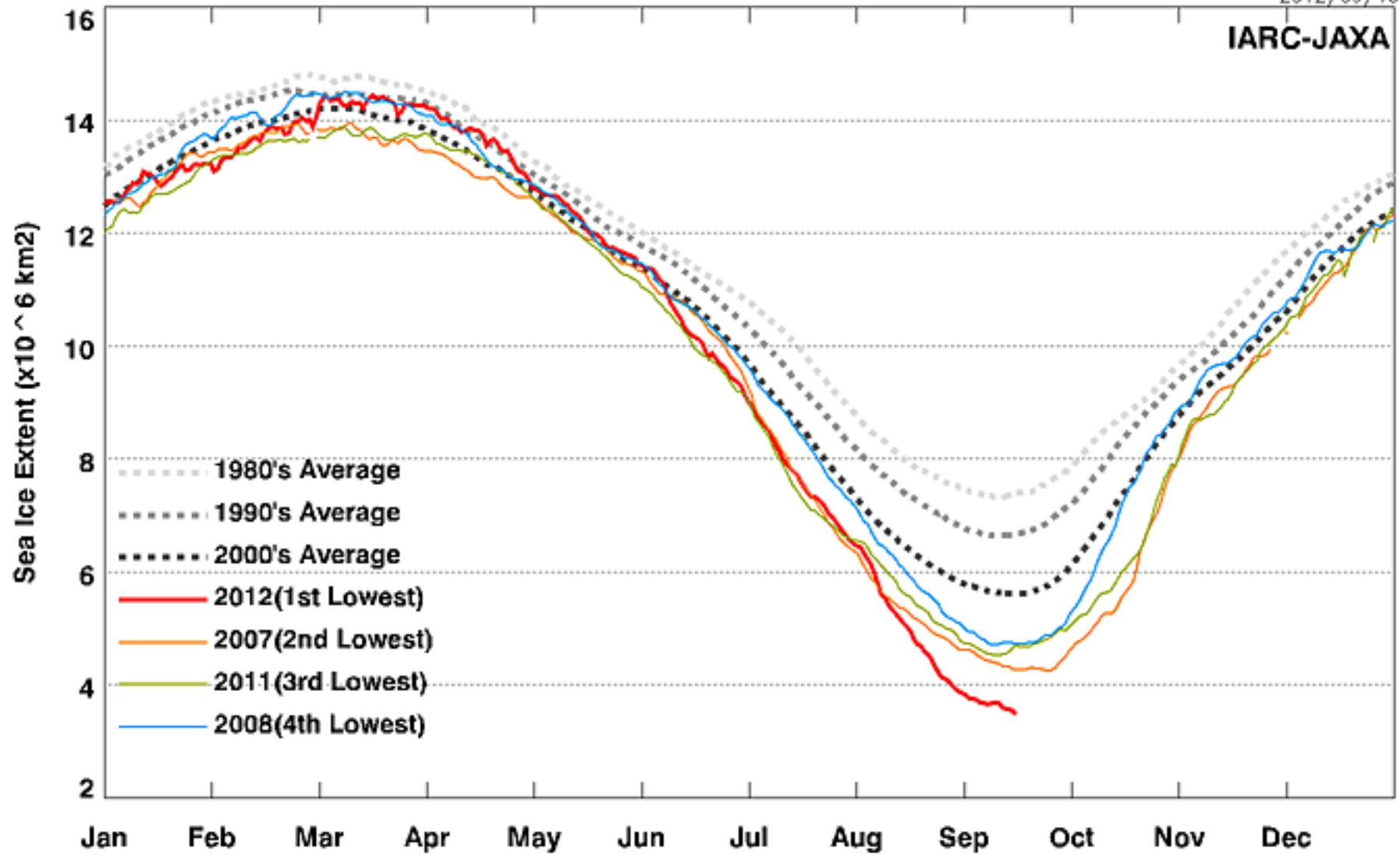


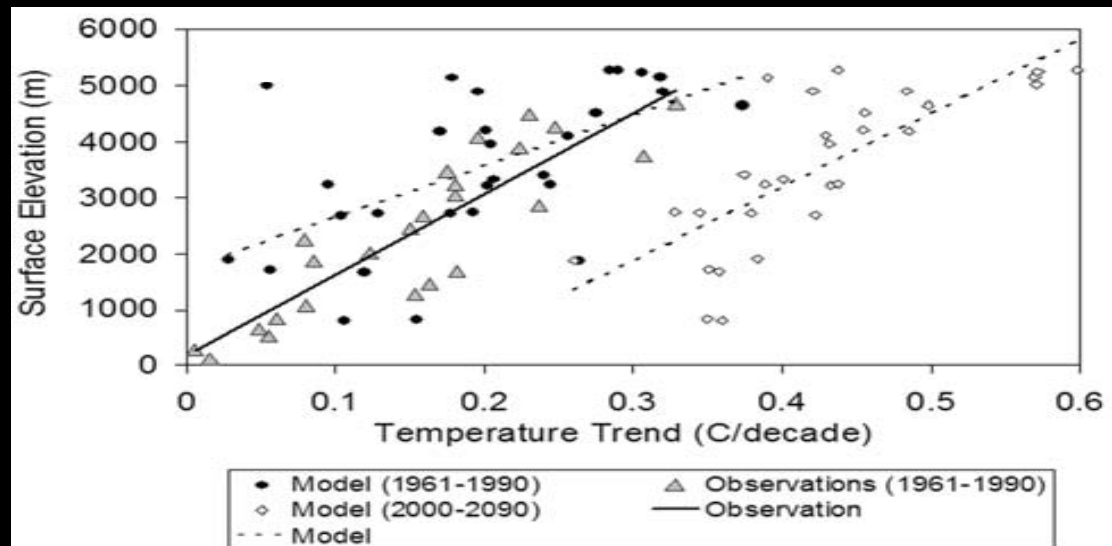
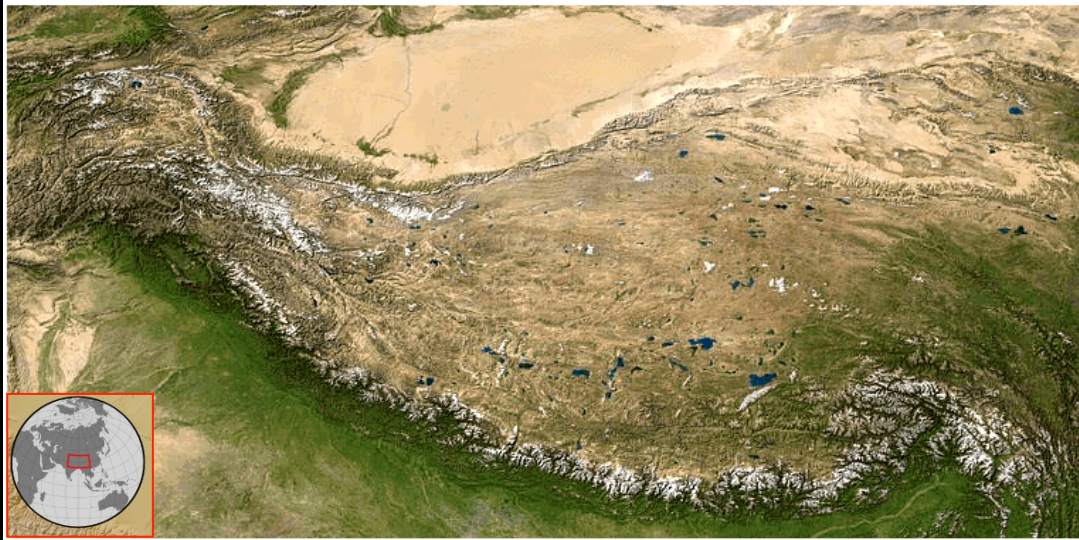
National Snow and Ice Data Center, Boulder CO

Arctic Sea Ice Extent

2012/09/15

IARC-JAXA



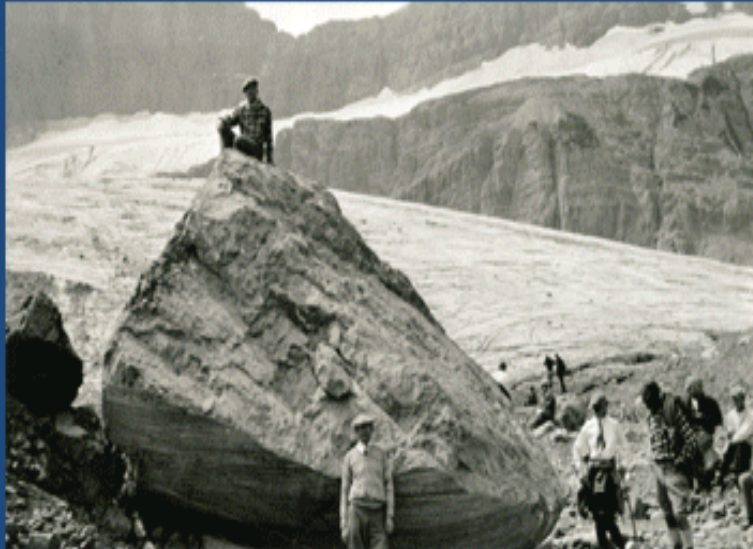


SEA LEVEL RISE

Melting Glaciers and Ice
Caps

Thermal Expansion





1926

Morton Elrod photo
K. Ross Toole Archives
Mansfield Library, UM

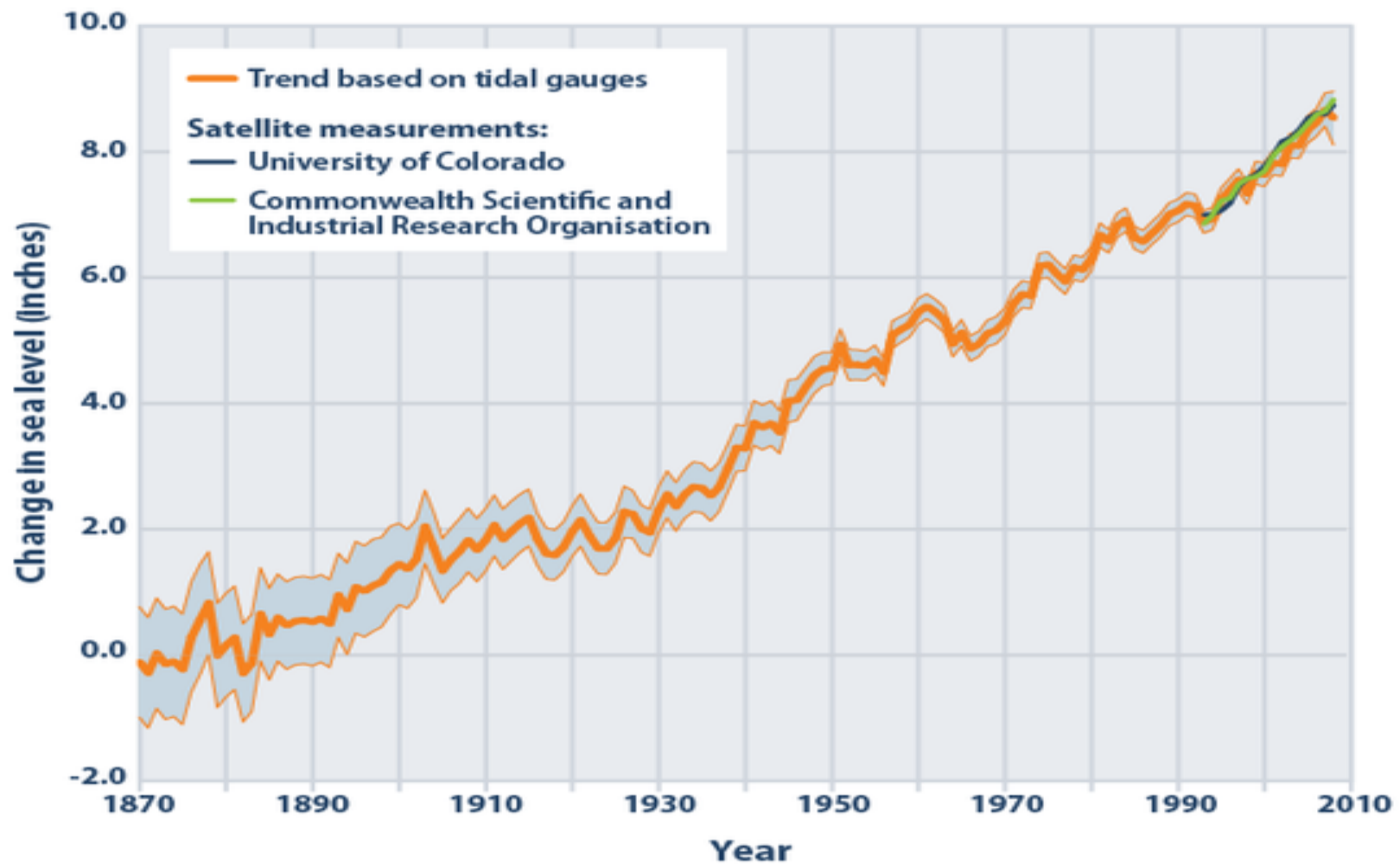


2008

Lisa McKeon photo
USGS

This large boulder was used by Morton Elrod and other scientists as a baseline to measure the retreat of Grinnell Glacier's terminus. It is now referred to as "Elrod's Rock," and the glacier's terminus is no longer visible from this point.

Trends in Global Average Absolute Sea Level, 1870–2008

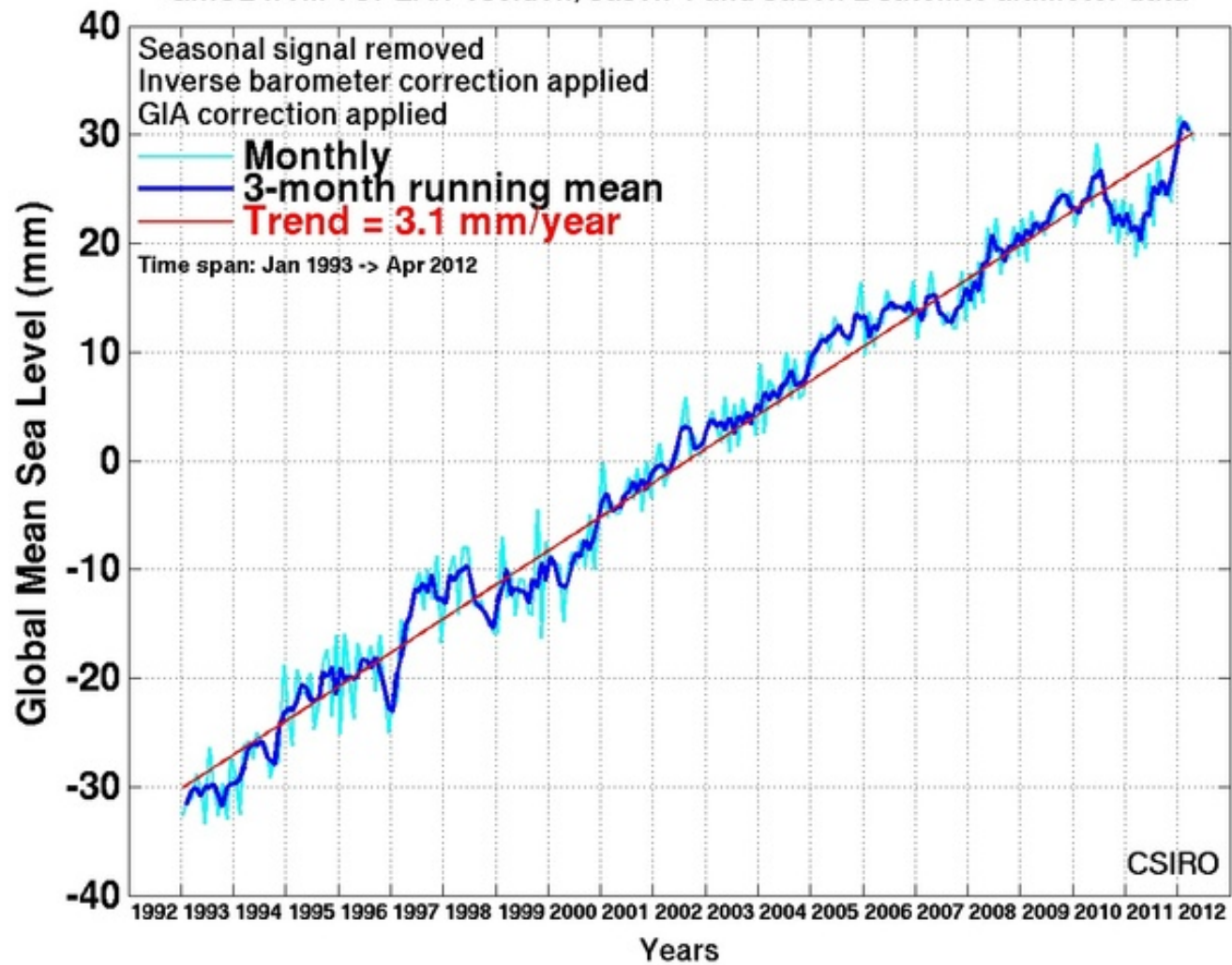


Data sources:

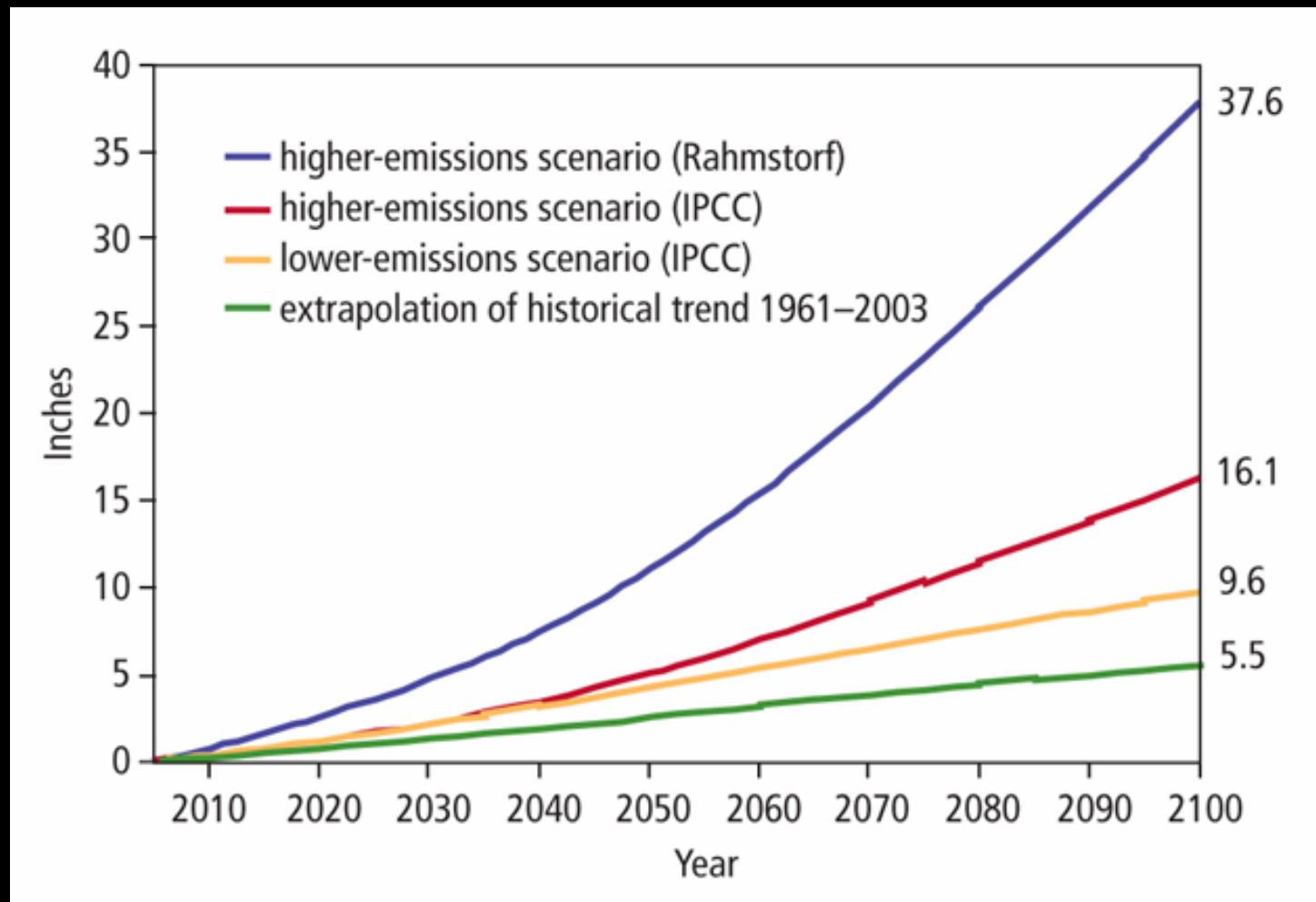
- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2009. Sea level rise. Accessed November 2009. <http://www.cmar.csiro.au/sealevel>.
- University of Colorado at Boulder. 2009. Sea level change: 2009 release #2. <http://sealevel.colorado.edu>.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/science/indicators.

GMSL from TOPEX/Poseidon, Jason-1 and Jason-2 satellite altimeter data



Projected Rise in Global Sea Level Relative to 2005

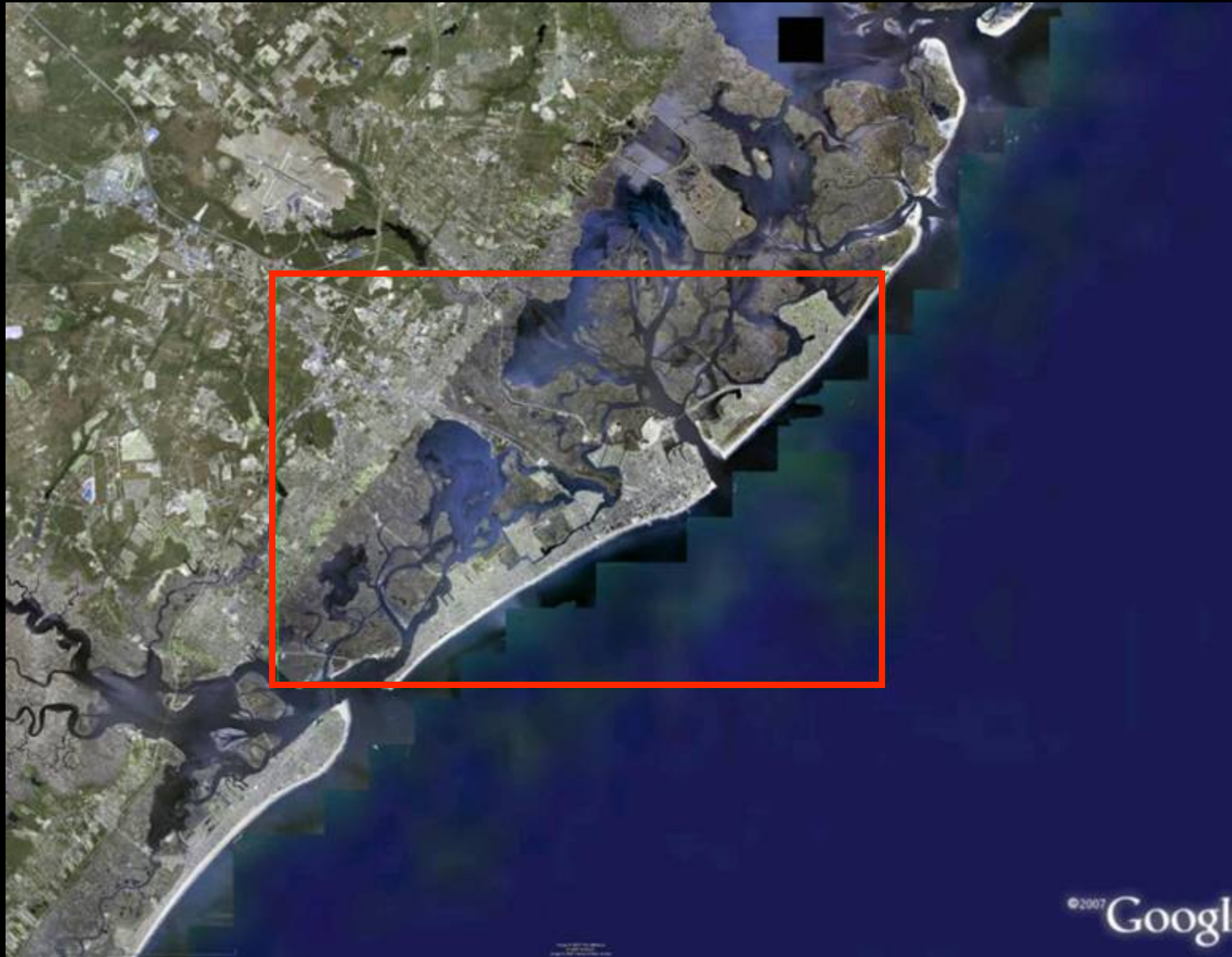




Coastal Impacts

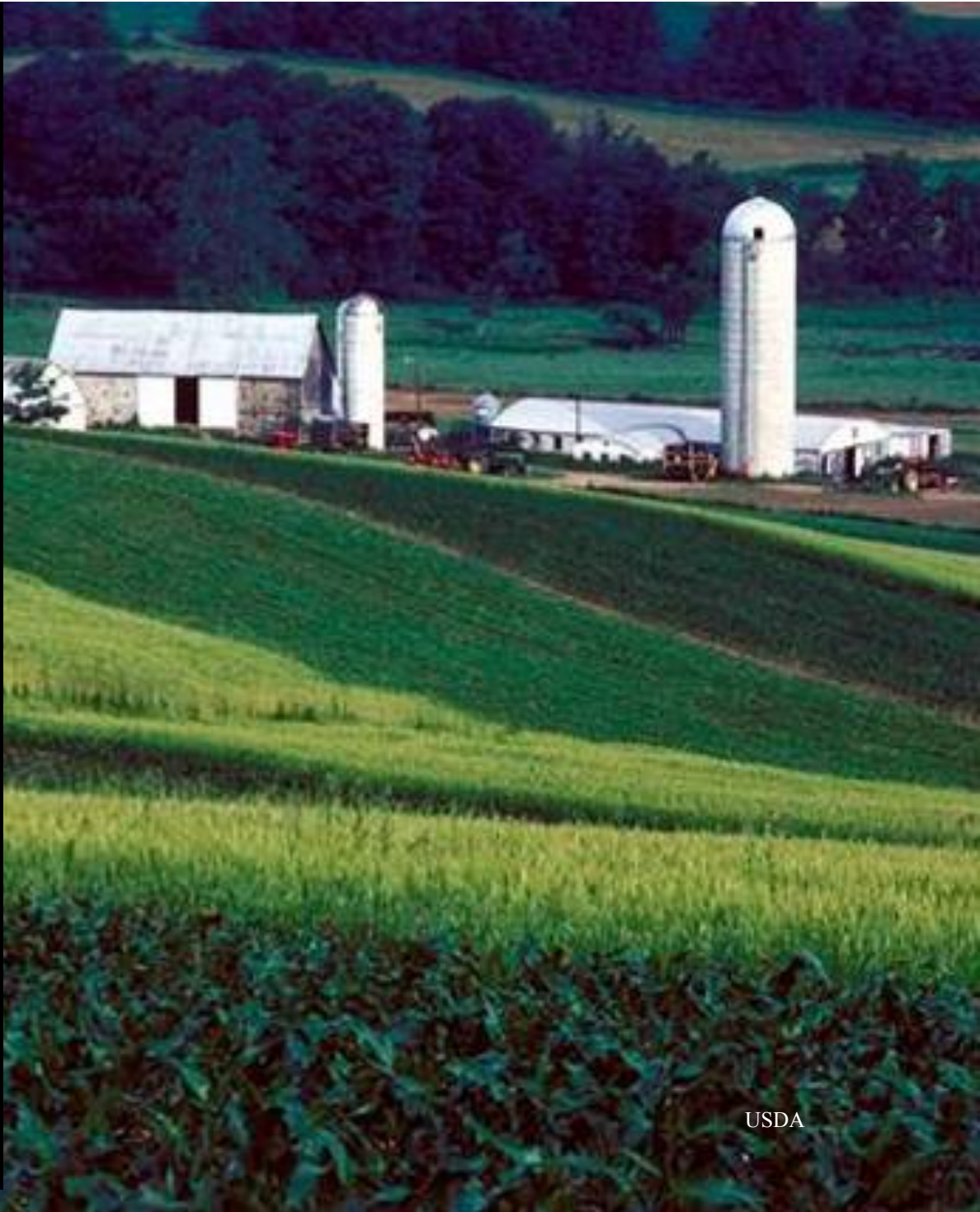
- Coastal Flooding
- Shoreline Change

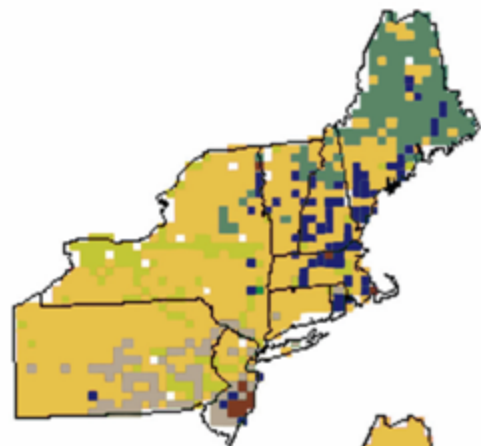
Atlantic City: Today's 100-Year Flood Could Become a 2-Year Flood by 2100



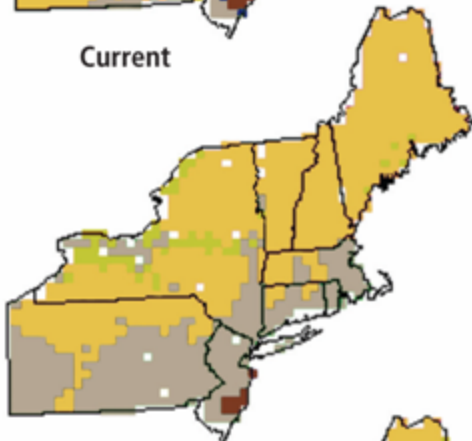
Impacts on Agriculture

- Dairy
- Crops
- Pests and Weeds

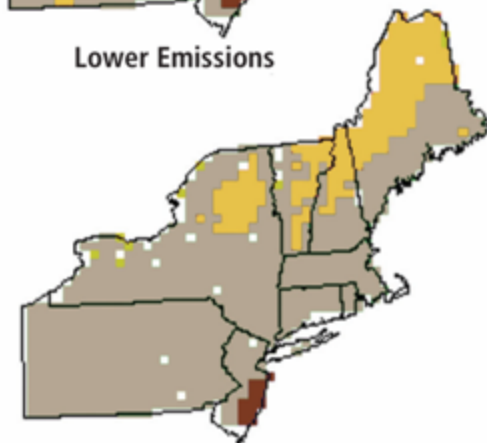




Current



Lower Emissions



Higher Emissions



Spruce/Fir



Maple/Beech/Birch



Oak/Hickory



Elm/Ash/Cottonwood



Loblolly/Shortleaf Pine

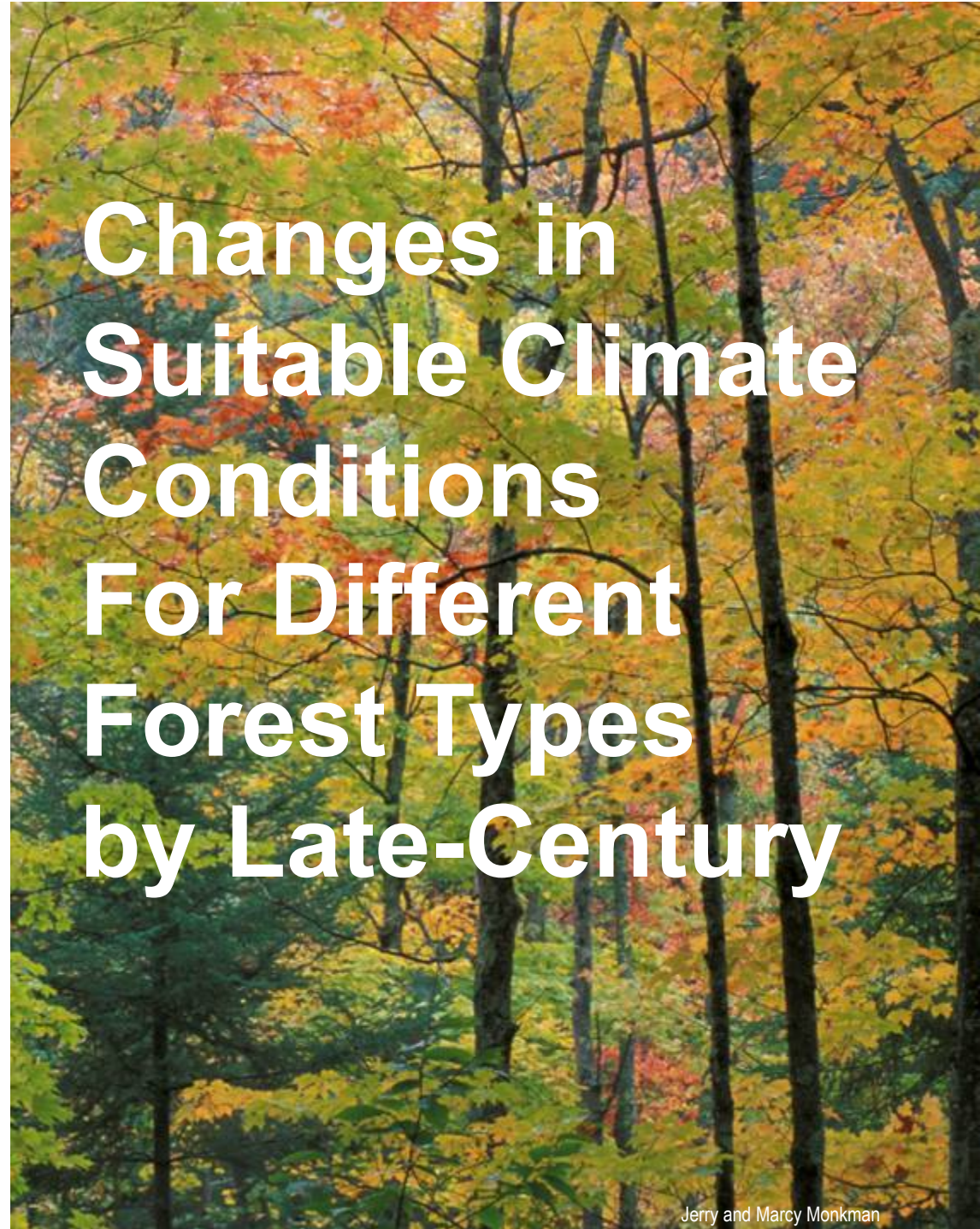


Other



No Data

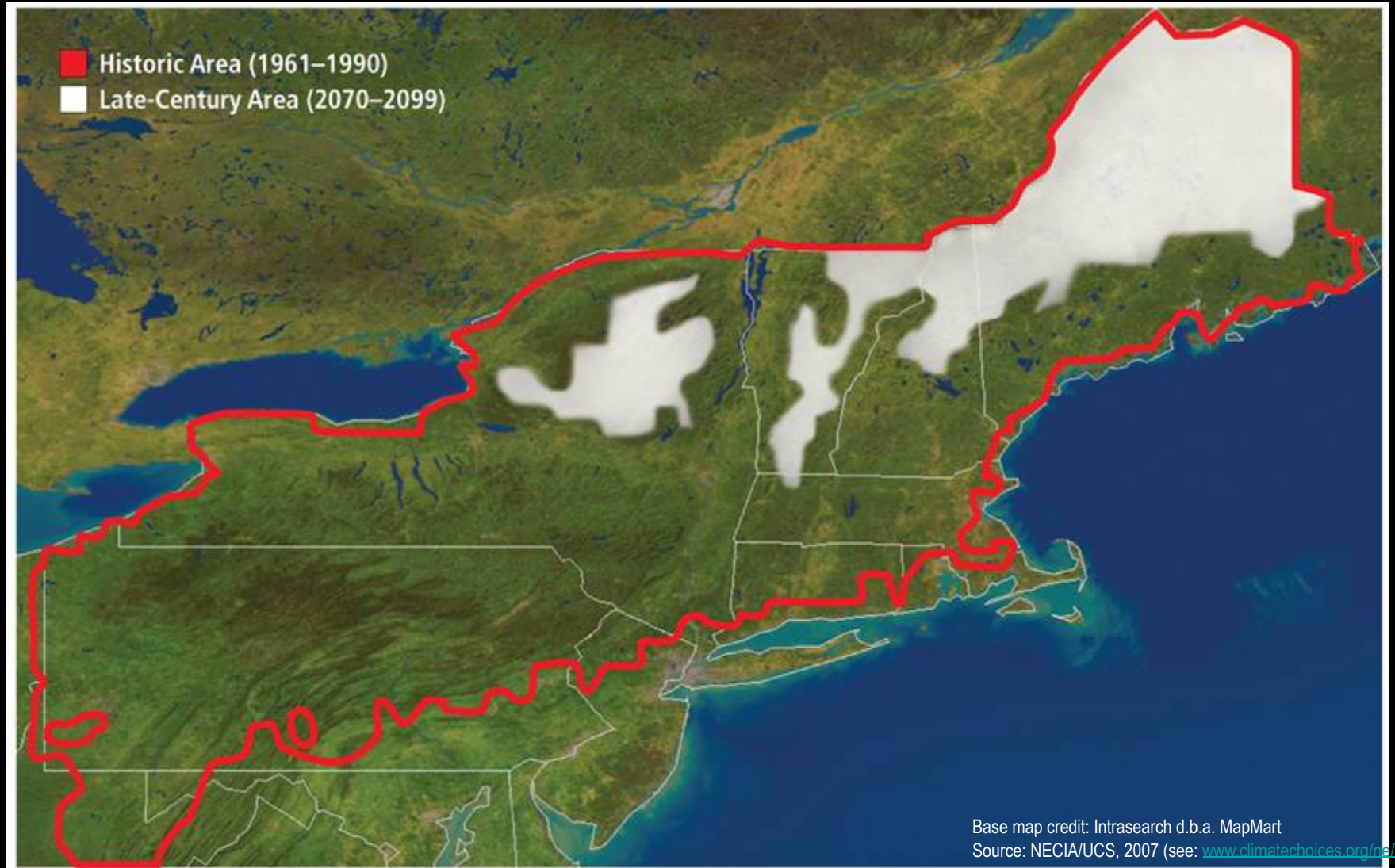
Changes in Suitable Climate Conditions For Different Forest Types by Late-Century



spruce/fir: Anastasiya Maksymenko; maple: Birthe Lunau; oak: Dave White; ash: Chad Davis; loblolly: Kentucky Division of Forestry.
Source: NECIA, 2007 (see: www.climatechoices.org/ne/).

Jerry and Marcy Monkman

The Changing Face of Winter



Cannonsville Reservoir, Dec. 2001



Delaware River, Sept. 2004



Easton-Phillipsburg Bridge
June 2006

Changes in Precipitation

Mike Aucott/NJDEP



Deleware River

Less water
when we do.

More water when
we don't need it.



USGS/David Armstrong

Extreme Precipitation Events

More Frequent and More Extreme

Nancy Brammer



Susquehanna River, PA 2004



Axe Handle Brook, NH 2006

Associated Press





Climate is Changing Now
Impacts Already Being Felt
Models Needed to Project Future Changes

