

A Changing Climate and the Future of Lake Management



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Traditional Issues of Concern for Lake Water Quality

- Population Growth & Development
 - Land Use Change from forests/fields to homes
 - Impervious Surface Cover-more pavement & buildings
 - Non-Point Source Pollution –polluted runoff
- Resource Use
 - Excess withdrawals (water and aquatic species)
- Changes in Biological Communities
 - Invasive species
 - Algae Blooms -cyanobacteria
- Aging Infrastructure (e.g., dam safety)

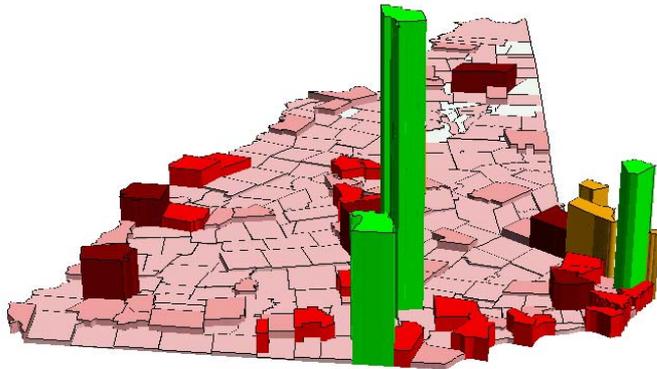
Current New Hampshire Land Use Patterns

- Rapidly growing small towns
- Scattered development
- Dispersing population
- Increasing rate of land development
- Segregated land uses
- Lack of activity centers
- Poor accessibility

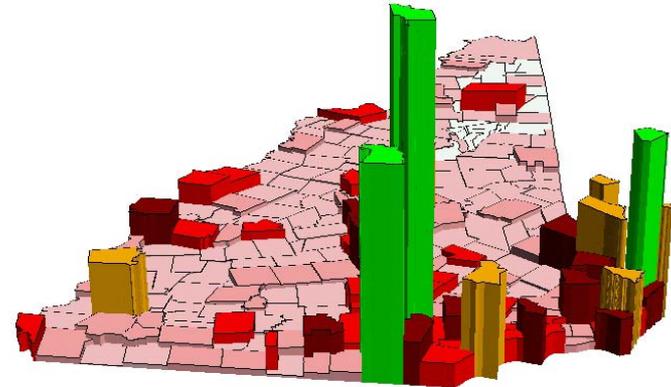
Development is Spreading Out!

Population Density – 1950 to 2020

1950



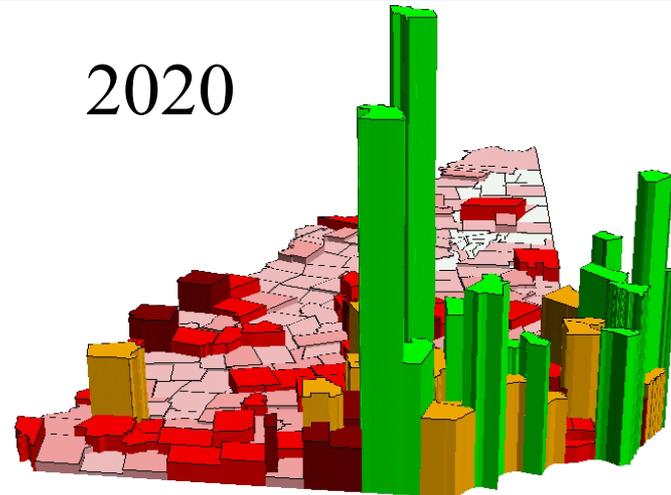
1970



1998



2020



Effects of Increased Land Development on Water Resources:

- ↑ Flooding Risks
- ↑ Streambank Erosion
- ↑ Water Pollution
- ↓ Groundwater Recharge



Photo.com

“Landscape Services” we depend on

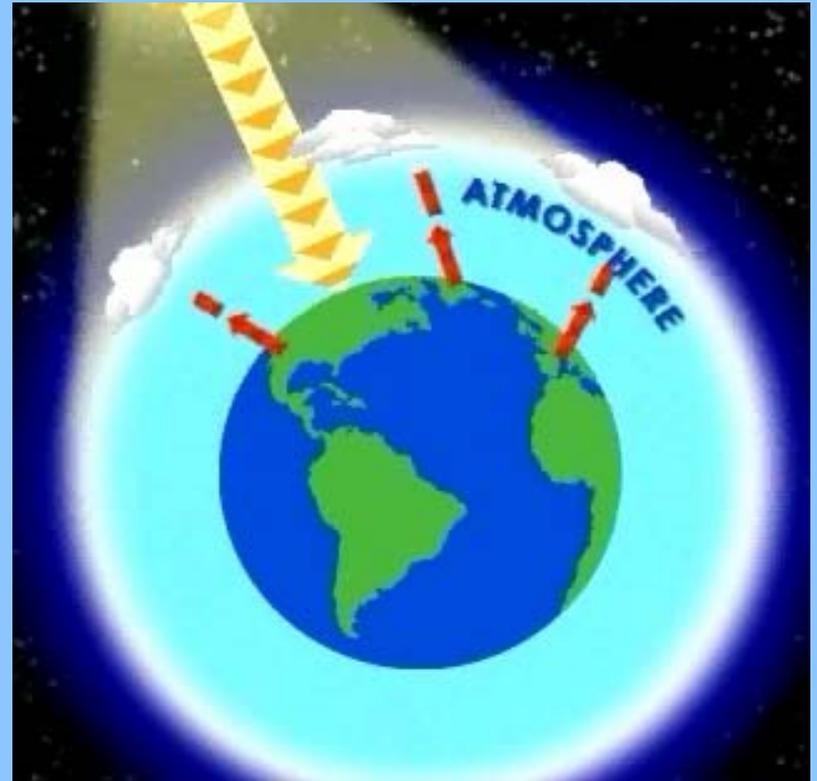
- Water supply
- Water filtration and purification
- Groundwater recharge
- Flood and drought mitigation
- Wildlife habitat
- Recreation = Economy
- Carbon sequestration



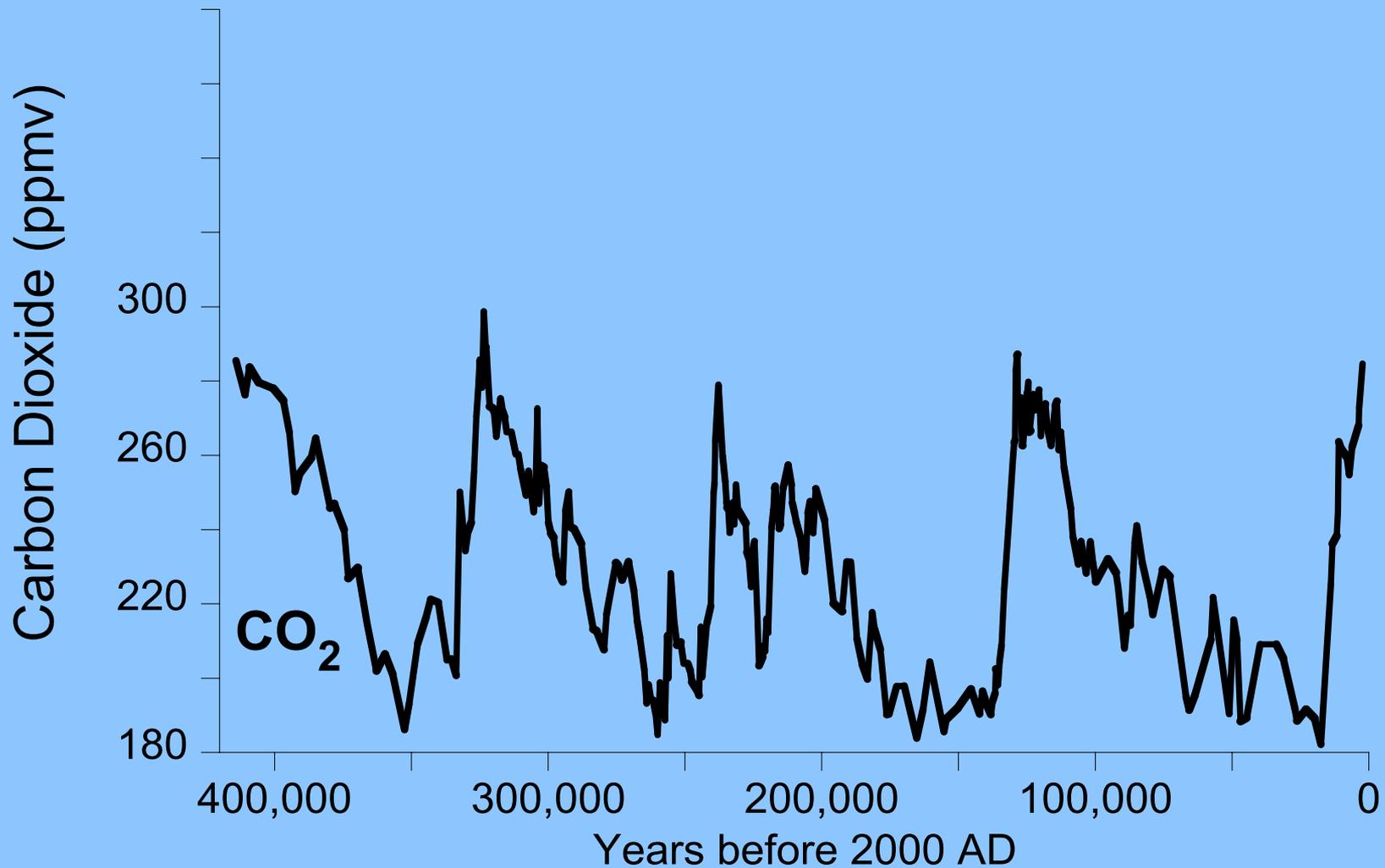
How might Climate Change intensify the Traditional Issues of Concern for Lake Water Quality?



Our Planet Has a “CO₂-Blanket”

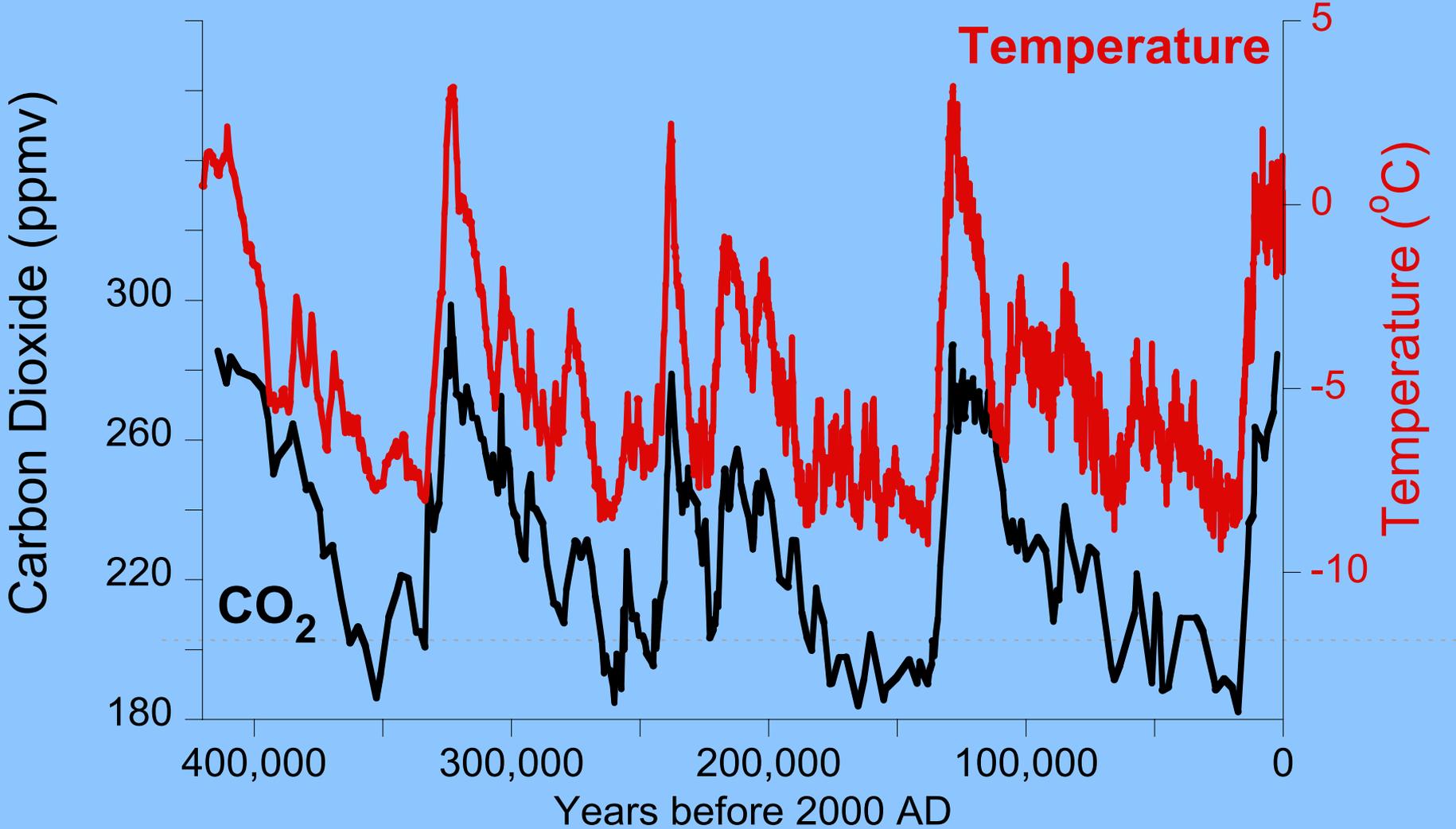


Atmospheric Carbon Dioxide Record



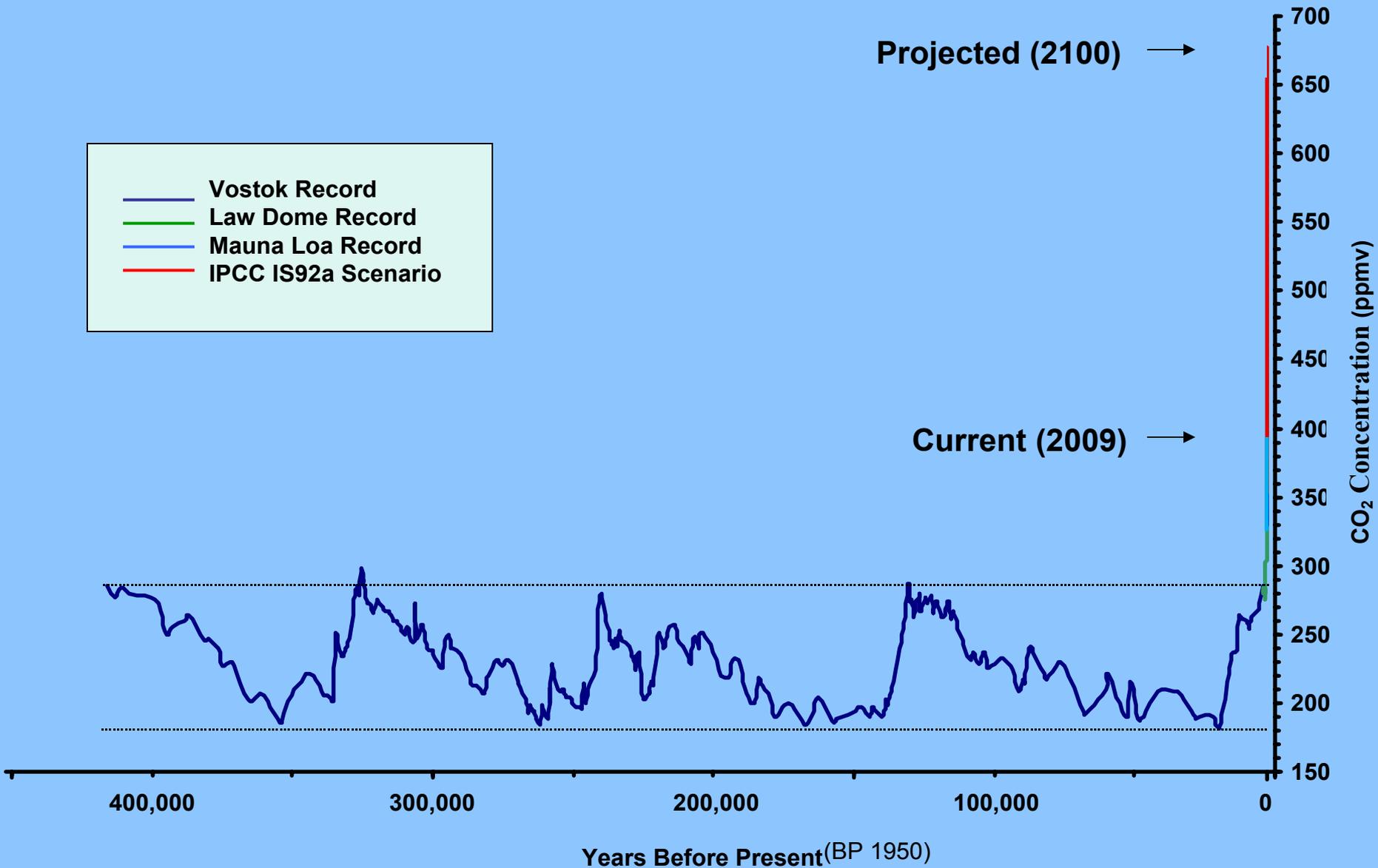
Petit et al., 1999

Atmospheric Carbon Dioxide & Temperature Record



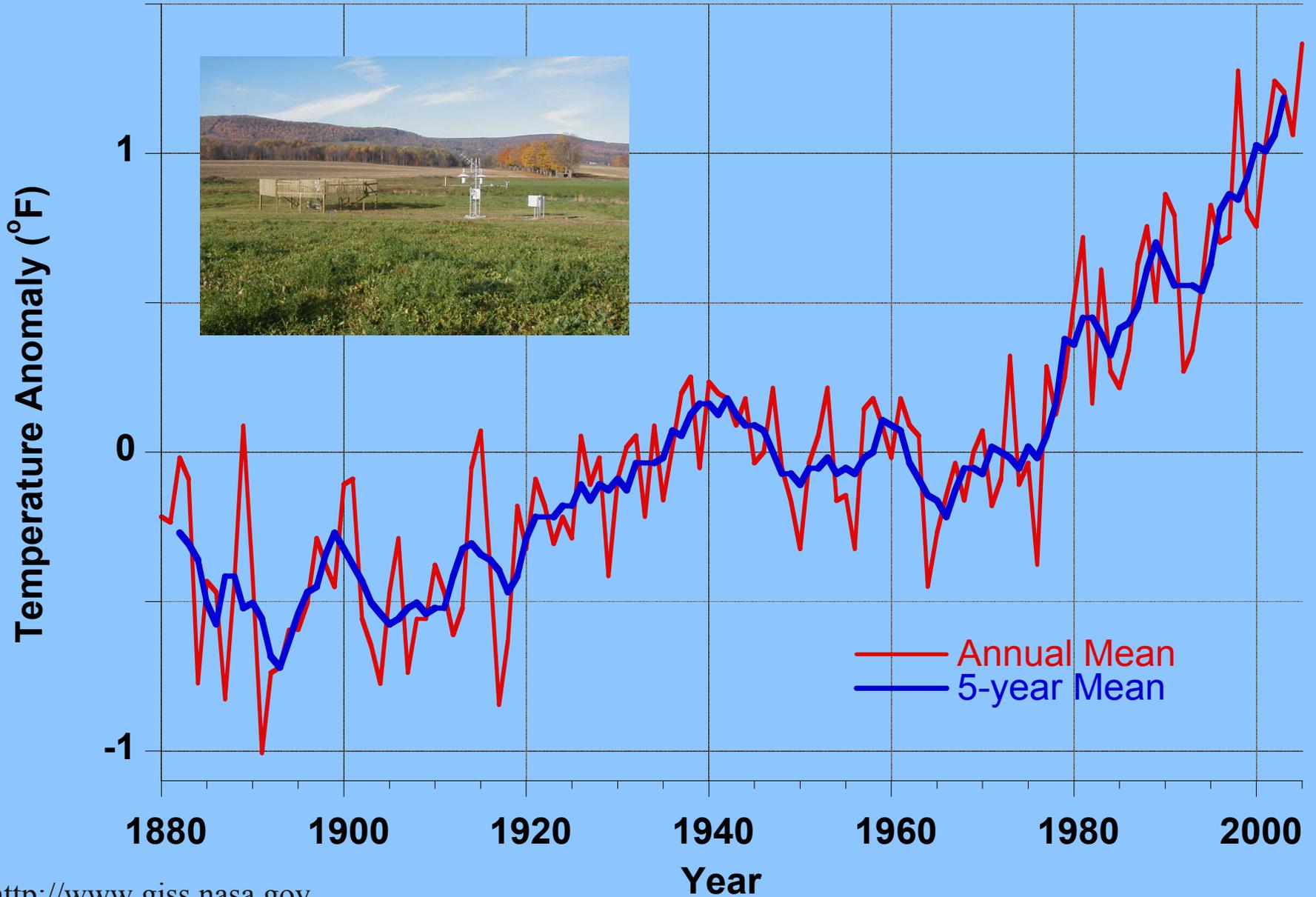
Petit et al., 1999

Historical and Future Carbon Dioxide Levels

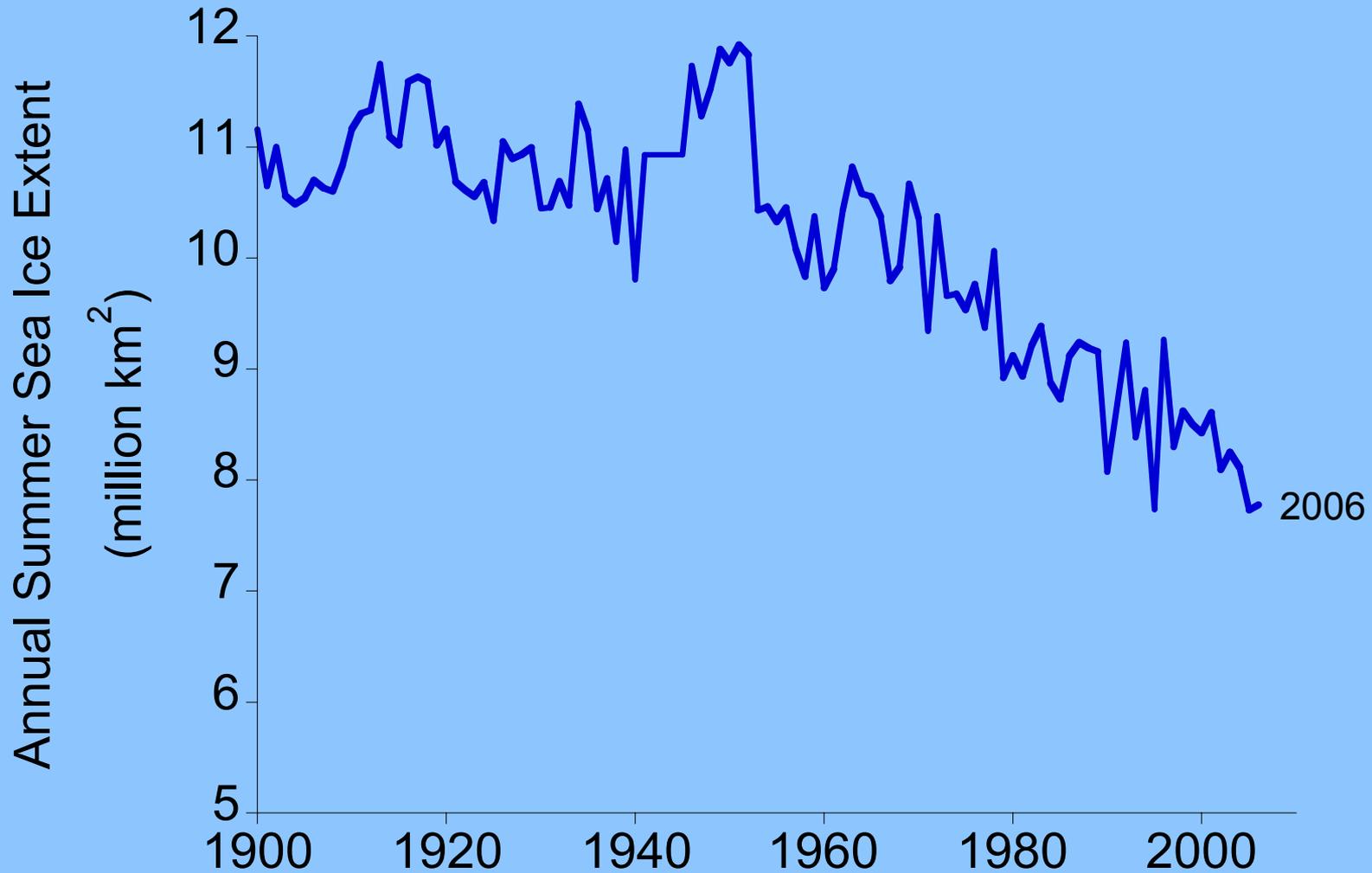


Source: C. D. Keeling and T. P. Whorf; Etheridge *et.al.*; Barnola *et.al.*; (PAGES / IGBP); IPCC

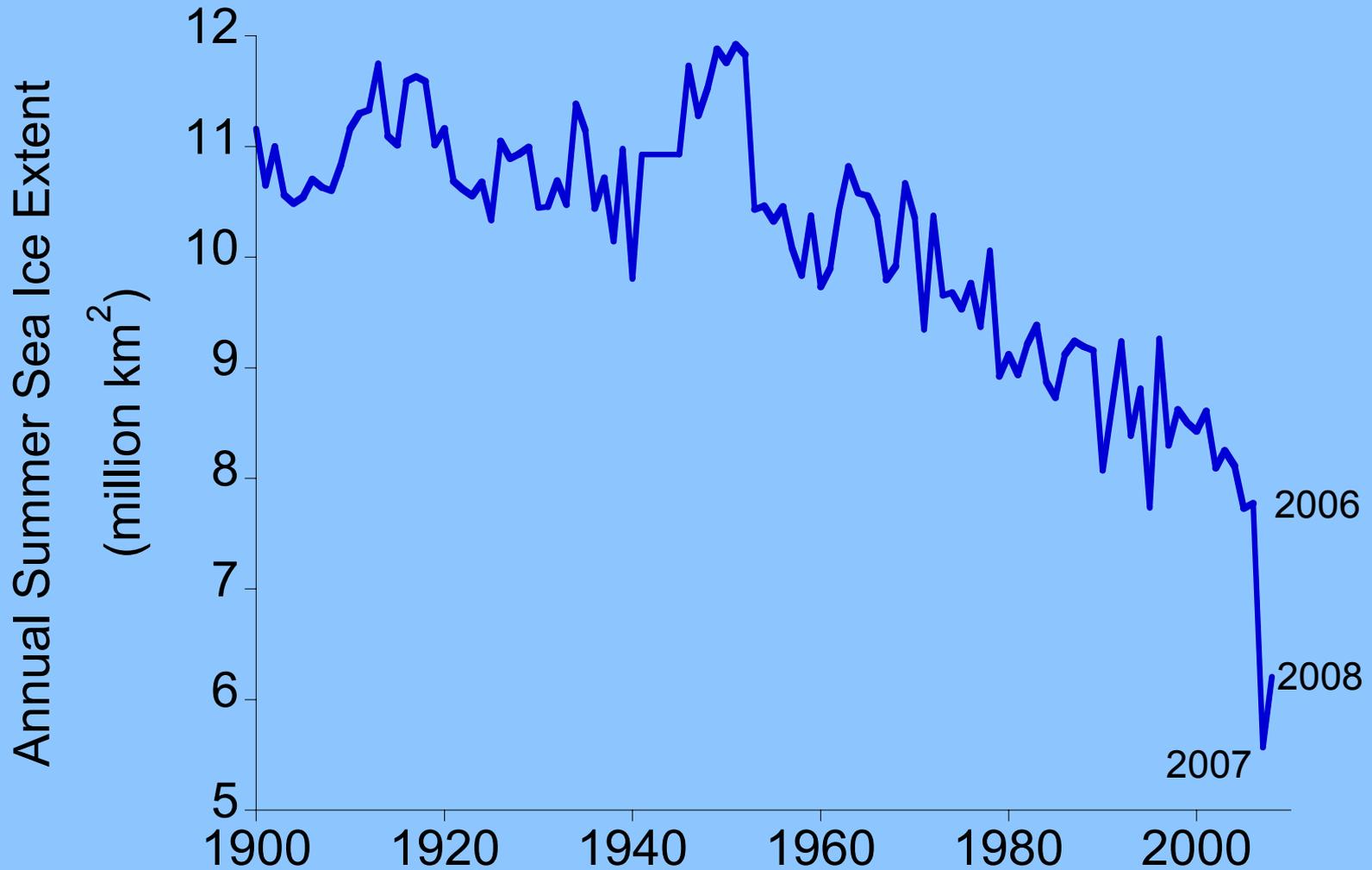
Global Temperature 1880-2005



Summer (JJA) Arctic Sea Ice Extent



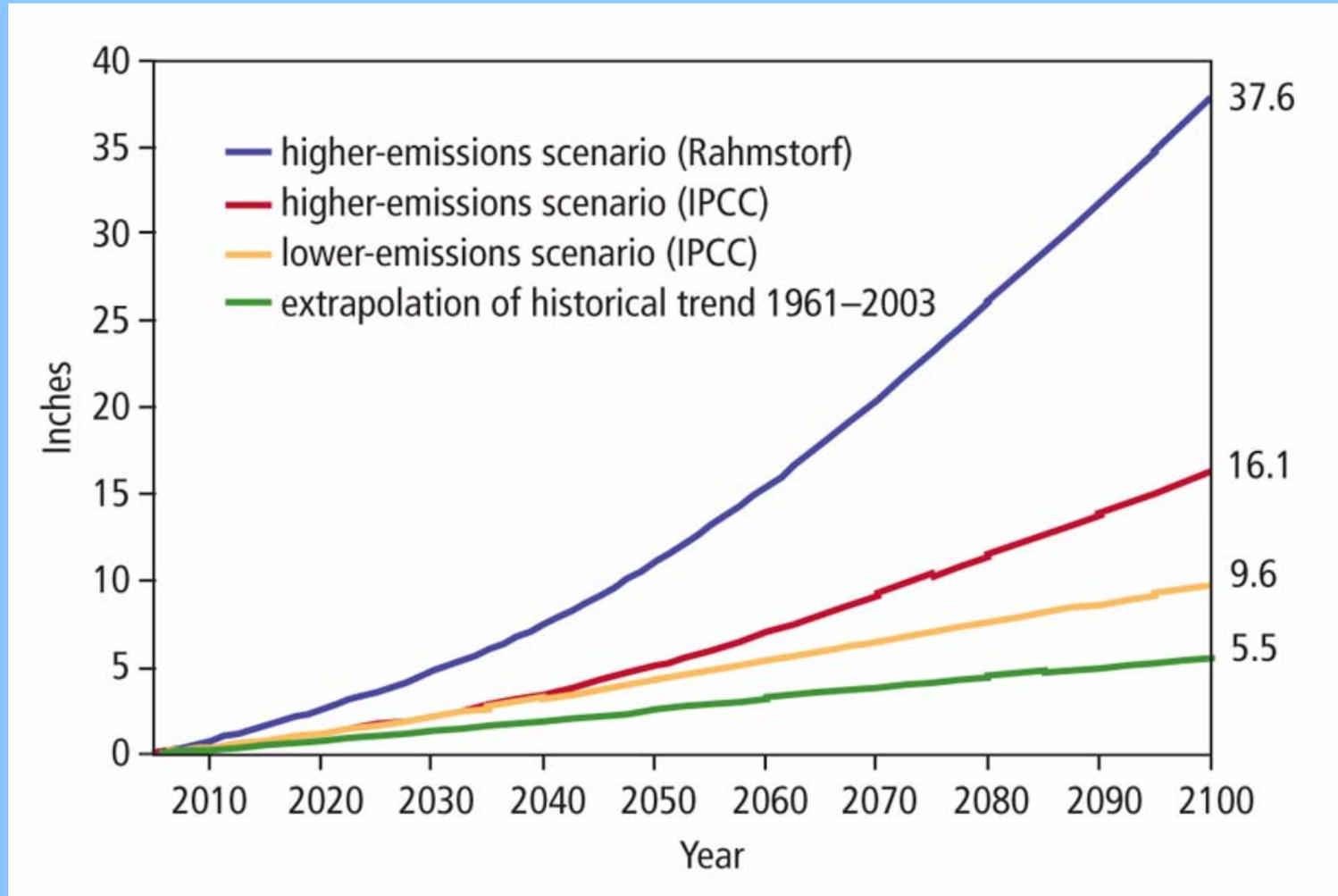
Summer (JJA) Arctic Sea Ice Extent



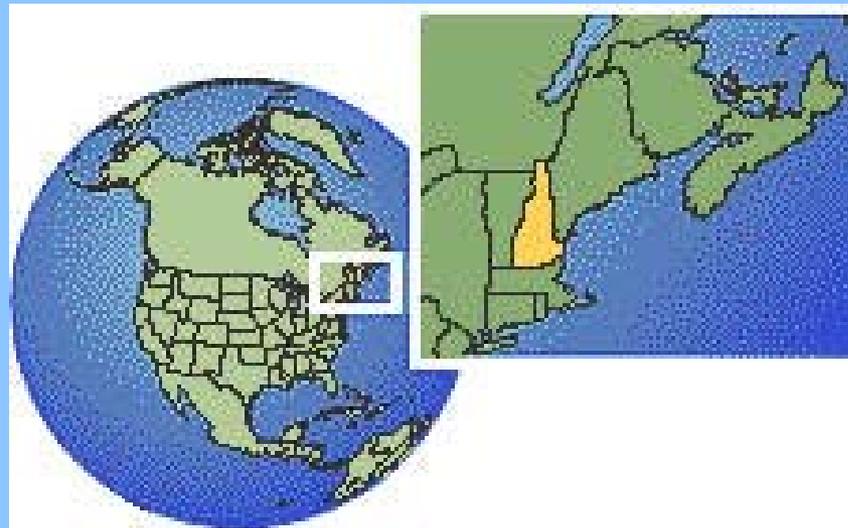
University of Illinois

The Cryosphere Today <http://arctic.atmos.uiuc.edu/cryosphere/>

Projected Rise in Global Sea Level



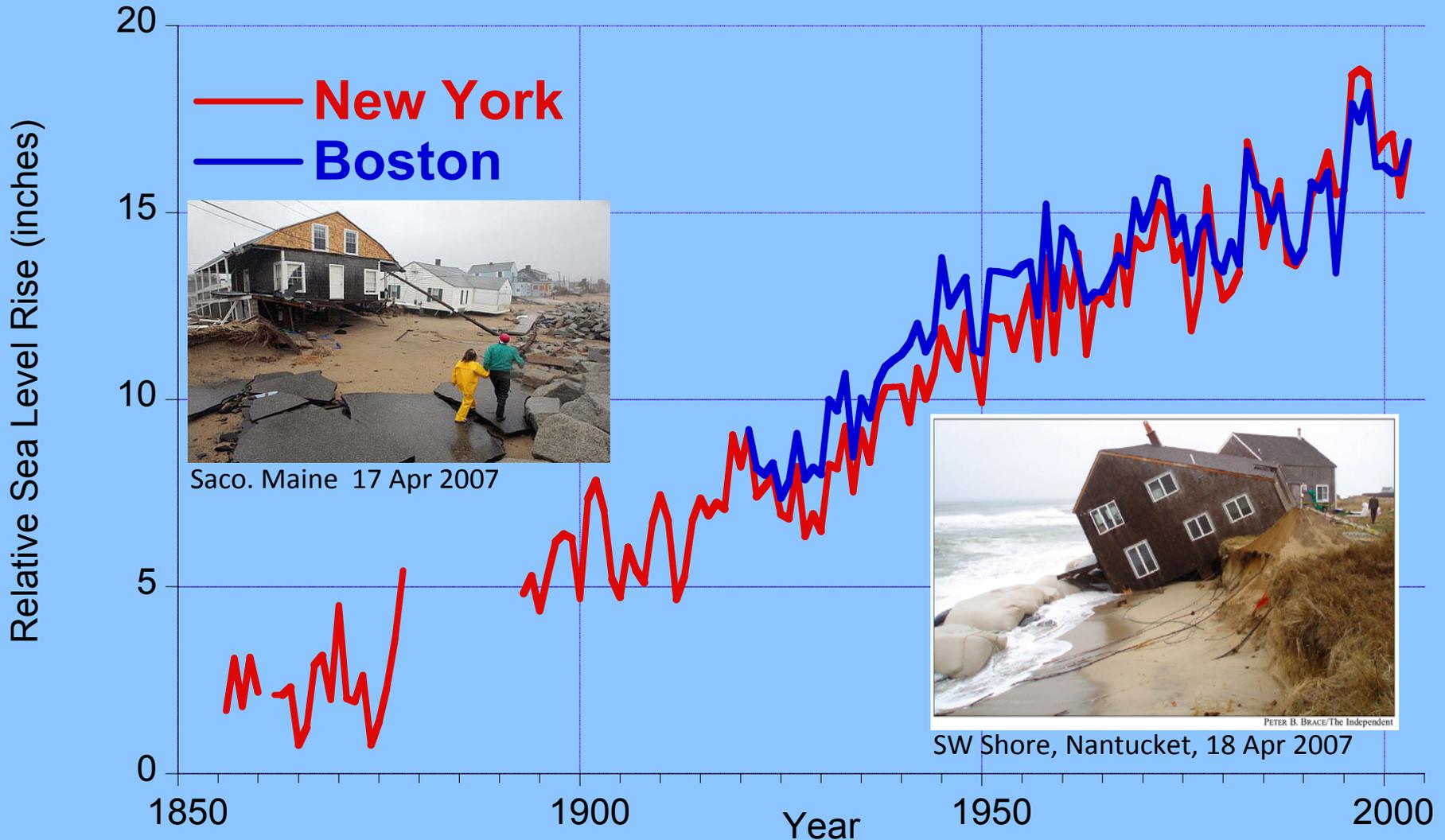
So how do we know if this is
happening in
New Hampshire?



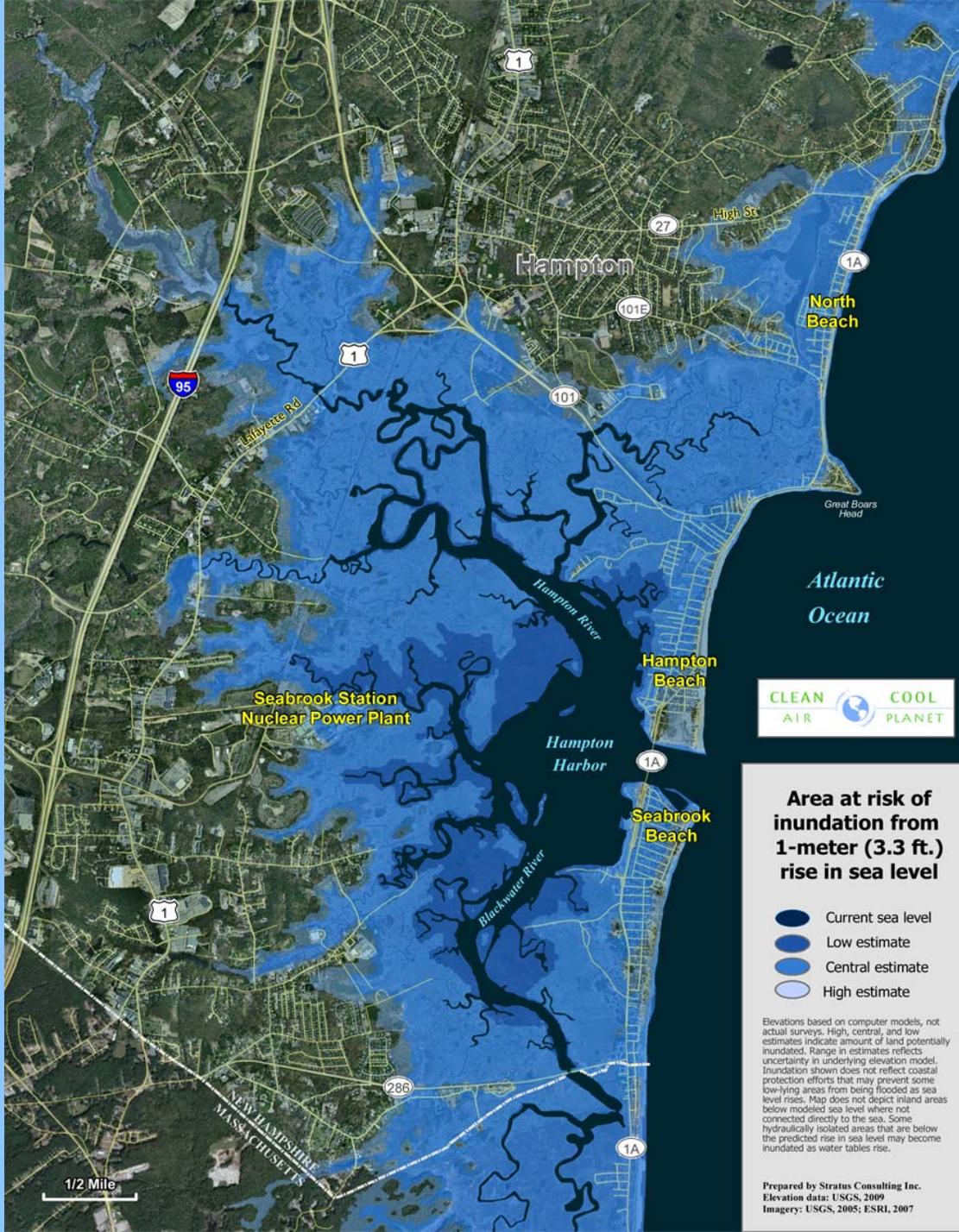
Indicators of Climate Change in the Northeast

- More precipitation
- More frequent extreme precipitation
- Winter warming
- Decreased snowfall
- Fewer days with snow on ground
- Lake ice out dates earlier
- Earlier spring runoff
- Extended growing season
- Sea-level rise
- Drought

Relative Sea Level Rise 1856 - 2005



Data from Permanent Service for Mean Sea Level <http://www.pol.ac.uk/psmsl/>



Hampton NH with 3.3 feet of sea level rise



Area at risk of inundation from 1-meter (3.3 ft.) rise in sea level

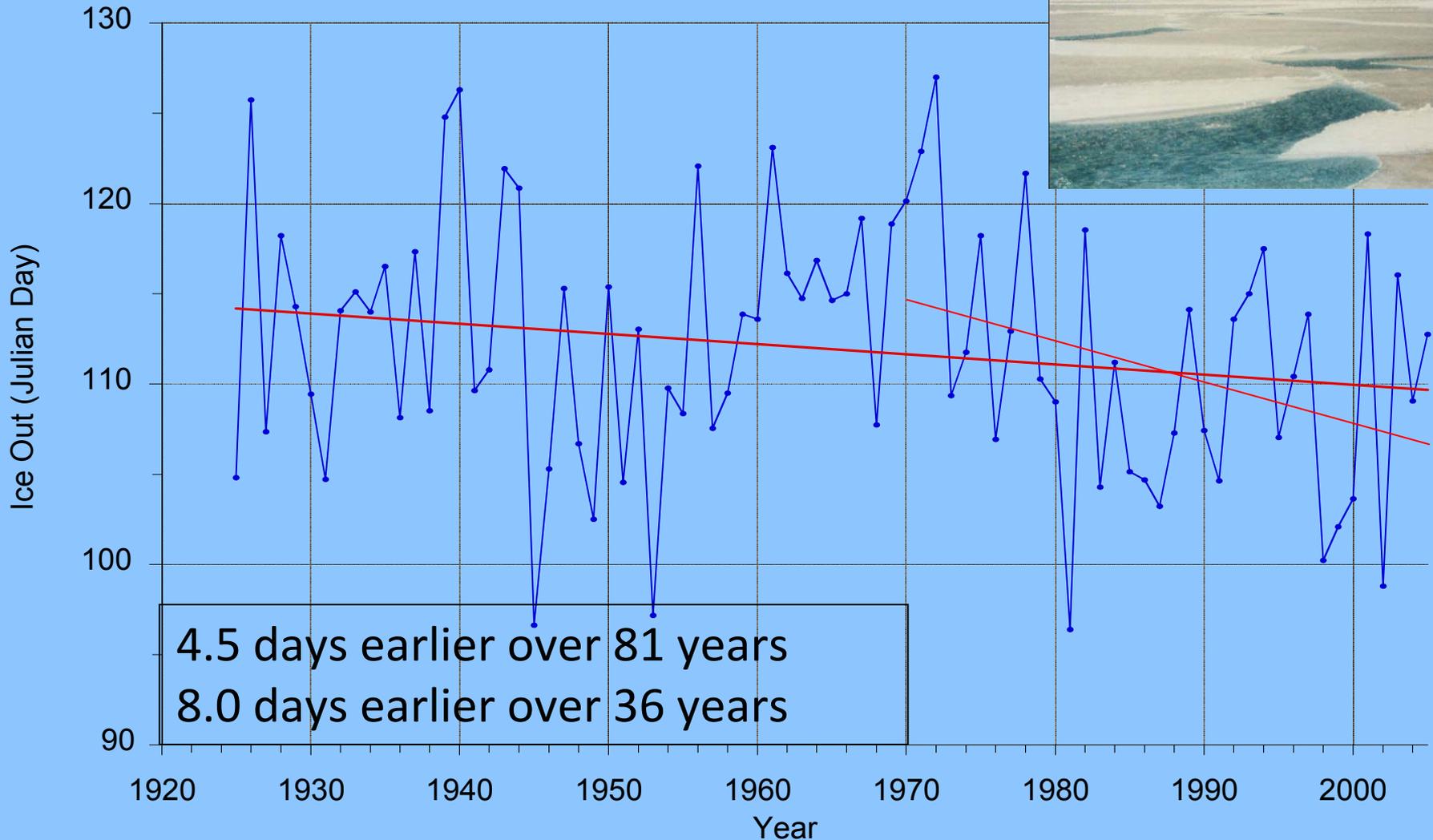
- Current sea level
- Low estimate
- Central estimate
- High estimate

Elevations based on computer models, not actual surveys. High, central, and low estimates indicate amount of land potentially inundated. Range in estimates reflects uncertainty in underlying elevation model. Inundation shown does not reflect coastal protection efforts that may prevent some low-lying areas from being flooded as sea level rises. Map does not depict inland areas below modeled sea level where not connected directly to the sea. Some hydraulically isolated areas that are below the predicted rise in sea level may become inundated as water tables rise.

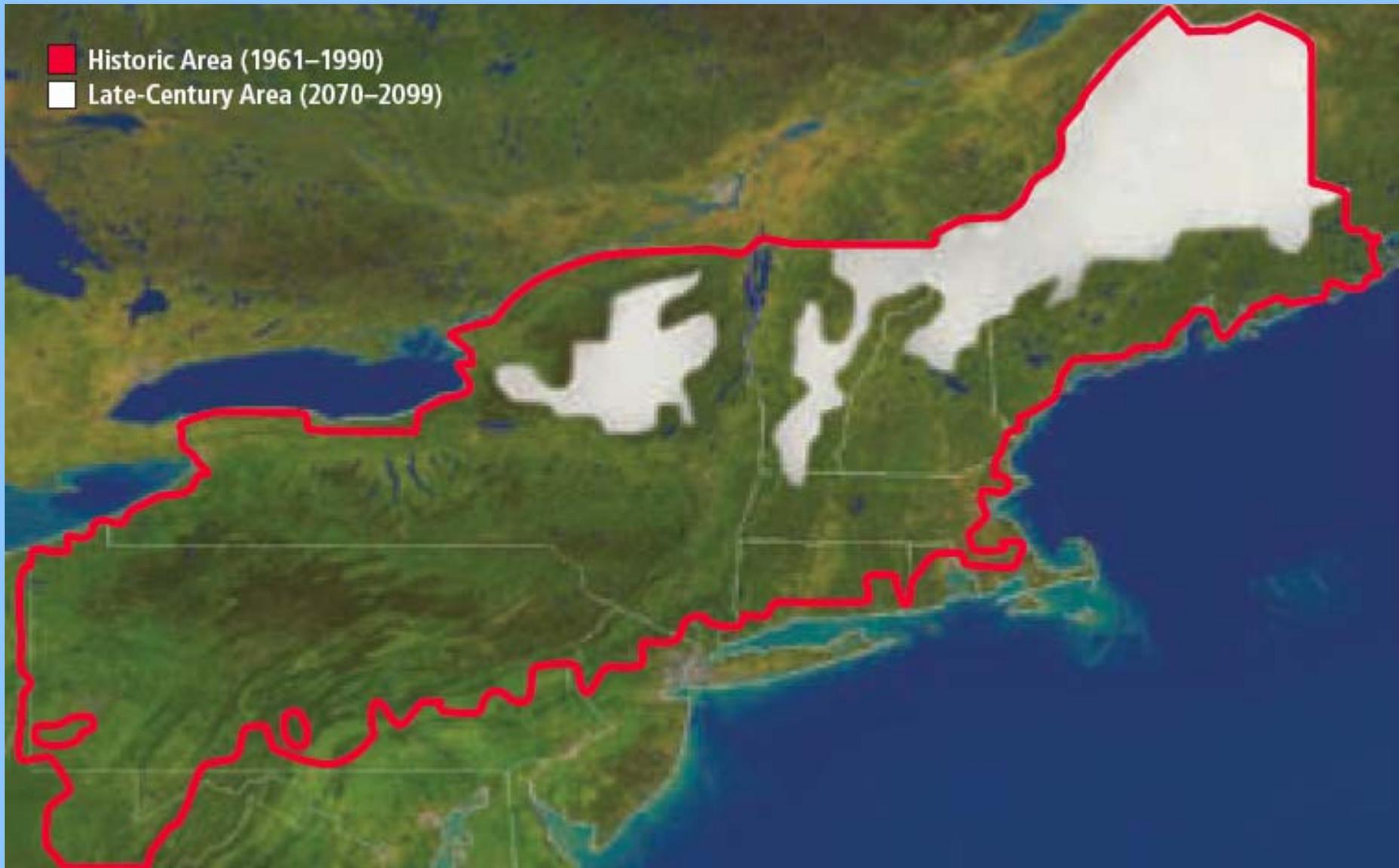
Prepared by Stratus Consulting Inc.
Elevation data: USGS, 2009
Imagery: USGS, 2005; ESRI, 2007

Average Ice Out Day Trend

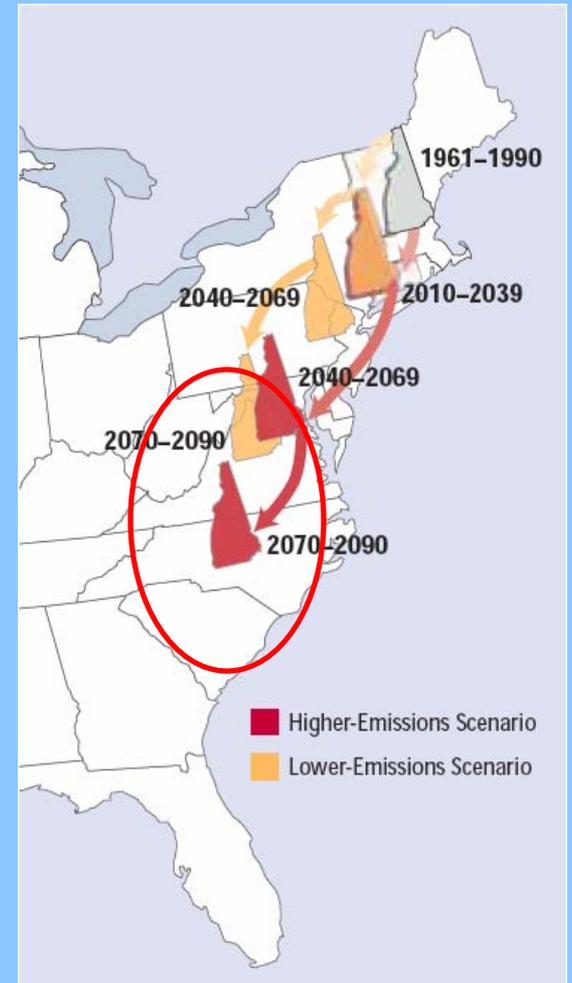
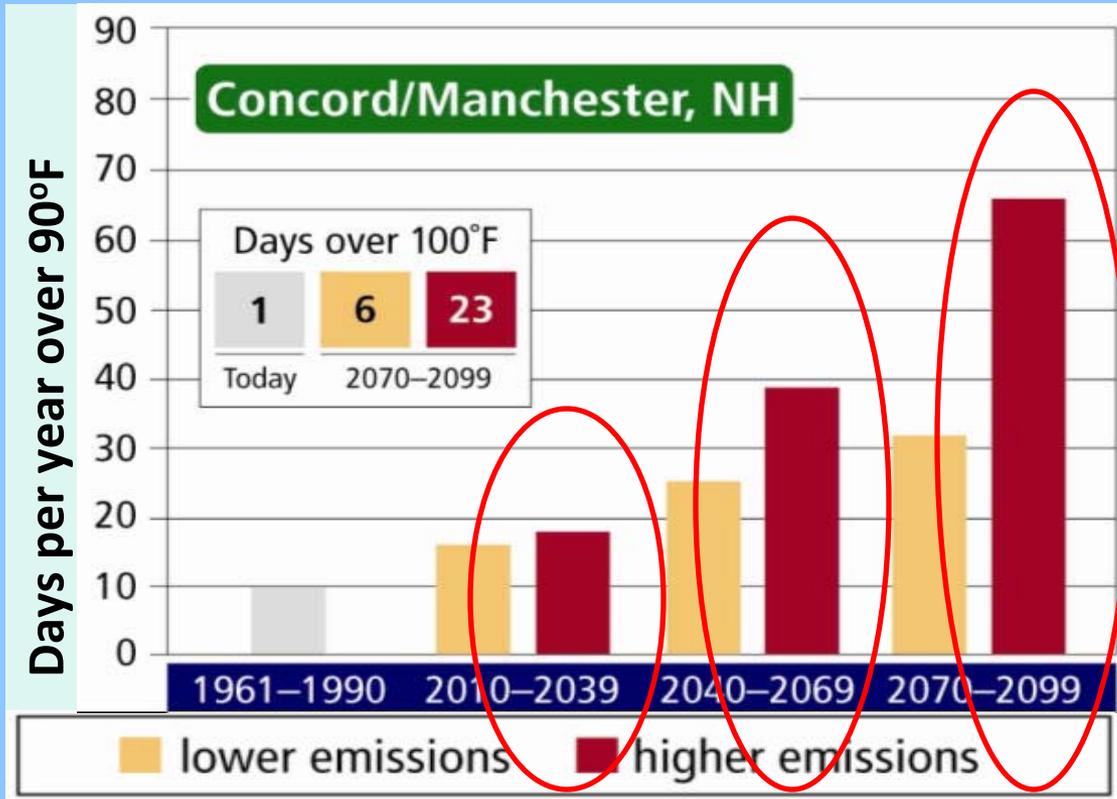
1925-2005 (27 Lakes)



Reduced Snow-on-Ground Days



Projections of Climate Change in New Hampshire



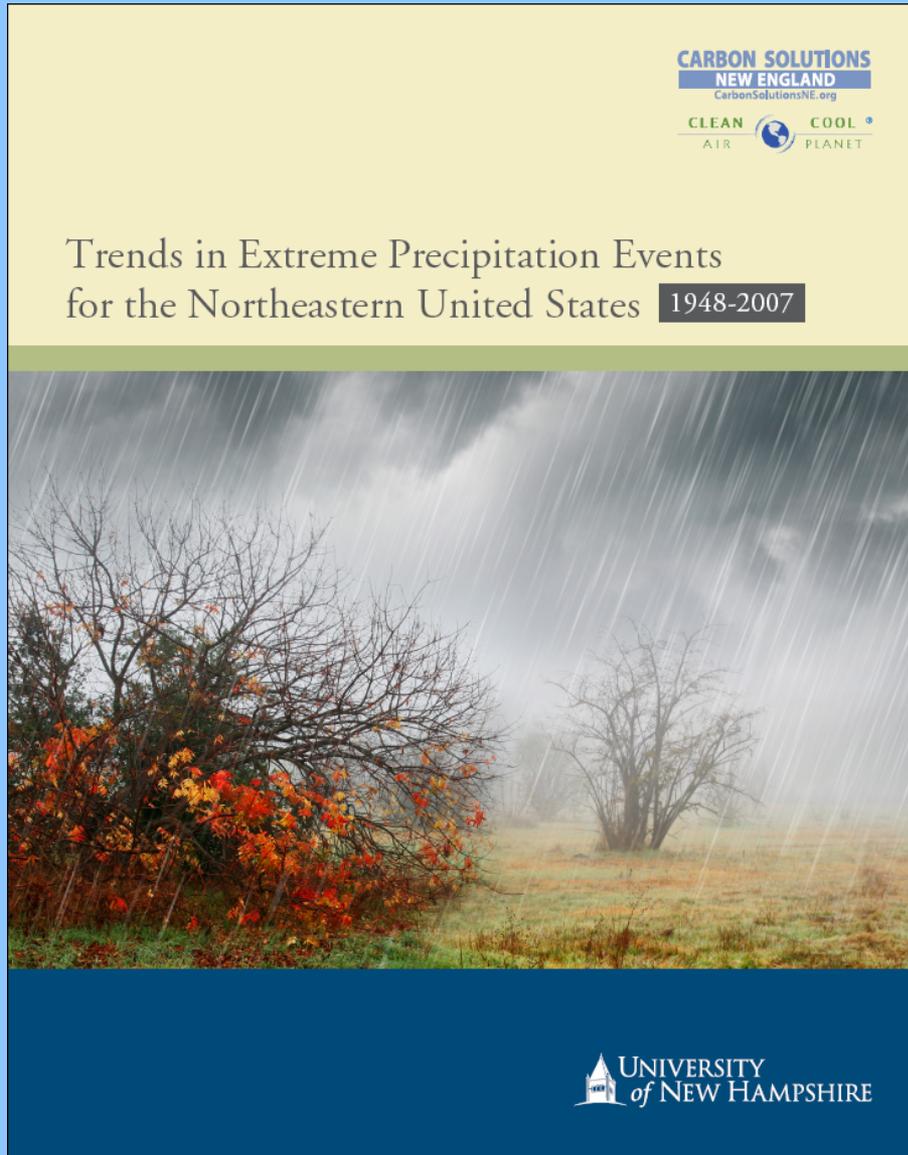
Flooding in NH

- October 2005
- May 2006
- April 2007
- September 2008
- March 2010
- August 2011
- May 2012



Surry Road, Surry
May 29, 2012

New 2010 Report



Conclusions

- Historical trends of increasing extreme precipitation are connected to greenhouse gas-enhanced climate change...
- Driven primarily by the burning of fossil fuels and land use changes...
- More likely than not that human influence contributed to the trend toward more extreme precipitation events...
- Future increases in extreme precipitation are very likely.



February 2, 2011

- Historic winter storm, blizzard, thunder snow, ice storm, tornados
- At least 3.9 billion dollars in damages
- Affected over 100 million people; at least 36 fatalities
- Max snow 27", winds over 60 mph, over 1" of ice build up



July 21, 2011

- Record-breaking heat wave from Texas up through the Midwest and east to the mid-Atlantic states and New England.
- Heat warnings in 30 states.
- At least 22 deaths attributed to the plus-100 degree temperatures.
- It's news in many places:
 - "Hot Yesterday? Look Out Today." ([Boston Globe](#))
 - "Excessive Heat Warnings Posted For Maryland." ([Baltimore Sun](#))
 - "Mercury Hits 100 At Lakefront; Scorching Heat Likely To Hang Around." ([Chicago Sun-Times](#))
 - "Heat Advisory Issued For Central Oklahoma." ([The Oklahoman](#))



August 27, 2011

Hurricane Irene

- \$7 billion in damages, 33 people killed
- Power outages, bridges and roads washed out, agriculture devastated
- "2011, even before Hurricane Irene, was going to go down as one of the most momentous in terms of natural catastrophes in the United States," Insurance Information Institute .

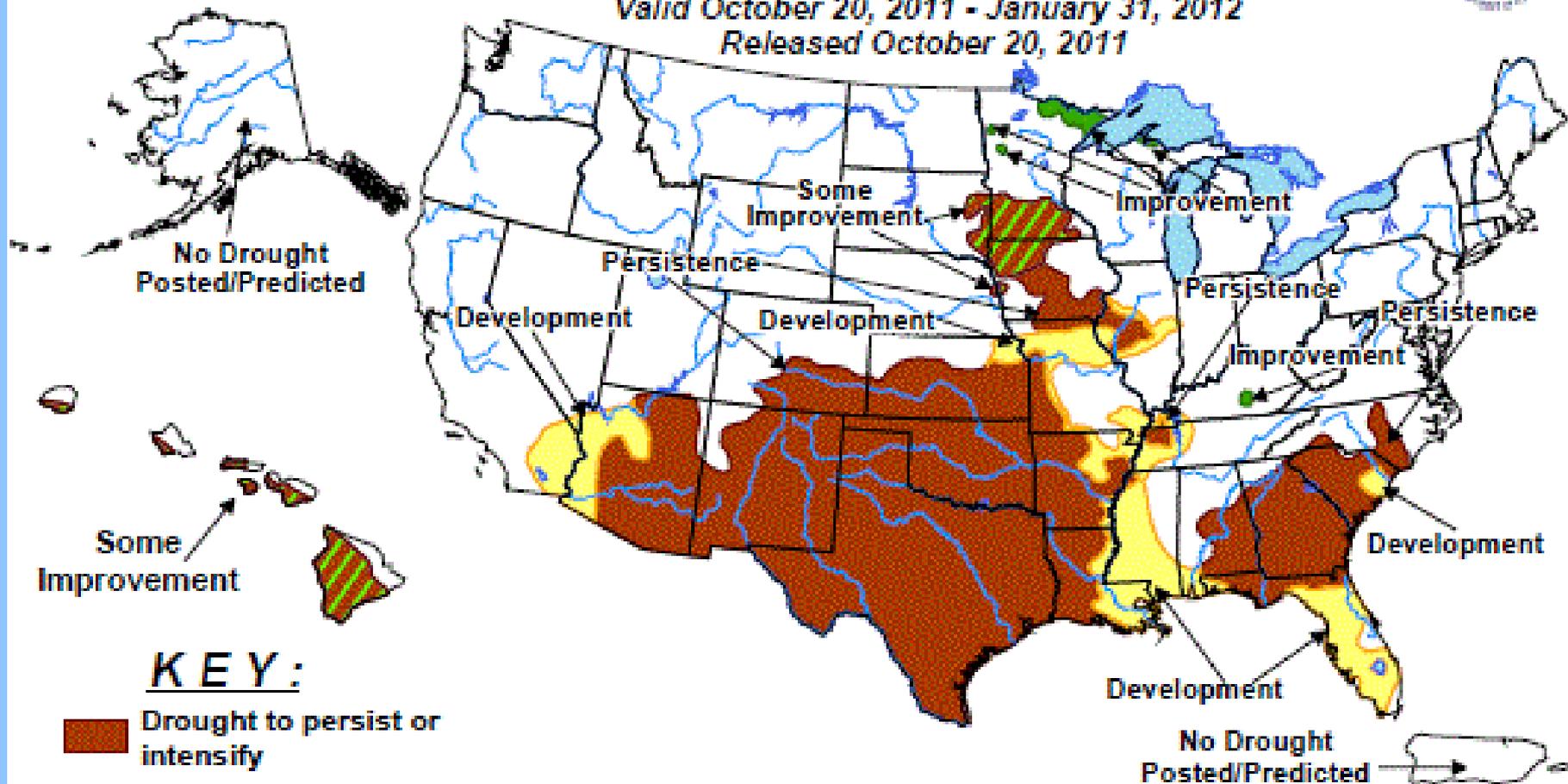


U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid October 20, 2011 - January 31, 2012

Released October 20, 2011



KEY:

-  Drought to persist or intensify
-  Drought ongoing, some improvement
-  Drought likely to improve, impacts ease
-  Drought development likely

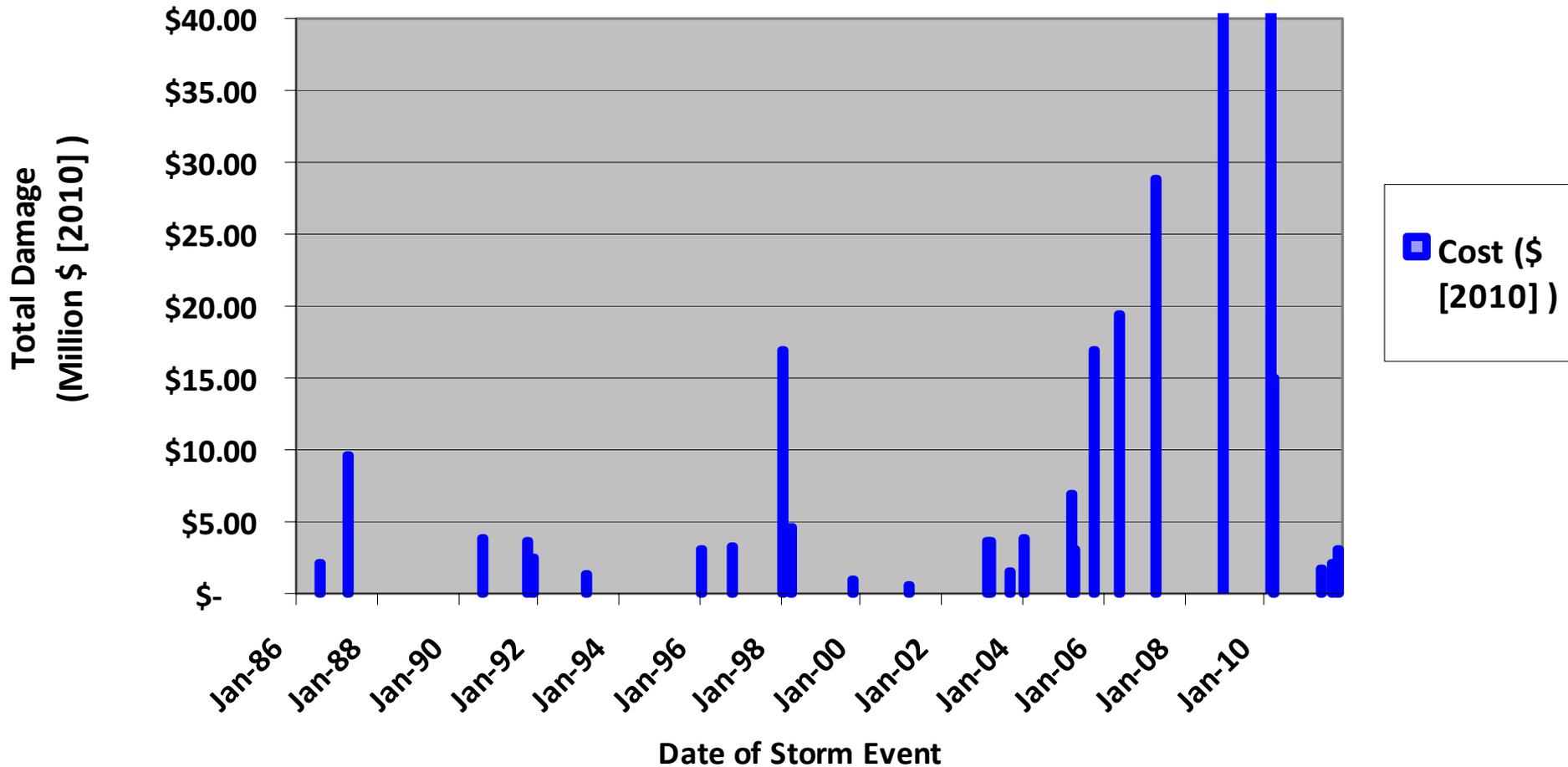
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events – such as individual storms – cannot be accurately forecast more than a few days in advance. Use caution for applications – such as crops – that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 Intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green Improvement areas imply at least a 1-category Improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

New Hampshire Federally Declared Disasters

- **2003-2011**
 - **13 Declared Disasters**
 - **1 Tropical Storm**
 - **10 Severe Storms (1 Fall Snow Storm)**
 - **2 Winter Storms**

- **1953-1999**
 - **14 Declared Disasters**

Presidentially Declared Storm-Related Disasters (Million \$ [2010])

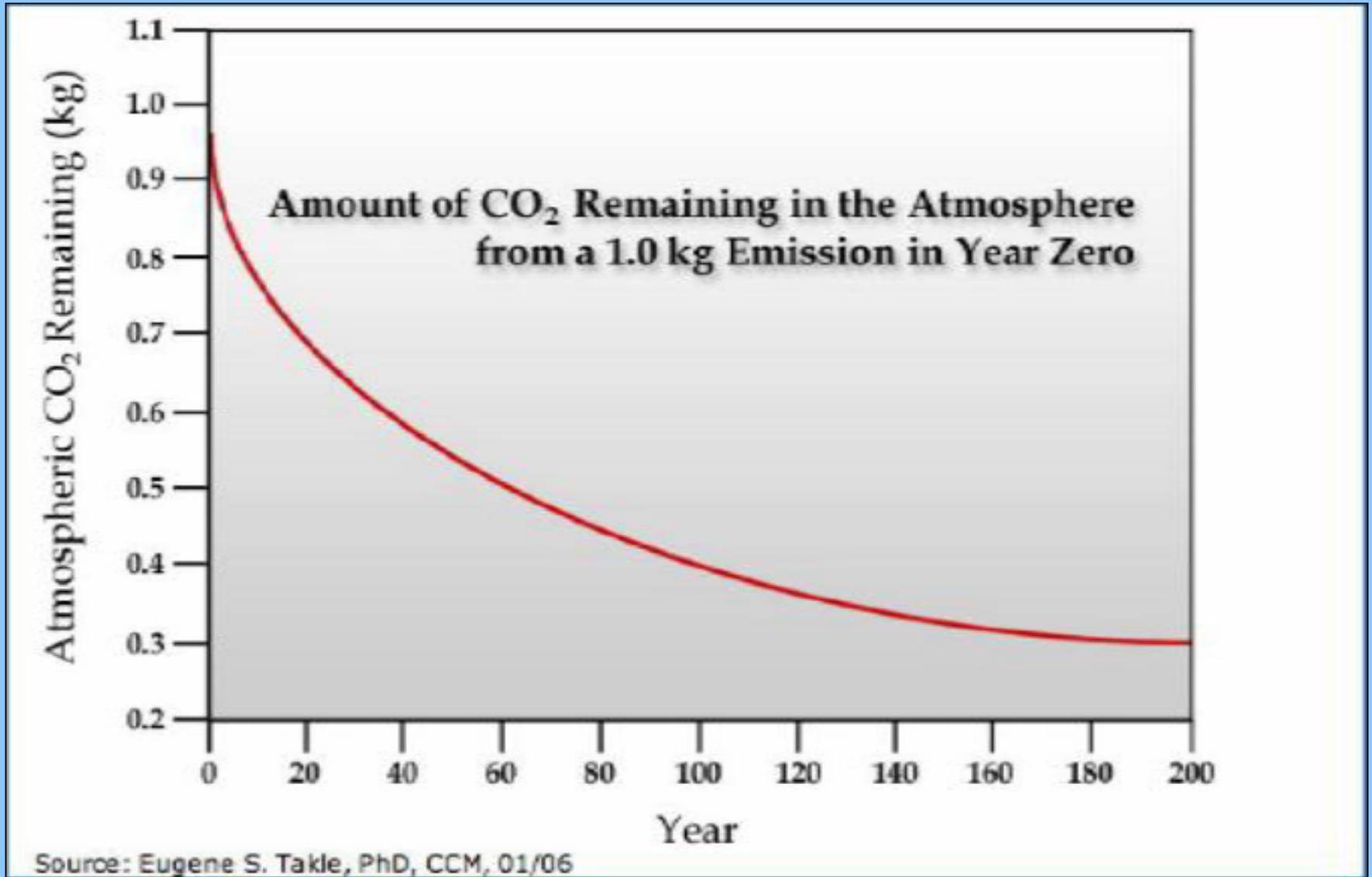


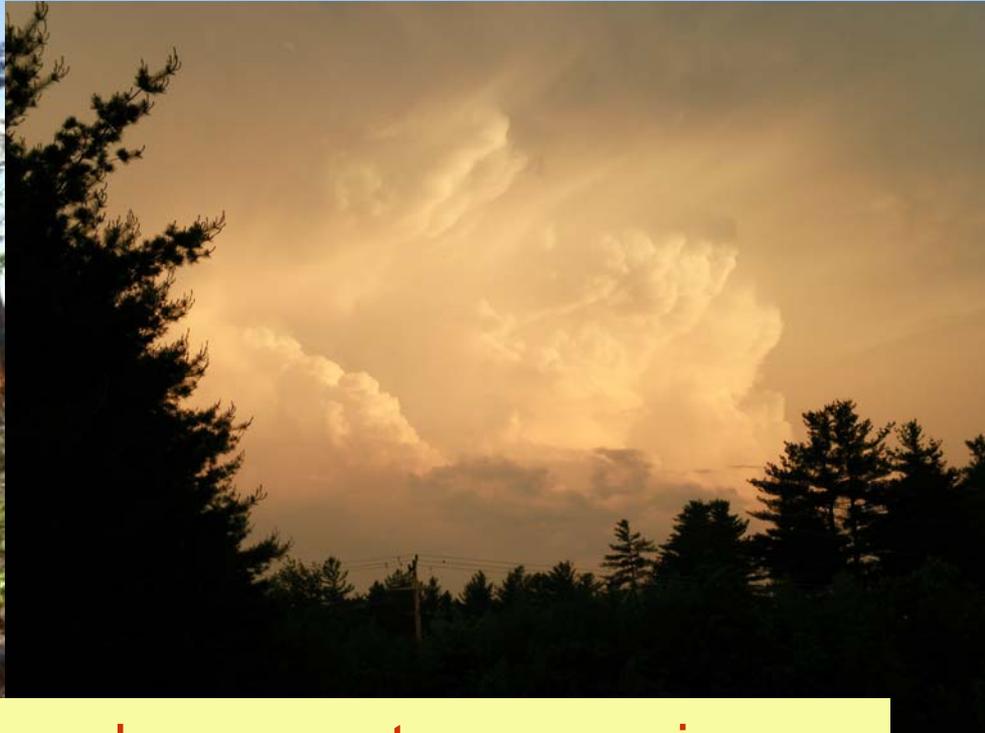
Potential Impacts of Climate Change on Human Health



ertainty / Displacement

CO₂ Persists in the Atmosphere





Tornados and severe storm warnings

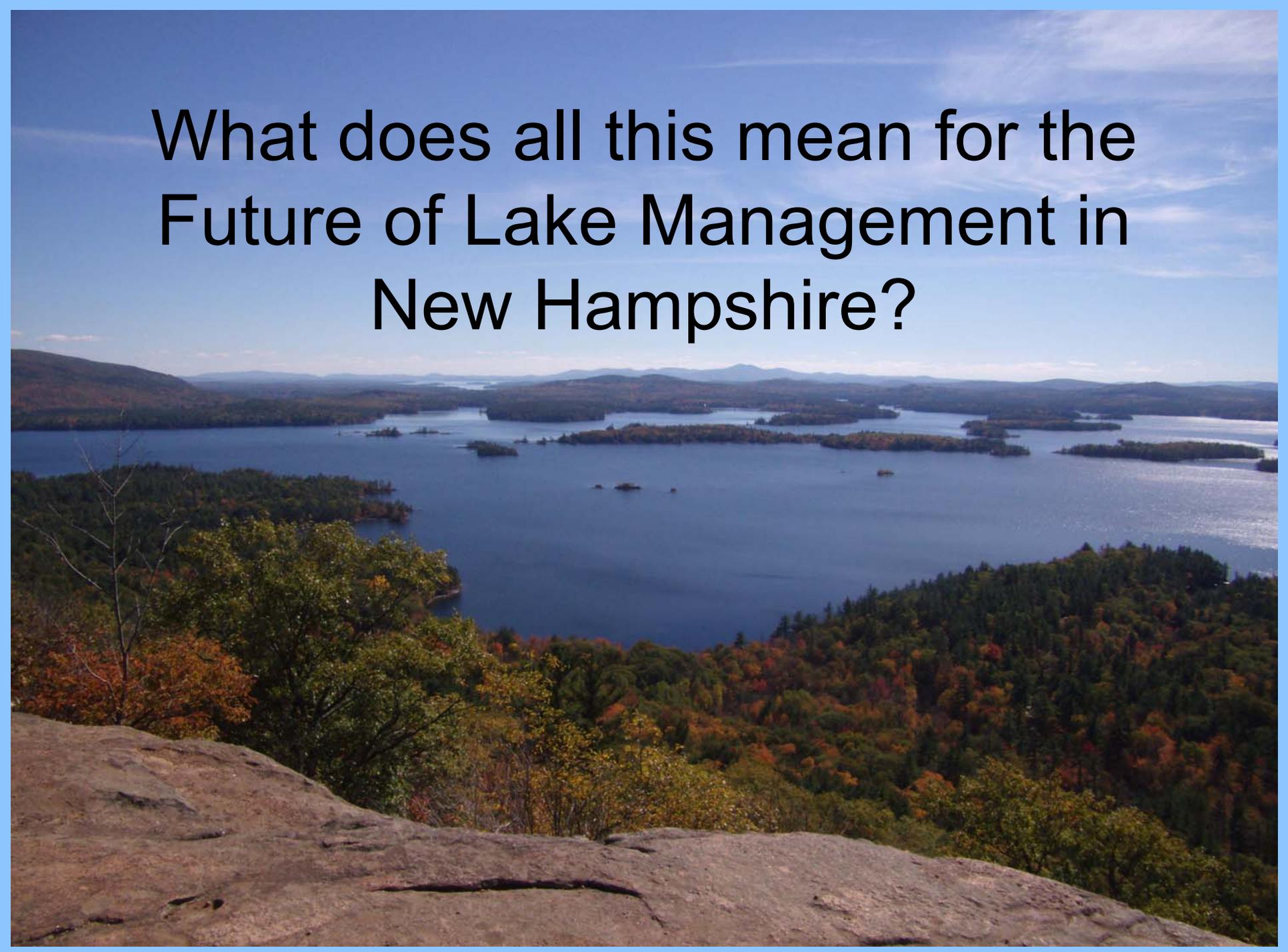


Flooding



Ice storms

What does all this mean for the Future of Lake Management in New Hampshire?



A Water-Rich New Hampshire

- 17,000+ miles of rivers and streams
- 1,000+ lakes and ponds
- 230+ miles of coastal/estuarine shoreline
- 500,000 acres of wetlands
- Groundwater
 - Bedrock
 - Sands and gravels left by glaciers (14% of state)
- **Down-side:** N.H. economy more vulnerable to deteriorating water resources, being one of top 10 states in tourism as % of economy!

How will impacts from Climate Change add Concern for Lake Water Quality?

- More frequent extreme precipitation – turbidity, more runoff into lakes, dam safety
- Winter warming
- Decreased snowfall - fewer days with snow on ground
- Lake ice out dates earlier
- Lake warming – dissolved oxygen decrease, cyanobacteria, impacts on fish
- Earlier spring runoff
- Extended growing season – invasive species
- Sea-level rise – coastal storm surge
- Drought

What can YOU do?

As a VLAP volunteer:

- Pay extra attention!
- Document changes, note timings of things
- Compare notes from year to year
- When are plants or algae blooming
- Water temperatures, lake levels etc...
- What happened during drought conditions?
- What happened after a big storm?

The more local information YOU collect, the better WE can plan for the future.

What can YOU do?

As a concerned citizen:

- Use energy efficiently
 - Energy star appliances
 - Efficient light bulbs
 - Wash full loads, use clothes lines
 - Use fans in summer (4-6 degrees cooler)
- Eat local foods
- Drive a fuel efficient vehicle (keep vehicle tuned, don't idle)
- Better insulate your home (use drapes), home energy audit
- Cut the Carbon Kit, available at your local library
- Support Local Energy Commissions



SAVE MONEY TOO!

About Climate Change

- It is happening now – we can see it in our own lives. Warmest March on record (9F higher than average). Collect lake data to help future planning.
- It is us – fossil fuels make CO₂; CO₂ traps heat
- We have a choice – solutions are happening right now. We have the technology!
- Wide scientific agreement – National Academy of Science, NOAA, American Geophysical Union, US Global Change Research Program, IPCC etc...)

We have met environmental challenges in the past!

- 40 years ago – Smog
 - Solution: Catalytic converters
 - Smog reduced by one-third to one-half
- 25 years ago – Ozone layer destruction
 - Solution: Chlorofluorocarbon (CFC) phase out
 - CFCs all but eliminated, ozone layer (slowly) rebounding
- 20 years ago – Acid Rain
 - Solution: “cap and trade” system for regulating utility SO₂ emissions
 - Acid rain emissions cut by 1/3; forests rebounding, lakes (slowly) rebounding

Solutions to Climate Change

Solution: Households, industry & government working together!

- Energy Efficiency
- National Security
- Energy Independence
- Economic Vitality

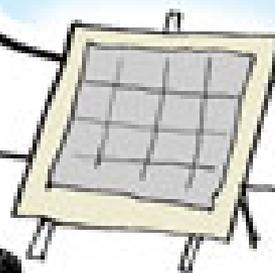




CLIMATE SUMMIT

WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- ETC. ETC.



AMERICAN PEOPLE

JOEL PITT