U.S. Global Change Research Program

Impacts of Climate Change in the Mid-Atlantic

Illustrative Conclusions from the U.S. Climate Change Science Program's Synthesis and Assessment Reports and Other Major Assessments

Peter Schultz
Director, CCSP Office

Acknowledgements: Peggy Schultz (images); Chad Tolman, Phil Cherry, and many others (planning)

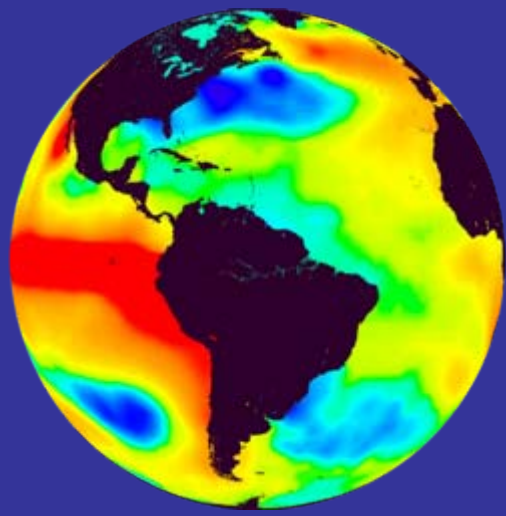
U.S. Global Change Research Program

U.S. Climate Change Science Program

Vision: A nation and the global community empowered with the science-based knowledge to manage the risks and opportunities of change in the climate and related environmental systems.

Mission: Facilitate the creation and application of knowledge of the Earth's global environment through research, observations, decision support, and communication.

Responsibility: Coordination and integration of scientific research on global variability and change sponsored by 13 participating departments and agencies of the U.S. Government.



CCSP Assessments

- Complement IPCC; U.S.-focused
- Scientifically rigorous development and review process
- Full color fact sheets at www.climatescience.gov
- Overarching synthesis under development---addresses key regions/sectors; adaptation

Some Overarching Conclusions

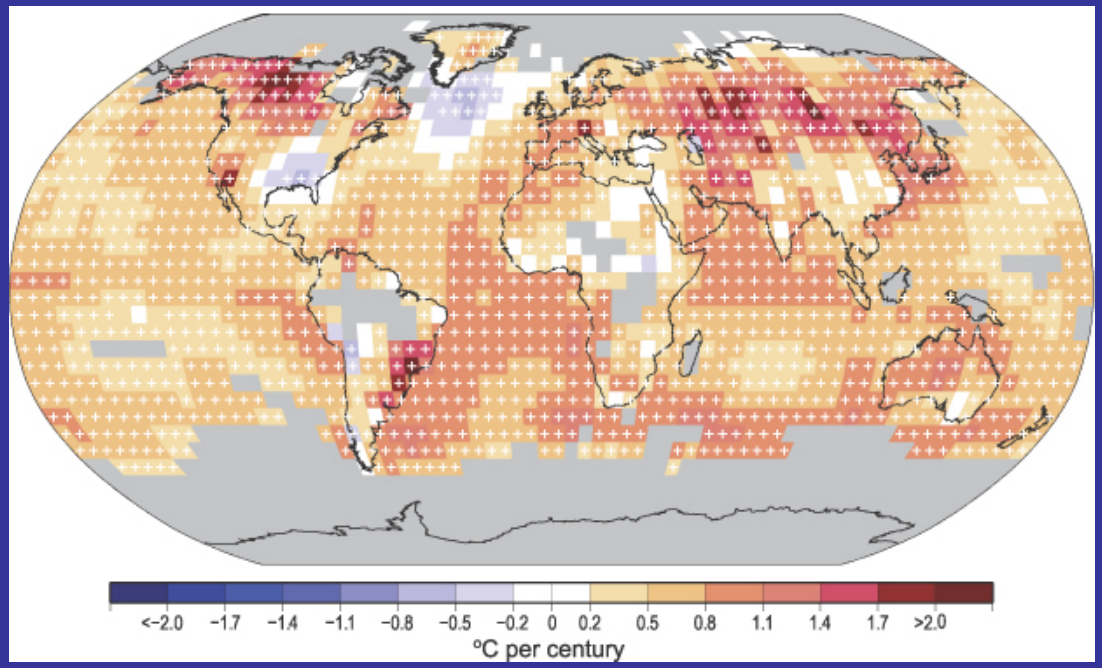
- Climate changes are already affecting U.S. water resources, agriculture, land resources, and biodiversity (*very likely*).
- Climate change will continue to have significant effects on these resources over the next few decades and beyond (*very likely*).
- Many other stresses and disturbances are also affecting these resources (*very likely*)

Sandy Hook, DE

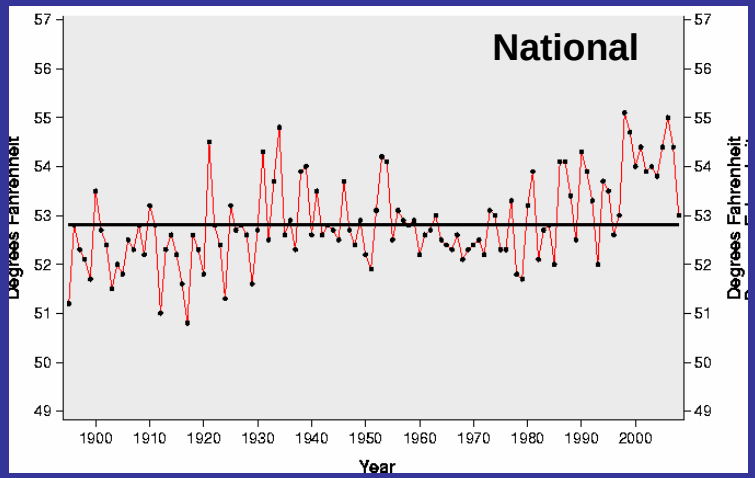
Pike Creek, DE

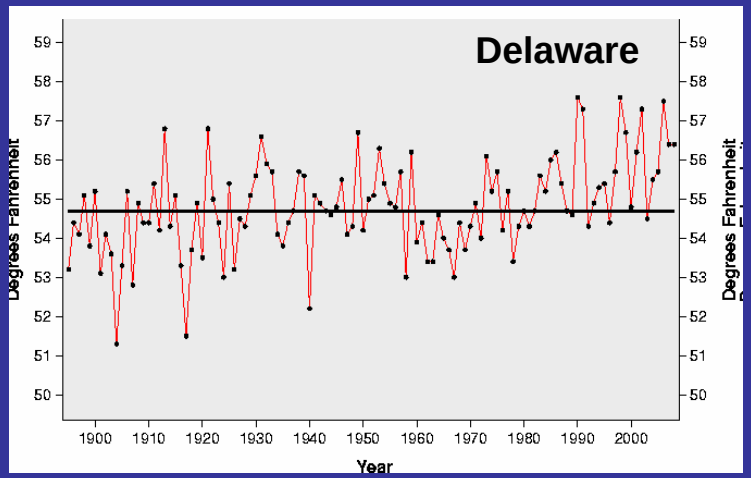
See CCSP S&A Product 4.3

Observed Temperature Trends



IPCC, 2007





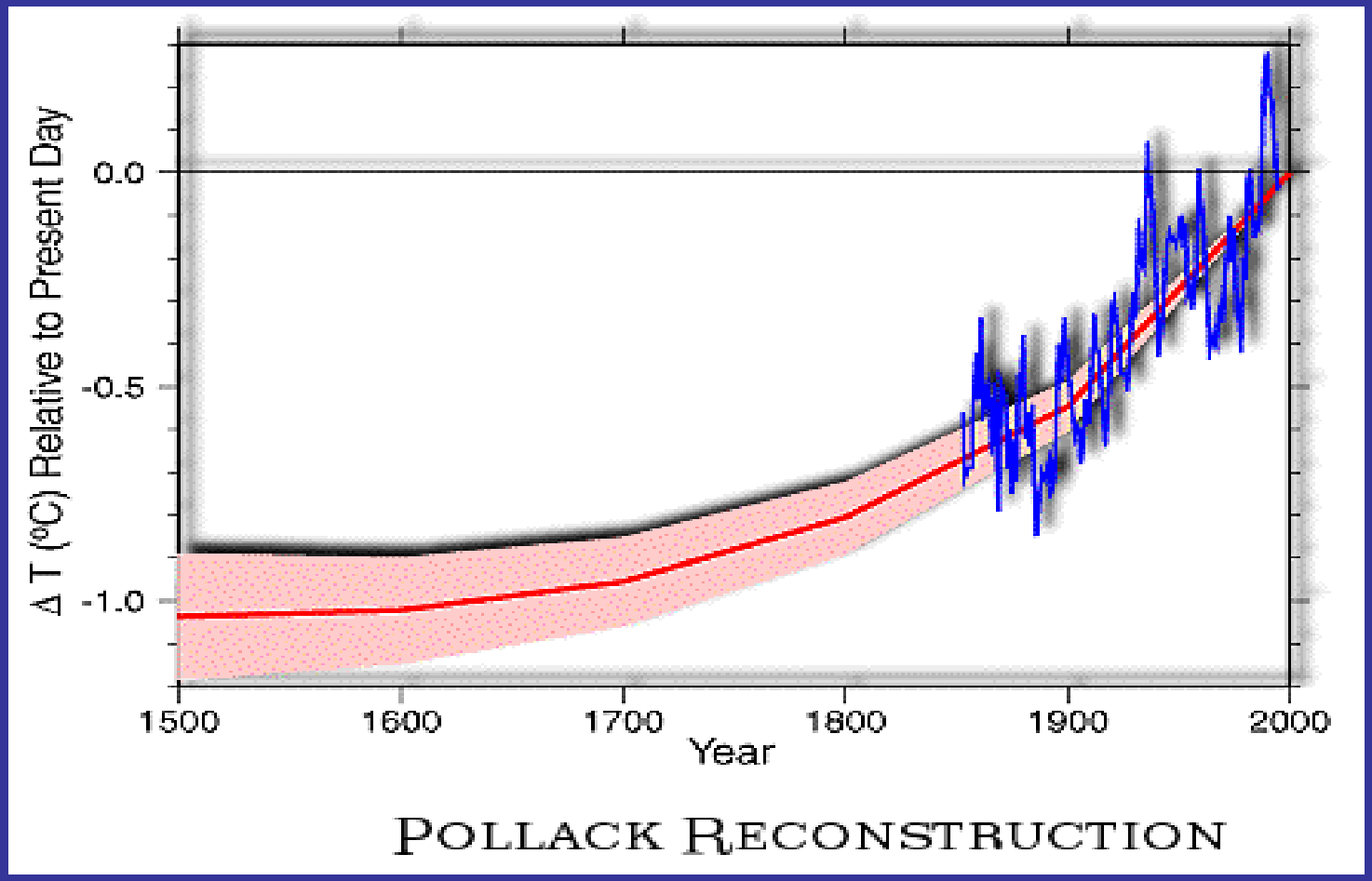
NOAA/NCDC

Causes of Global Warming

Suddenly, Bob realizes that he's "part of the problem".

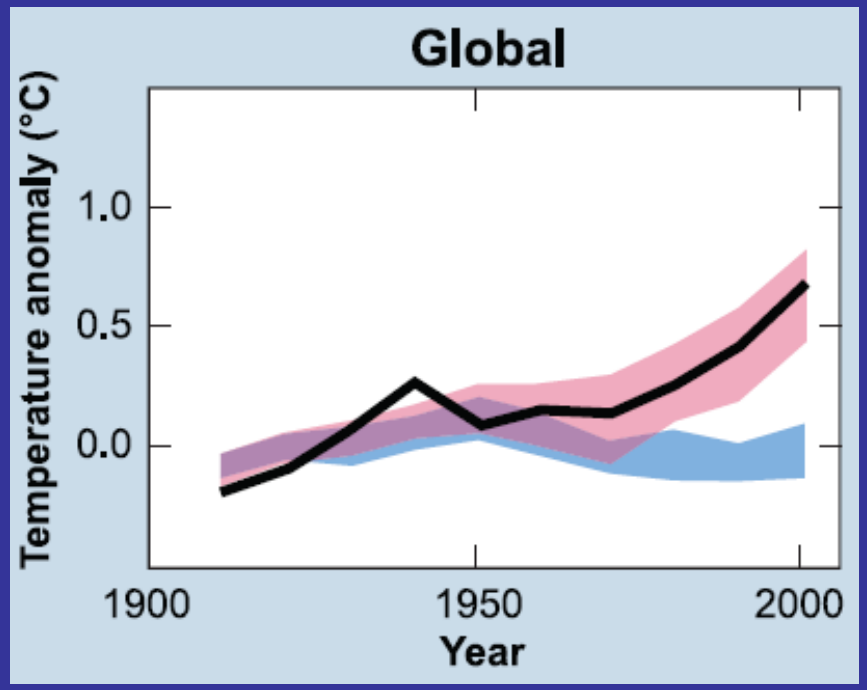
Confirmation from Multiple Sources of Information

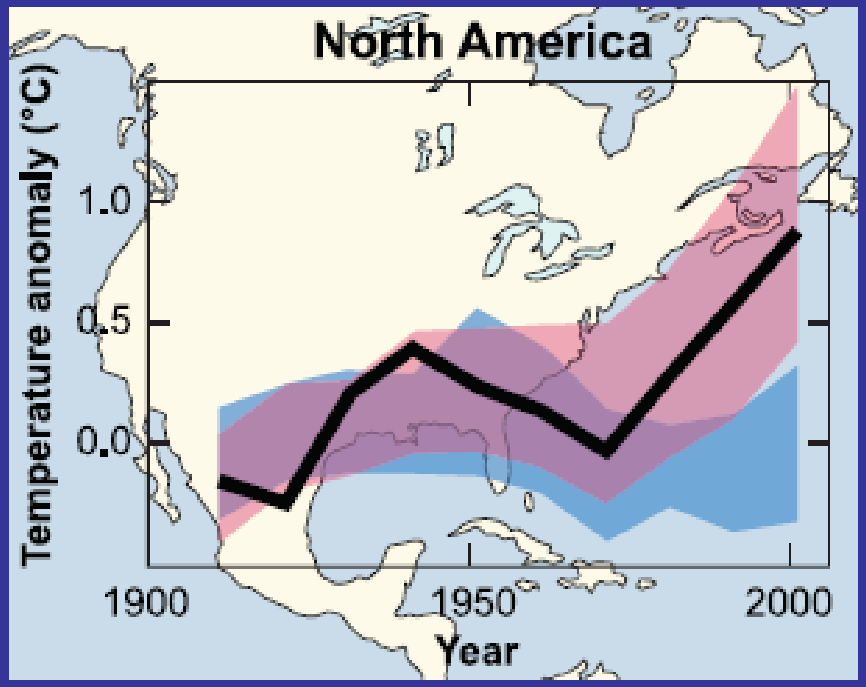
Bore Hole Temperature Reconstructions

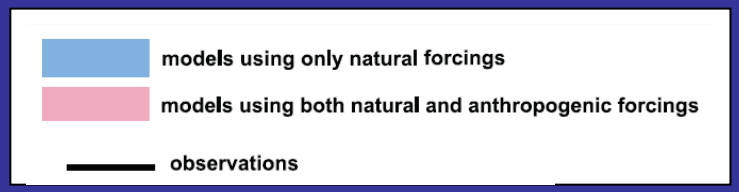


Causes of Global Warming

"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)



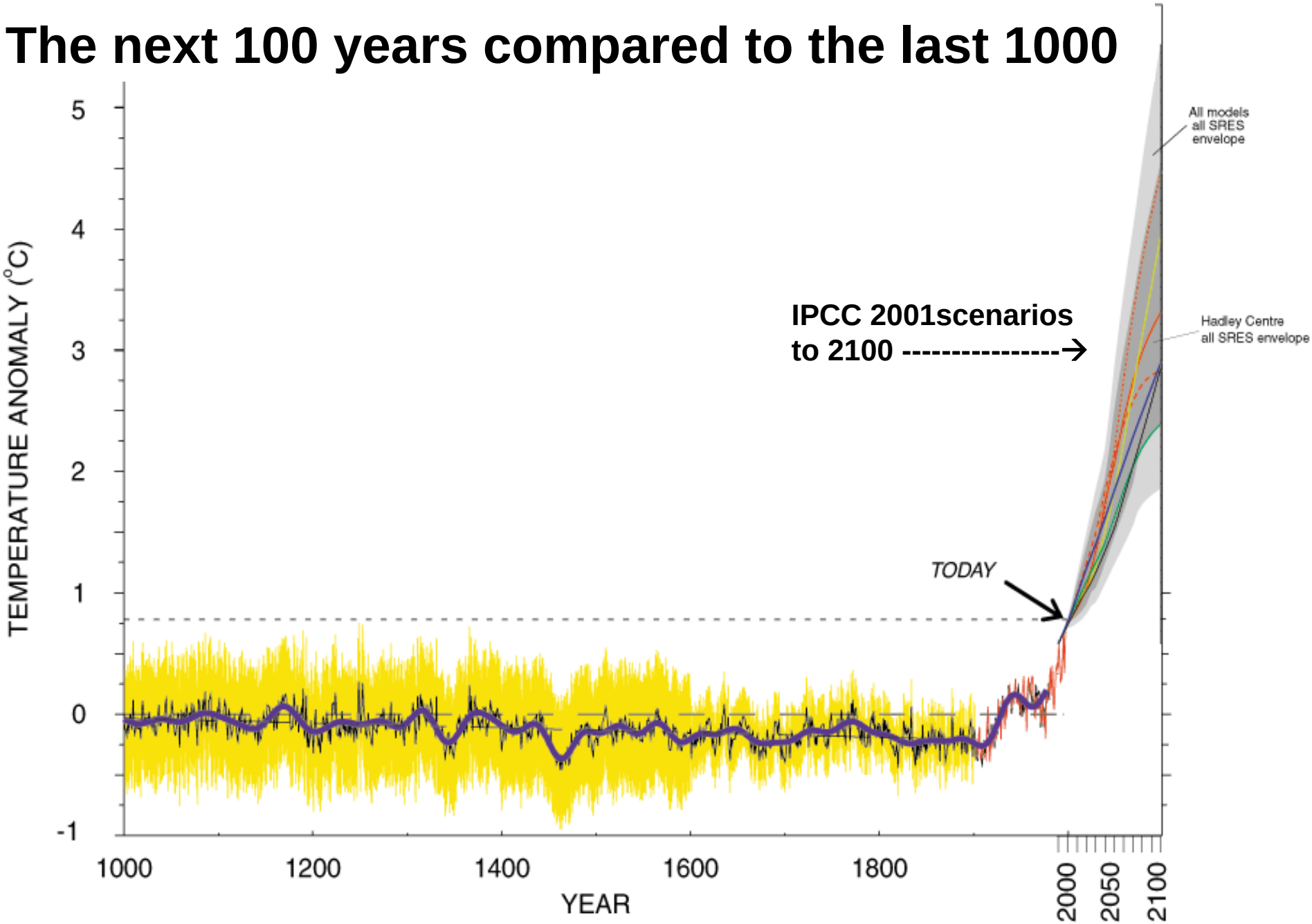




IPCC SPM

Where are we headed?

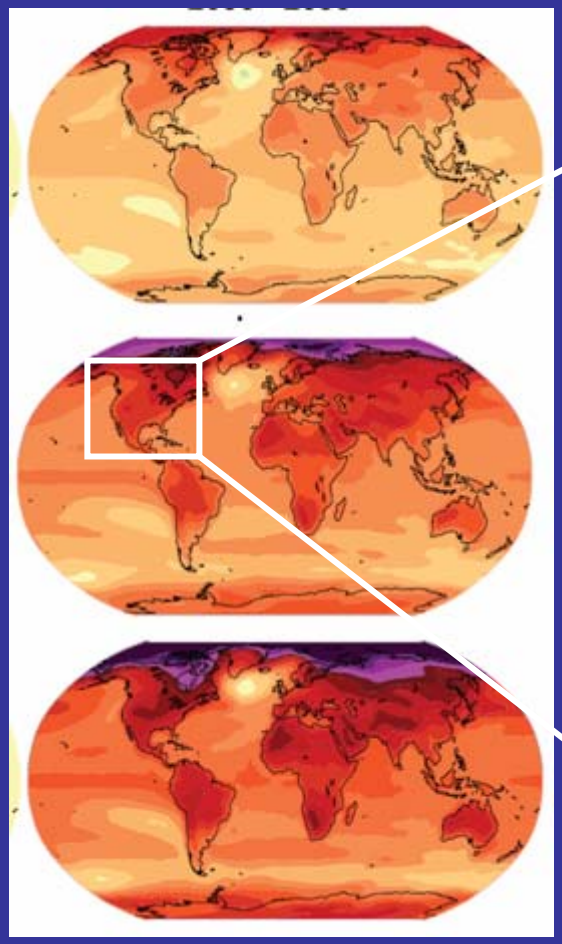
The next 100 years compared to the last 1000



U.S. Global Change Research Program

Temperature Projections for 2090-2099

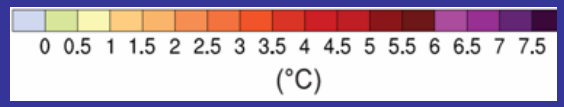
3 Different Emission Scenarios



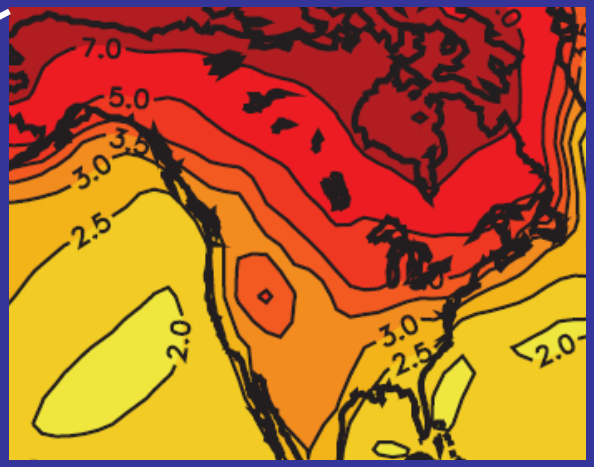
B1

A1B

A2

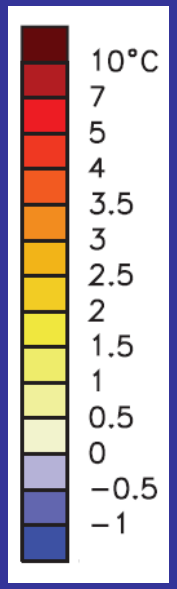


N. America, Scenario A1B, in Summer & Winter



Winter

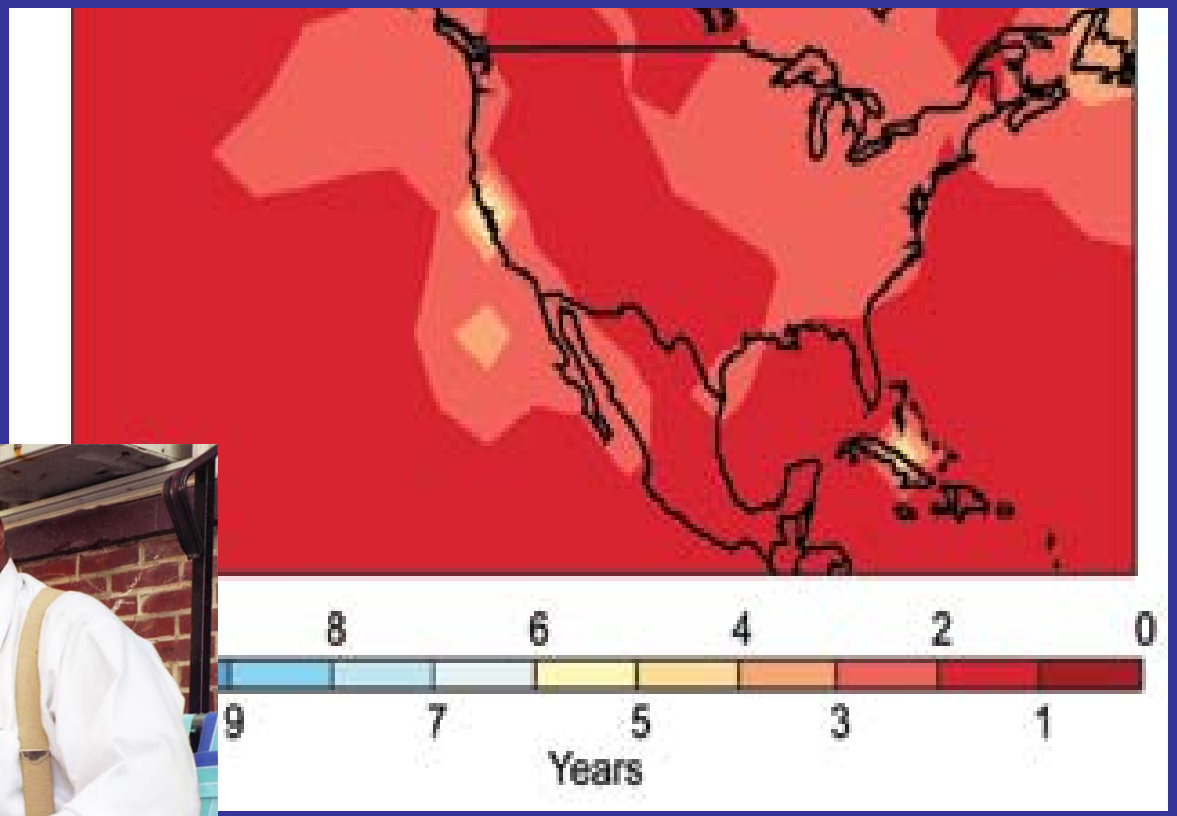
Summer



IPCC WG1 Ch11

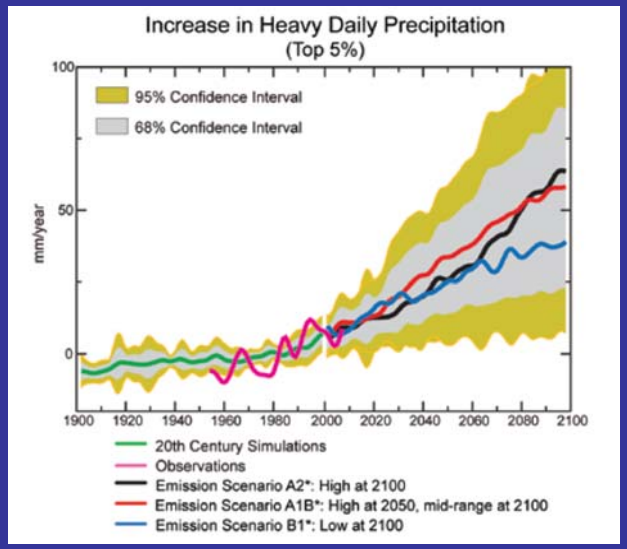
Hot Days to Become Much More Common

Return frequency of 1-in-20-yr days by 2090-2099

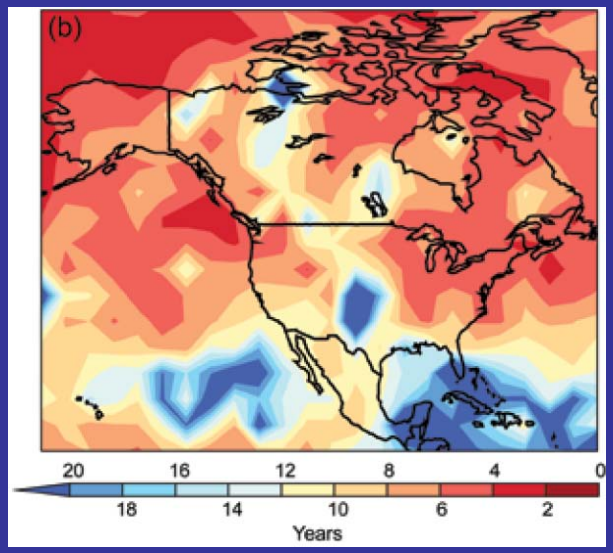


See CCSP S&A Product 3.3

"Gully Washer" Rains Will Tend to Become More Common



Return frequency of 1-in-20-yr events by 2090-2099



See CCSP S&A Product 3.3

Water Supply

Runoff and evaporation changes likely to affect reservoir performance, water management effectiveness, etc.

- However, increases in water-use efficiency likely to continue, which will help reduce impacts of climate change on water resources.

Water quality likely to be affected in future by climate change; however, to-date other factors have been more important

- Increases in intense rains will increase sediment and pollutant loading
- Saltwater intrusion into groundwater likely in some coastal regions
- Changes could impose huge costs on water treatment infrastructure.

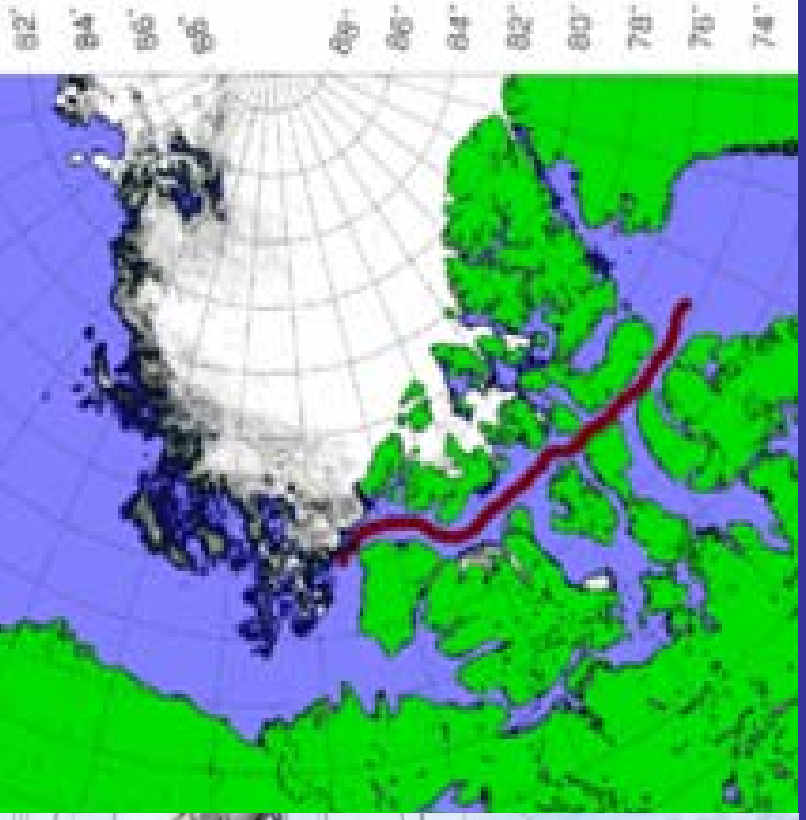
Less reliable water supplies likely to create challenges for managing urban water systems.

Past not a good guide to the future!

See CCSP S&A Product 4.3

Hurricanes

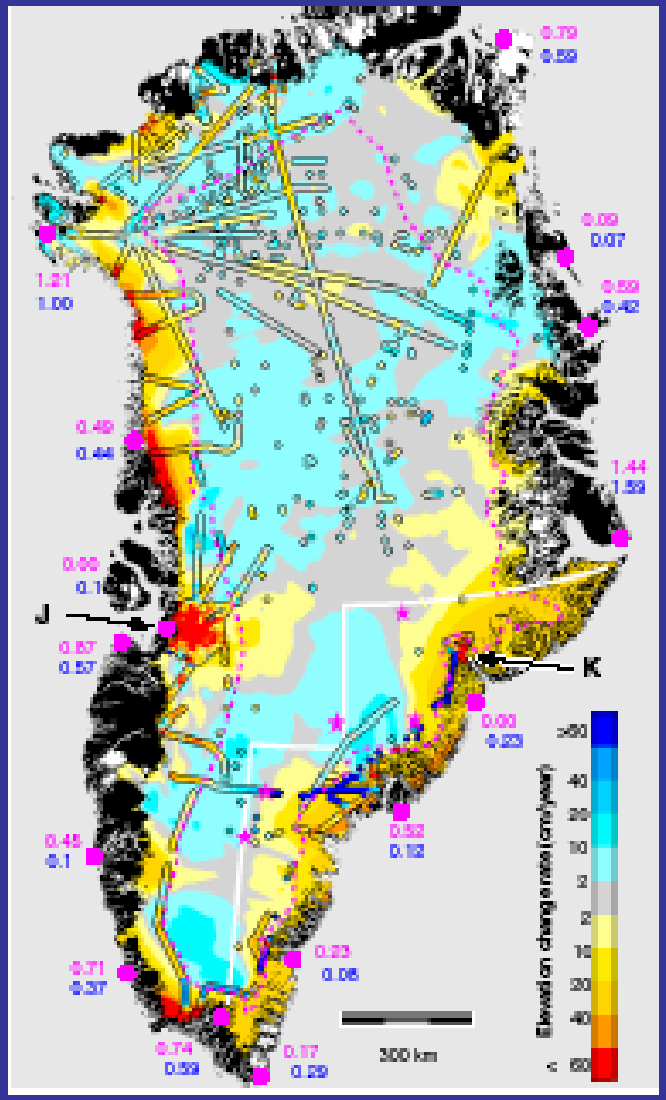
See CCSP S&A Product 3.3



See CCSP S&A Product 1.2

Climate is changing, rapidly…

Accelerating Ice Sheet Discharge



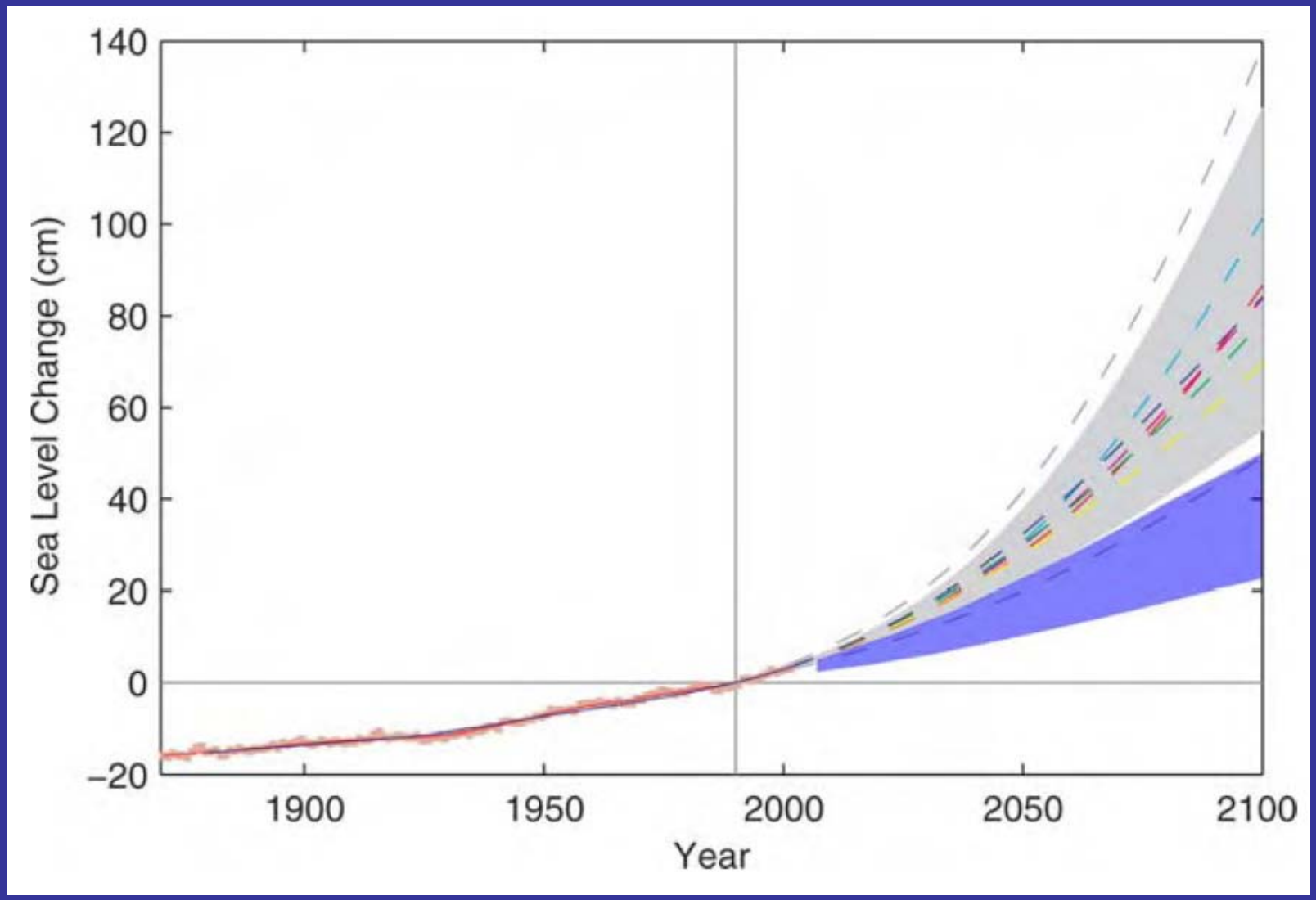
Source: Prof. Konrad Steffen, Univ. of Colorado

Blue = slow thickening

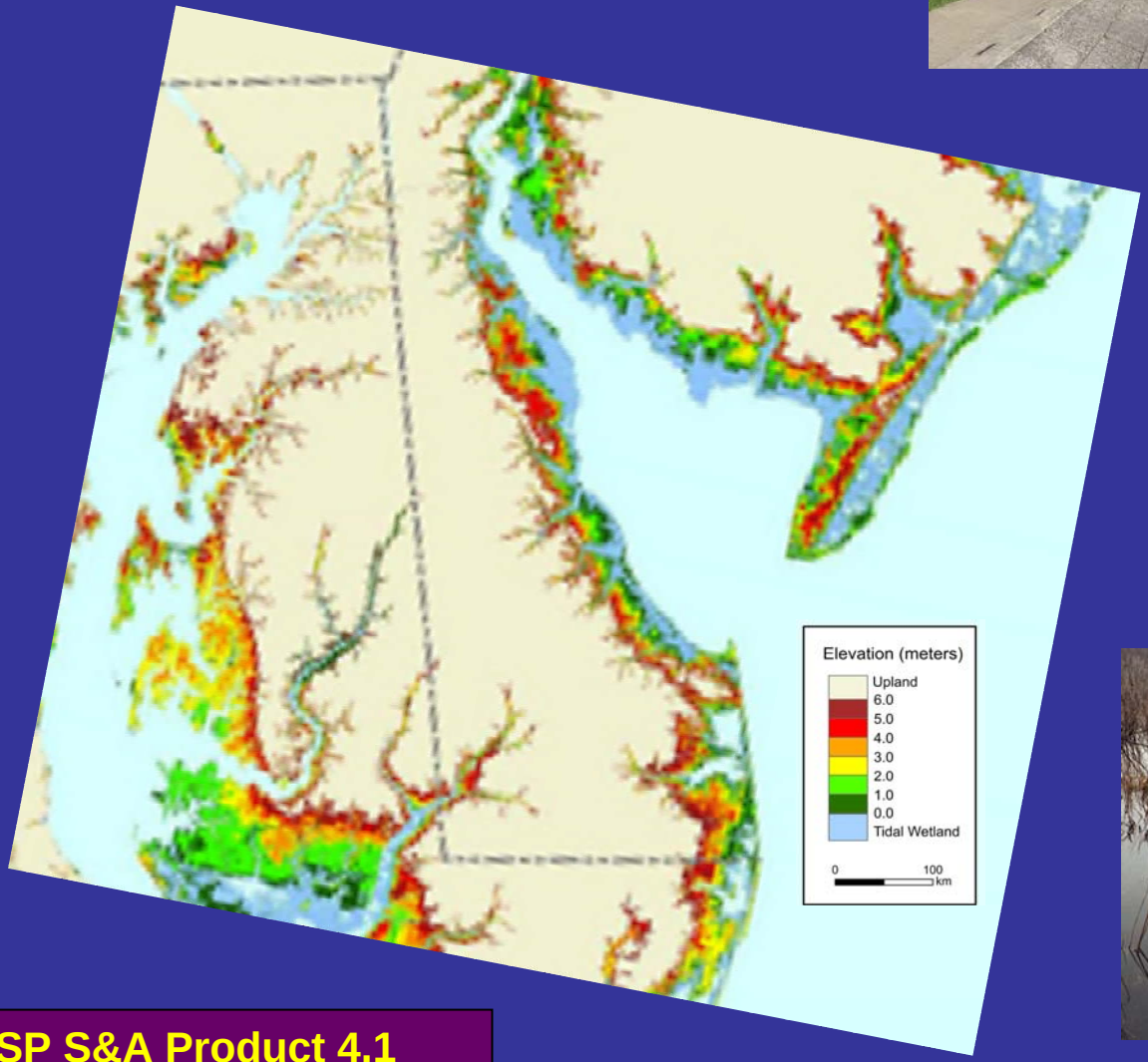
Red, yellow = fast thinning

Krabill et al., 2004, GRL

Sea Level Rise Projections



See CCSP S&A Product 4.1



See CCSP S&A Product 4.1

Sea Level Rise Response Options

Response options for large near-term impacts include:

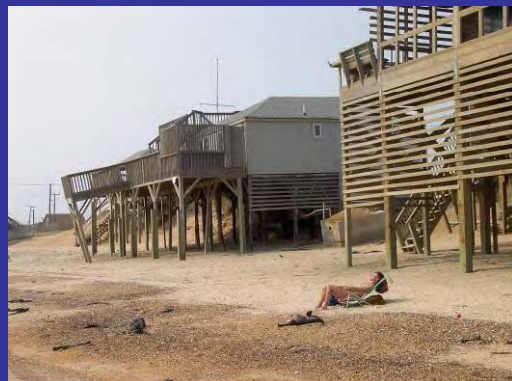
- Beach nourishment
- Enhancing vertical accretion
- Elevating homes
- Fortifying dikes

Low regret response options include:

- Home setback
- Building with higher floor elevation
- Designing new coastal drainage with larger pipes
- Rebuilding roads to higher elevation during routine reconstruction
- Designing bridges & other major facilities to account for sea level rise

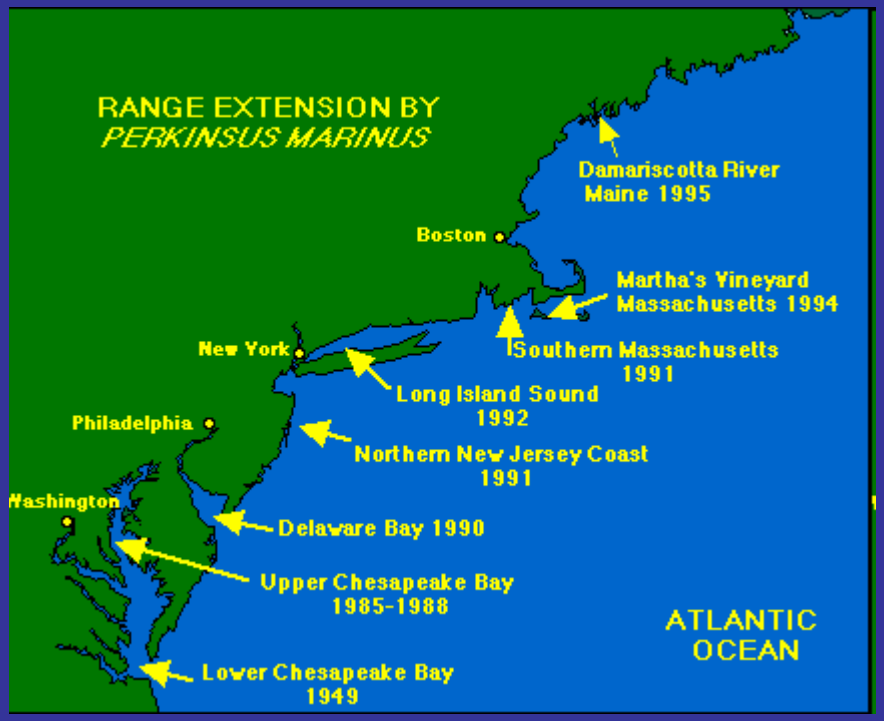
Options that reallocate or clarify risks include:

- Concentration of development
- Rolling easements
- Insurance incentives/disincentives; clarification of coverage



Changing Climate Tends to Promote Oyster Diseases

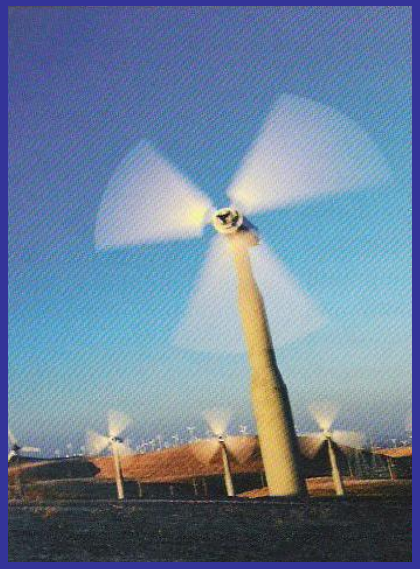
(e.g., dermo and MSX)



Increasing Ocean Acidification Threatens Base of Food Chain

Energy Supply

- Direct impacts from increased intensity of extreme weather events
- Warming will affect efficiency of thermal power plant cooling
- Facility siting decisions affected by changing conditions
- Positive or negative impacts on production of biomass, wind power, or solar energy where climate conditions change.



Costs of proactive adaptation in vulnerable regions generally much less than the costs of reactive responses. (SAP 4.7)

See CCSP S&A Product 4.5

Energy Demand

- Decreased energy consumed for space heating
- Increased energy consumed for cooling & refrigeration;
- Northern regions to reduce consumption of heating fuel more than increases in consumption of elec.; Reverse true in the south
- Increased electricity peak demand

See CCSP S&A Product 4.5

Transportation

Warmer / less snowy winters:

- improved ground & air transportation reliability
- decreased need for winter road maintenance

Summer heat waves:

- railroad track buckling/kinking
- road softening and traffic-related rutting
- decreased airplane lift

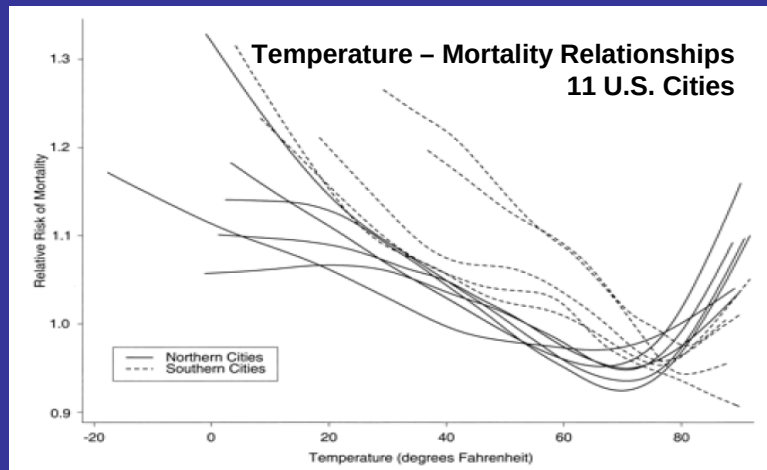
Increased frequency of extreme precipitation, river, and coastal flooding events may contribute to:

- increased accident rates
- more road closures due to flooding and landslides (single point failures)
- more frequent short-term flooding and bridge scour
- more culvert washouts
- exceedence of storm drain capacity

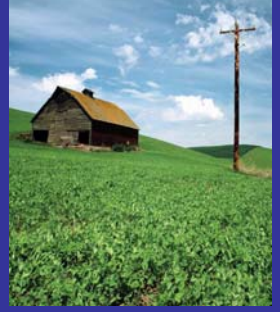
See CCSP S&A Product 4.7

Health Impacts

- Very likely that heat-related death and illness will increase over the coming decades.
- There will likely be an increase in spread of several food- and water-borne diseases among susceptible populations
- Range of many vectors (e.g., insects, rodents) likely to extend northward
- Higher urban temps in urban and likely associated increases in tropospheric ozone concentrations can contribute to cardiovascular and pulmonary illness if current regulatory standards are not attained.
- Hurricanes, extreme precipitation resulting in floods, and wildfires also have the potential to affect public health through direct and indirect health risks.



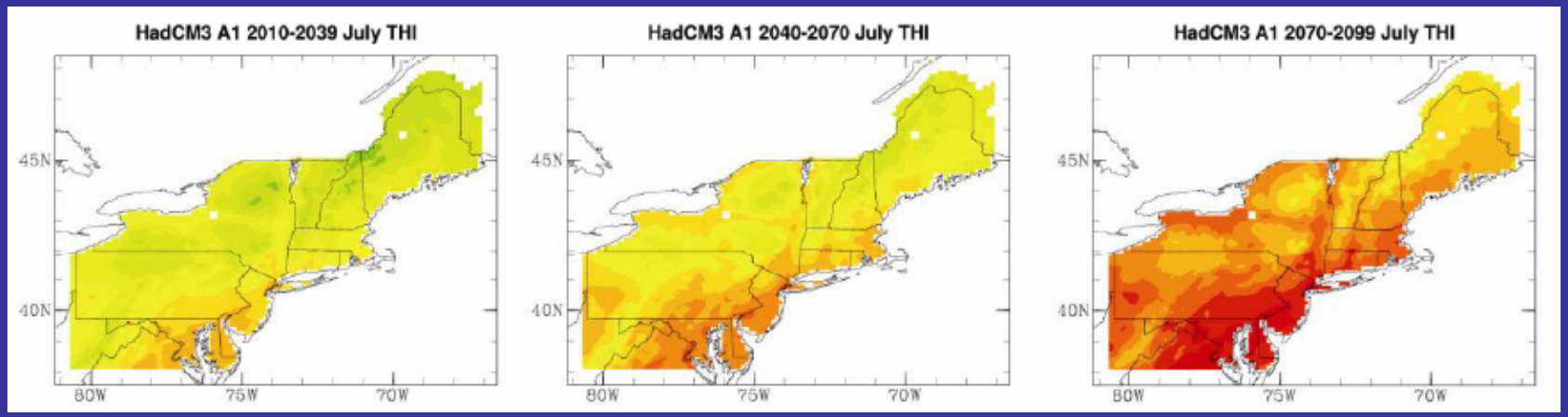
See CCSP S&A Product 4.6



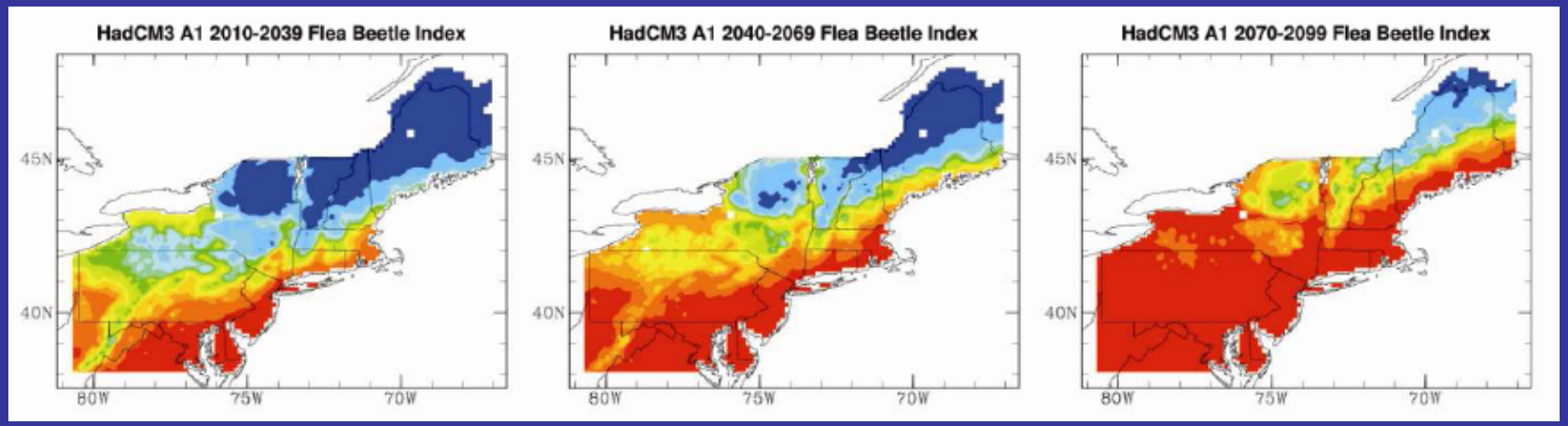
Agriculture Impacts

- Life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure.
- Horticultural crop yields – e.g. tomatoes, onions, fruits – very likely to be more sensitive to climate change than grain and oilseed crops.
- Climate change likely to lead to northern migration of weeds. Many weeds respond more positively to increasing CO_2 than most cash crops, particularly C3 “invasive” weeds.
  - Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO_2 levels likely in the coming decades.
- Disease pressure on crops and domestic animals will likely increase with earlier springs and warmer winters, due to proliferation and higher survival rates of pathogens and parasites.
- Higher temperatures will very likely reduce livestock production during summer. For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of changing climate.

See CCSP S&A Product 4.3



Heat Influence on Dairy Cattle Milk Production. **Thermal Heat Index >72 production**

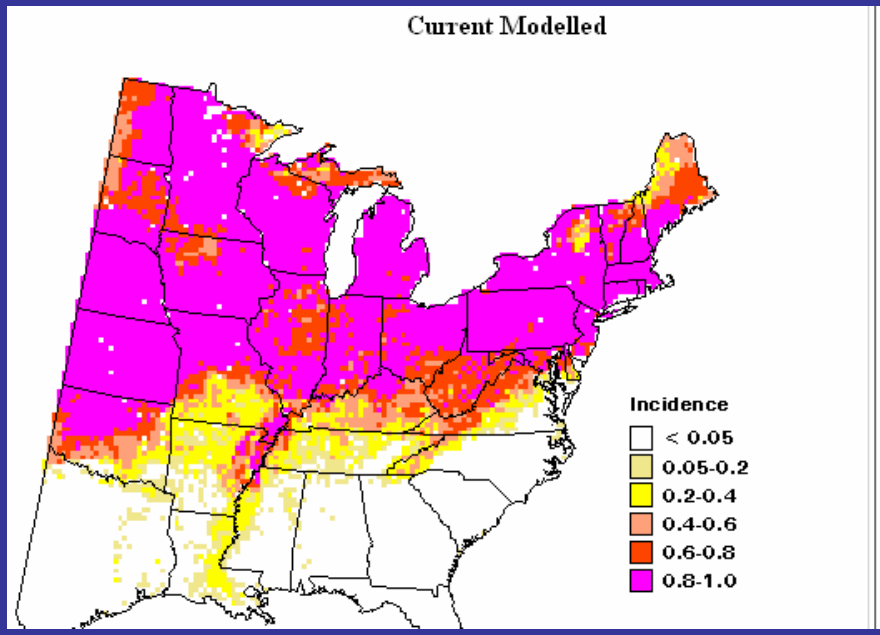


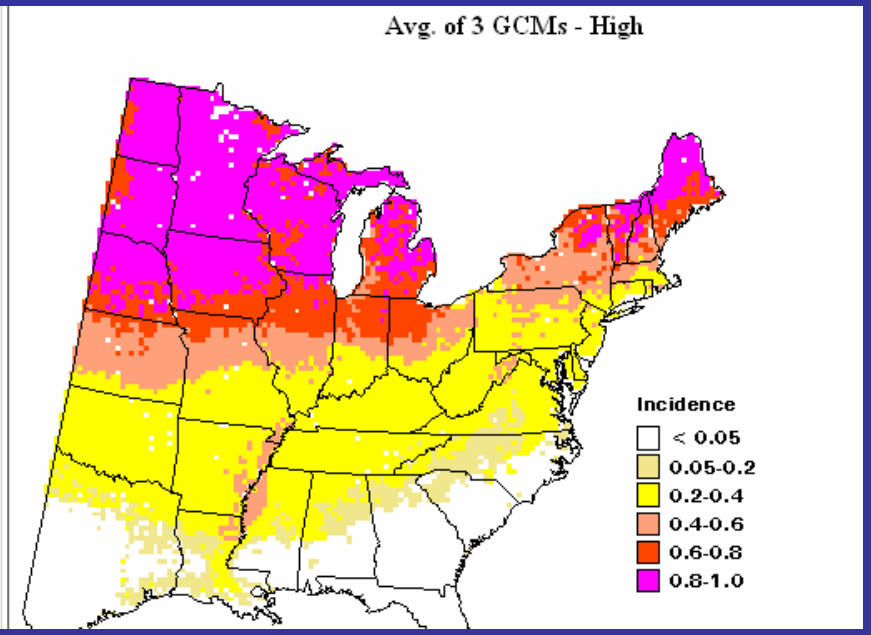
Flea Beetle. **Yellow and orange indicates expansion of overwintering and mod-sev. beetle pressure.**

Wolfe et al, 2008

Ecosystems Changes

(e.g., Future Oriole Incidence)





http://www.nrs.fs.fed.us/atlas/bird/RFbirdmod_5070.html

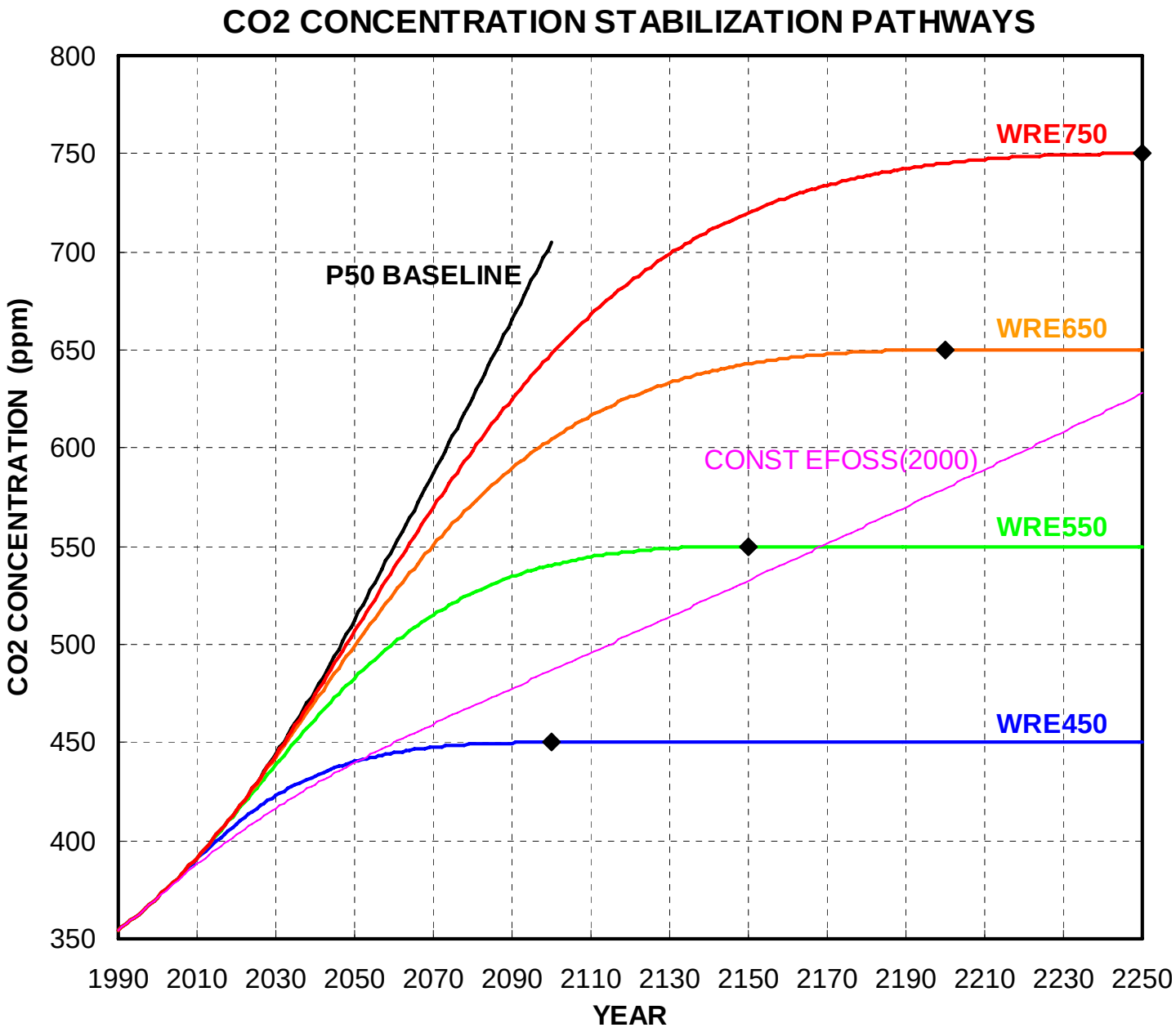
Two Responses to a Changing Climate

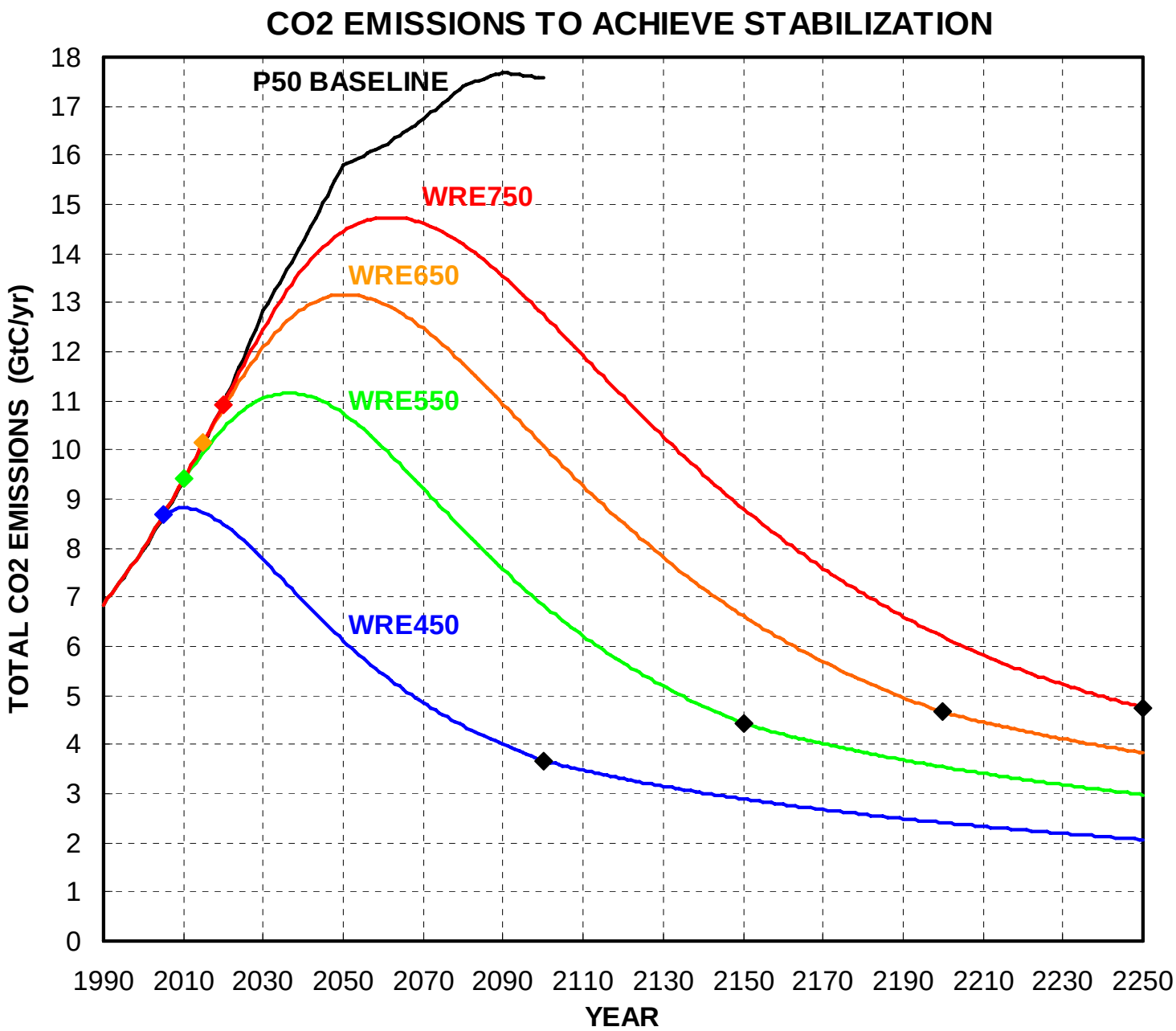
Mitigation: reduce emissions; energy efficiency; alternative energies, etc.

Impacts on climate change: 50-100 yrs.

Adaptation: planning ahead; incorporating likely future climate states into regular planning;

Impacts on community: Now and in Future.


CO2 CONCENTRATION STABILIZATION PATHWAYS
CO2 CONCENTRATION (ppm)
YEAR
800
750
700
650
600
550
500
450
400
350
1990
2010
2030
2050
2070
2090
2110
2130
2150
2170
2190
2210
2230
2250
WRE750
P50 BASELINE
WRE650
CONST EFOSS(2000)
WRE550
WRE450

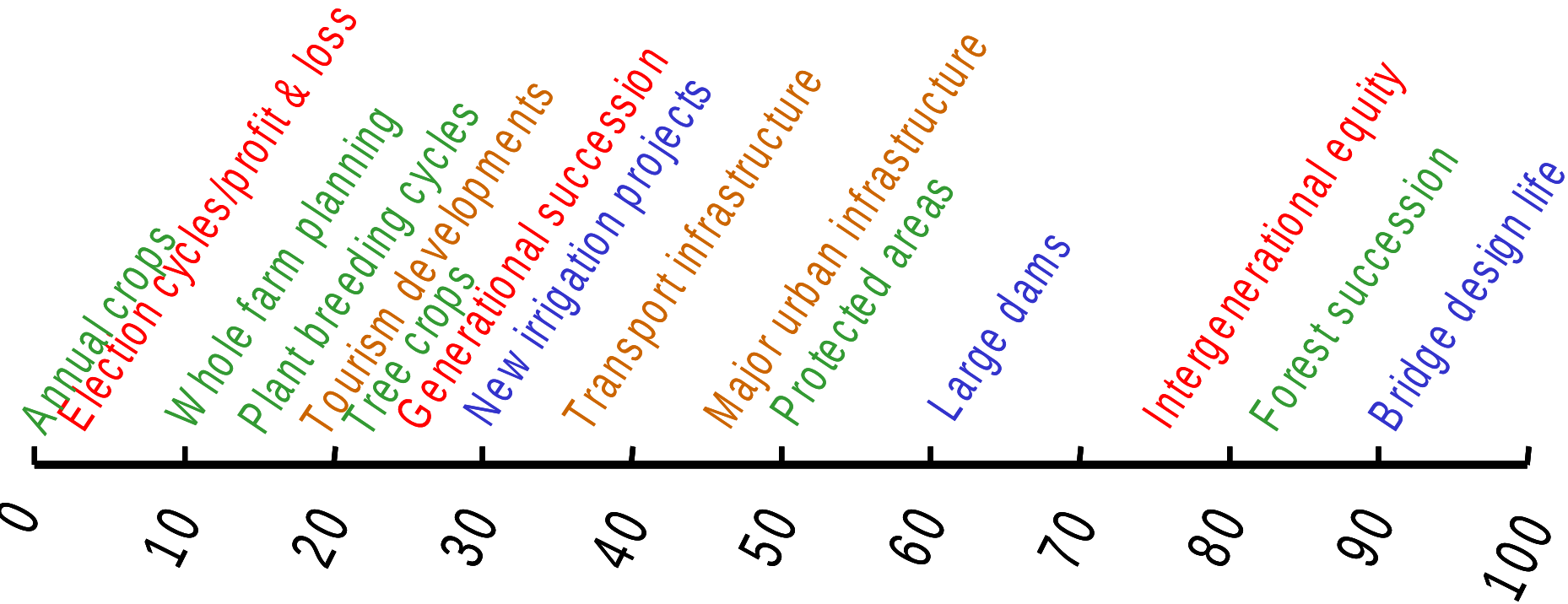

CO2 EMISSIONS TO ACHIEVE STABILIZATION
P50 BASELINE
WRE750
WRE650
WRE550
WRE450
TOTAL CO2 EMISSIONS (GtC/yr)
YEAR
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
1990
2010
2030
2050
2070
2090
2110
2130
2150
2170
2190
2210
2230
2250

We can plan ahead … or we can react.

We can anticipate, plan, act.

Or we can just respond.

Adaptation Planning: Many Timeframes

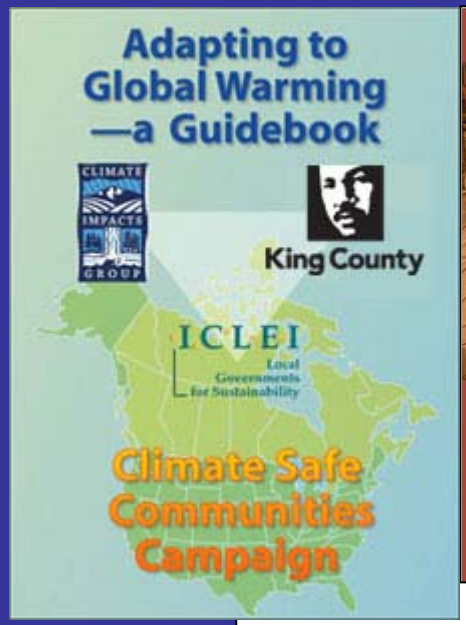


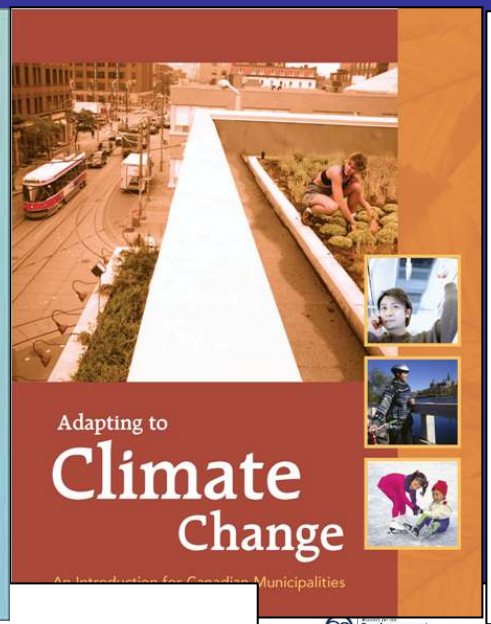
Adaptation options include: management, technology, institutions, monitoring, R & D

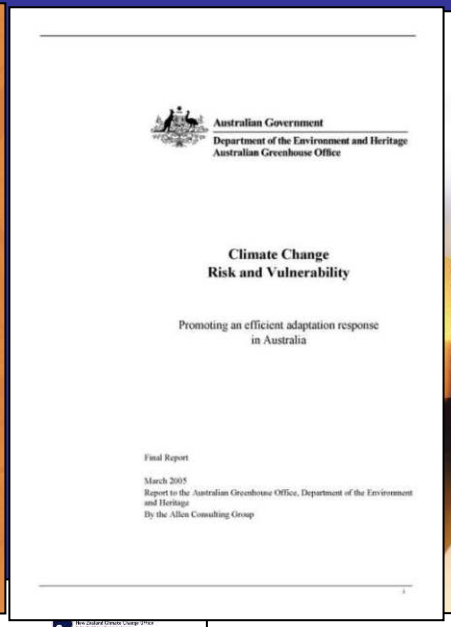
- Prioritize lands to preserve
- Design of migration corridors
- Emergency response plans
- Early warning alert systems / surveillance
- Infrastructure to withstand new “extremes”
- Linking of reservoirs to enhance supply
- Seed banks, mass propagation techniques
- Incentives / disincentives / insurance

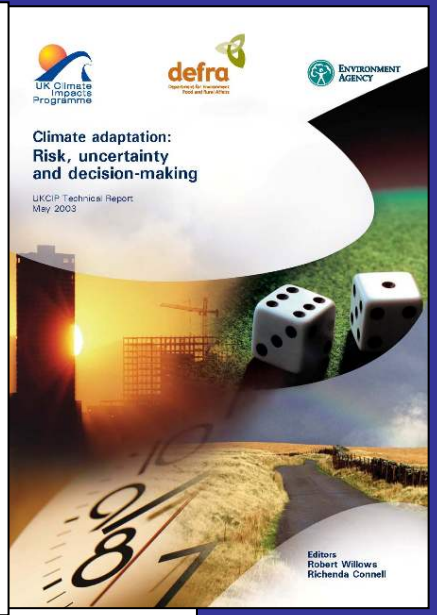
Source: R. Bierbaum, Coping with Climate Change: National Summit, May 8-10, 2007

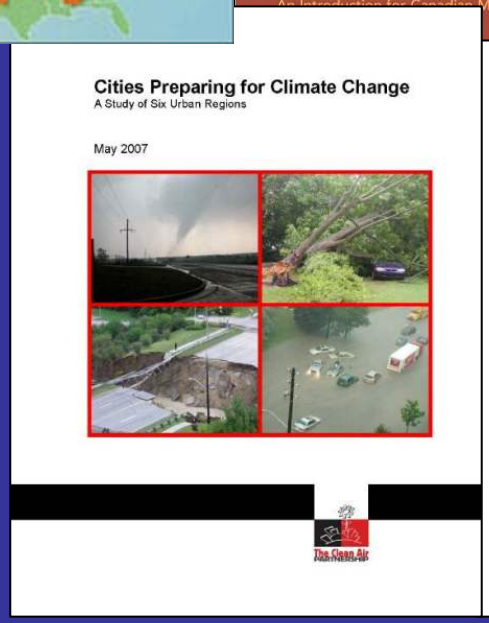
Guidebooks and Frameworks

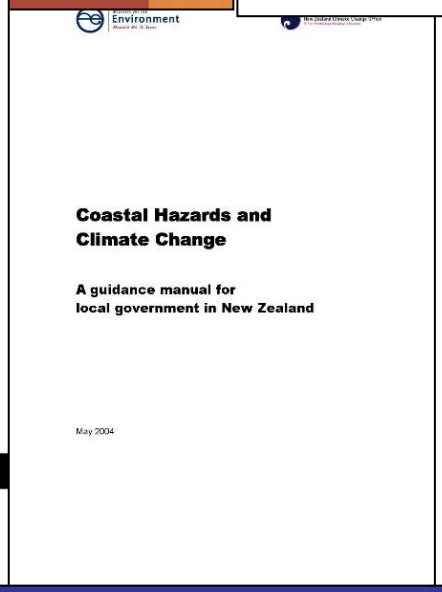


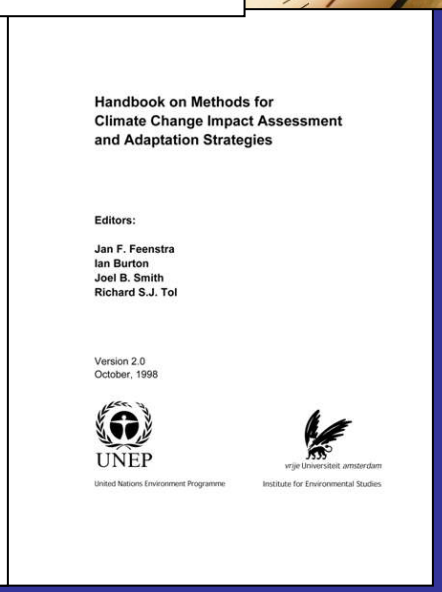


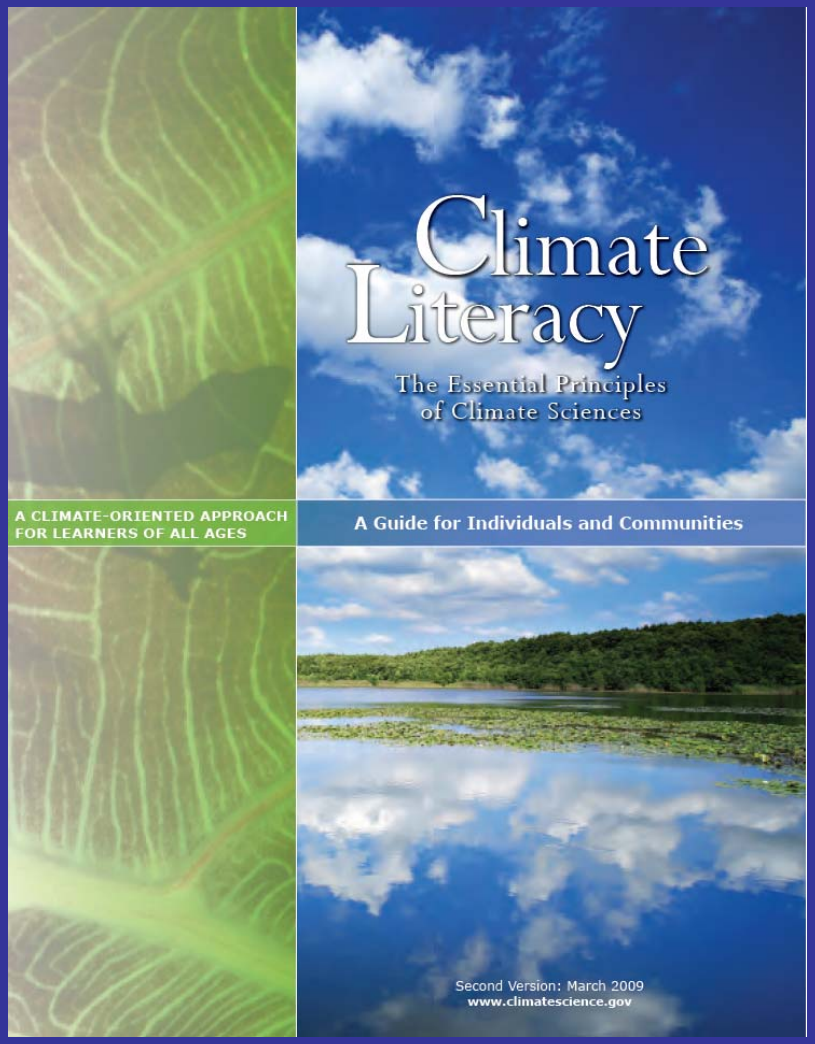












ABOUT THIS GUIDE

Climate Literacy: The Essential Principles of Climate Science presents information that is deemed important for individuals and communities to know and understand about Earth's climate, impacts of climate change, and approaches to adaptation or mitigation. Principles in the guide can serve as discussion starters or launching points for scientific inquiry. The guide aims to promote greater *climate science literacy* by providing this educational framework of principles and concepts. The guide can also serve educators who teach climate science as a way to meet content standards in their science curricula.

Development of the guide began at a workshop sponsored by the National Oceanic and Atmospheric Administration (NOAA) and the American Association for the Advancement of Science (AAAS). Multiple science agencies, non-governmental organizations, and numerous individuals also contributed through extensive review and comment periods. Discussion at the National Science Foundation- and NOAA-sponsored Atmospheric Sciences and Climate Literacy workshop contributed substantially to the refinement of the document.

To download this guide and related documents, visit www.climatescience.gov.

FURTHER INFORMATION

For future revisions and changes to this document or to see documentation of the process used to develop this brochure, please visit www.climate.noaa.gov/education.

In addition, further information relating to climate literacy and climate resources can be found at:

- earthobservatory.nasa.gov
- www.epa.gov/climatechange
- http://nsdl.org
- www.education.noaa.gov

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climate.literacy@climatescience.gov

Current Science and Educational Partners:

American Association for the Advancement of Science Project 2061
American Meteorological Society
Association of Science-Technology Centers
Bowman Global Change
Centers for Disease Control & Prevention
Challenger Center for Space Science Education
Climate Literacy Network
College of Exploration
Cooperative Institute for Research in Environmental Sciences
Federation of Earth Science Information Partners
Lawrence Hall of Science, University of California, Berkeley
National Environmental Education Foundation
National Geographic Education Programs
National Institute of Standards & Technology
National Oceanic and Atmospheric Administration
National Science Teachers Association
North American Association For Environmental Education
Sally Ride Science™
TERC Inc.
The GLOBE Program
The National Center for Atmospheric Research
University Corporation for Atmospheric Research
U.S. Geological Survey
U.S. Forest Service

For an up to date list of partners please refer to U.S Climate Change Science Program at http://www.climatescience.gov.

This document has been reviewed by the following Federal agencies. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Second Version: *March 2009*

Recycled Content Paper

We Need to Hear From You

What major climate-related challenges or questions are you facing?

- What state- and local-level issues might the federal climate science program not have on its radar screen?

How can climate change science and information needed to support your decisions and discussions be better provided?

- Observations, models, tools?
- Format, access, interpretation, localization, training, etc.?

Do you find scientific assessments related to climate change (e.g., IPCC reports, CCSP Synthesis and Assessment Products) useful in helping you make informed decisions?

- Are you aware of these reports?
- What improvements for future assessments would you suggest?

What do you feel are the roles and responsibilities of the federal government in addressing climate change?

- How should those roles relate to local/state/tribal governments? Business and industry? NGOs? Academia? Community organizers? Individual citizens?
- Is there a need for a central federal coordinating entity?

Thanks