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Climate Change 101: An Overview of the Science

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Climate Change and Coastal Hazards
Ocean County Library
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Climate Change 101: The Basics

- Combustion of fossil fuels (coal, petroleum, natural gas) emits carbon dioxide into the atmosphere (currently more than 8 billion tons of carbon per year)
- Roughly half of the carbon dioxide remains in the atmosphere; most of the remainder goes into the ocean (causing ocean acidification)
- Increasing carbon dioxide heats the earth; global temperatures have risen by 1-1.5°F during the past century.
- Increasing temperatures also cause other changes in climate and sea level.

Three lines of evidence link CO_2 and climate:

- Basic physics
- Observations
- Modeling

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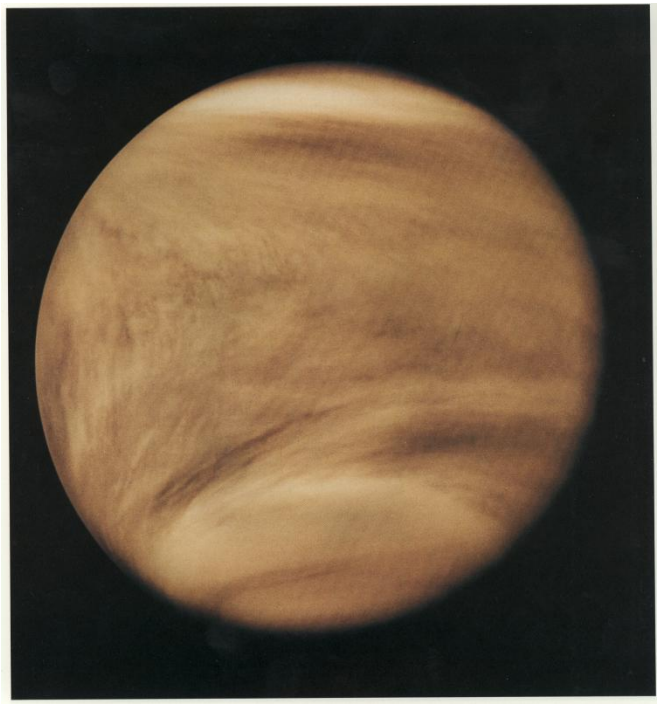
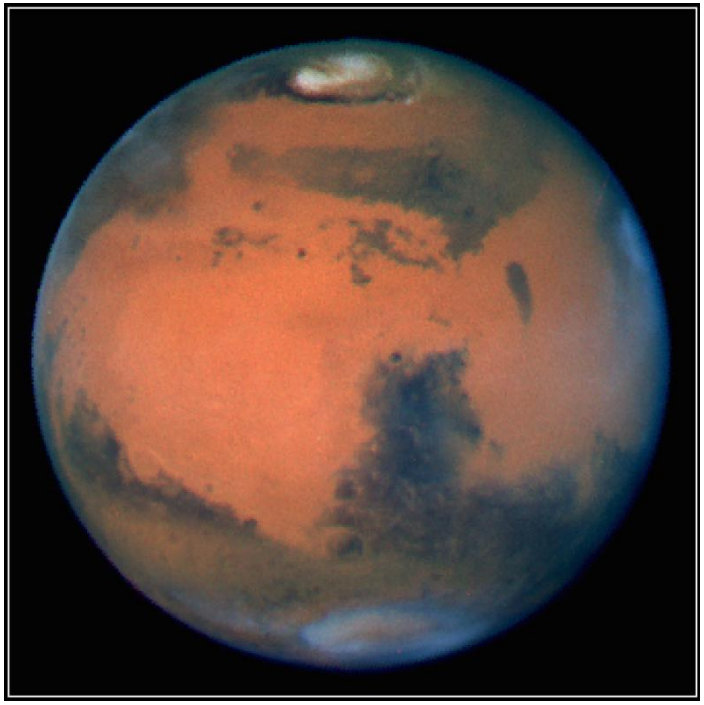
Basic physics of CO_2 and climate

- If an object receives energy in the form of visible light, as the earth does from the sun, it warms up.
- The warmer an object is, the more energy it emits in the form of infrared light.
- CO_2 and water vapor are "greenhouse gases" that absorb infrared light, making it more difficult for energy to escape into space. This is the earth's cooling mechanism that balances the heating from the sun's visible light.
- Without greenhouse gases the earth would be much colder (i.e., its average temperature would be well below freezing).

Venus and Mars



Dense CO_2 atmosphere
Surface temperature: 900° F



Some CO_2 but little water vapor
Surface temperature: -70° F

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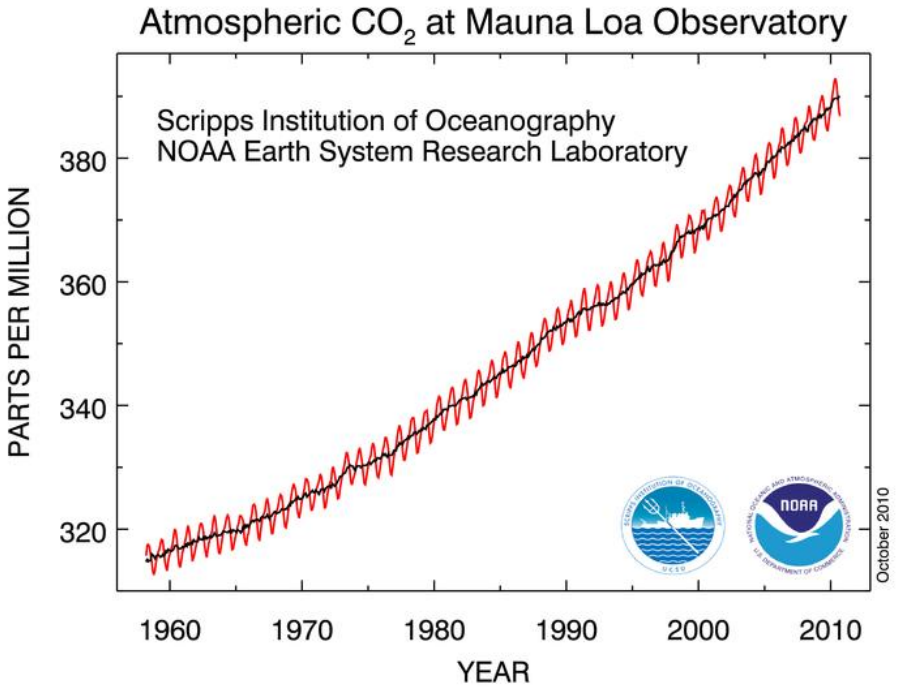
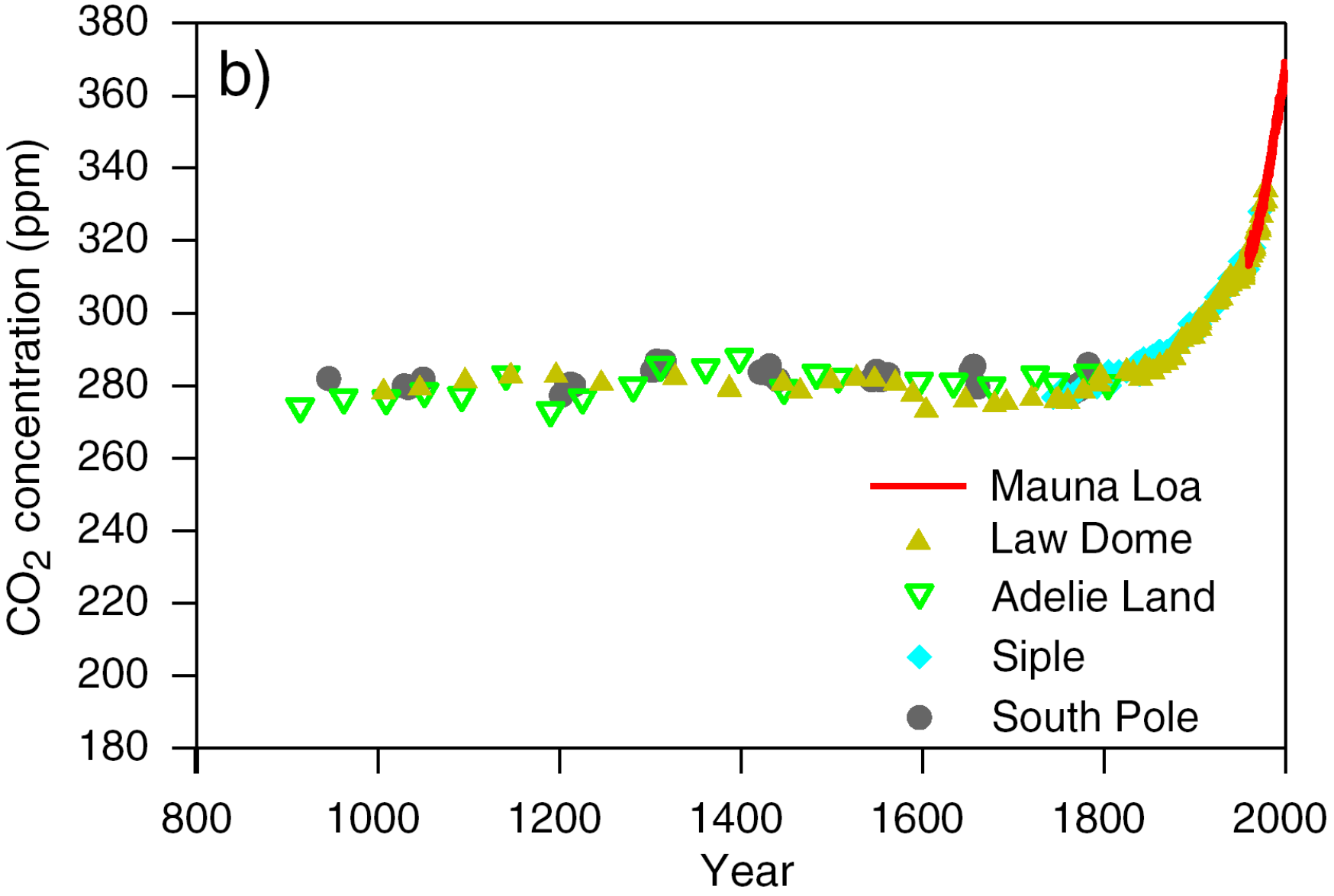
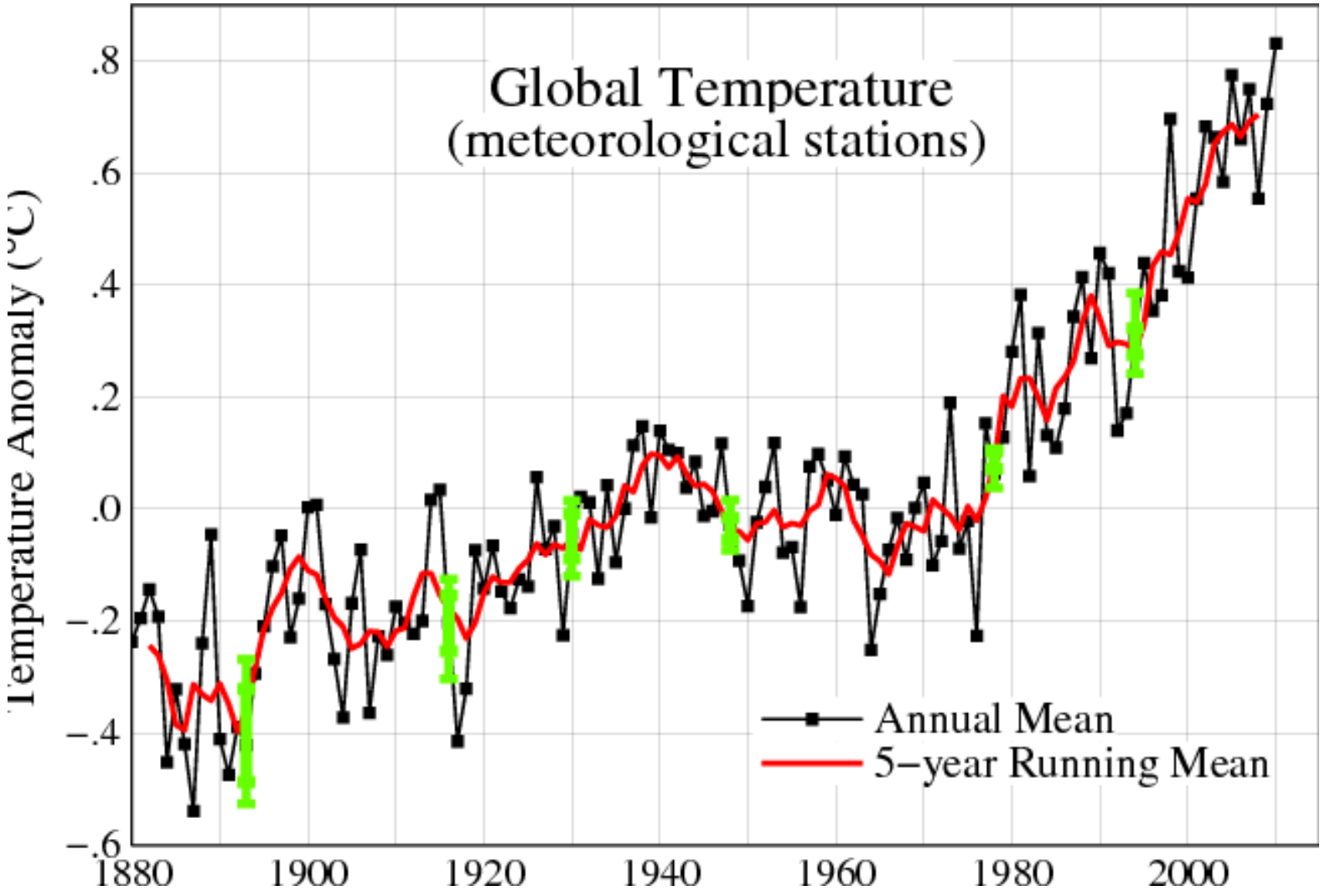
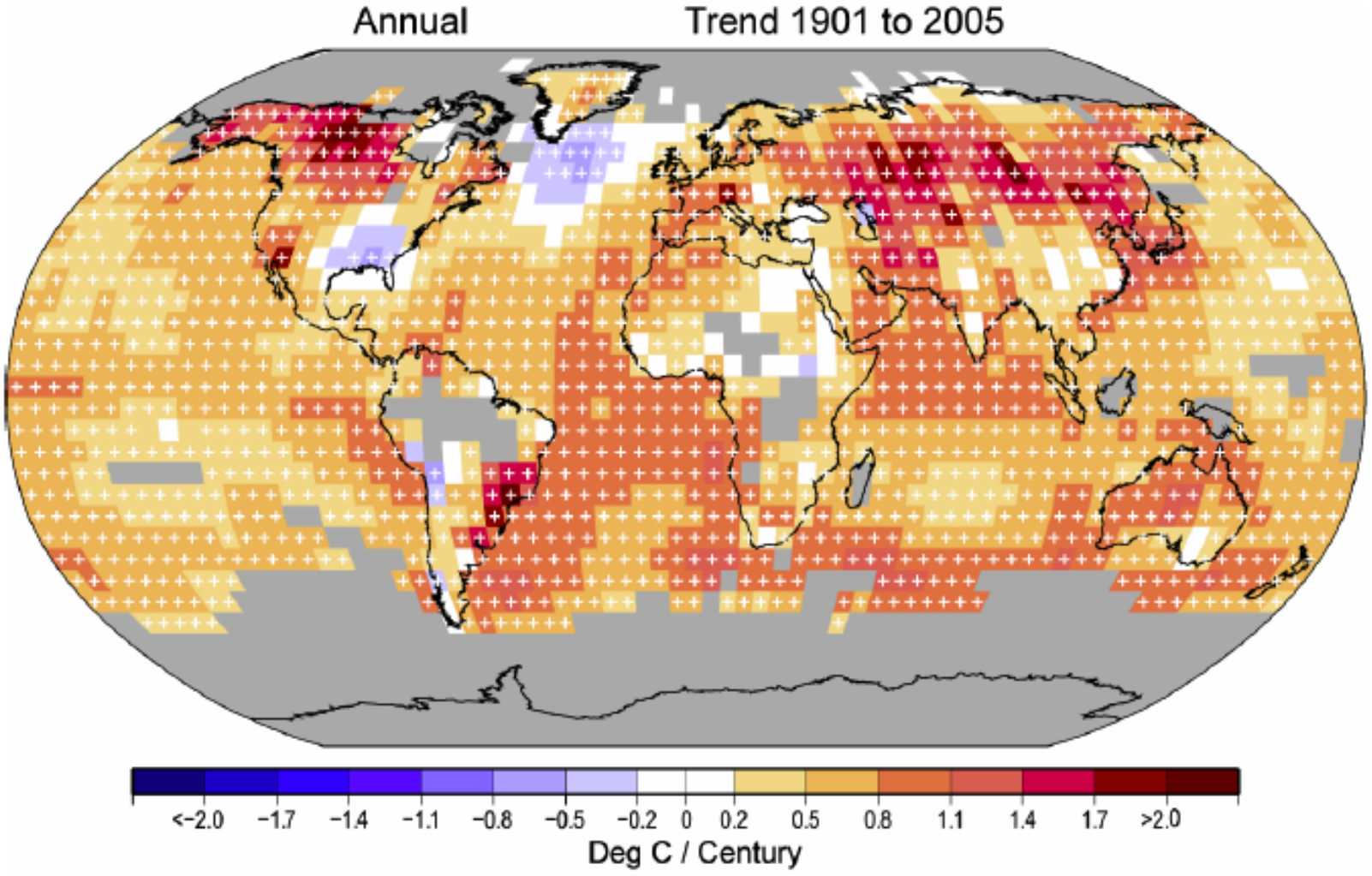

Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
NOAA
October 2010



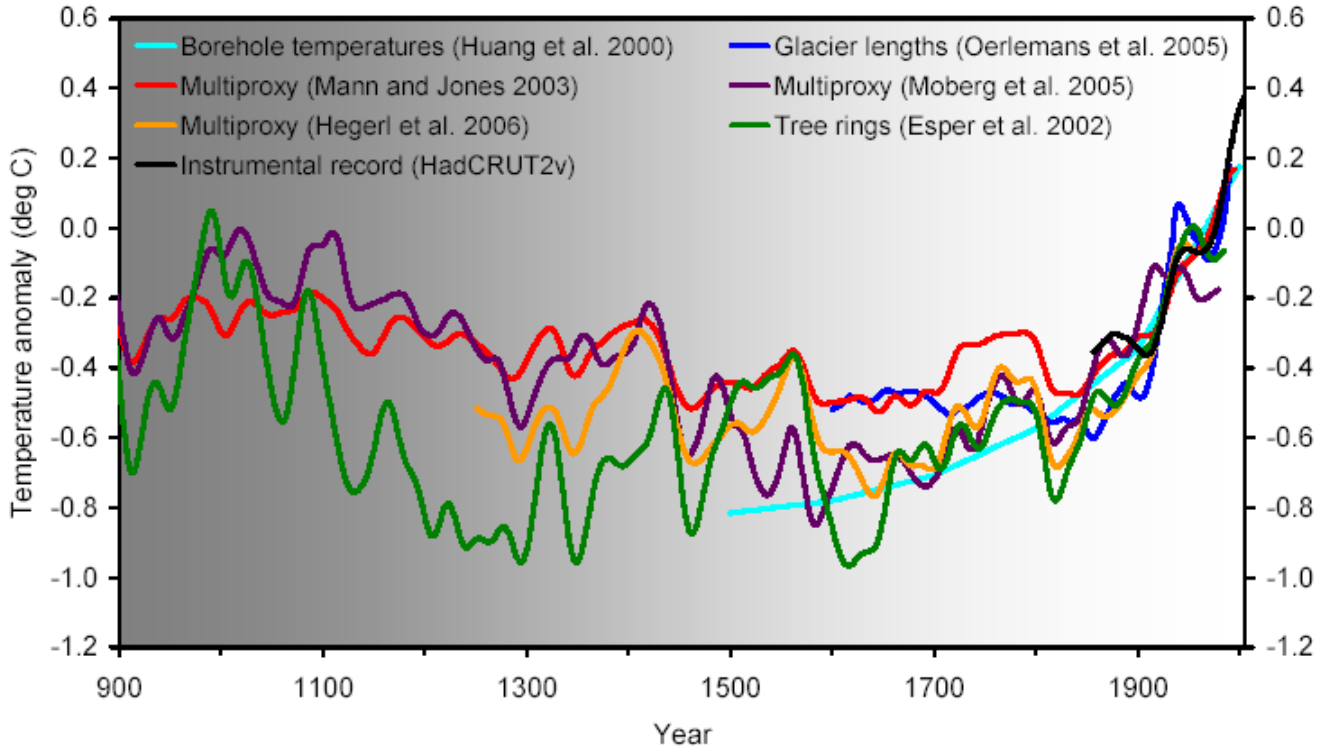
[Source: Intergovernmental Panel on Climate Change, Third Assessment Report]



Source: NASA/Goddard Institute for Space Studies

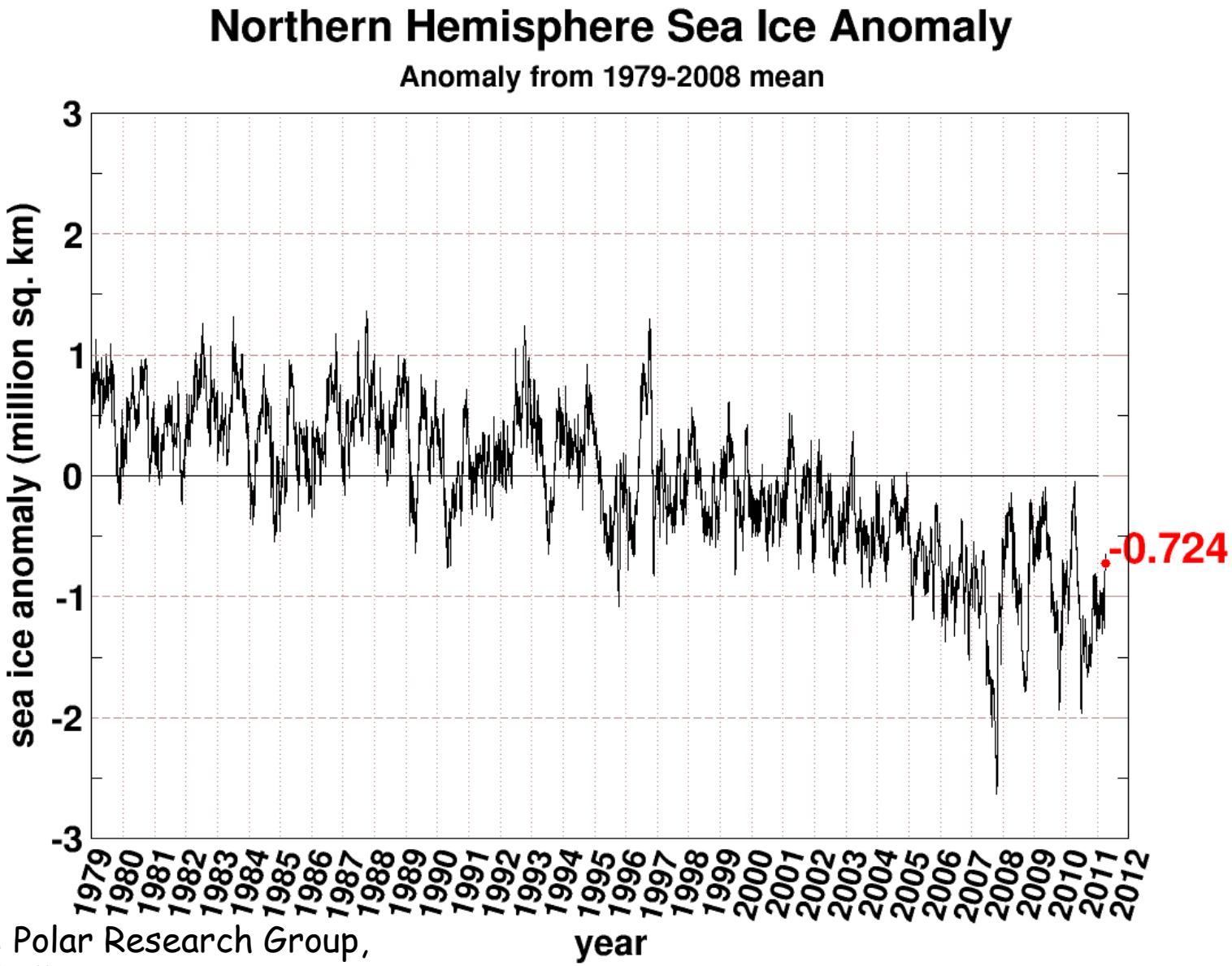

Annual
Trend 1901 to 2005
<-2.0
-1.7
-1.4
-1.1
-0.8
-0.5
-0.2
0
0.2
0.5
0.8
1.1
1.4
1.7
>2.0
Deg C / Century

Northern Hemisphere Temperature Reconstructions

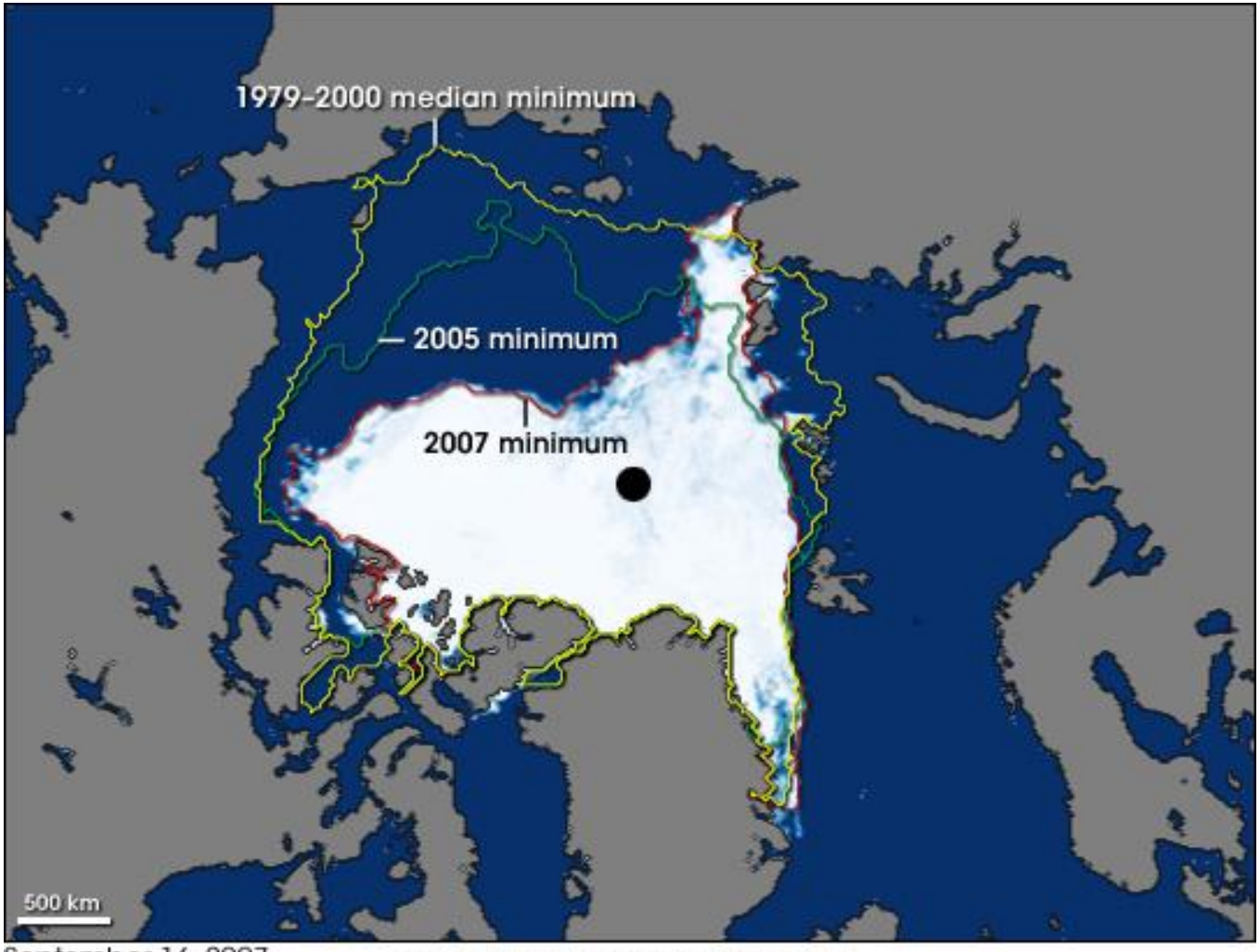


"It can be said with a high level of confidence that **global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries**"

"…the committee finds it plausible that **the Northern Hemisphere was warmer during the last few decades of the 20th century than during any comparable period over the preceding millennium.**" National Research Council



Source: Polar Research Group, Univ. of Illinois



September 16, 2007

Sea Ice Concentration (percent)

0 50 100

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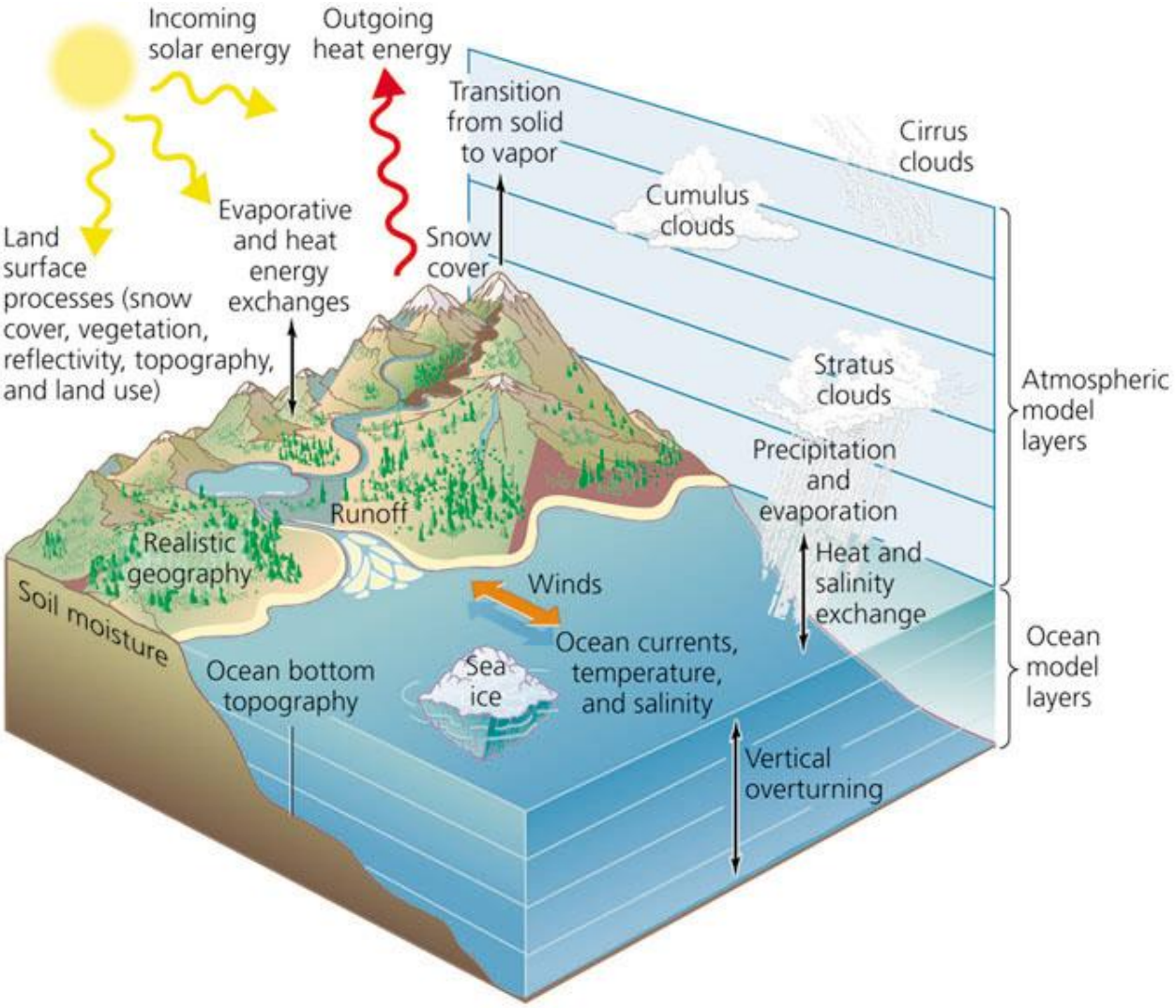
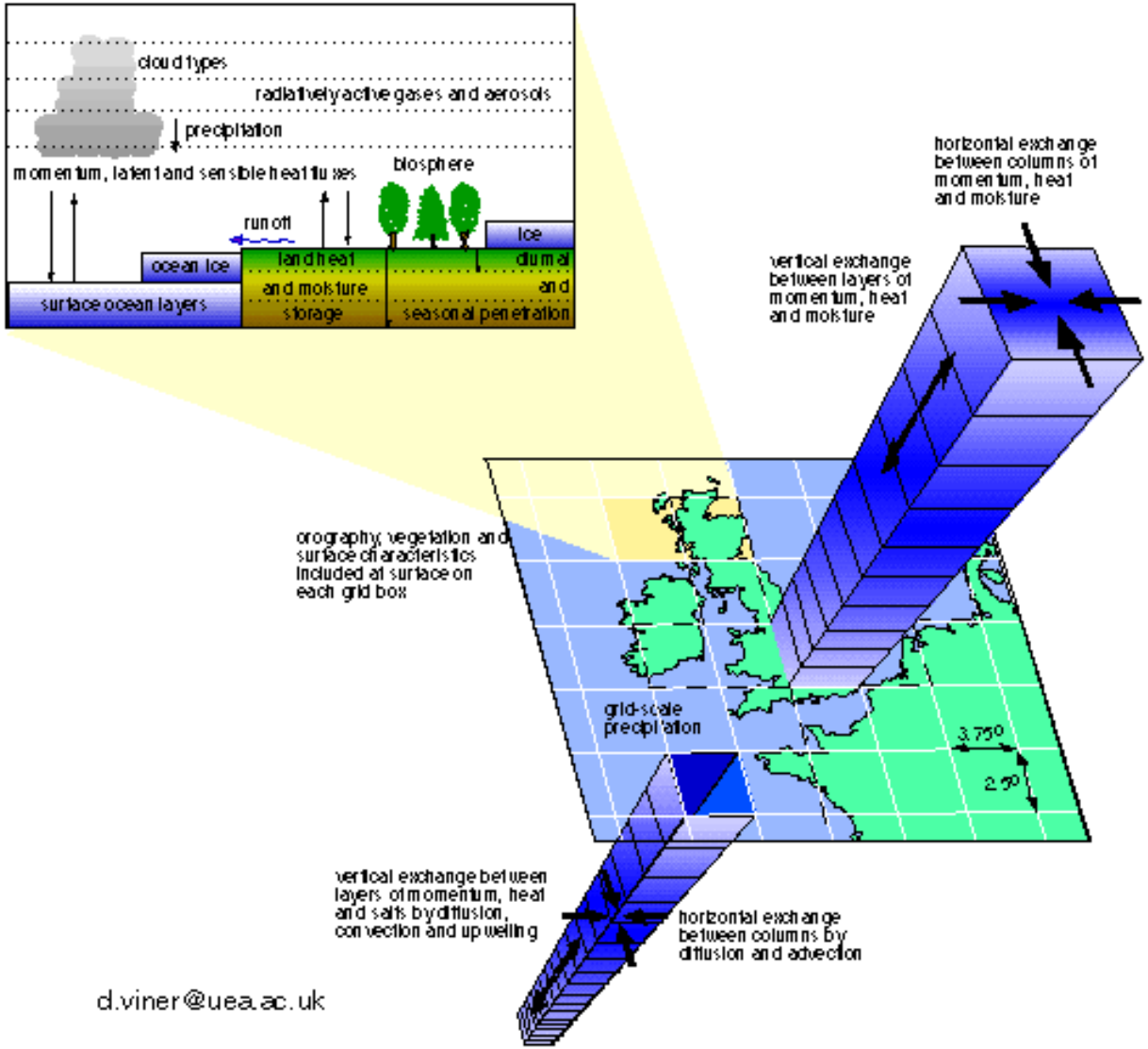
What Are Climate Models?



Coupled Climate Model Schematic



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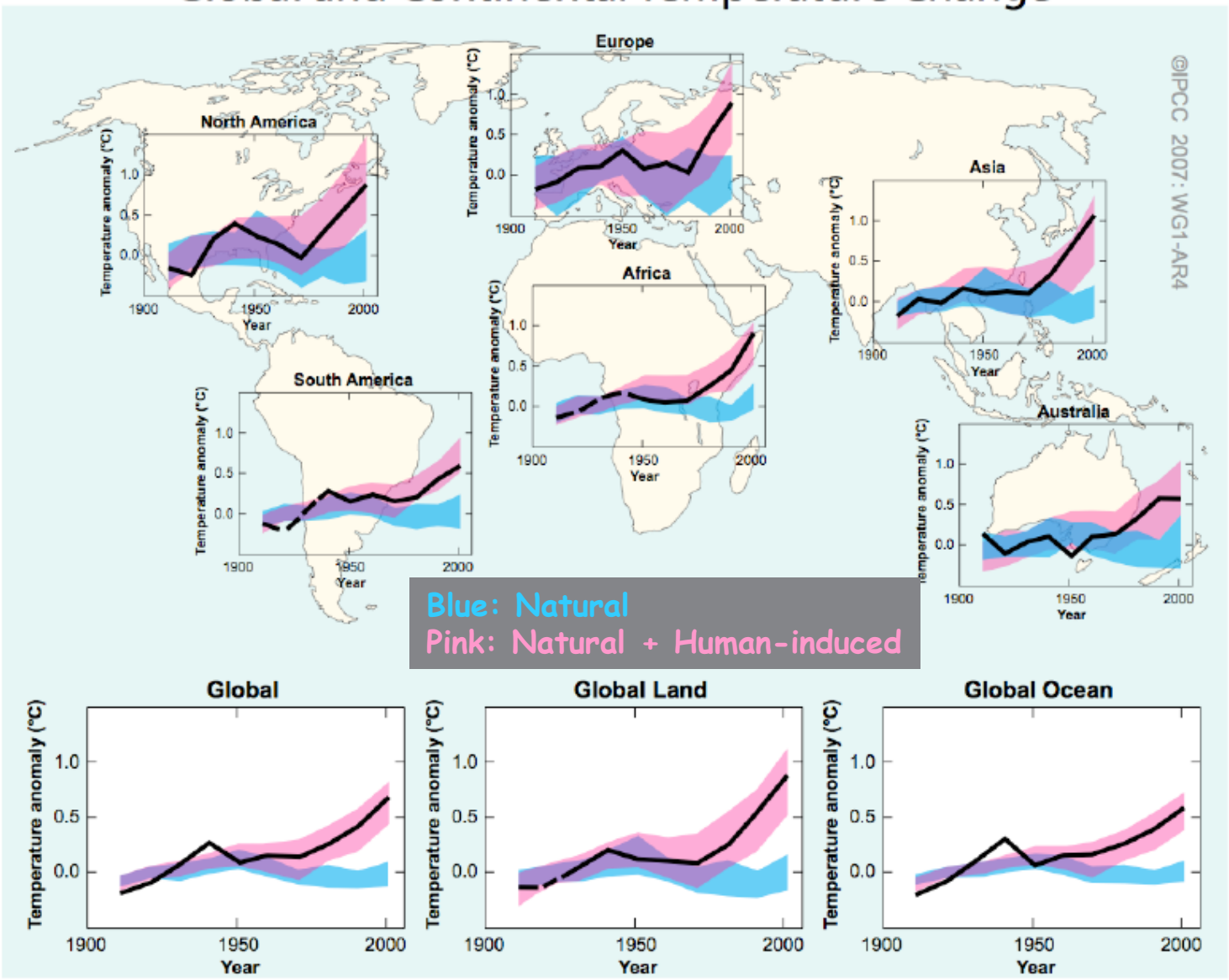
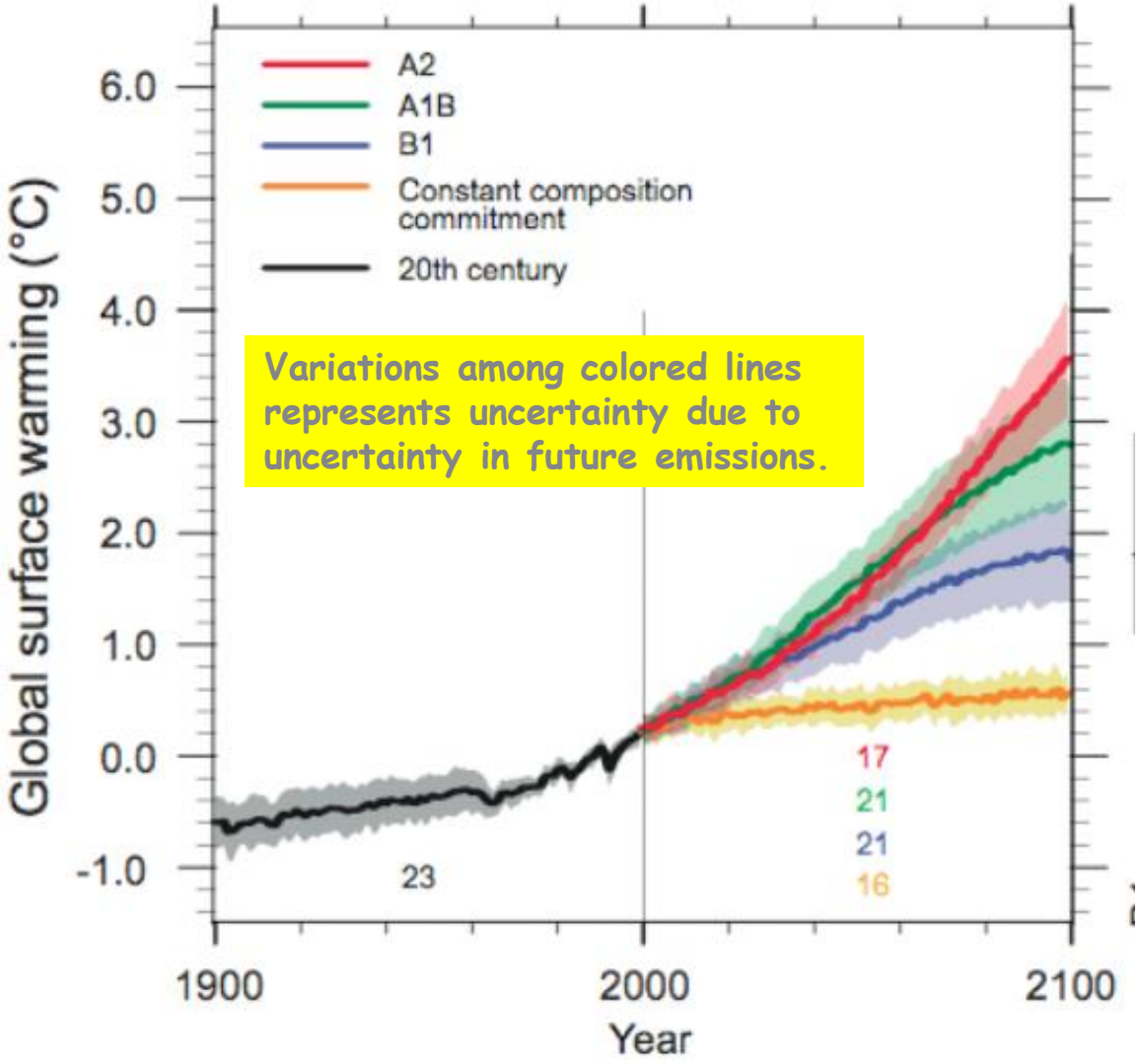
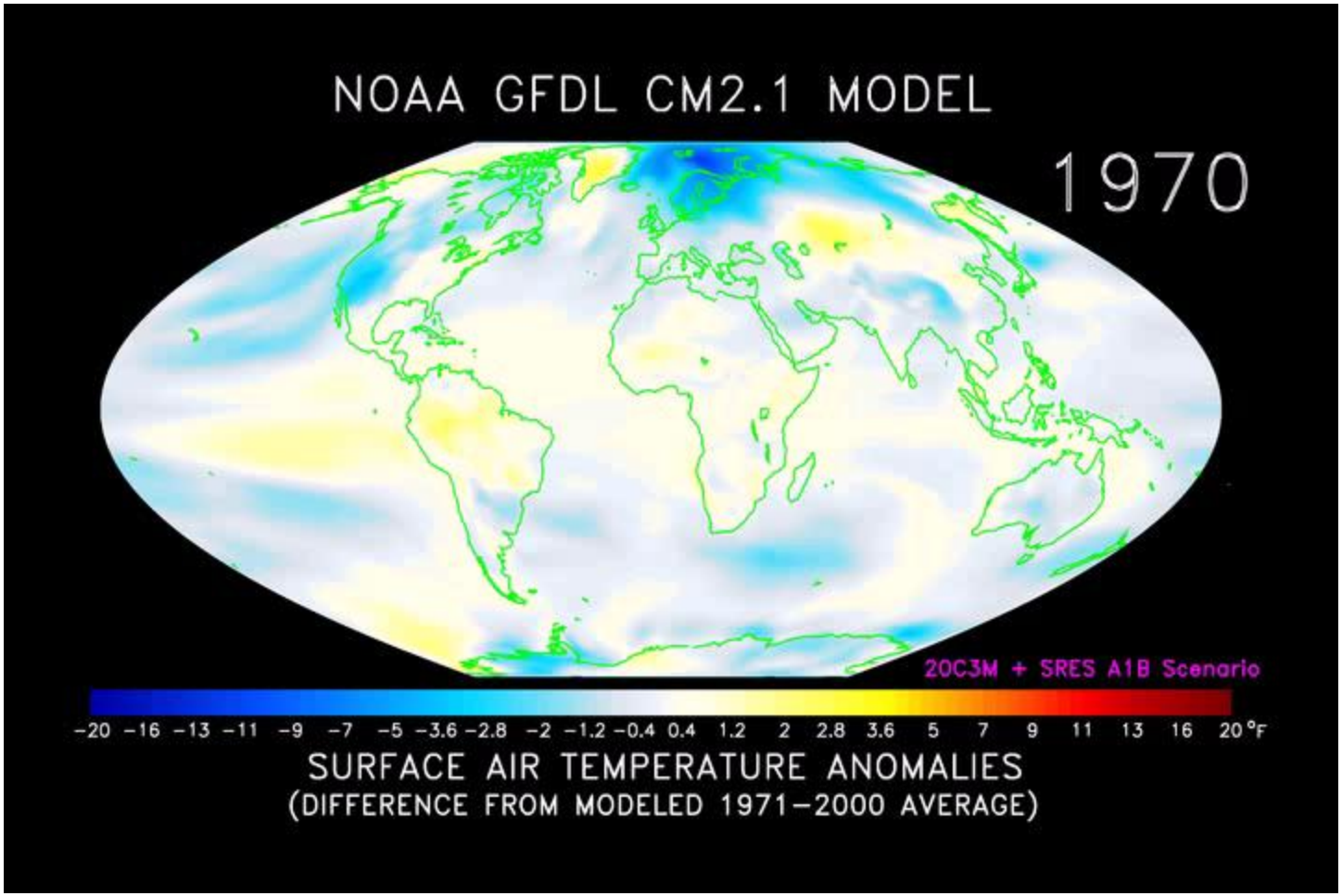
Global and Continental Temperature Change



Projections of Future Climate

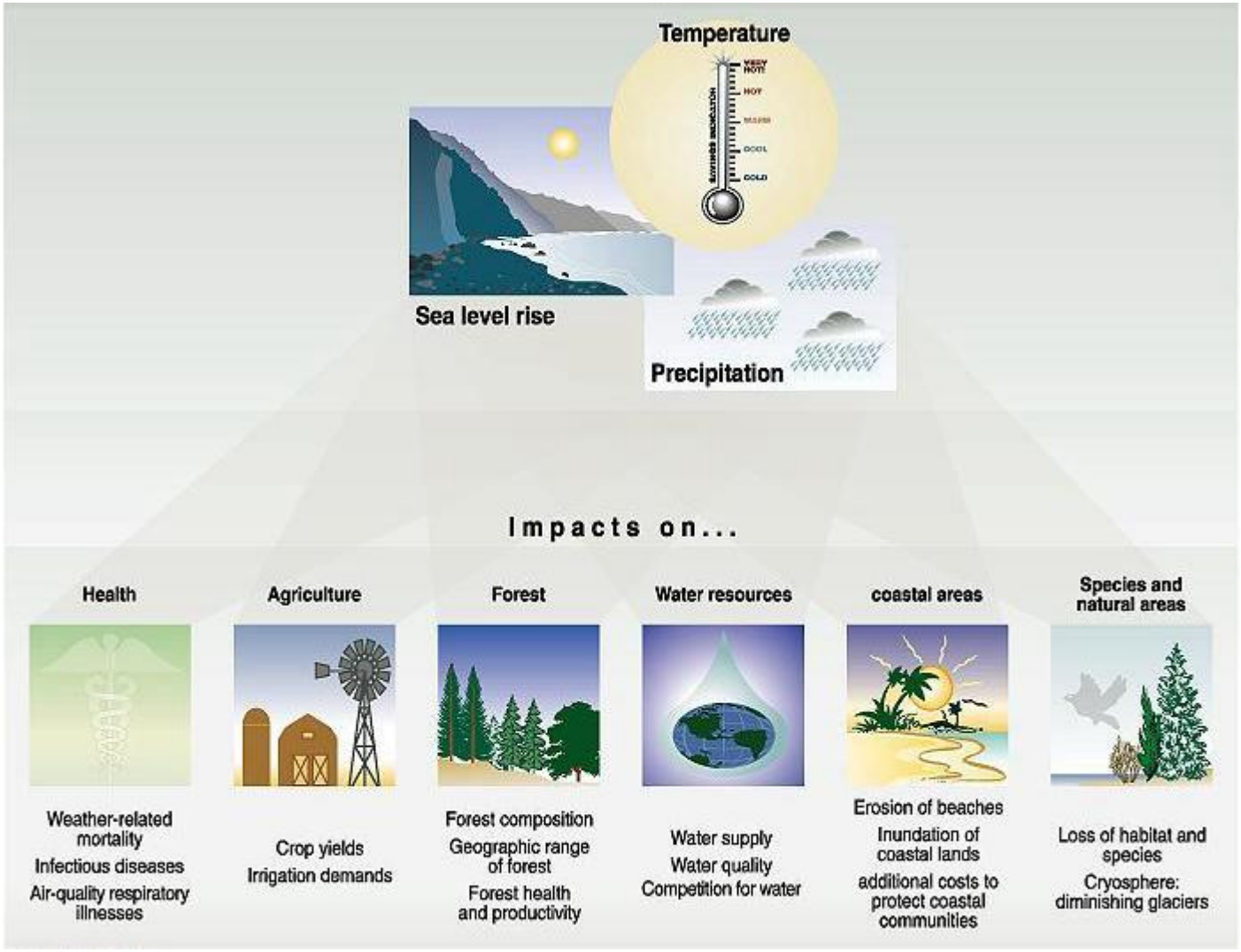


Simulating Future Climate Change



Source: NOAA Geophysical Fluid Dynamics Laboratory

Potential Climate Change Impacts

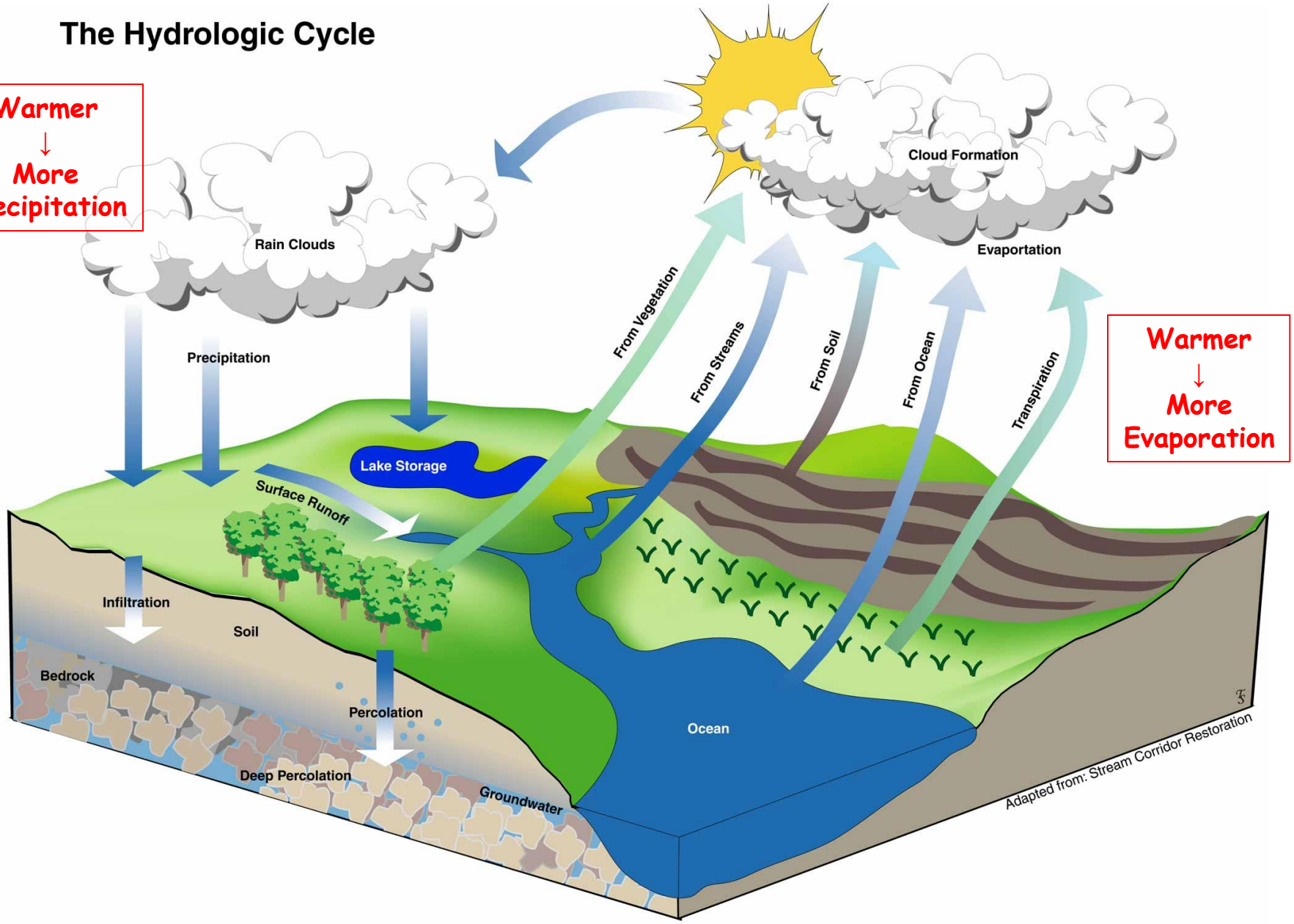


Sea Level Rise

Precipitation Extremes

The Hydrologic Cycle

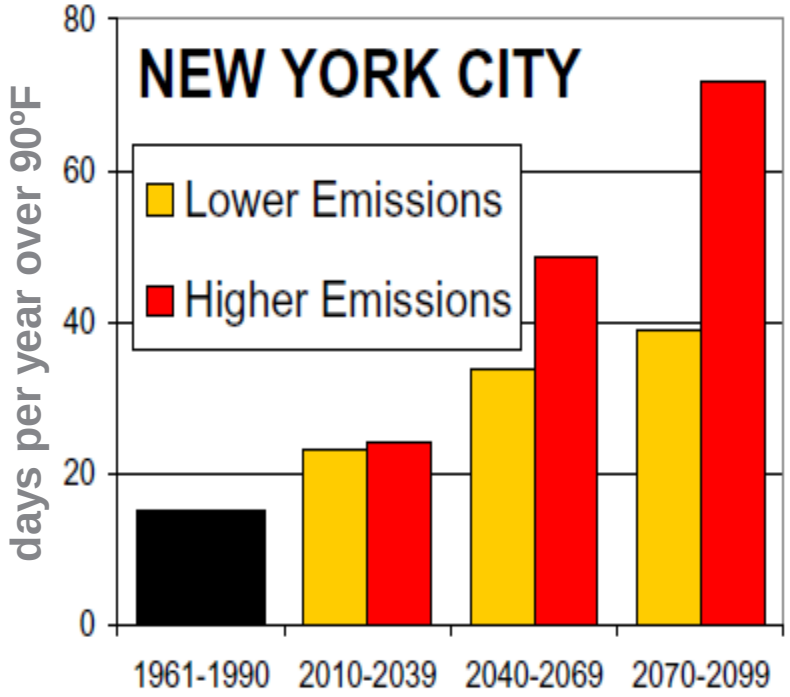
Warmer
↓
More
Precipitation

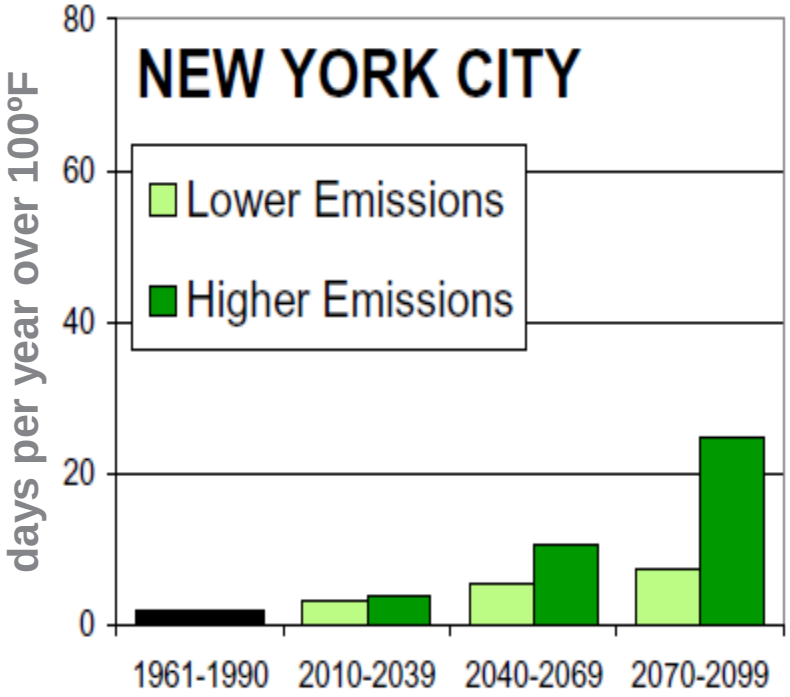


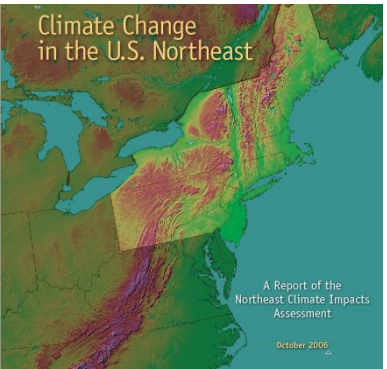
Warmer
↓
More
Evaporation

Heat Waves

IPCC: "It is *very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent."



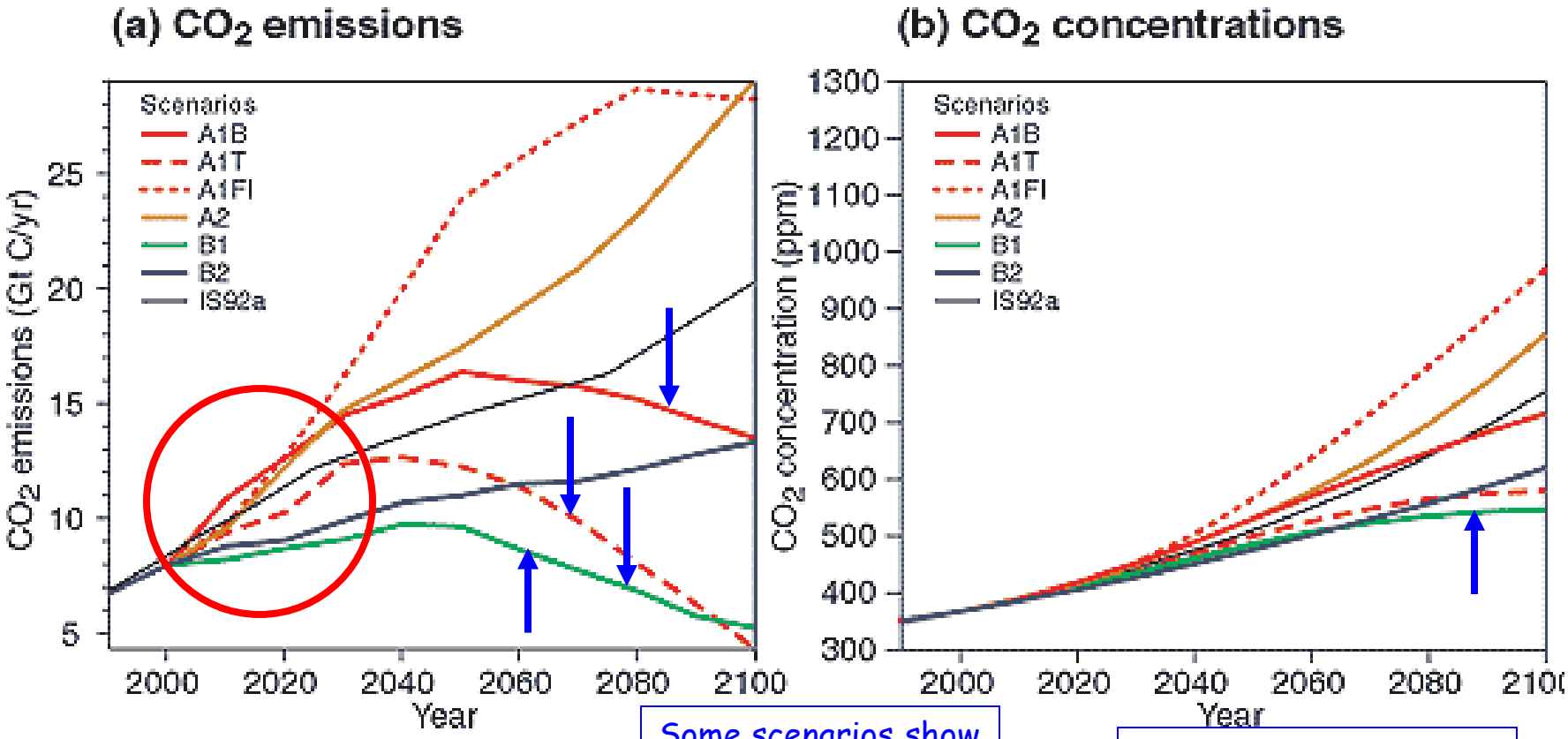




Changes in number of days with heat waves

from UCS Northeast Climate Impacts Assessment

Future Emissions Scenarios

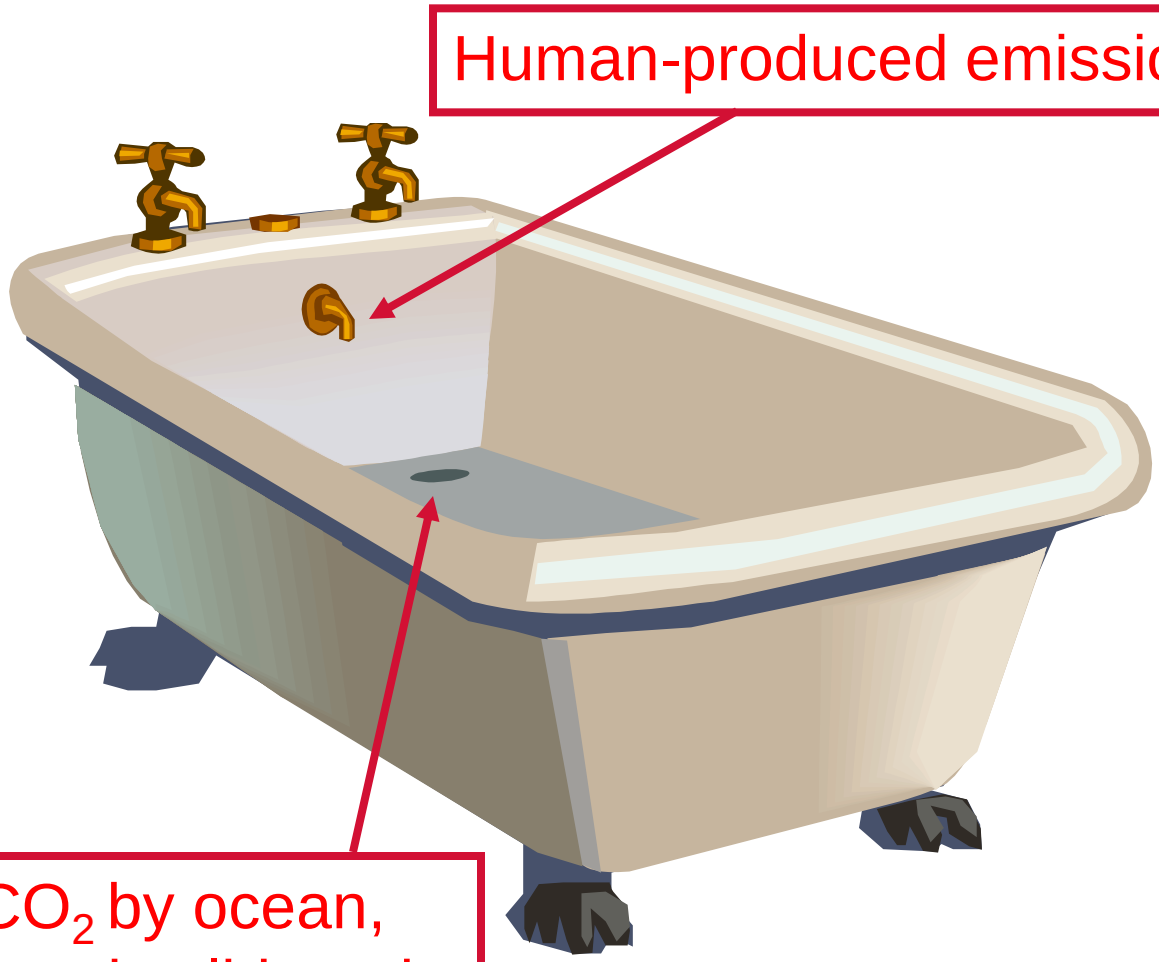


All scenarios show increasing emissions during next several decades

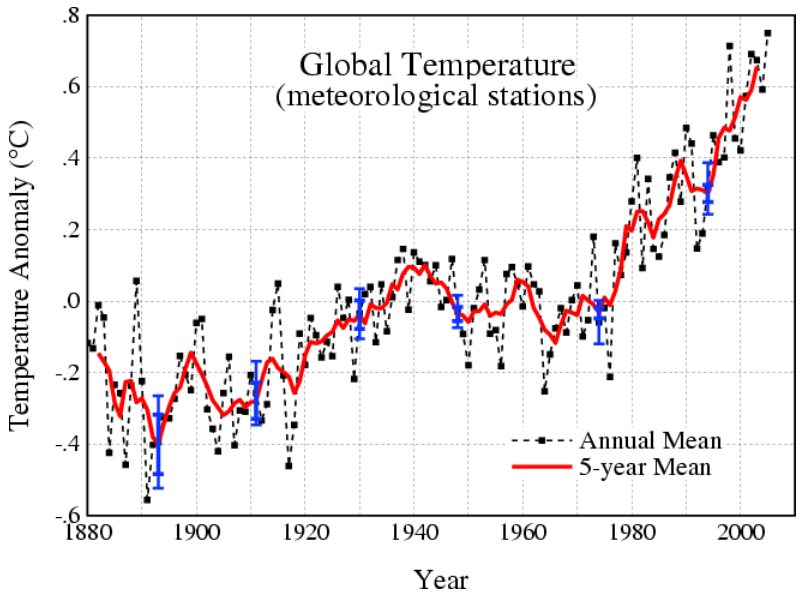
Some scenarios show decreased emissions in latter half of 21st century

Even with substantial reductions in emissions, CO_2 would rise to 2x preindustrial levels

The Atmospheric CO_2 Balance



More Warming in the Pipeline



Future emissions

Additional "zero-emission" warming (aka "commitment")

Warming to date

Outstanding scientific questions

- How sensitive is the earth's climate? In other words, how much will the climate change for a given change in greenhouse gas concentrations?
- How rapidly will sea level rise? Will Greenland and Antarctica melt more quickly or more slowly?
- How will climate change affect precipitation patterns (i.e., who gets wetter and who gets drier)?
- How will climate change affect severe storms (e.g., tornadoes, hurricanes, nor'easters)?
- Are there "tipping points" in the climate system?
- What impacts will climate change have on natural systems and society?