

Global Climate Change

➤ **San Ramon Valley Democratic Club**

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Global Climate Change

- **Do you think the earth is undergoing global climate change?**
- **Do you think the earth is undergoing global warming?**
- **Are industrial greenhouse gas emissions contributing to global climate change?**
- **If so, to what extent (%) ?**
- **Is knowledge of global climate change a recent phenomena?**

Global Climate Change

Climate versus Weather

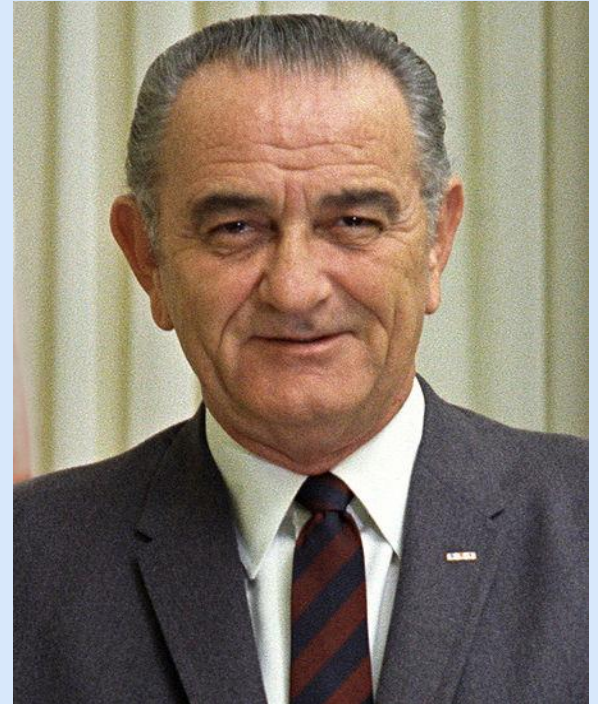
Climate' refers to long-term atmospheric conditions,

Weather' refers to what we experience in the short term. Weather varies constantly

Changes in climate are natural: e.g. after the last ice age (11,500 years ago) global temperatures were 5°C lower than now

Global Climate Change

- ***This generation has altered the composition of the atmosphere on a global scale... a steady increase in carbon dioxide from the burning of fossil fuels.***
- ***-Lyndon Johnson***
- ***Special Message to Congress, 1965***



Global Climate Change

Svante August Arrhenius (1859-1927)

Swedish scientist, one of the founders of the science of physical chemistry.

The *Arrhenius equation* and the lunar crater Arrhenius are named after him.

First speculated that changes in the levels of carbon dioxide in the atmosphere could substantially alter the surface temperature through the greenhouse effect (1896)

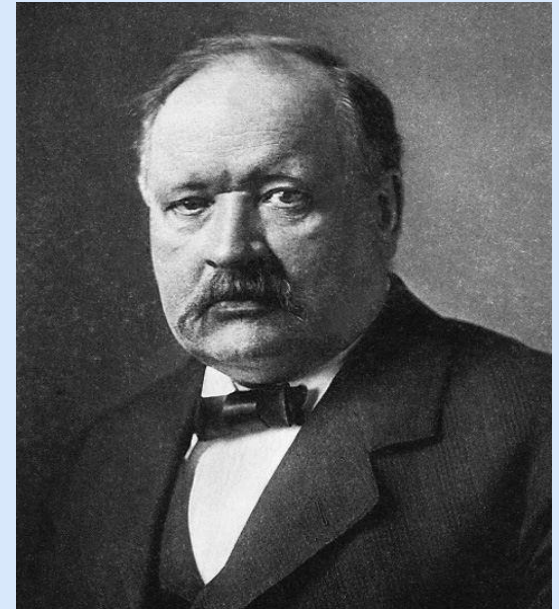


Global Climate Change

Arrhenius' greenhouse hypothesis reads as follows:

“if the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression.”

First person to predict that emissions of carbon dioxide from the burning of fossil fuels and other combustion processes would cause global warming. (1908)



Global Climate Change

John Tyndall (1820-1893)

English Physicist, initial scientific fame arose in the 1850s from his study of diamagnetism. Published over 147 technical papers.

He was the first to prove that the earth's atmosphere had a “greenhouse effect” by proving that water vapor strongly absorbed infrared radiation.

Tyndall explained the heat in the Earth's atmosphere in terms of the capacities of the various gases in the air to absorb radiant heat, a.k.a. infrared radiation



What is Known?

Scientists know with virtual certainty that:

- Human activities are changing the composition of Earth's atmosphere.
- Increasing levels of greenhouse gases like carbon dioxide (CO₂) in the atmosphere since pre-industrial times are well-documented and understood.

What is Known?

Scientists know with virtual certainty that:

- The atmospheric buildup of CO₂ and other green house gases is largely the result of human activities such as burning fossil fuels
- An “unequivocal” warming trend of about 1.0 to 1.7°F occurred from 1906-2005. Warming occurred in both the Northern and Southern Hemispheres, and over the oceans (IPCC 2007).

What is Known?

Scientists know with virtual certainty that:

- The major greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries.
 - It is therefore virtually certain that atmospheric concentrations of greenhouse gases will continue to rise.
- Increasing greenhouse gas concentrations tend to warm the planet.

What is Very Likely?

- The Intergovernmental Panel on Climate Change (IPCC) has stated "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC 2007).
- In short, a growing number of scientific analyses indicate, but cannot prove, that rising levels of greenhouse gases in the atmosphere are contributing to climate change (as theory predicts). In the coming decades, scientists anticipate that as atmospheric concentrations of greenhouse gases continue to rise, average global temperatures and sea levels will continue to rise as a result and precipitation patterns will change.

What is Not Certain?

Important scientific questions remain about how much warming will occur, how fast it will occur, and how the warming will affect the rest of the climate system including precipitation patterns and storms.

Answering these questions will require advances in scientific knowledge in a number of areas:

- Improving understanding of natural climatic variations, changes in the sun's energy, land-use changes, the warming or cooling effects of pollutant aerosols, and the impacts of changing humidity and cloud cover.

Global Climate Change

What Causes Climate Change?

Changes in the atmosphere

- **Natural processes**
 - **Volcanoes**
 - **Tectonic plate movement**
 - **Changes in the sun energy output**
- **Anthropogenic (Human activities) – any activity that releases “greenhouse gases” into the atmosphere**

The Greenhouse Effect

- **The Earth has a natural system that heats the troposphere (lower atmosphere) and surface.**
- **As electromagnetic energy (sunlight) reaches the Earth's surface, some energy is emitted back toward space as infrared radiation (heat).**
- **Greenhouse gases (H₂O vapor, CO₂ , CH₄ , N₂O, SF₆, CFC's, HCFC's, HFC's, Perfluorocarbons, and O₃ -in lower atmosphere) absorb some of the emitted infrared radiation, which heats the lower atmosphere.**

Greenhouse Gases

Gases in the atmosphere that absorb and emit radiation within the “Thermal Infrared” range

Fundamental Cause of the Greenhouse effect

Water Vapor

Methane

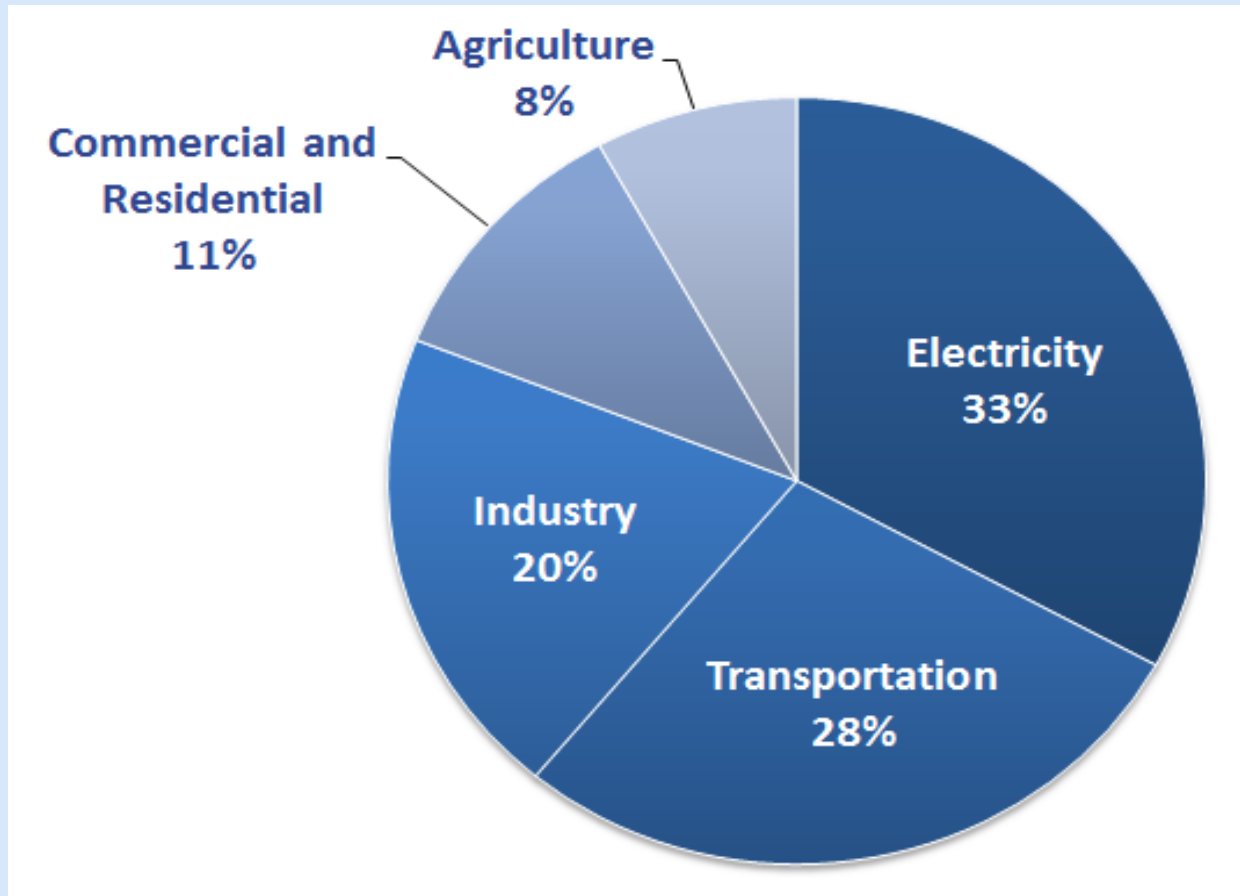
Ozone

Carbon Dioxide

Nitrous Oxide

Greenhouse Gases

➤ **Total U.S. Greenhouse Gas Emissions by Economic Sector in 2011**



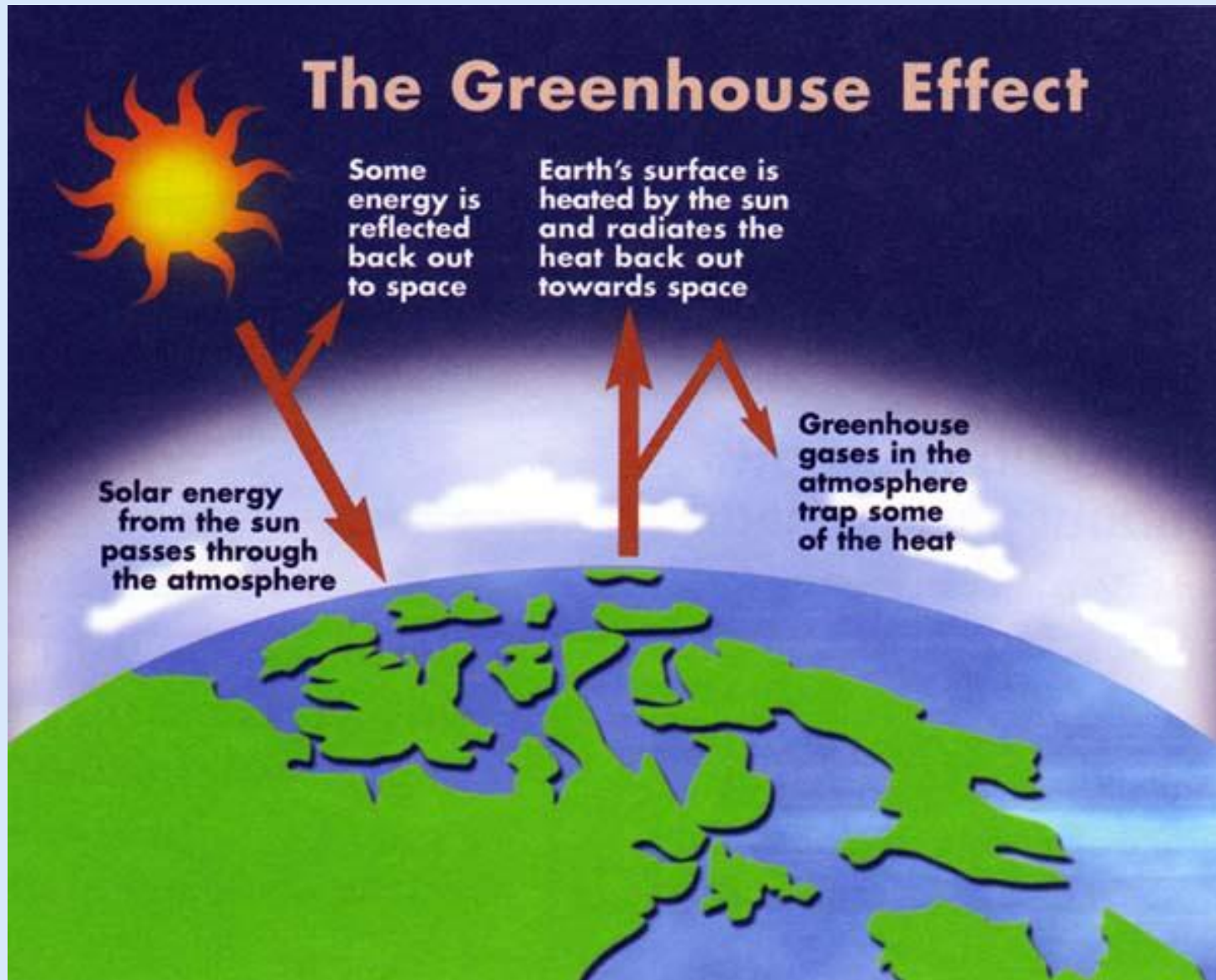
➤ **Total Emissions in 2011 = 6,702 MMT CO₂ Equiv.**

Greenhouse Gas Emissions

➤ 2007 UN Data

➤ <u>Country</u>	<u>Annual Emissions</u> Billions metric tons	<u>Per Capita</u> Metric Tons
➤ China	7.03	4.92
➤ USA	5.41	19.74
➤ EU (27)	4.18	
➤ India	1.72	1.38
➤ Russia	1.71	11.13
➤ Japan	1.21	10.23

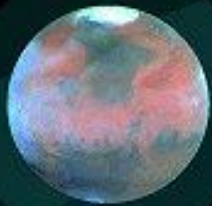
The Greenhouse Effect



Greenhouse Effect

Planets and atmospheres

Mars
Thin atmosphere
(Almost all CO₂ in ground)
Average temperature : - 50°C



Earth
0,03% of CO₂ in the atmosphere
Average temperature : + 15°C



Venus
Thick atmosphere
containing 96% of CO₂
Average temperature : + 420°C

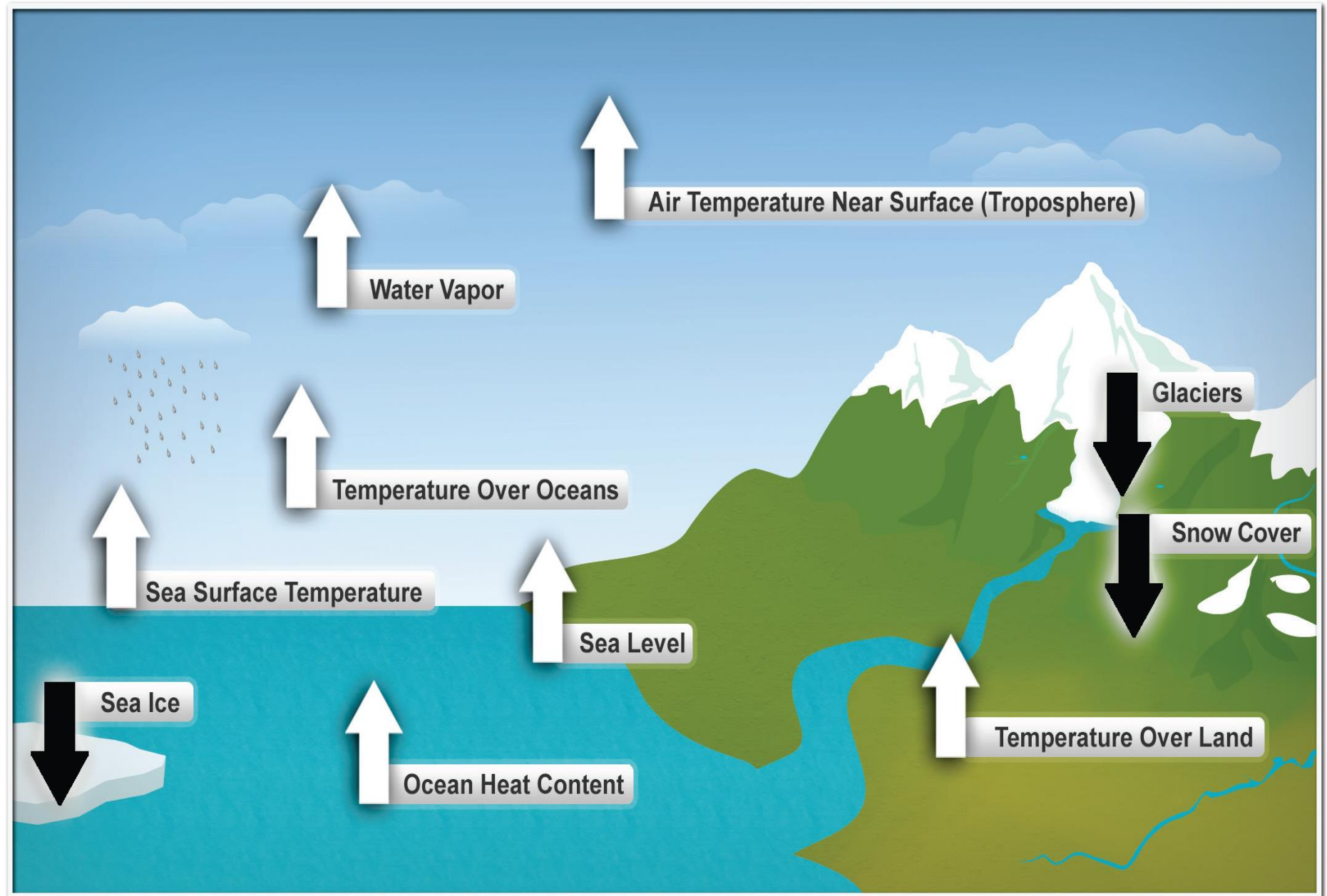


GRID
Arendal  **UNEP**

GRAPHIC DESIGN : PHILIPPE REKAGIEWICZ

Sources: Calvin J. Hamilton, Views of the solar system, www.planetscapes.com; Bill Amett, The nine planets, a multimedia tour of the solar system, www.seds.org/billa/tnp/nineplanets.html

Ten Indicators of a Warming World



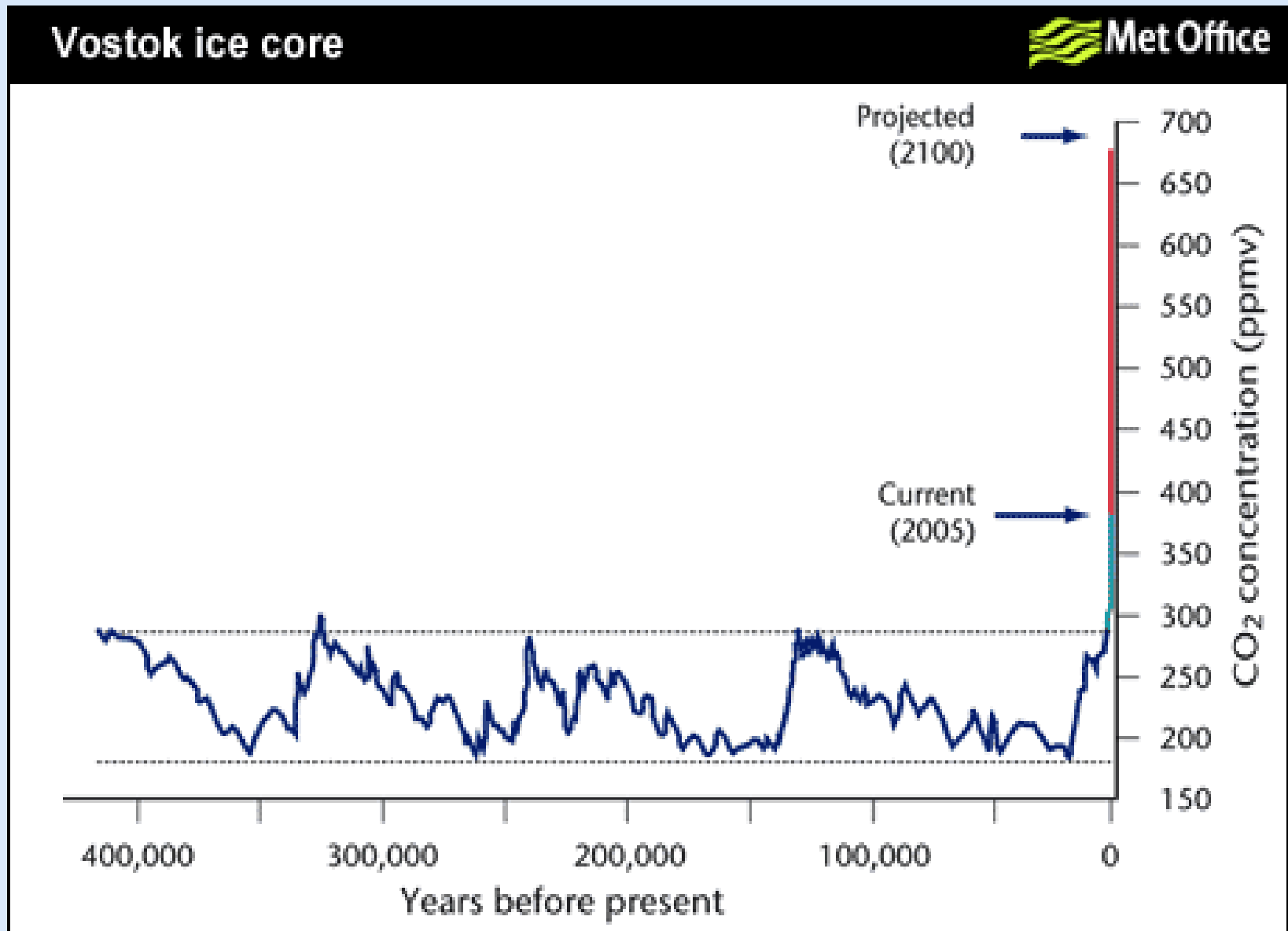
Key Piece of Evidence of Global Warming

The Stratosphere is Cooling

And

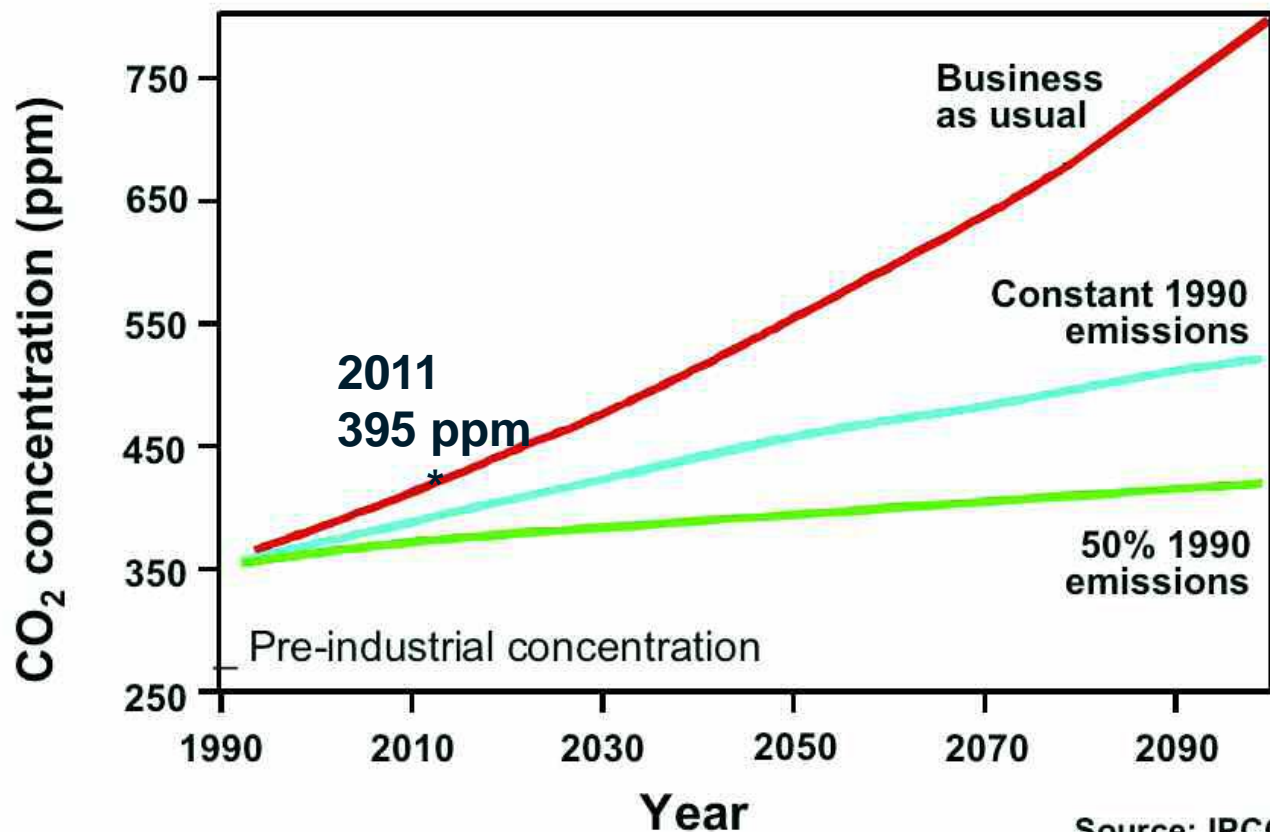
The Troposphere is Warming

Greenhouse Gases & Temperature



Greenhouse Gases & Temperature

Large reductions in CO₂ emissions are required to stabilise concentrations



Source: IPCC

Global Temperature and Carbon Dioxide

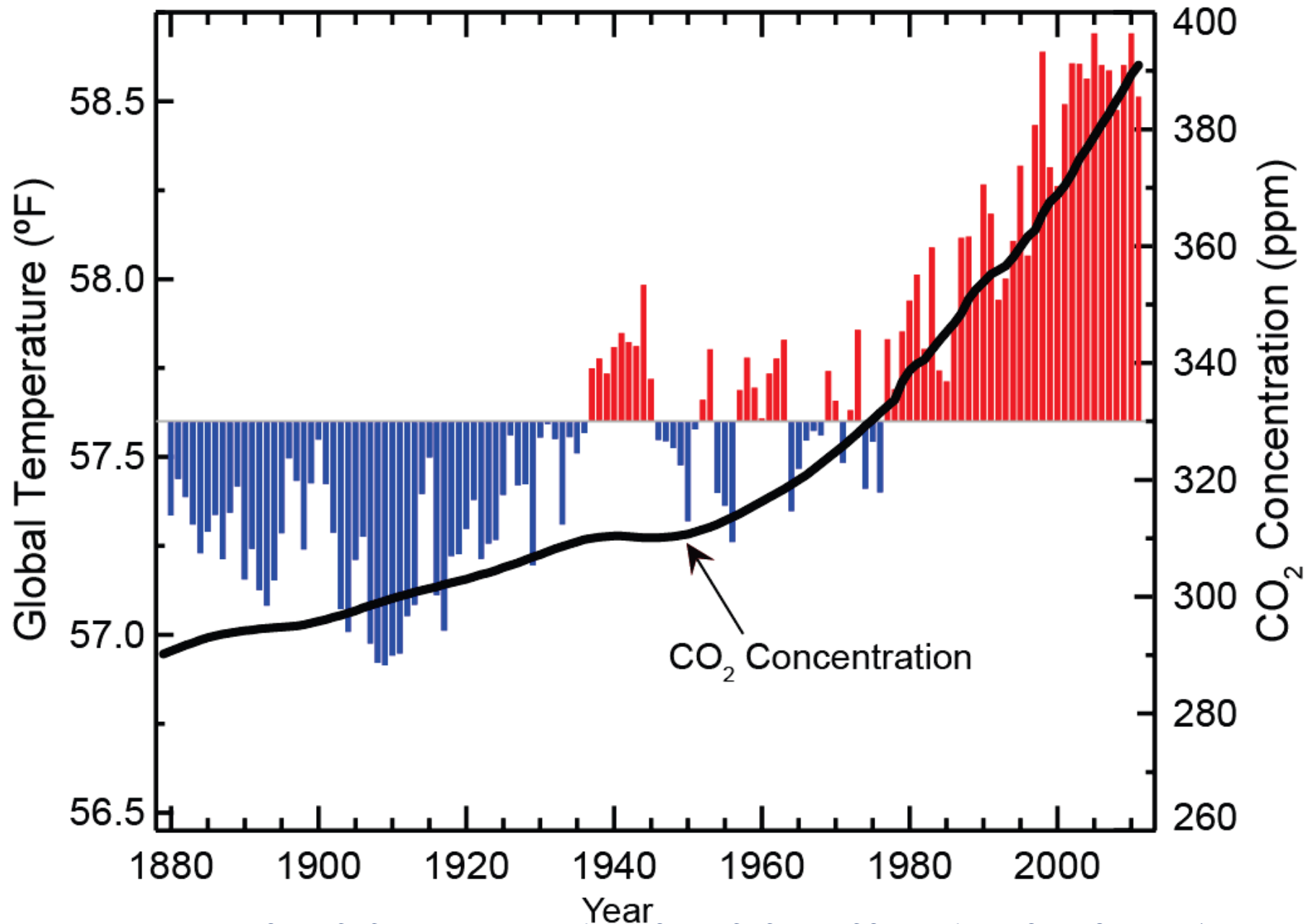
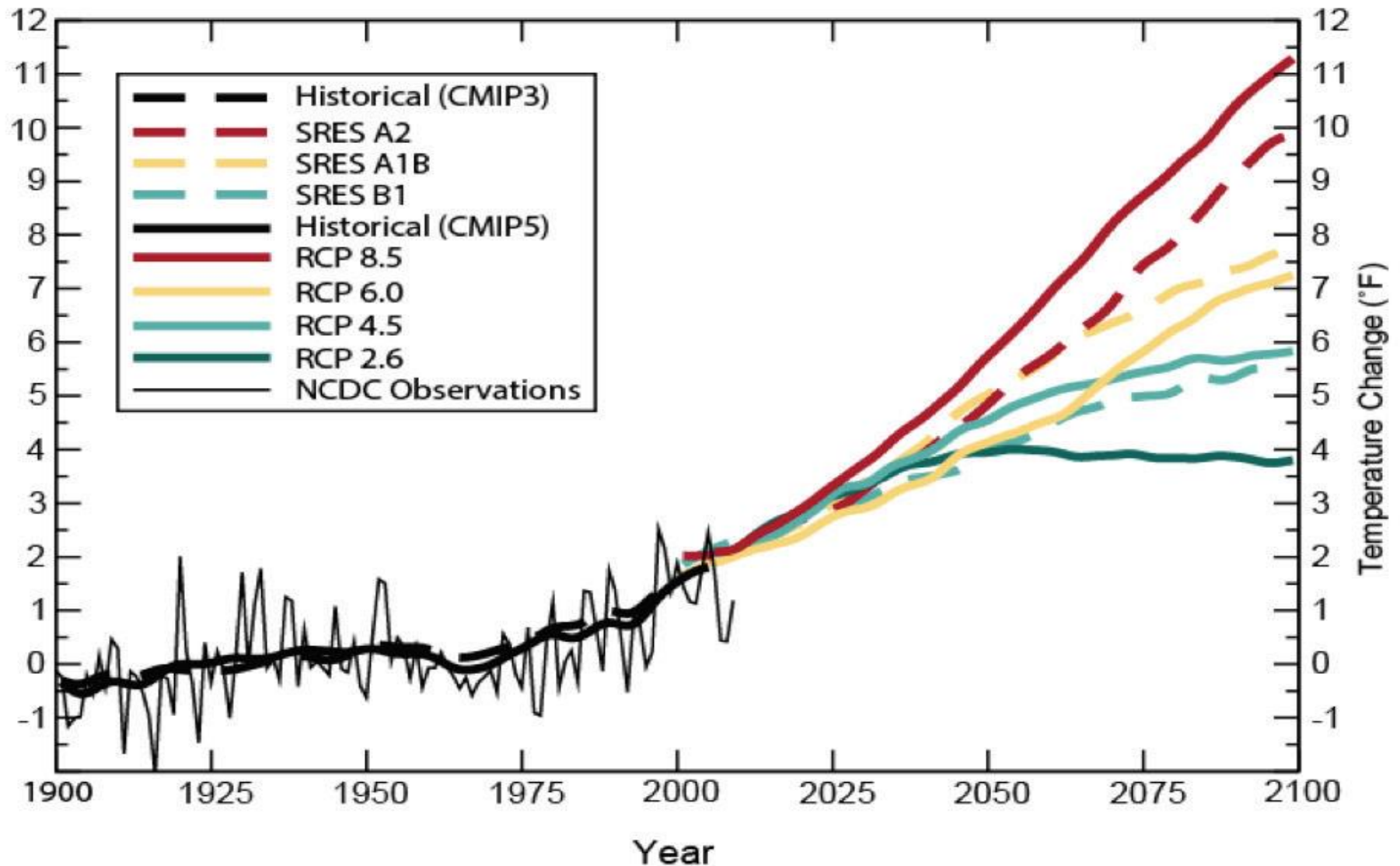


Figure source: NOAA NCDC. Temperature data from NOAA NCDC 2012; CO₂ data from NOAA ESRL 2012.)

U.S Average Temperature Projections

U.S. Average Temperature Projections

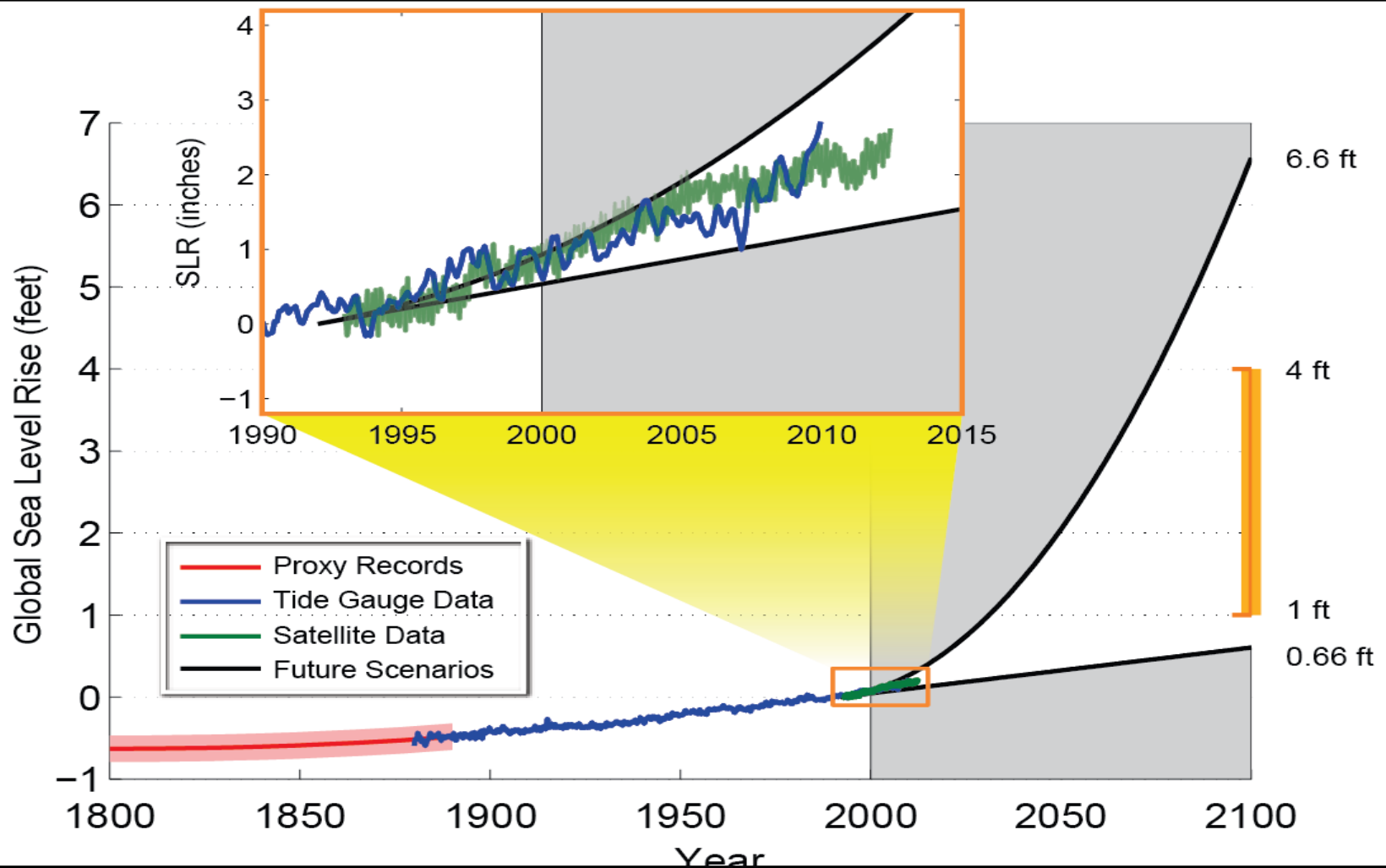


Sea-level rise projections : a few inches to a few feet

- 2 ft: U.S. would lose 10,000 square miles
- 3 ft: Would inundate Miami
- Affects erosion, loss of wetlands, freshwater supplies
- Half of the world's population lives along coasts
- Big question: Ice sheets

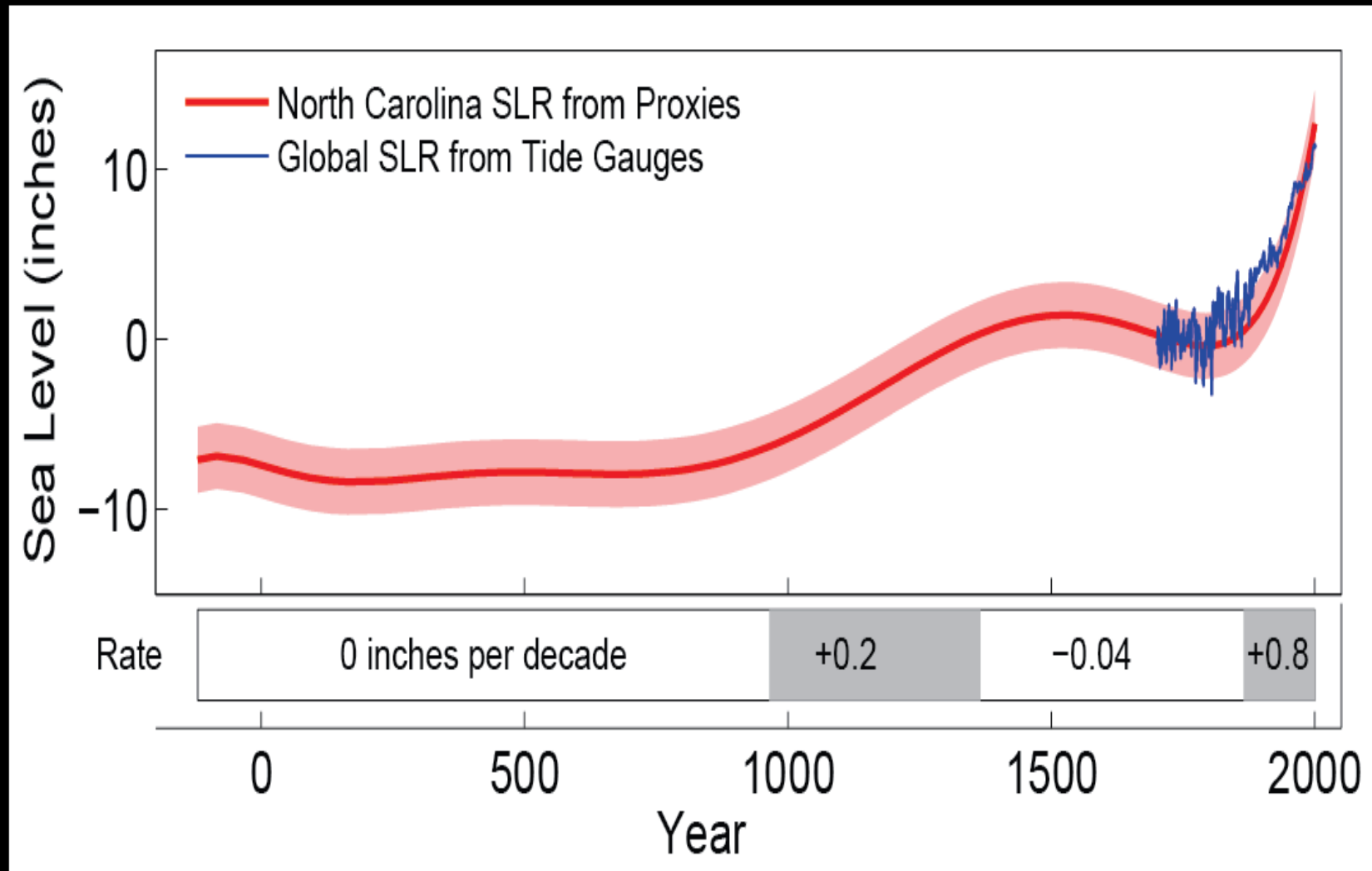
Sea level Rise; Past, Present & Future

Sea Level Rise: Past, Present, Future

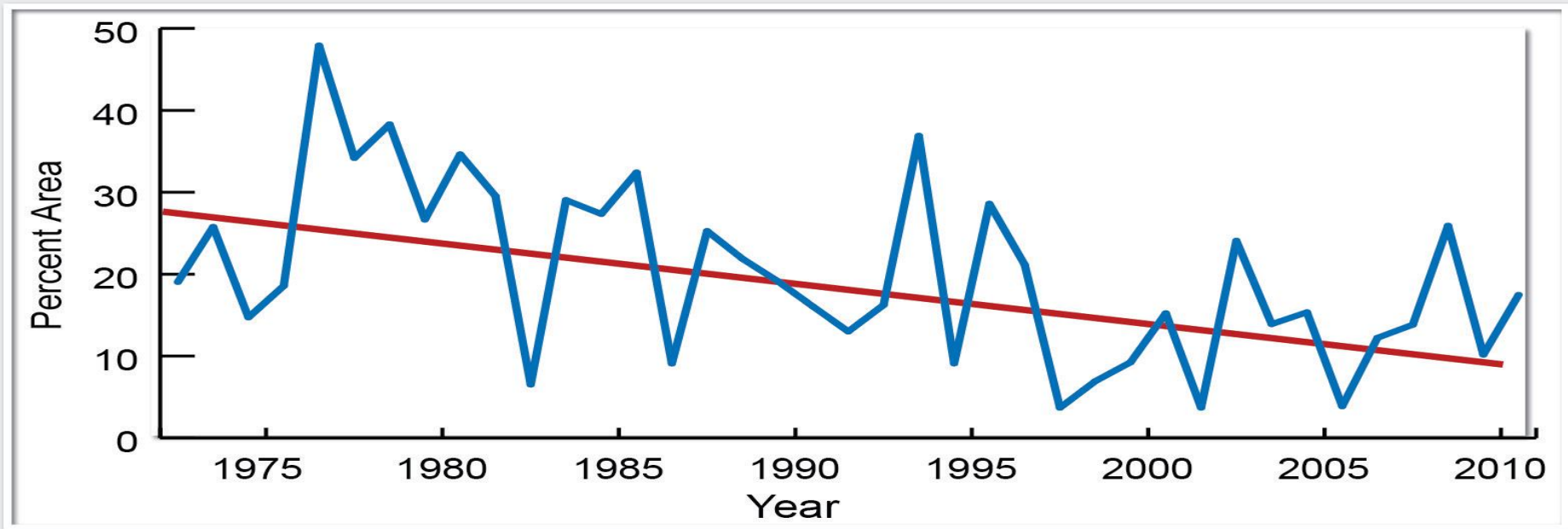


(Figure source: Josh Willis, NASA Jet Propulsion Laboratory)

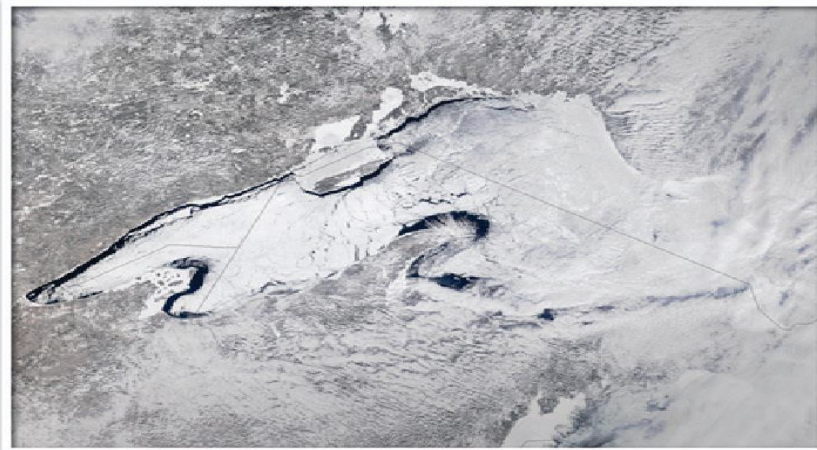
Rates of sea level change in the North Atlantic Ocean



Great Lakes Ice Coverage Decline



Lake Superior

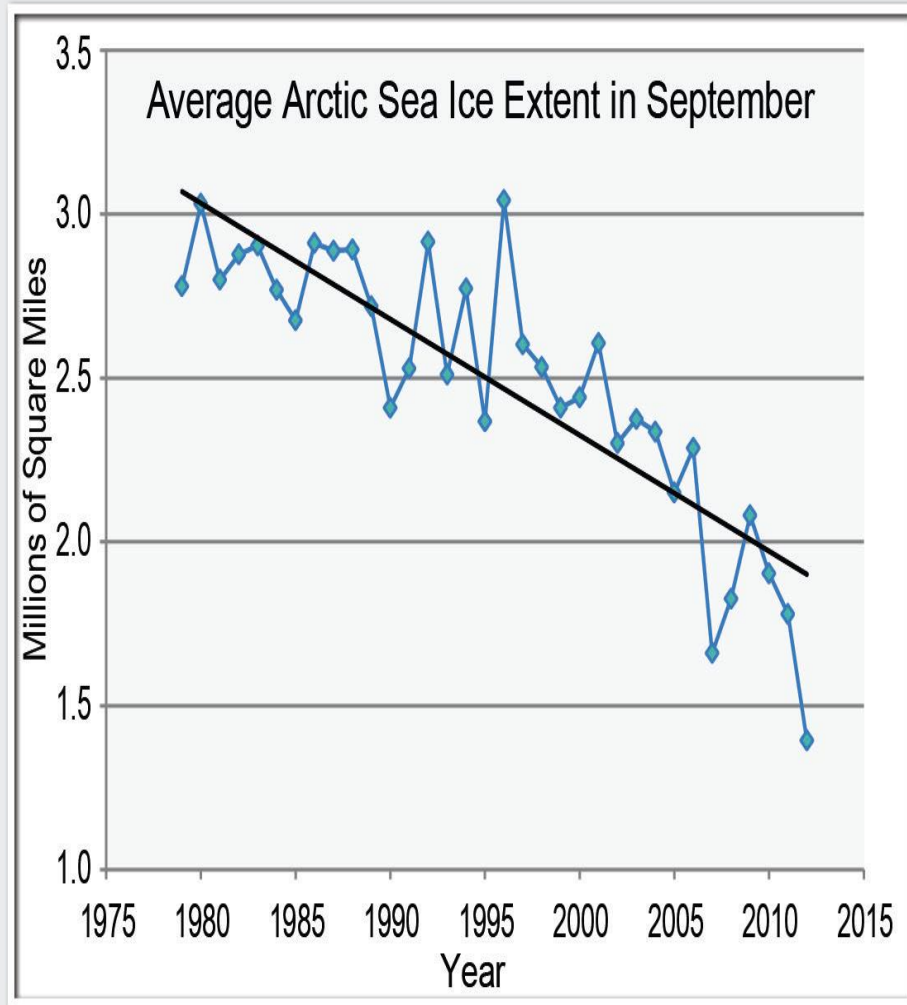
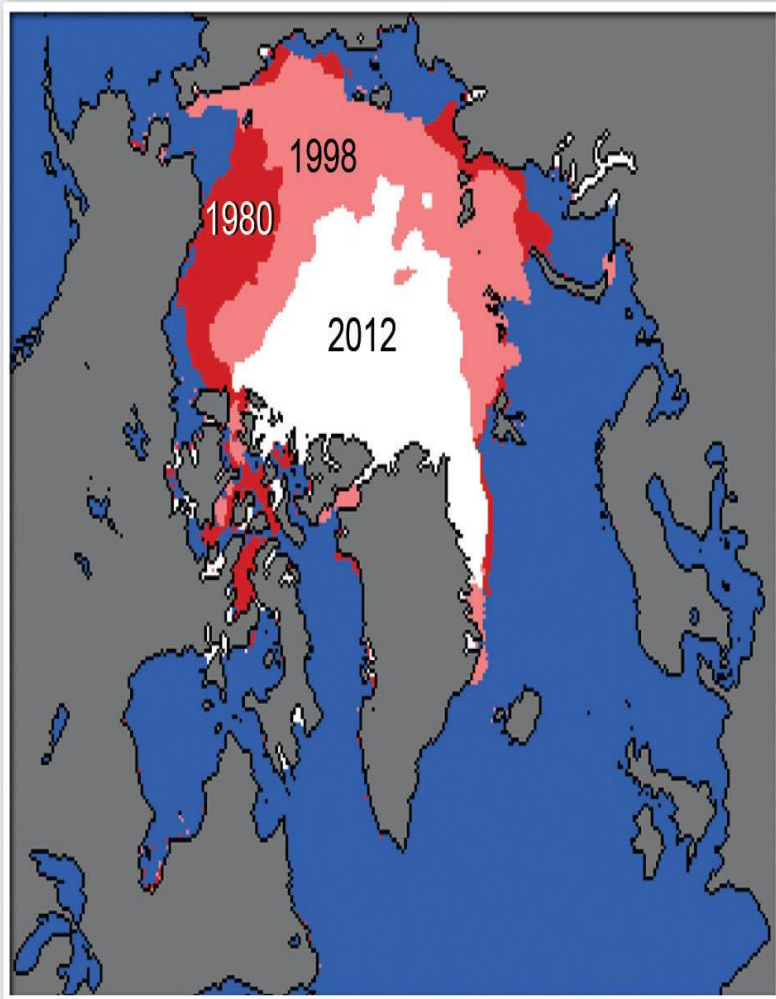


March 2003

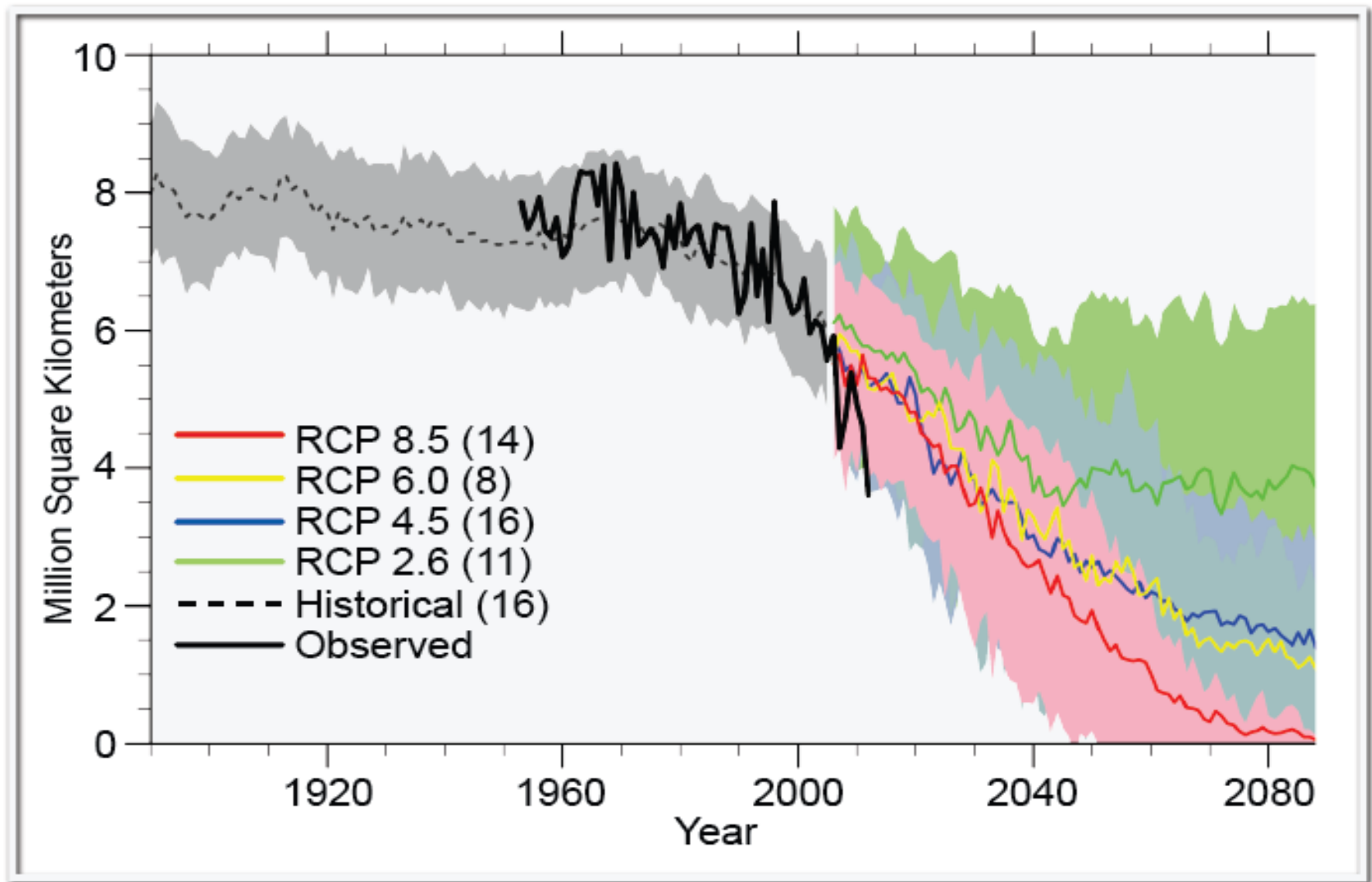


March 2012

Arctic Sea Ice Decline

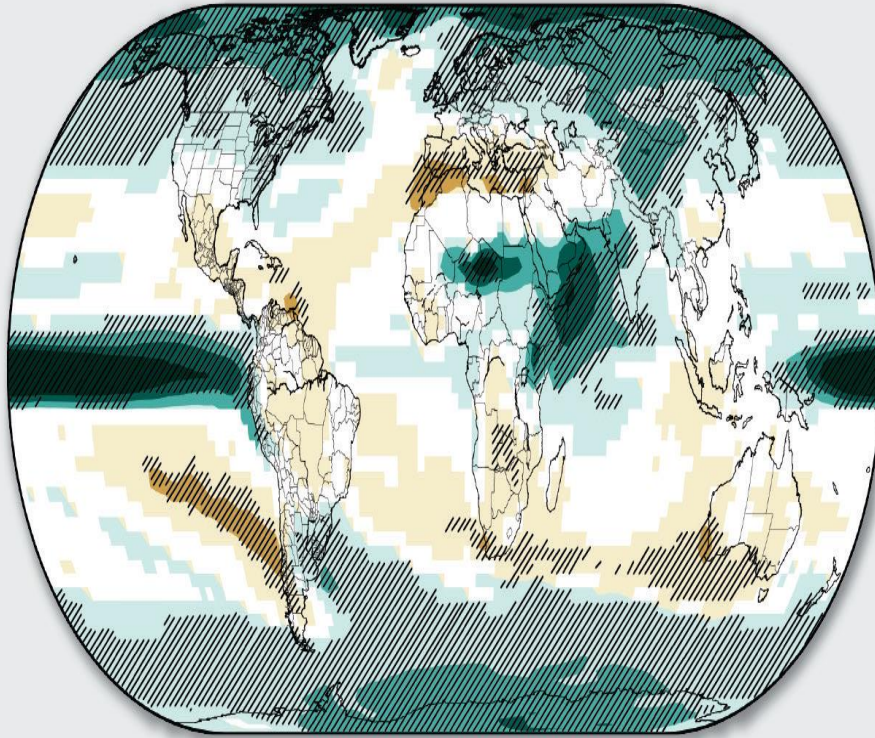


Projected Arctic Sea Ice Decline

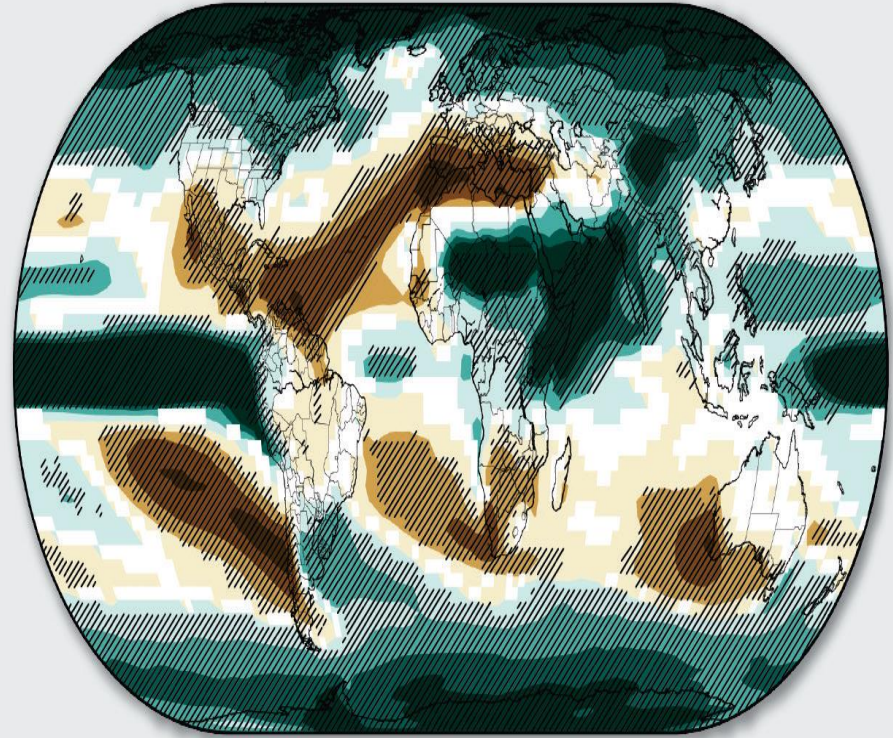


Generally, Wet Get Wetter and Dry Get Drier

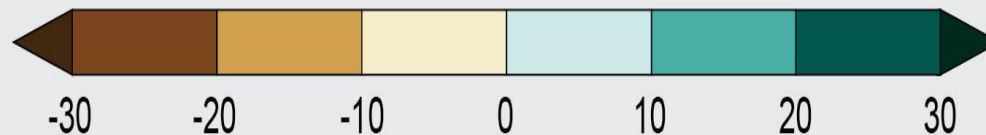
Low Pathway (RCP 2.6)



High Pathway (RCP 8.5)



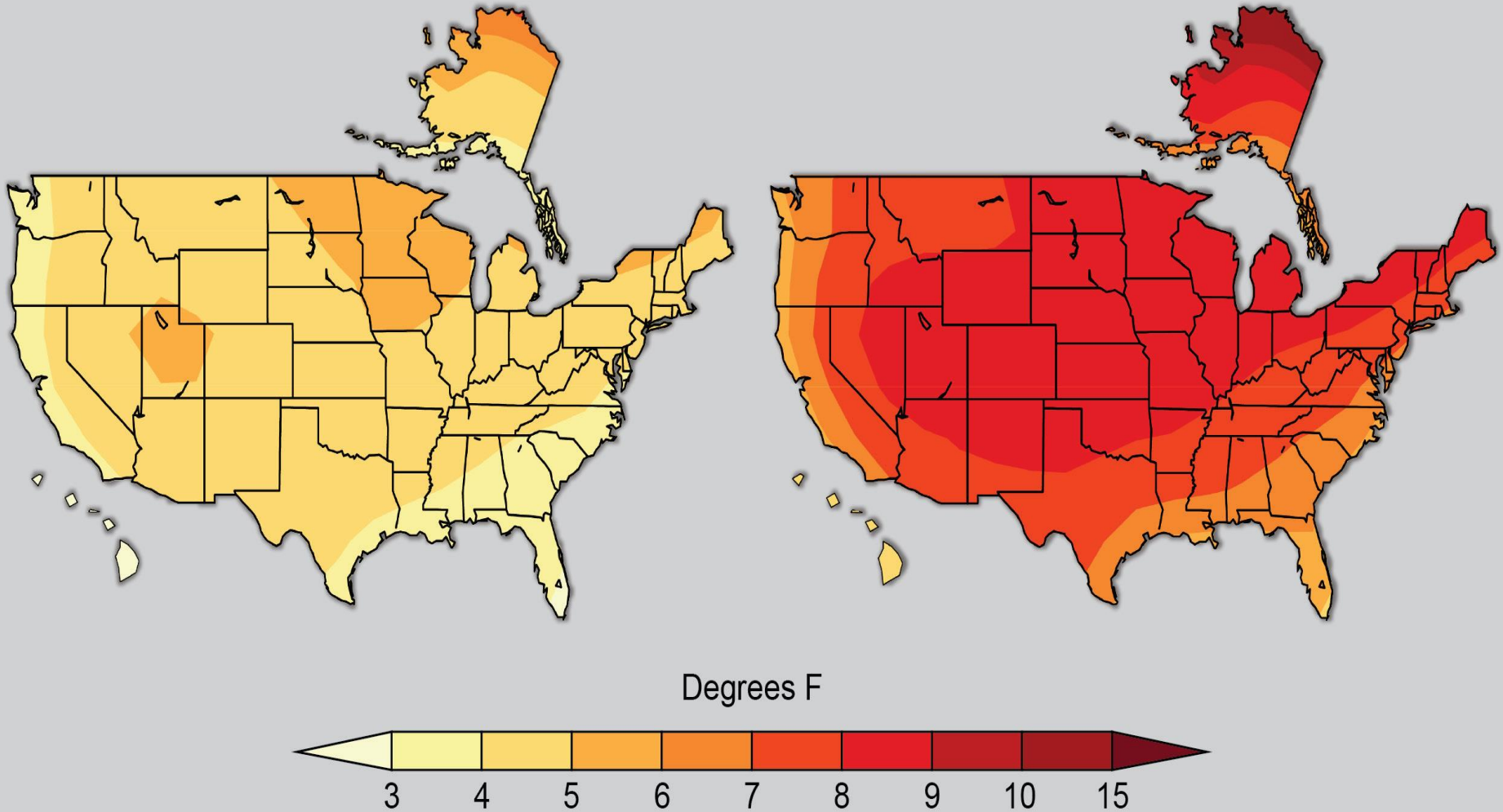
Percent Change



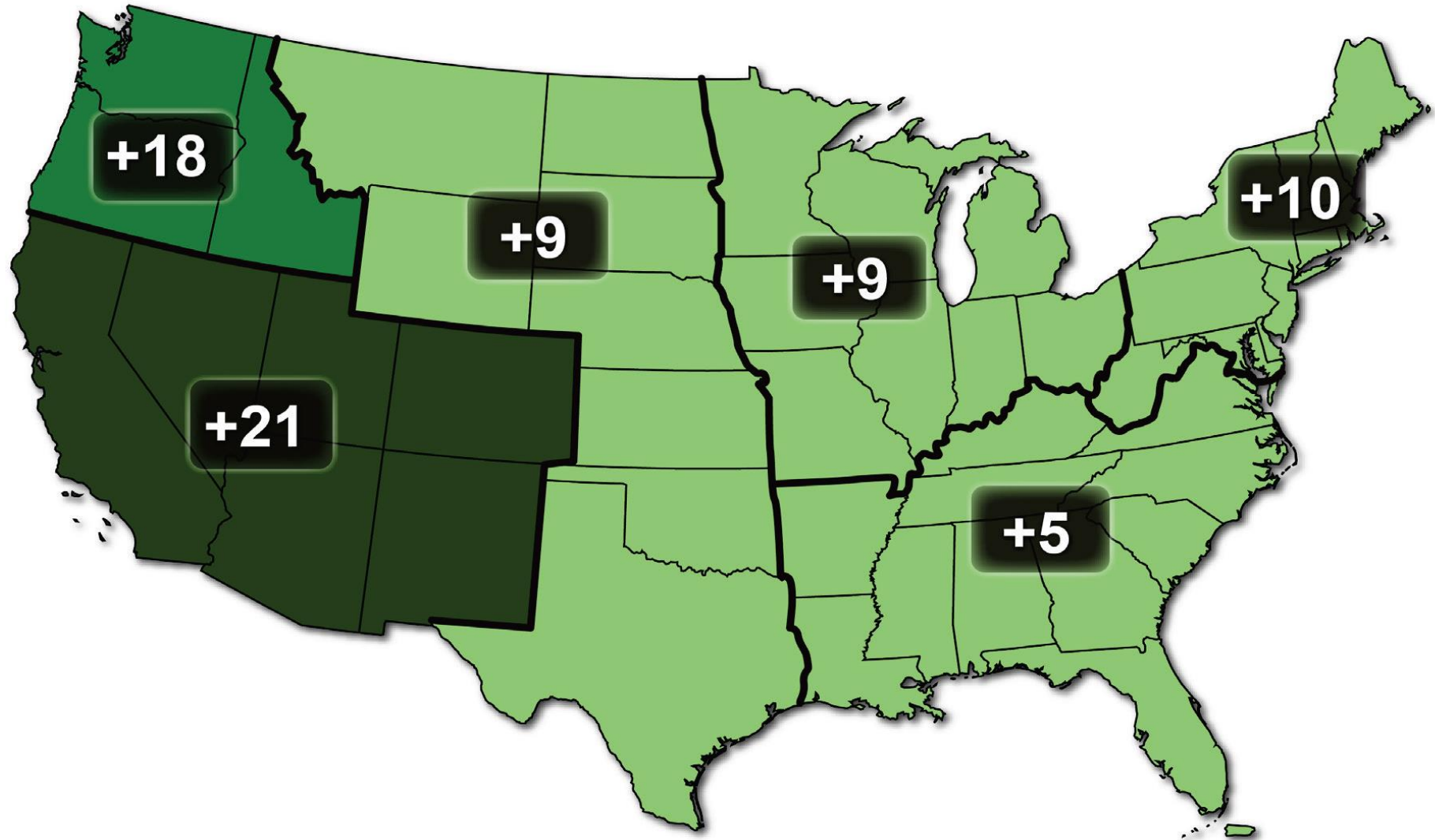
Projected Temperature Change

Lower Emissions (B1)

Higher Emissions (A2)



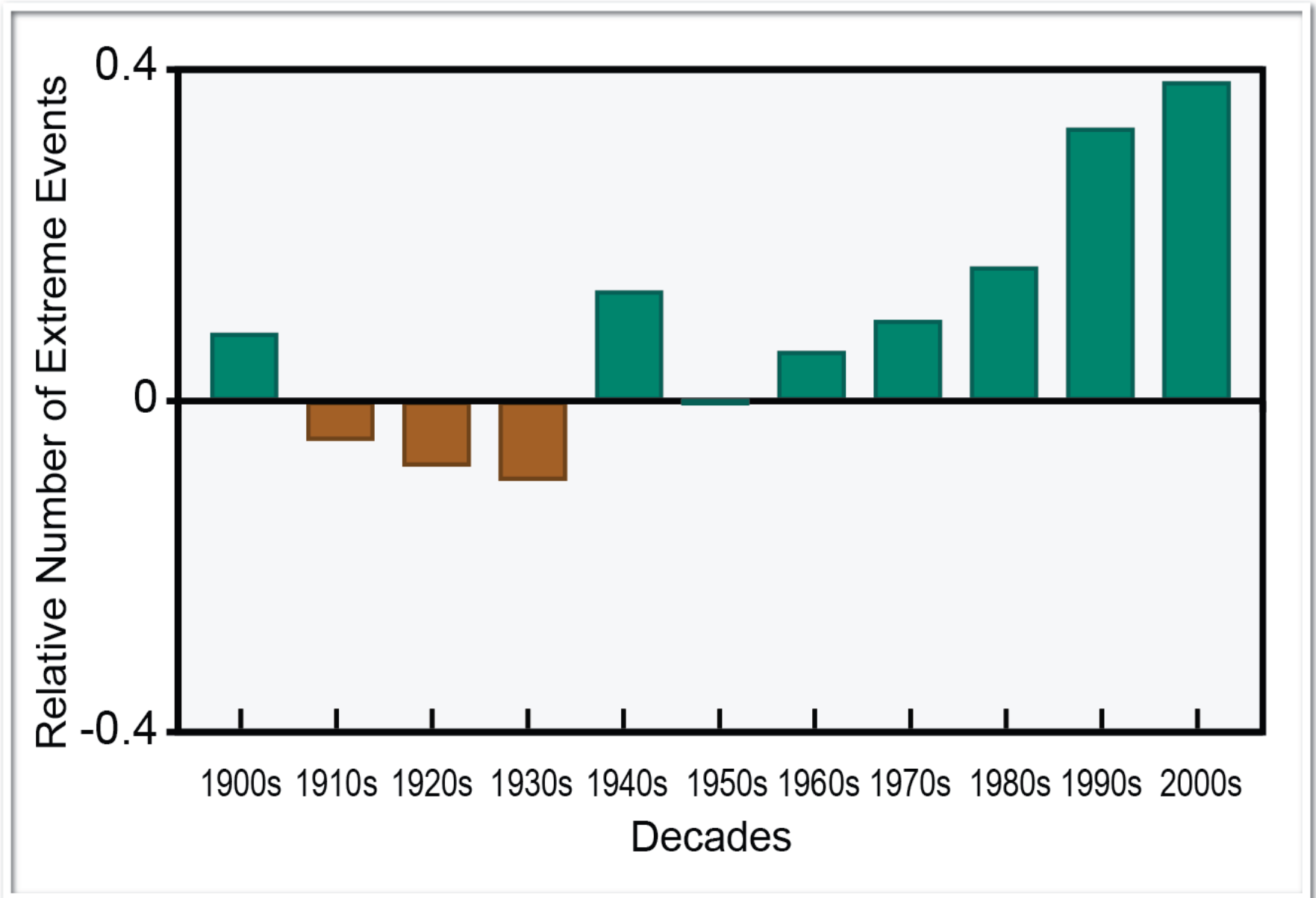
Observed Changes in Frost-Free Season



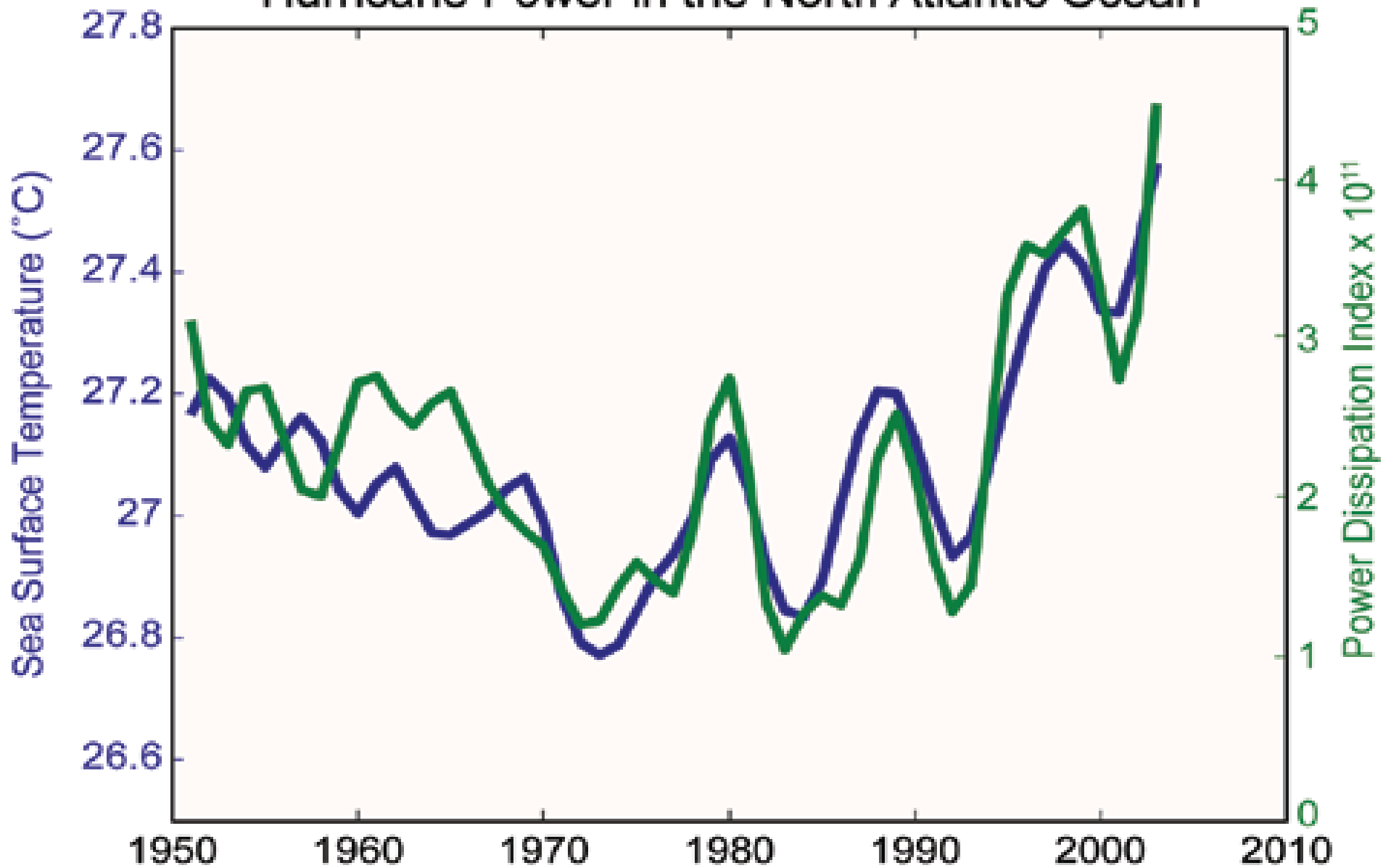
Increases in Annual Number of Days



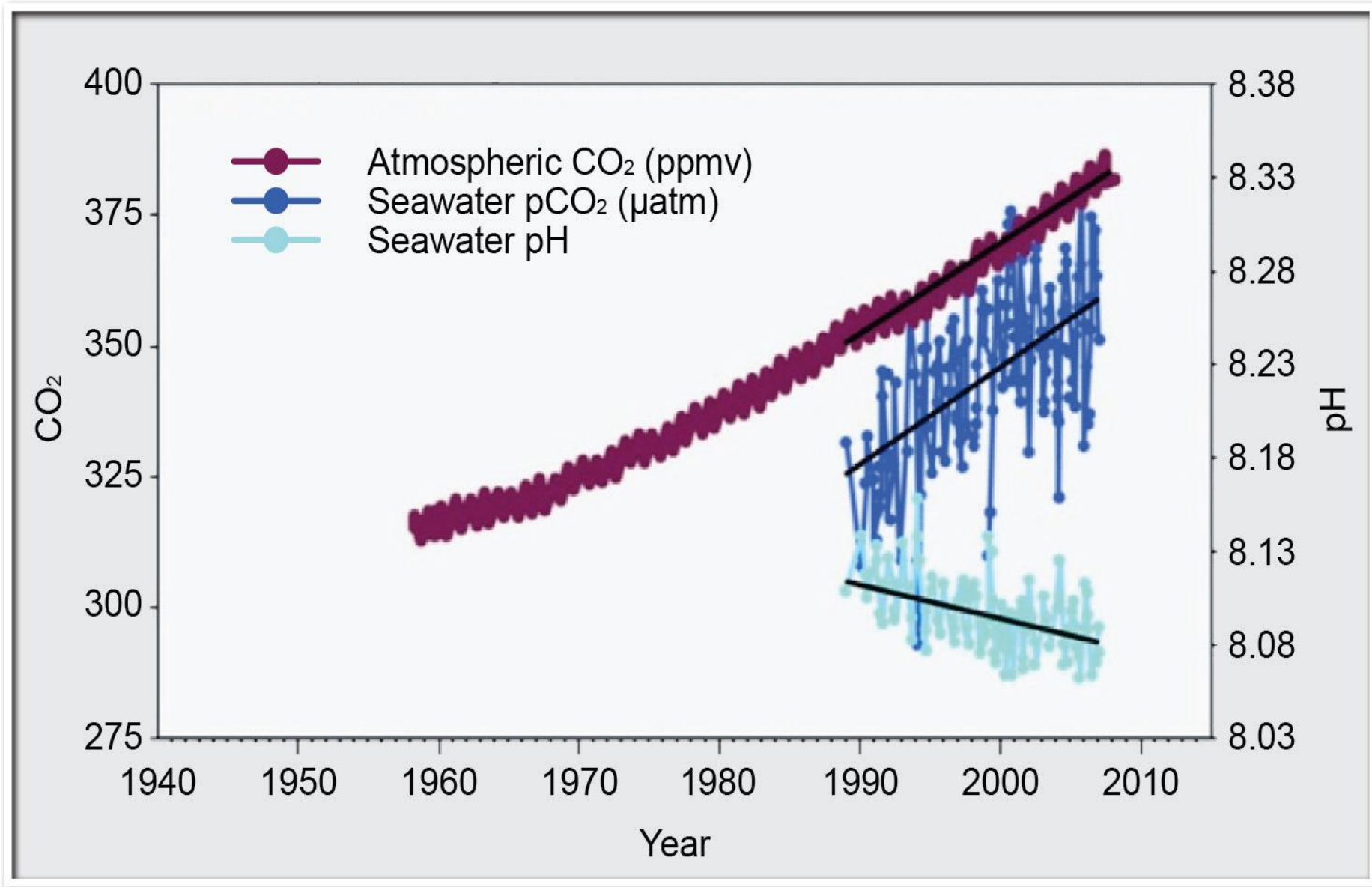
Observed U.S. Trends in Heavy Precipitation



Relationship Between Sea Surface Temperatures and Hurricane Power in the North Atlantic Ocean



As Oceans Absorb CO₂, They Become More Acidic



Shells Dissolve in Acidified Ocean Water



Pteropod's shell placed in seawater with pH and carbonate levels projected for the year 2100. The shell slowly dissolves after 45 days.

So.. What can we do?

There are several types of options...

- **Reduce emissions of greenhouse gases**
- **Attempt to develop alternatives energies**
- **Allow emission to continue, but prepare for global climate changes**
- **Allow emissions to continue as normal and leave preparations up to individual countries**
- **Combine any of these ideas**

Federal Advisory Committee Draft Climate Assessment Report Released for Public Review

For current information about Climate Change go to:

<http://ncadac.globalchange.gov>

<http://www.ipcc.ch/about/index.htm>

<http://epa.gov/climatechange/index.html>

<http://climate.nasa.gov/>

<http://www.metoffice.gov.uk/climate-change/resources/hadley>

www.climatechange.eu.com

Closing thought:

“The significant problems we face cannot be solved at the same level of thinking we used when we created them.”

Albert Einstein