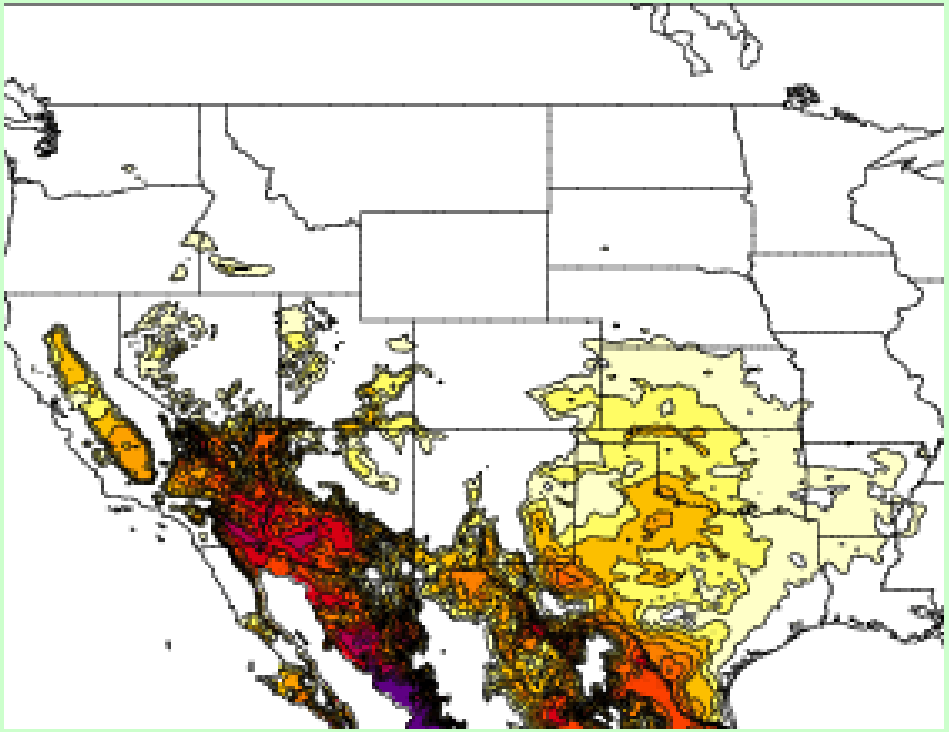
# global climate change impacts in the U.S.

## WHAT IS HAPPENING TO OUR WORLD AND WHY DOES IT MATTER?

KATHARINE HAYHOE



# America’s first climate refugees: ALASKA

# Frozen ground is melting & eroding

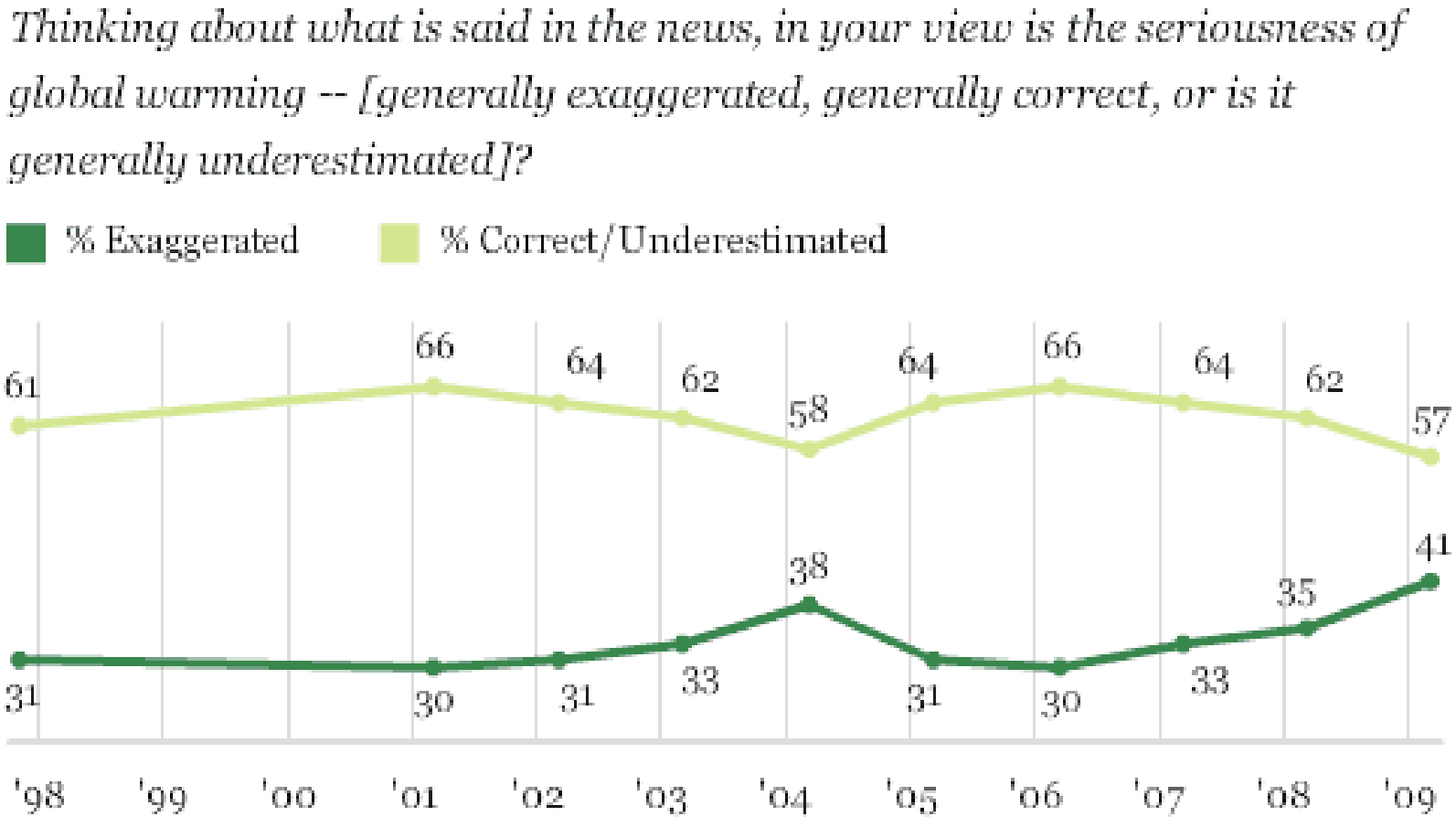
The people of Newtok, AK have already been driven from their homes.

Kivalina may be next.

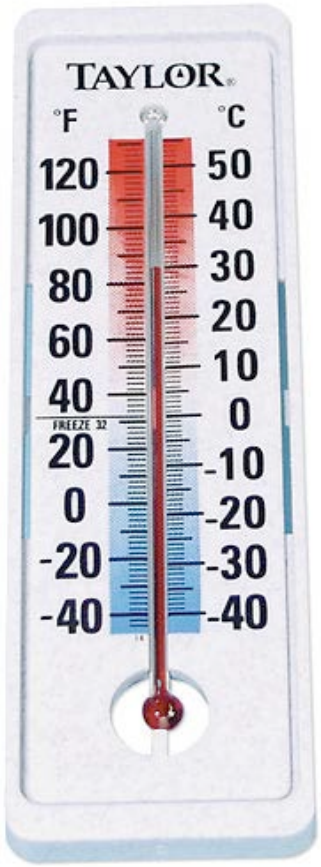
# What is happening to our world?

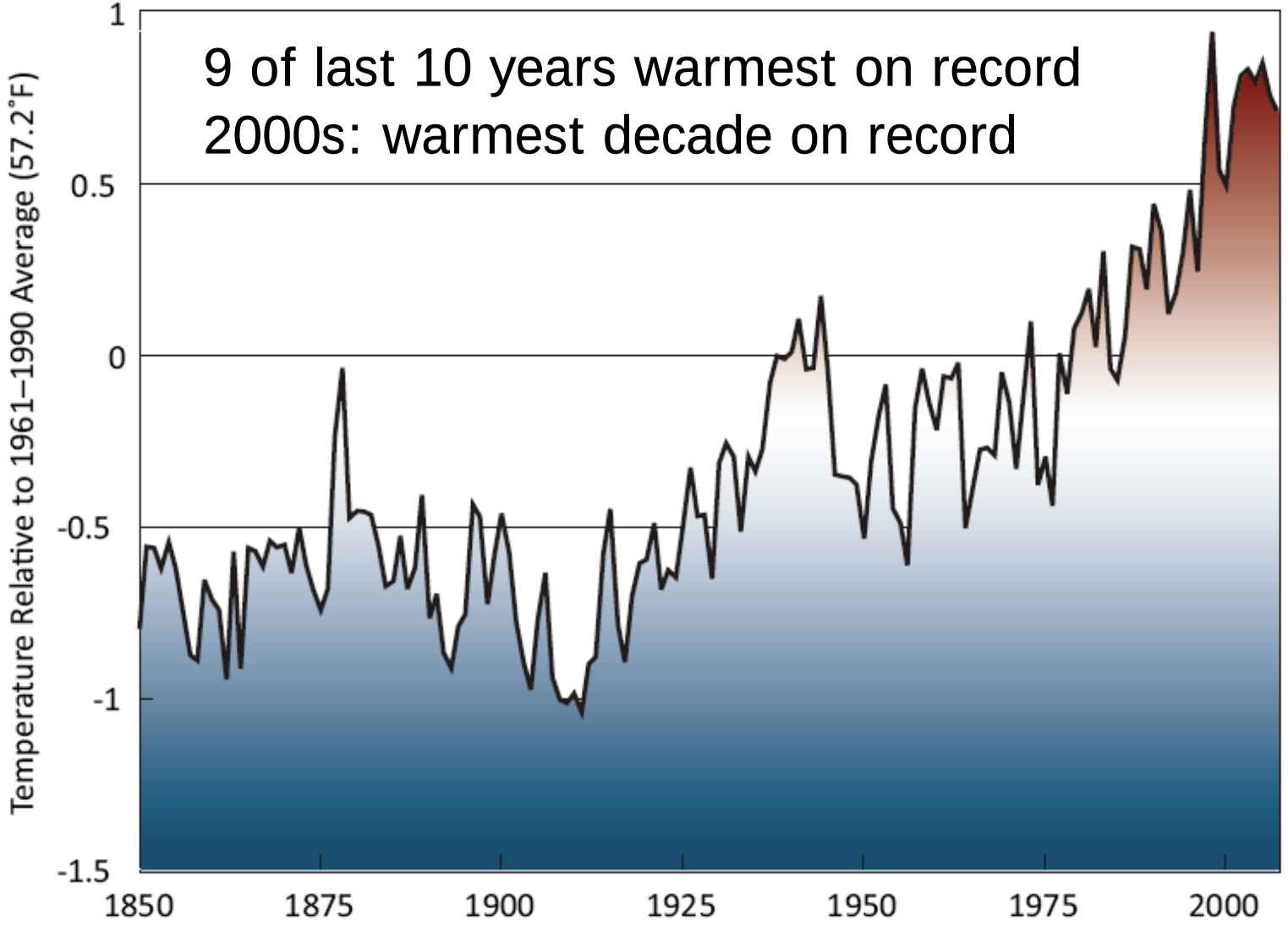
PART ONE

# Doubt regarding the seriousness of global warming is at an all-time high

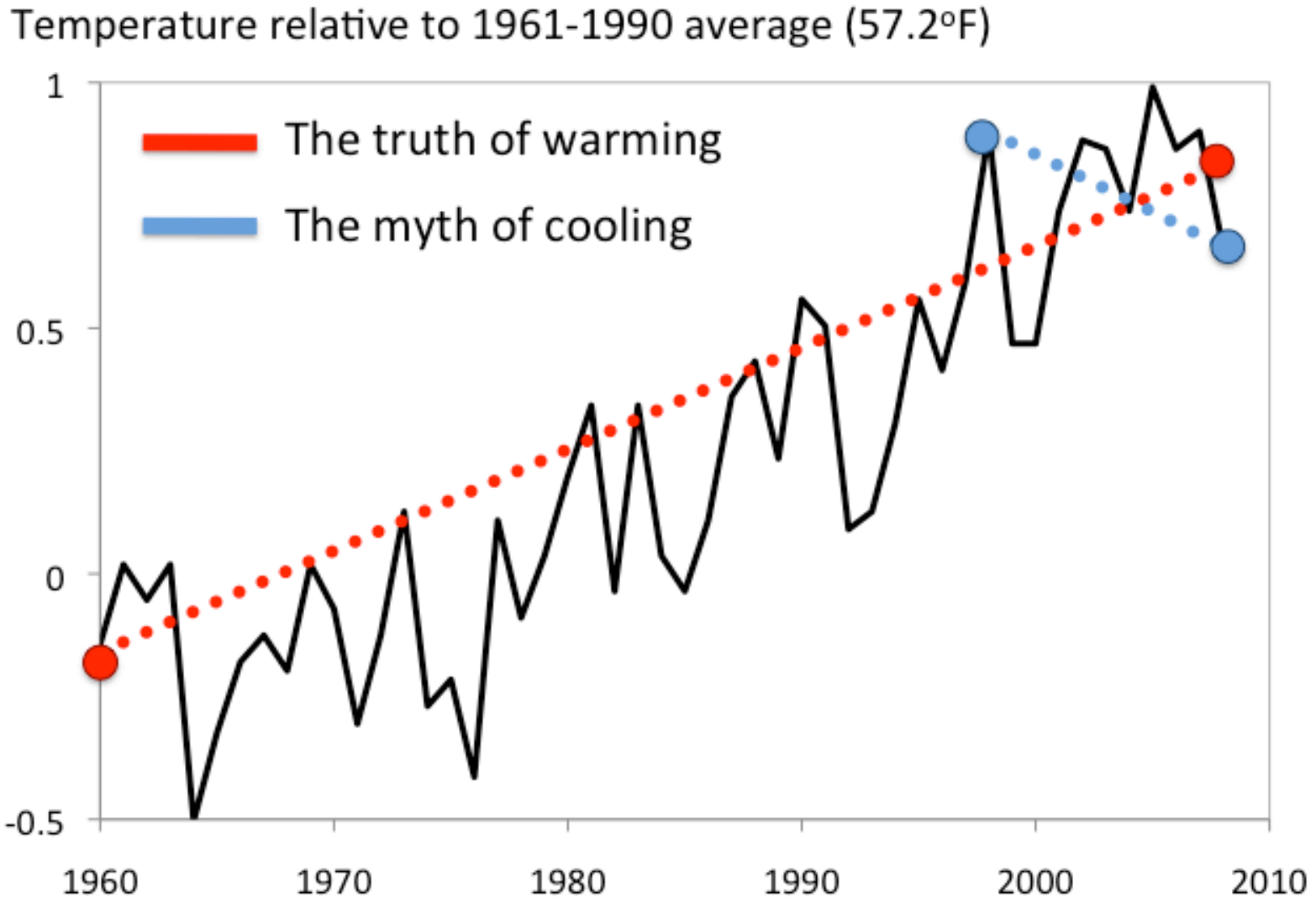


# The Earth is getting warmer …

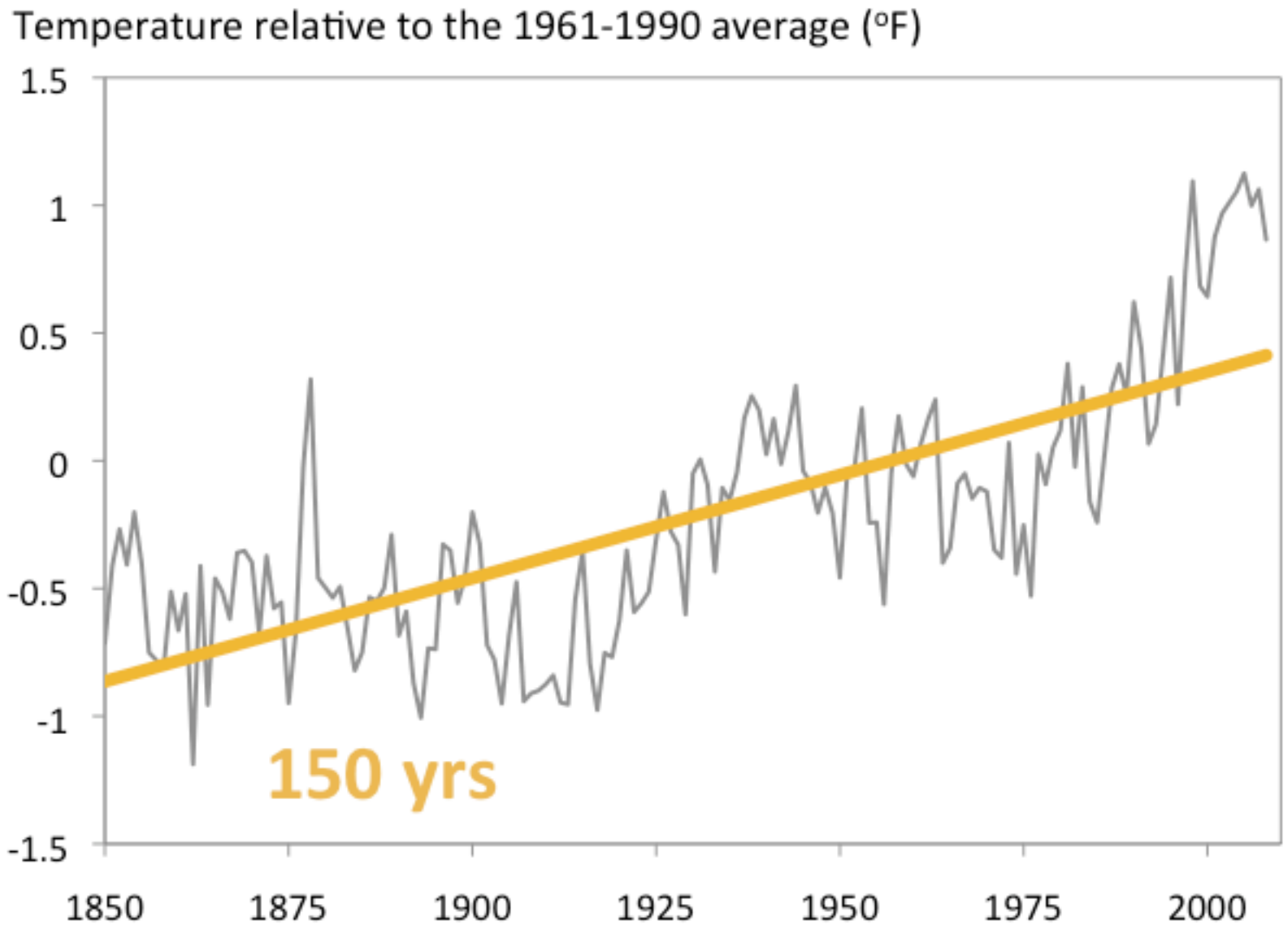


# … despite recent claims of “cooling”



# It’s happening faster and faster



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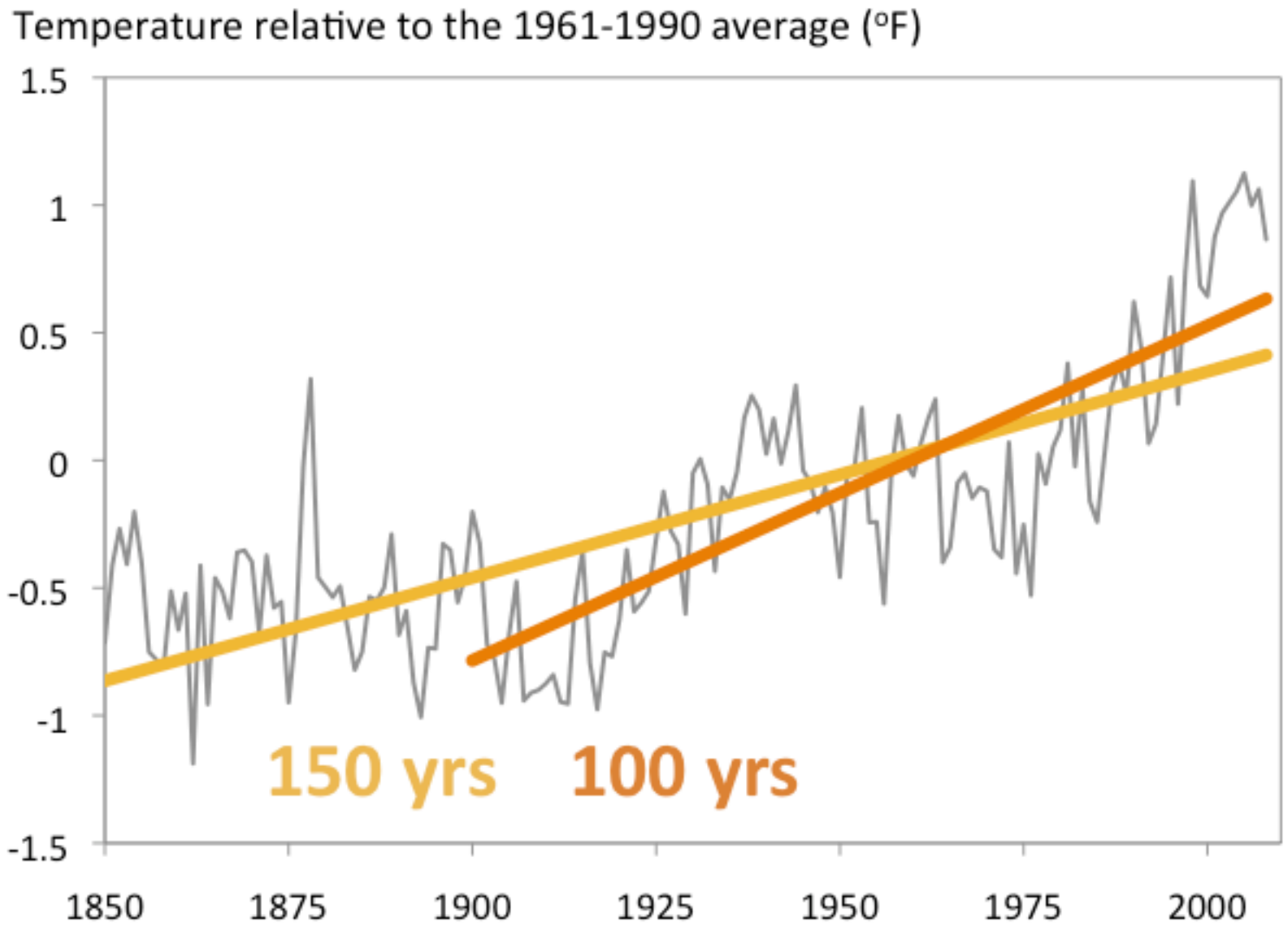

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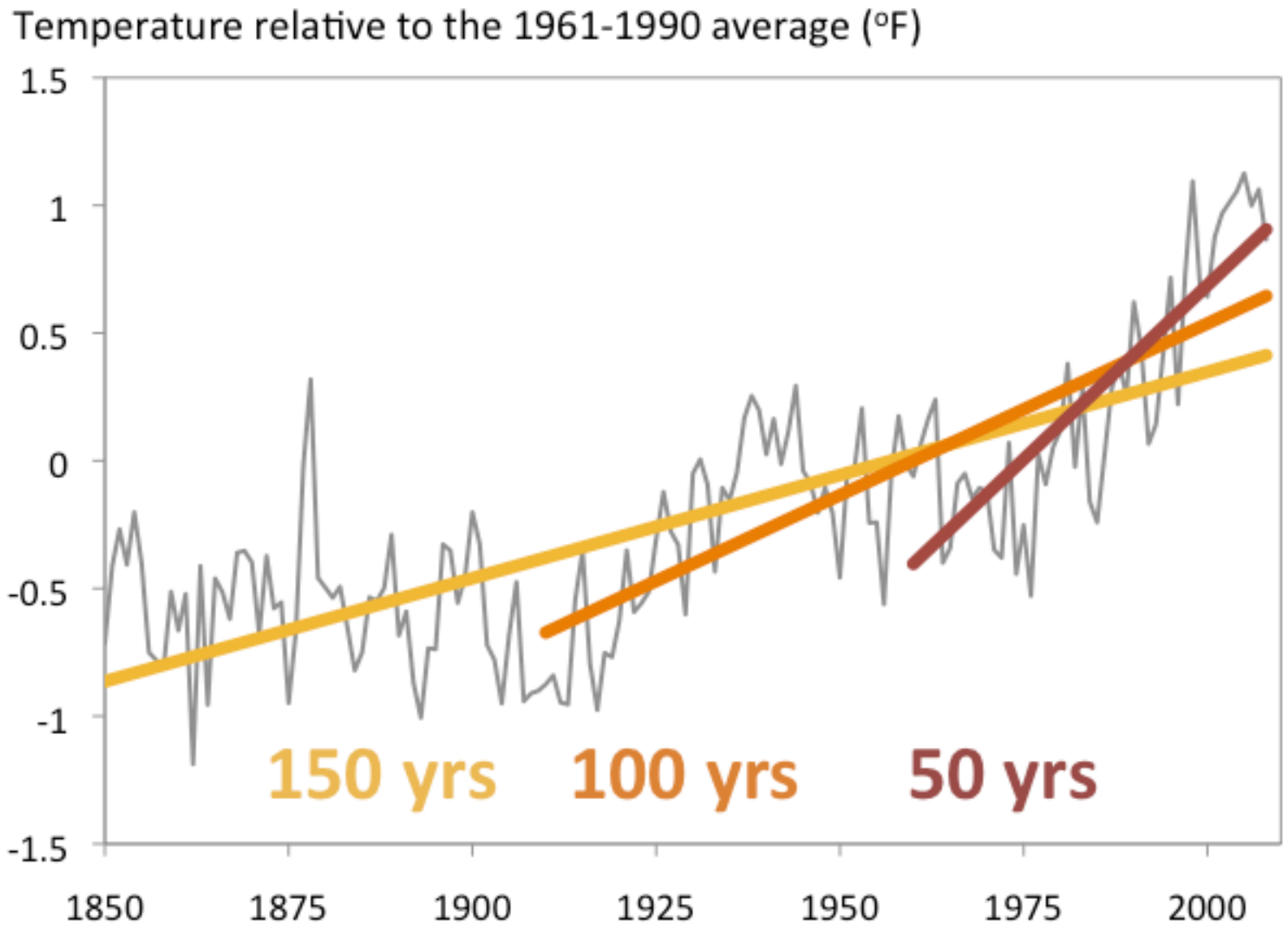

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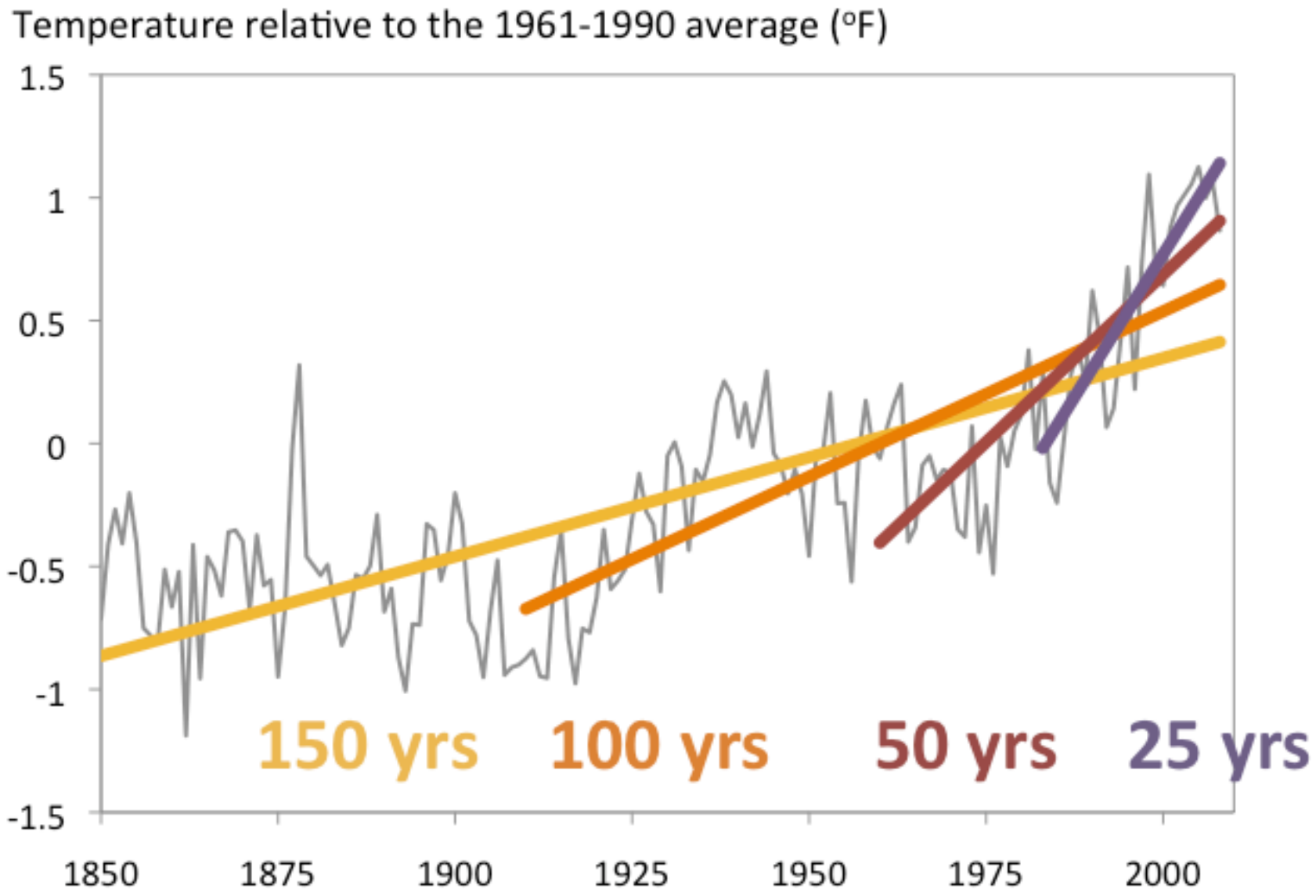
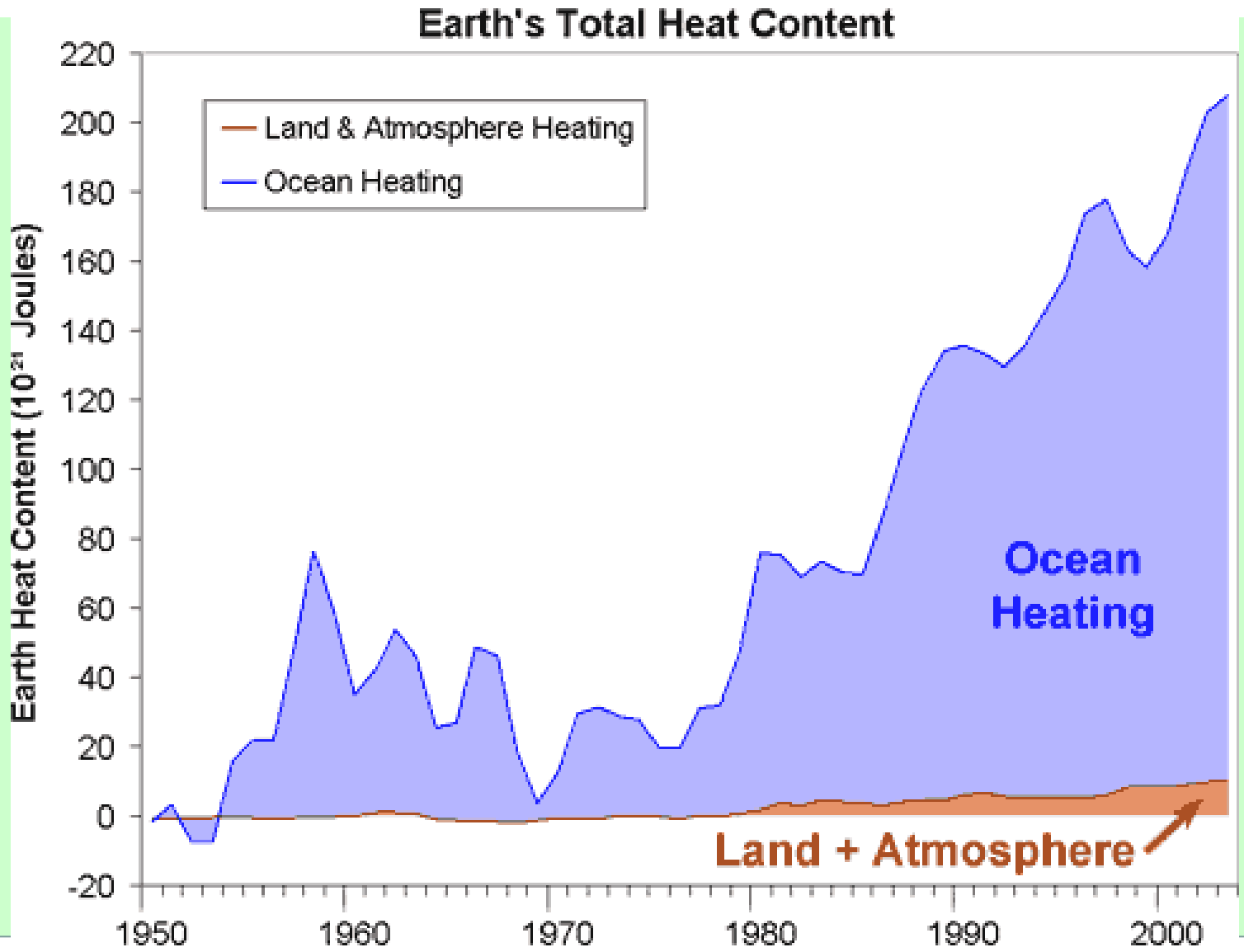
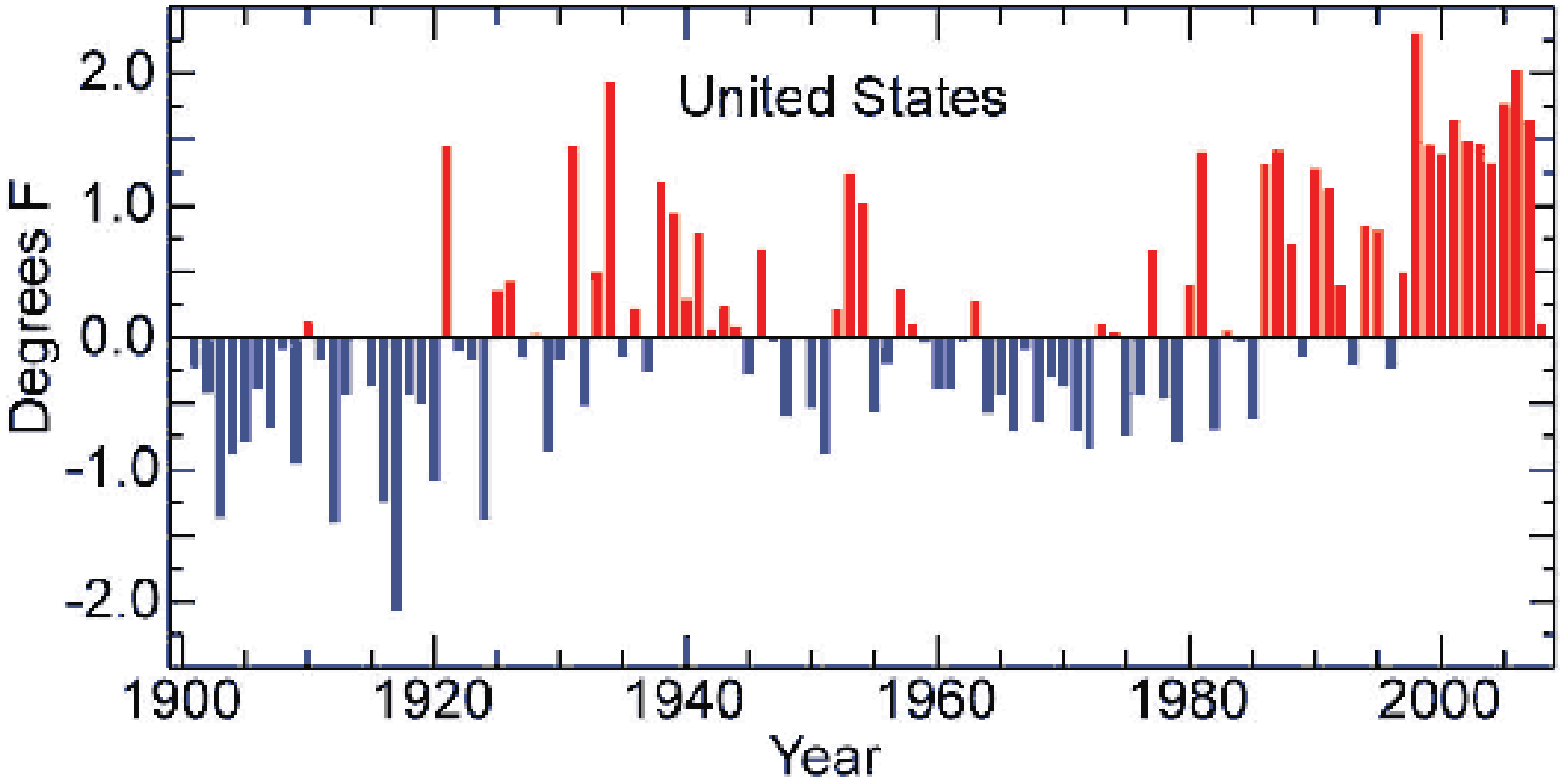


# And this is just a fraction of total heating.



# Temperature in the US is increasing



# Glaciers are melting

**1913**

**2005**

Shepard Glacier, Glacier National Park, USA

When the park was created: over 150 glaciers

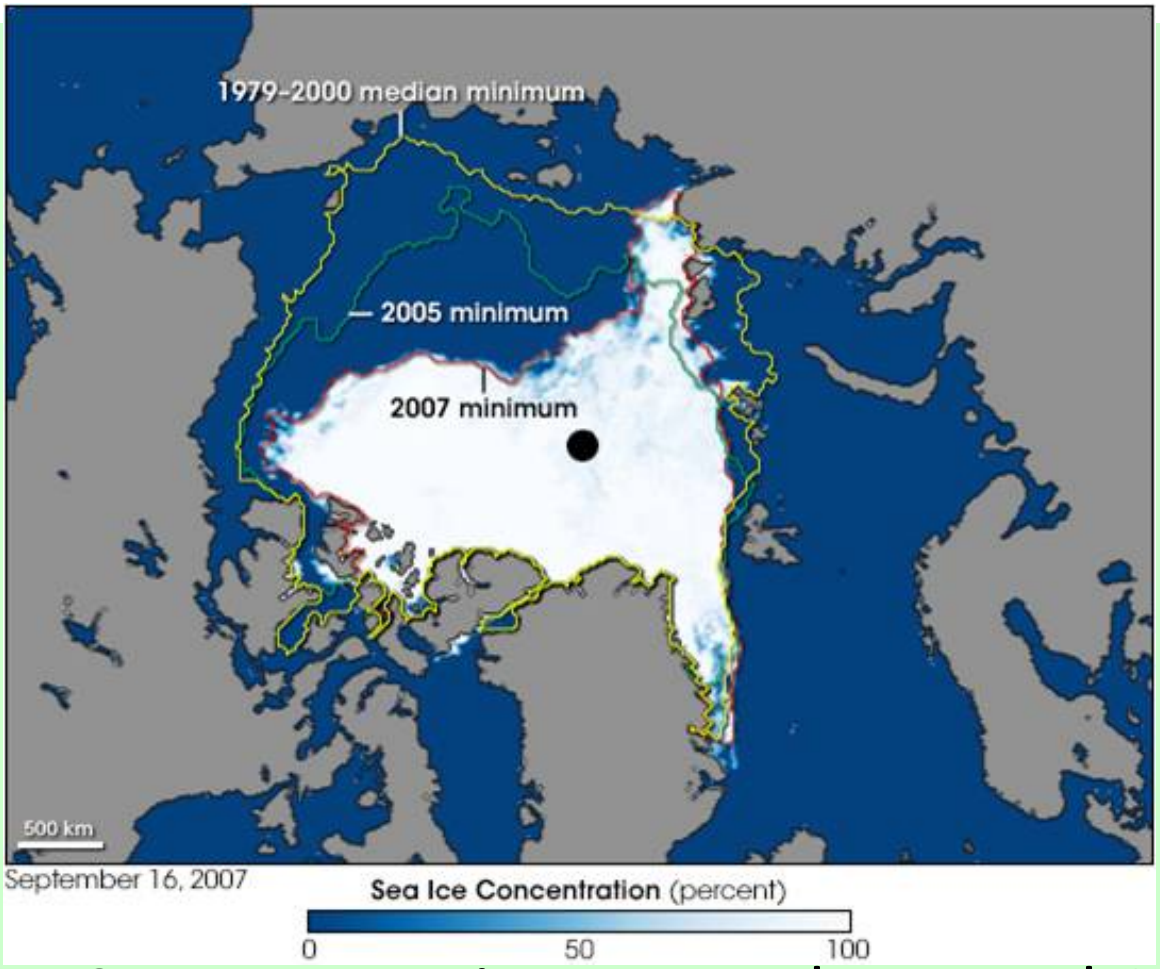
In 2005: 27 glaciers remaining

# Glaciers are melting



The Rhone glacier in the Bernese Oberland, Switzerland

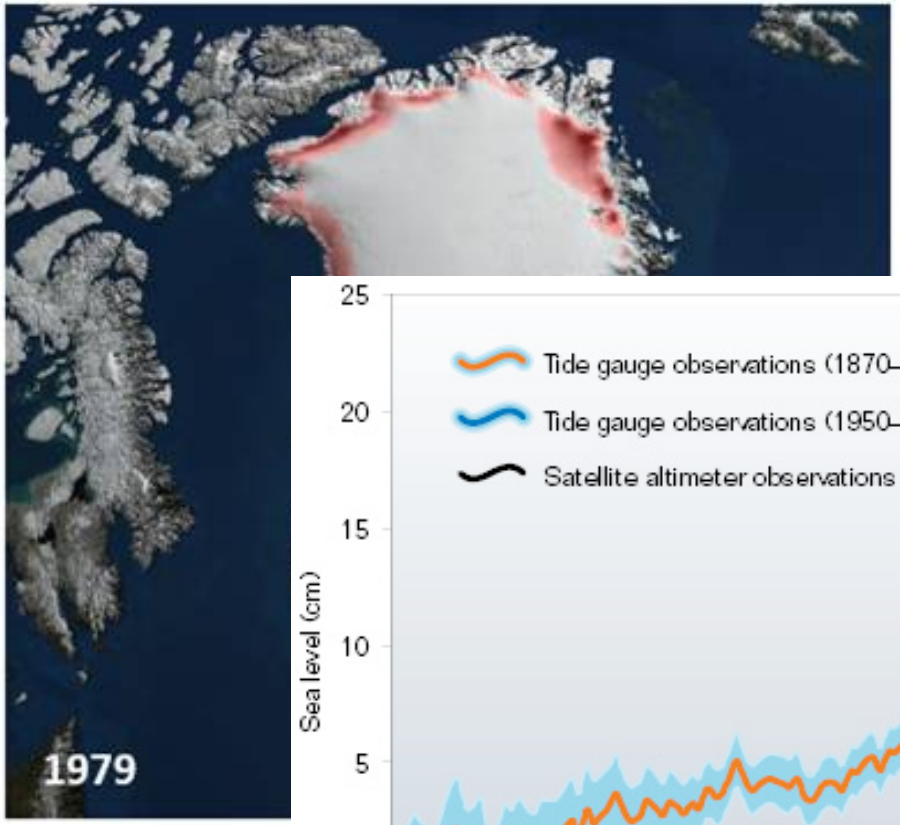
# Arctic sea ice is shrinking

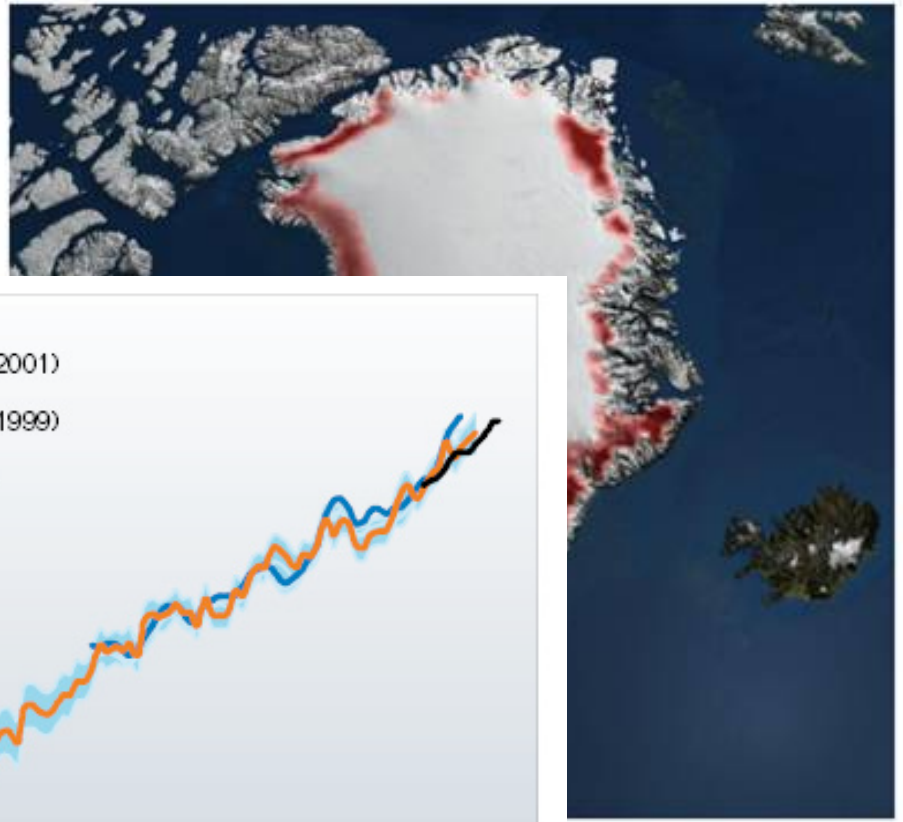


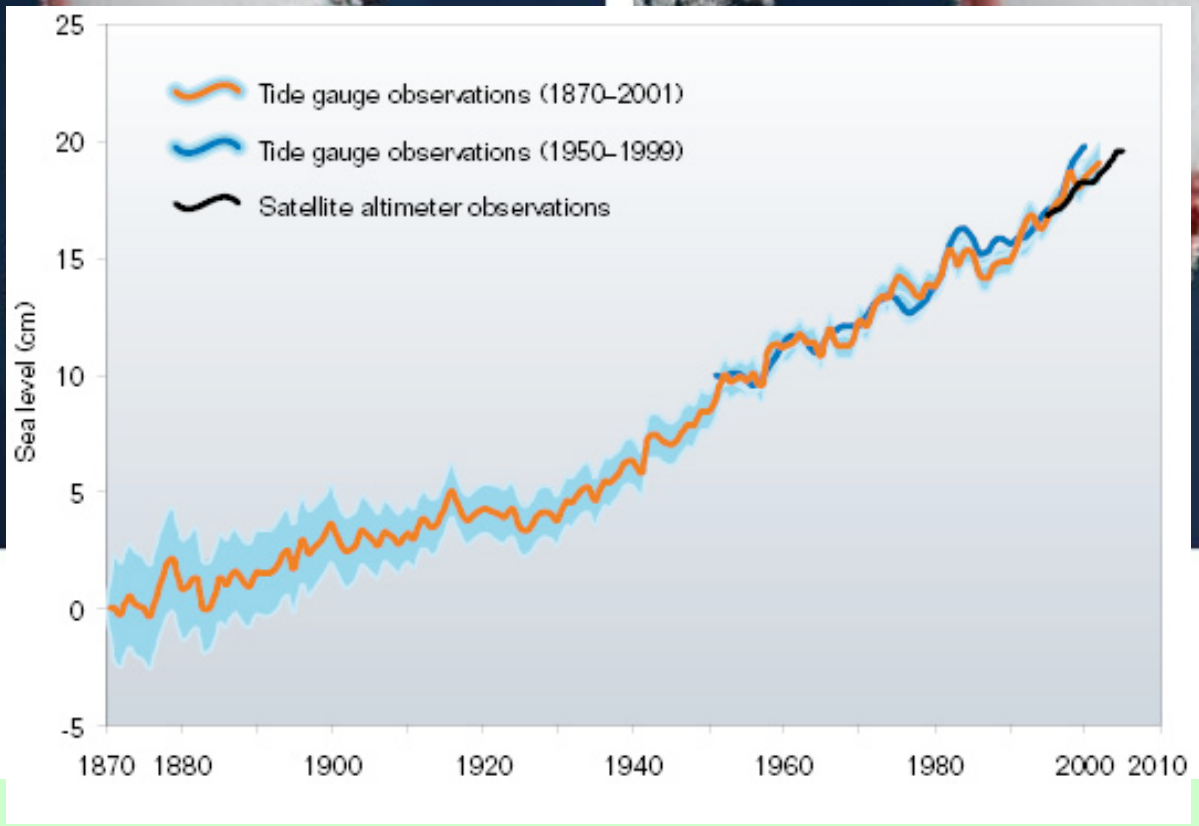


- Summer sea ice extent decreased 15-20% over last 40 yrs
- Ice-free summers likely common within 3 decades

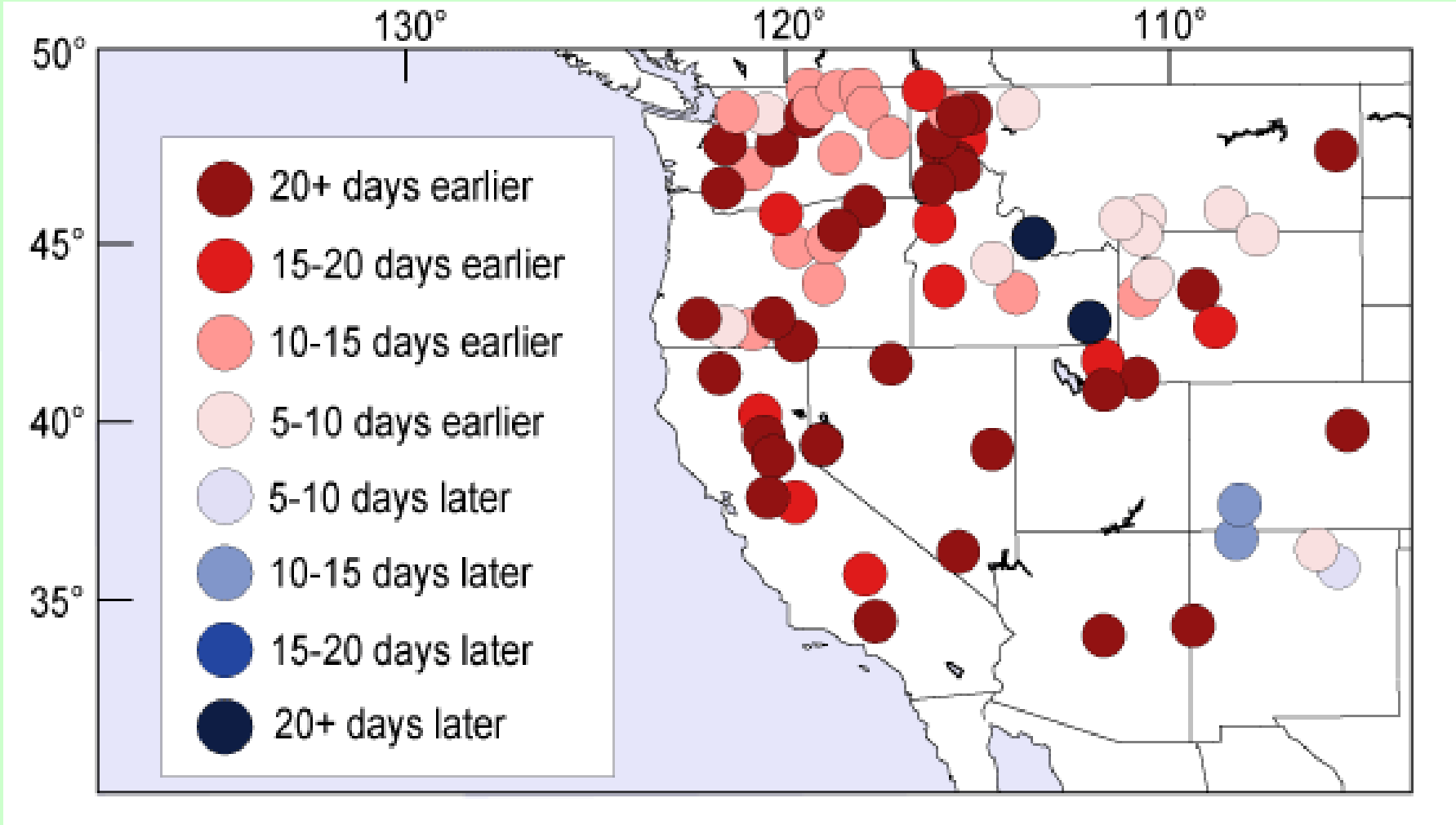
# Sea level is rising, as ice sheets melt



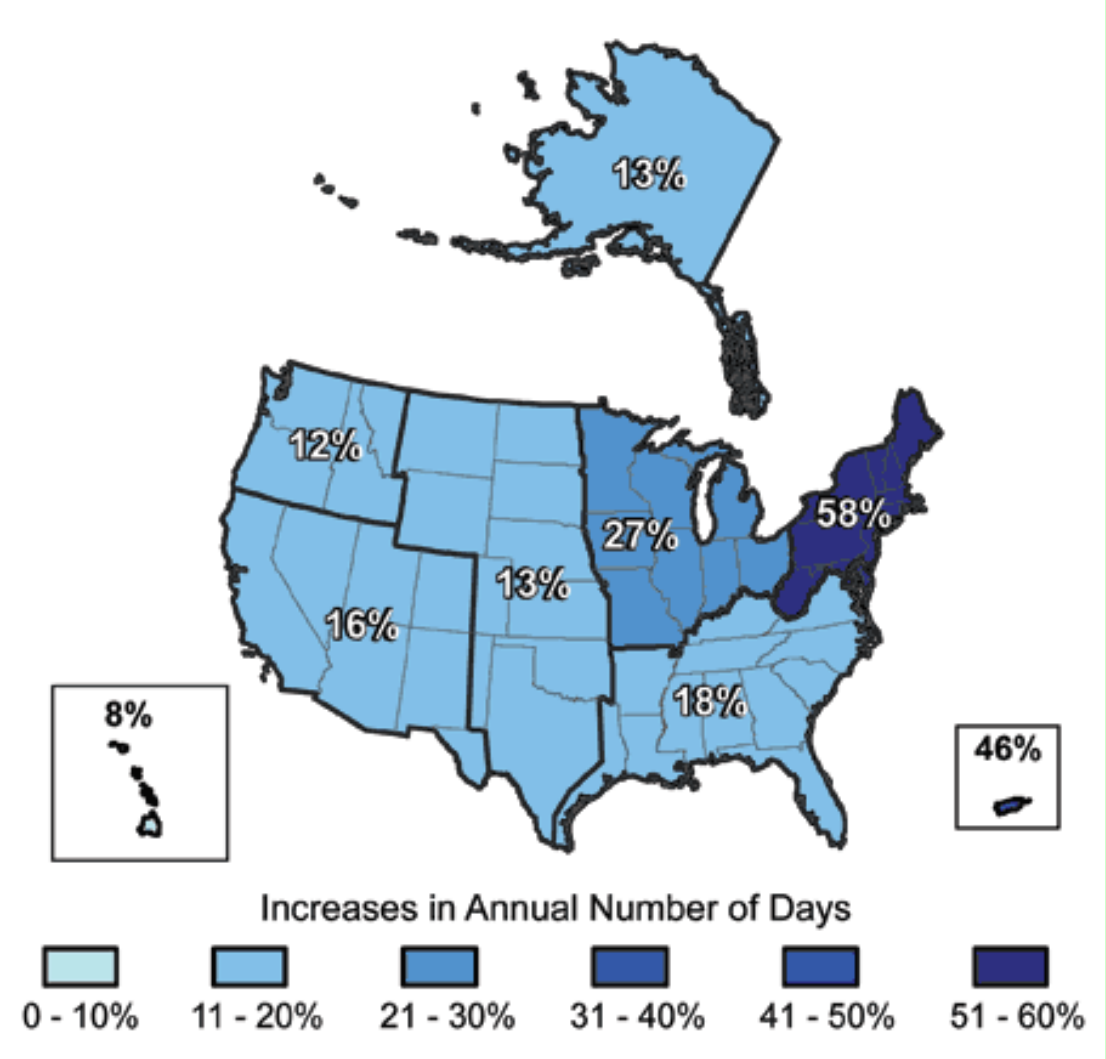





# Snow is melting earlier in the year

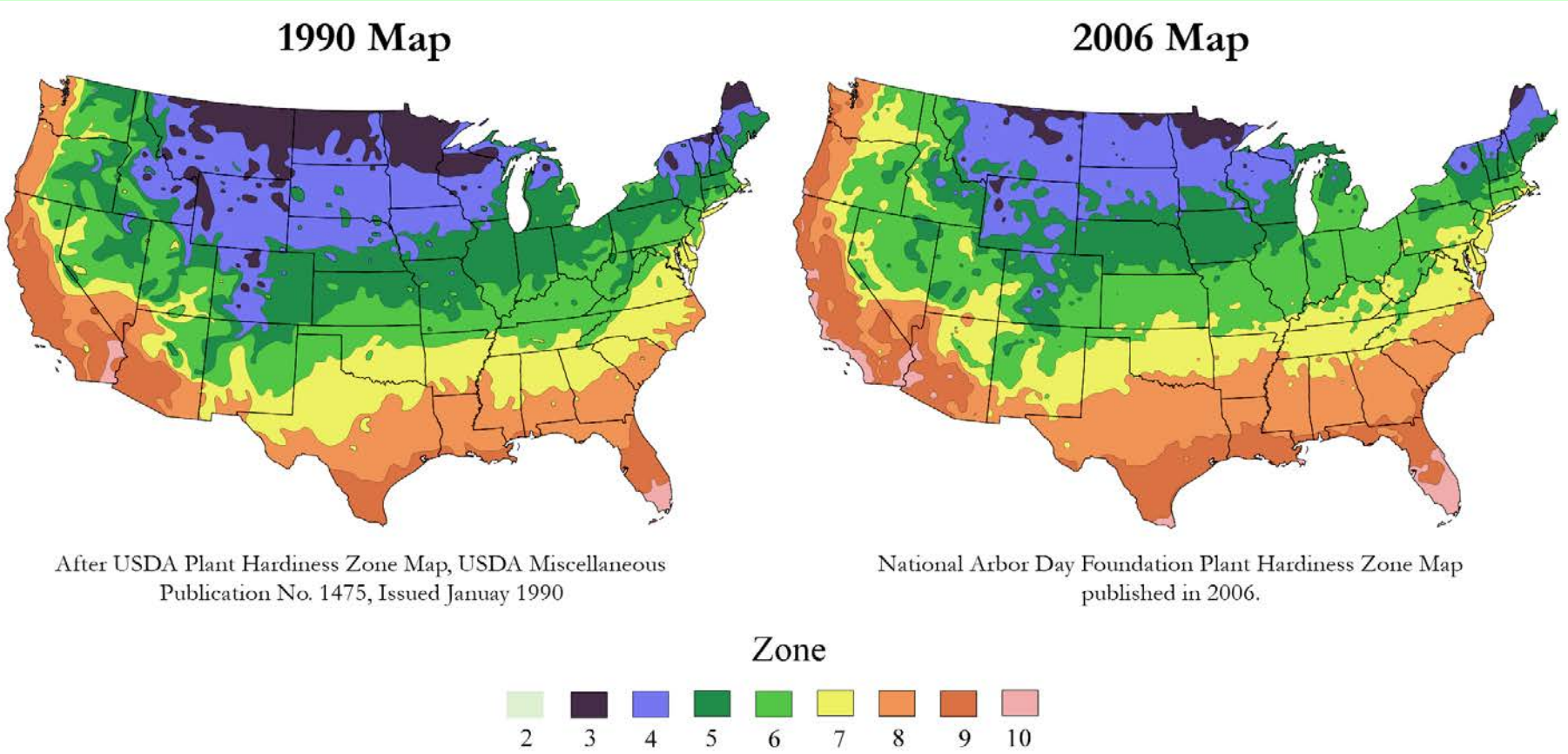


# Extreme rainfall becoming more frequent




Increases in average number of days with very heavy precipitation (1958 to 2007)

# Ecosystems shifting, as temperatures warm

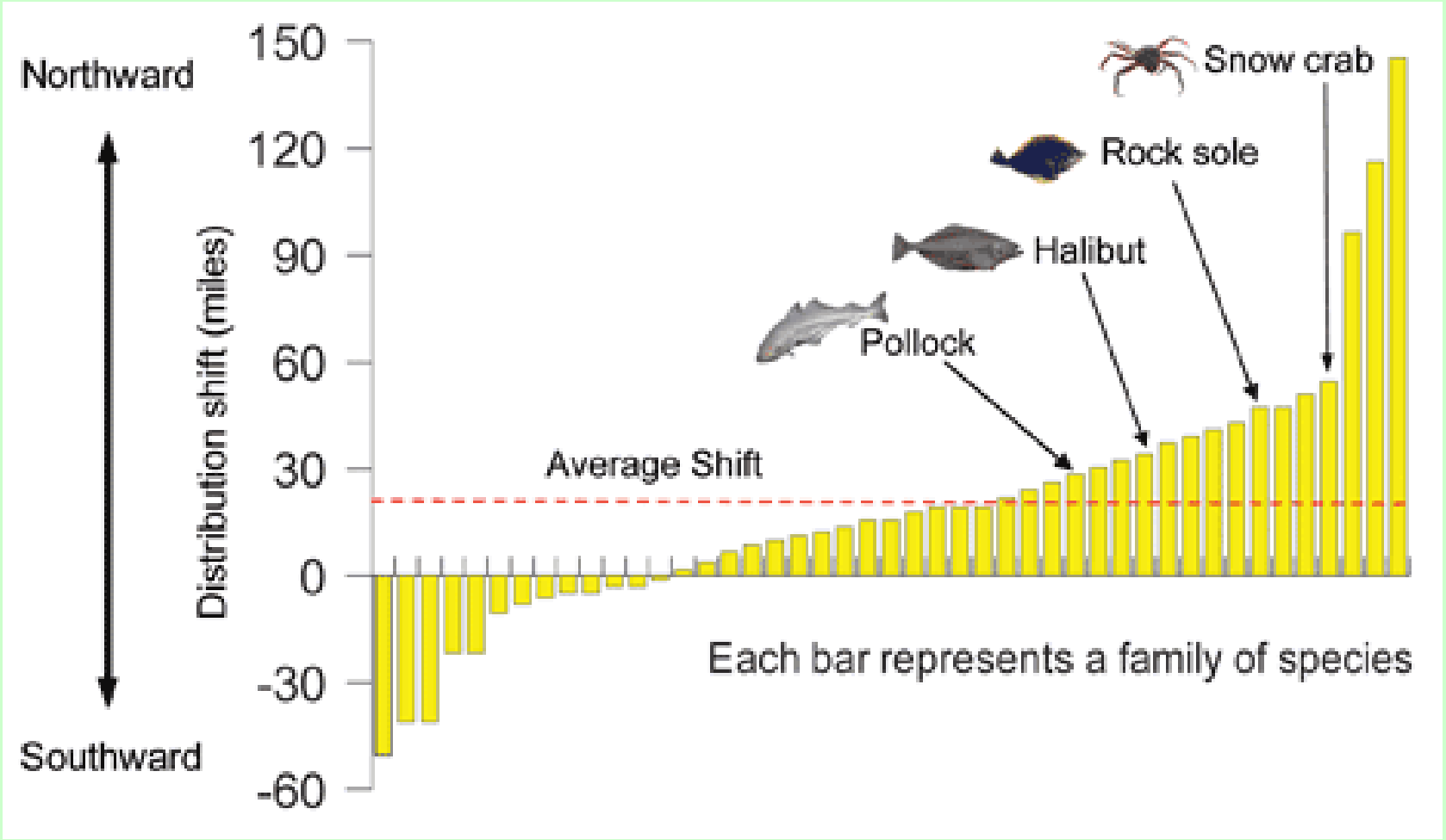



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

Where you live today feels like it used to ~200 miles south, just 25 years ago.

# Marine species are moving poleward



# Our world is changing

EARLIER SPRING
Lilacs, honeysuckle, and other harbingers of spring are flowering 1-2 weeks earlier in the year.

# Our world is changing

SHIFTING CROPS AND PLANTS

Center of blueberry production has shifted northward, from Maine to Quebec.

# Our world is changing

EXTREME HEAT
Record high temperatures and heat waves 2x more frequent.

# Our world is changing

DROUGHT

Crop losses of $5B per year since 1980s.

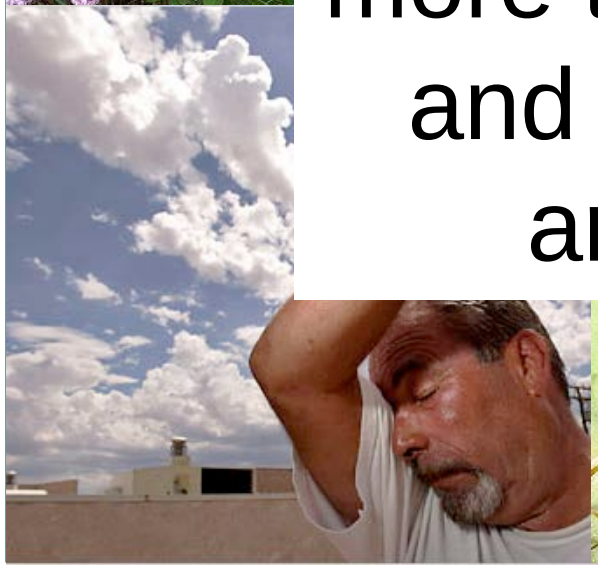
# Our world is changing

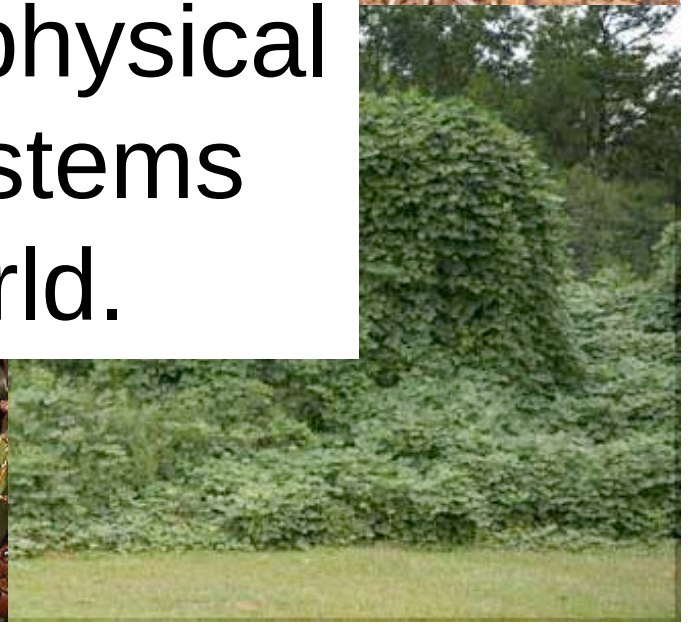
PESTS MOVING NORTH
Less cold days to keep red ants & kudzu at bay

# Our world is changing



Responses to warming temperatures seen in more than 25,000 physical and biological systems around the world.

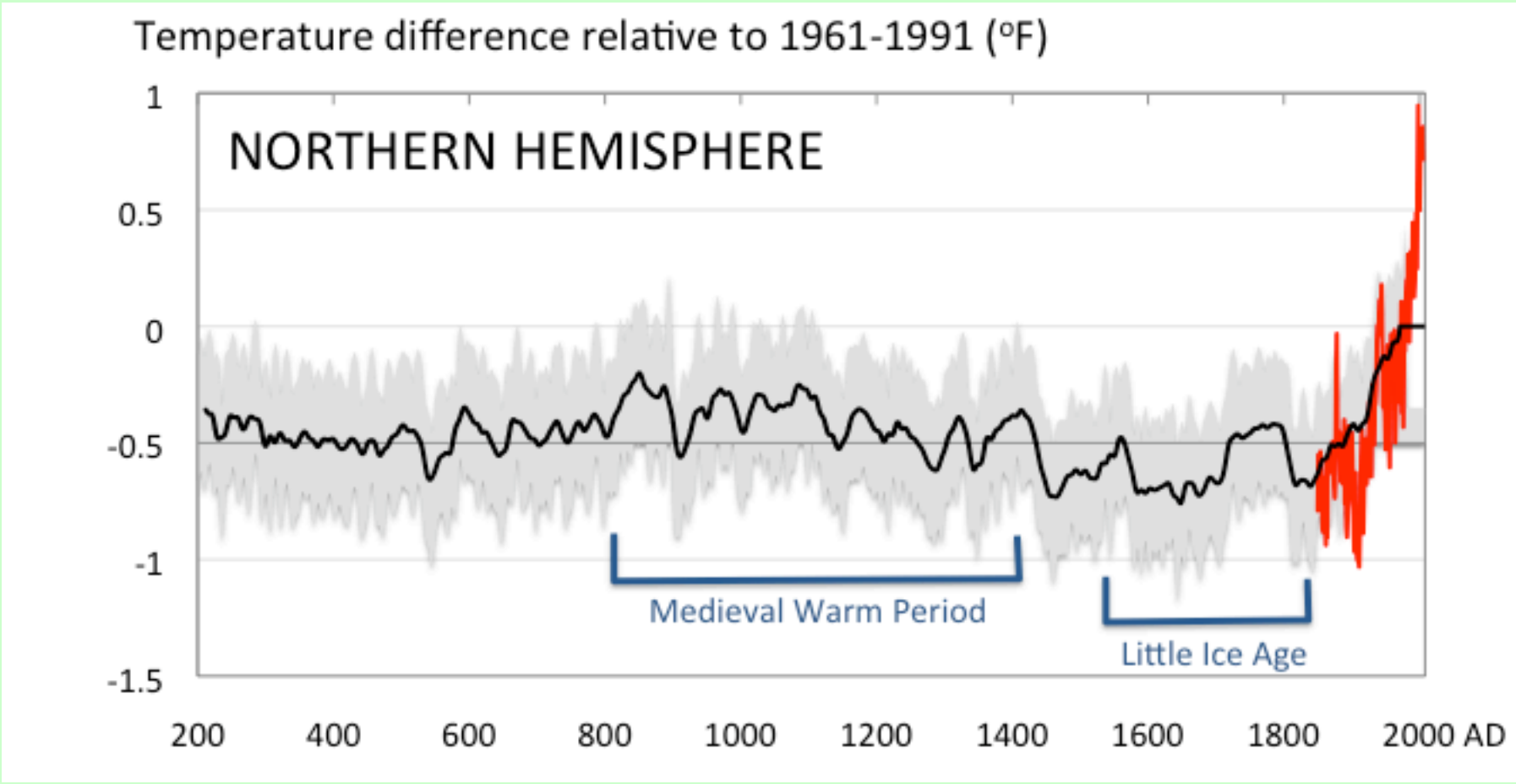




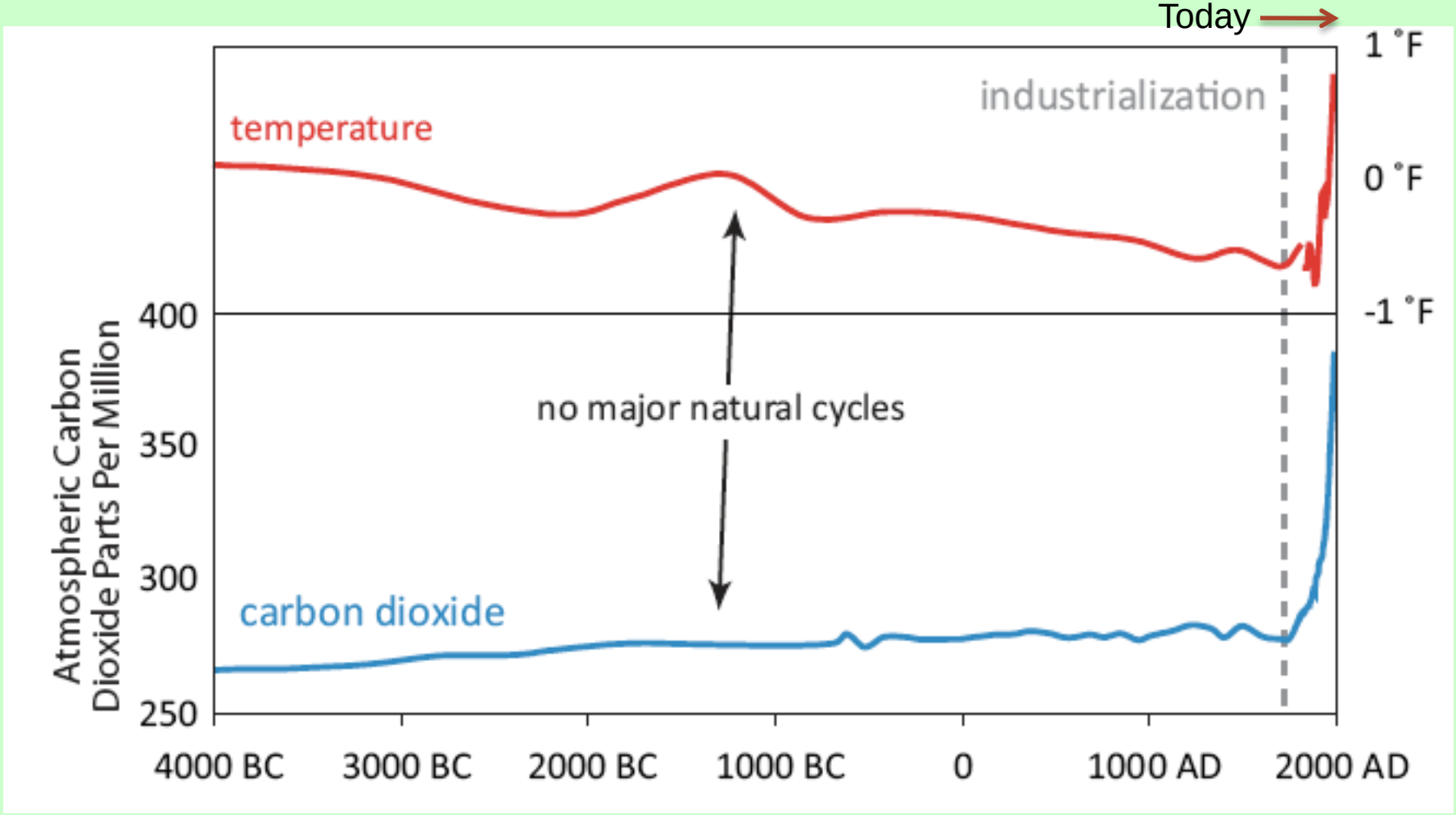
# Why is this happening?

PART TWO

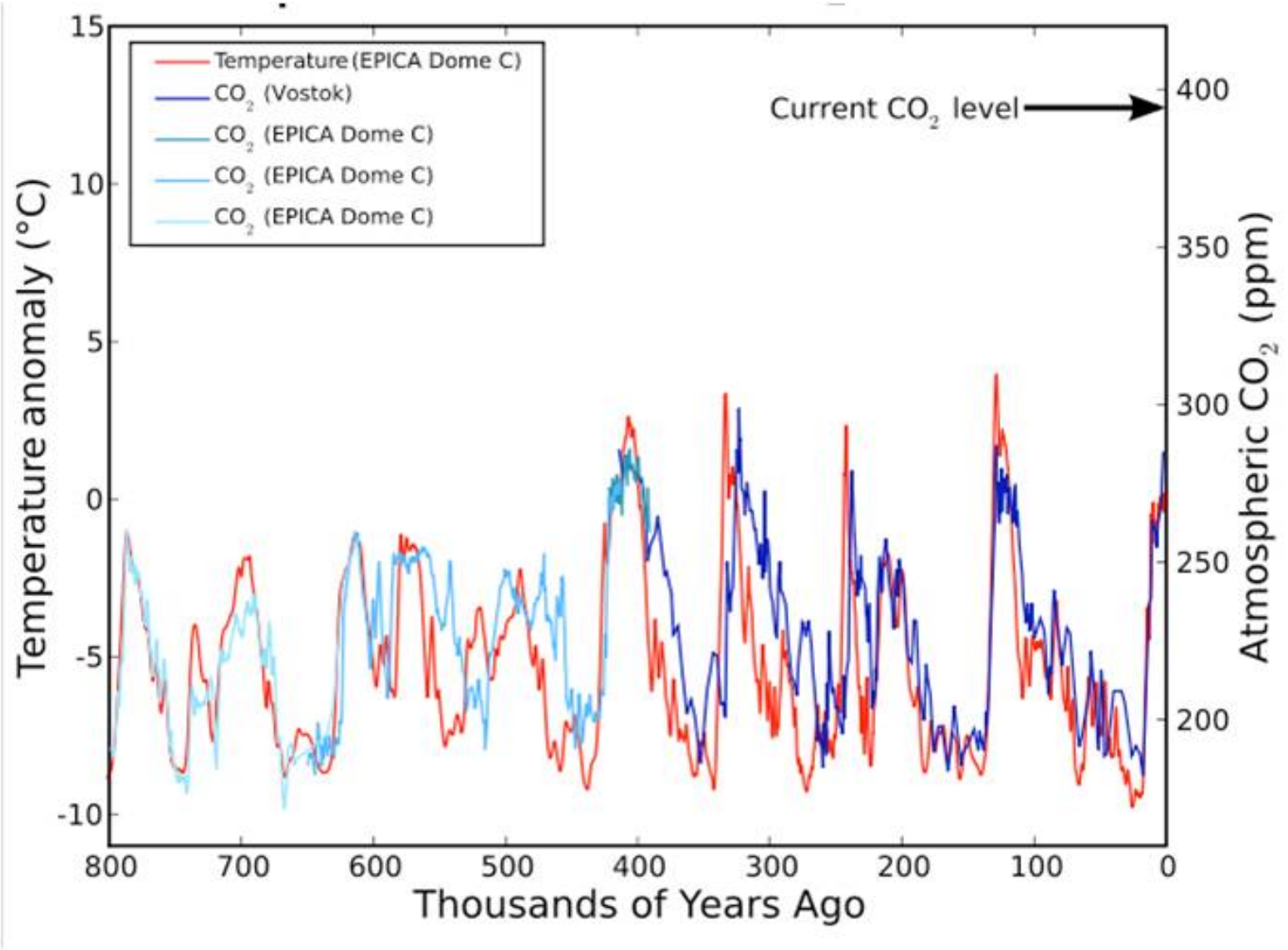
# Conditions today are unusual in the context of the last 2,000 years …



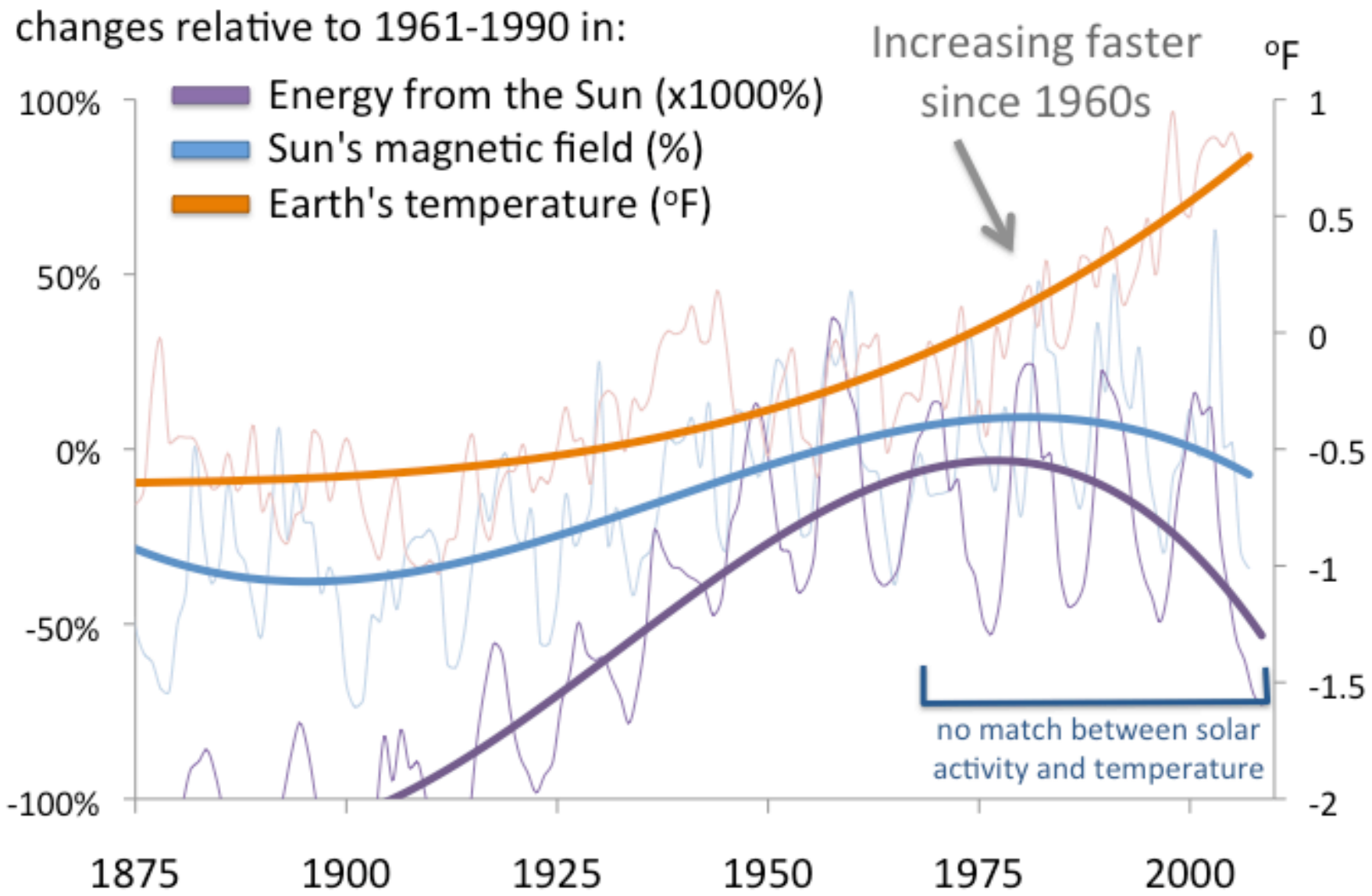
# … the last 6,000 years,



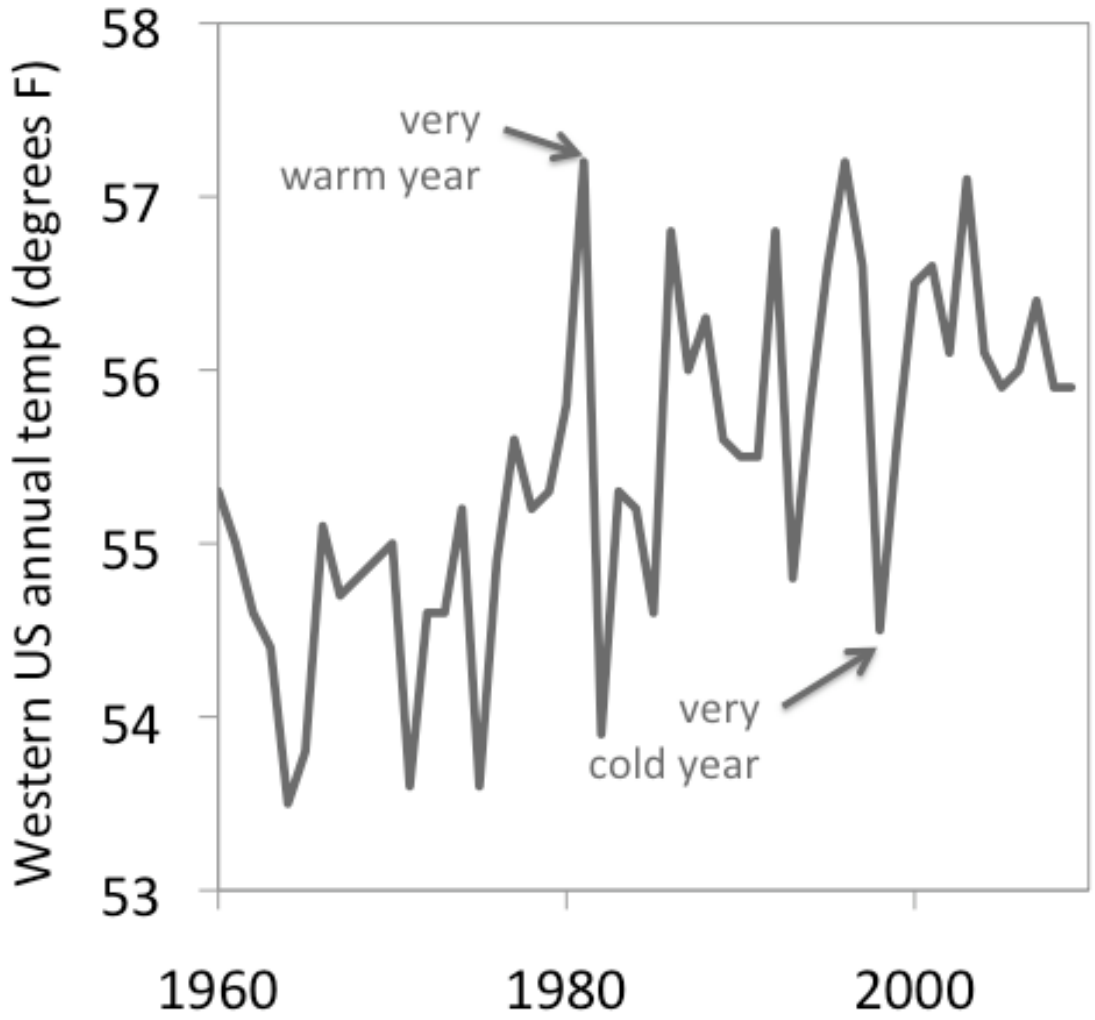
# … and even the last 800,000 years.



# Changes in the sun can’t explain it



# Record snowfalls can't dismiss it




WEATHER: How conditions change from day to day, or even year to year
-> unpredictable!

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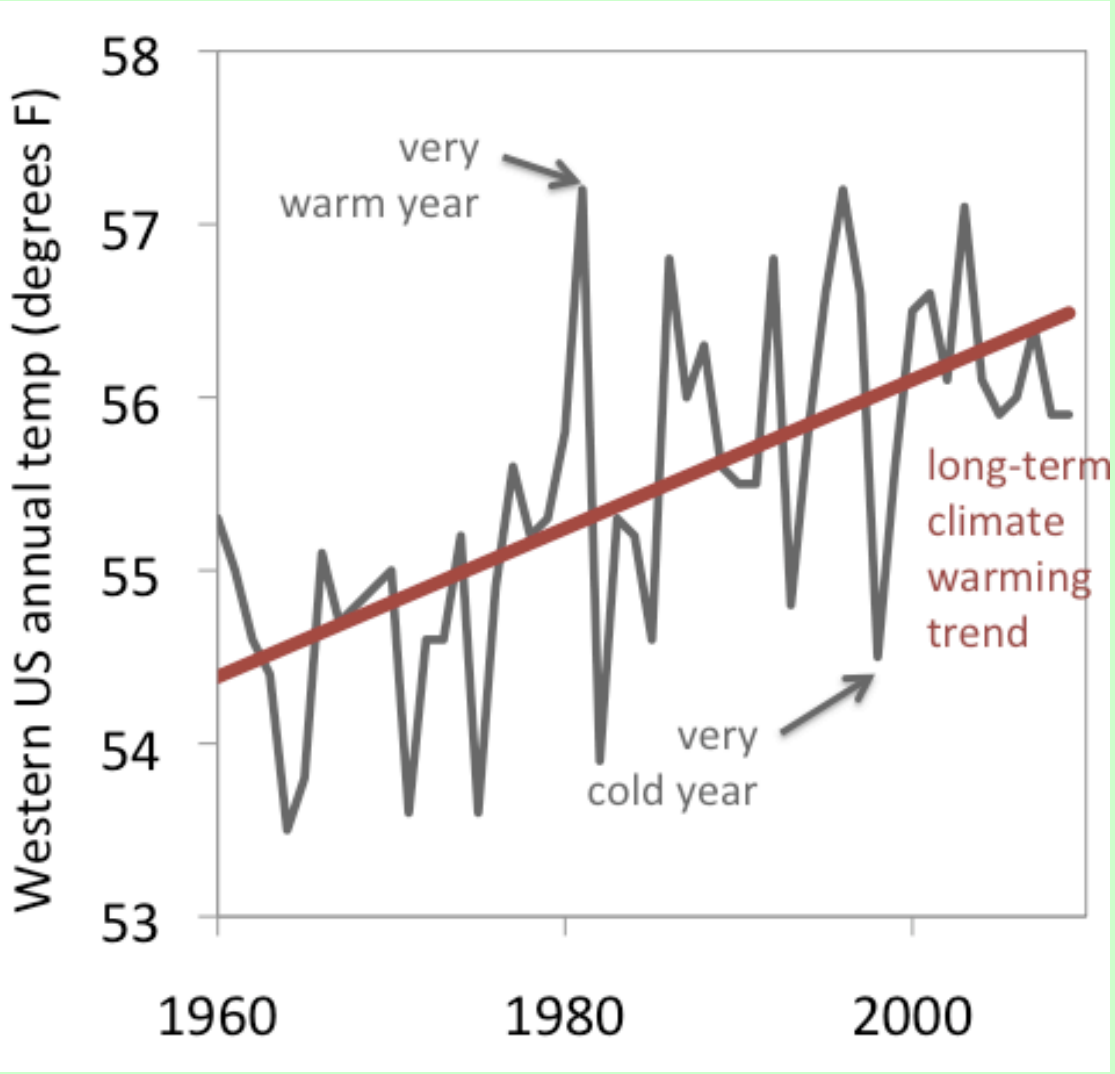



WEATHER: How conditions change from day to day, or even year to year
-> unpredictable!

CLIMATE: The long-term average of weather over decades
-> very predictable!

# There is only one explanation that fits

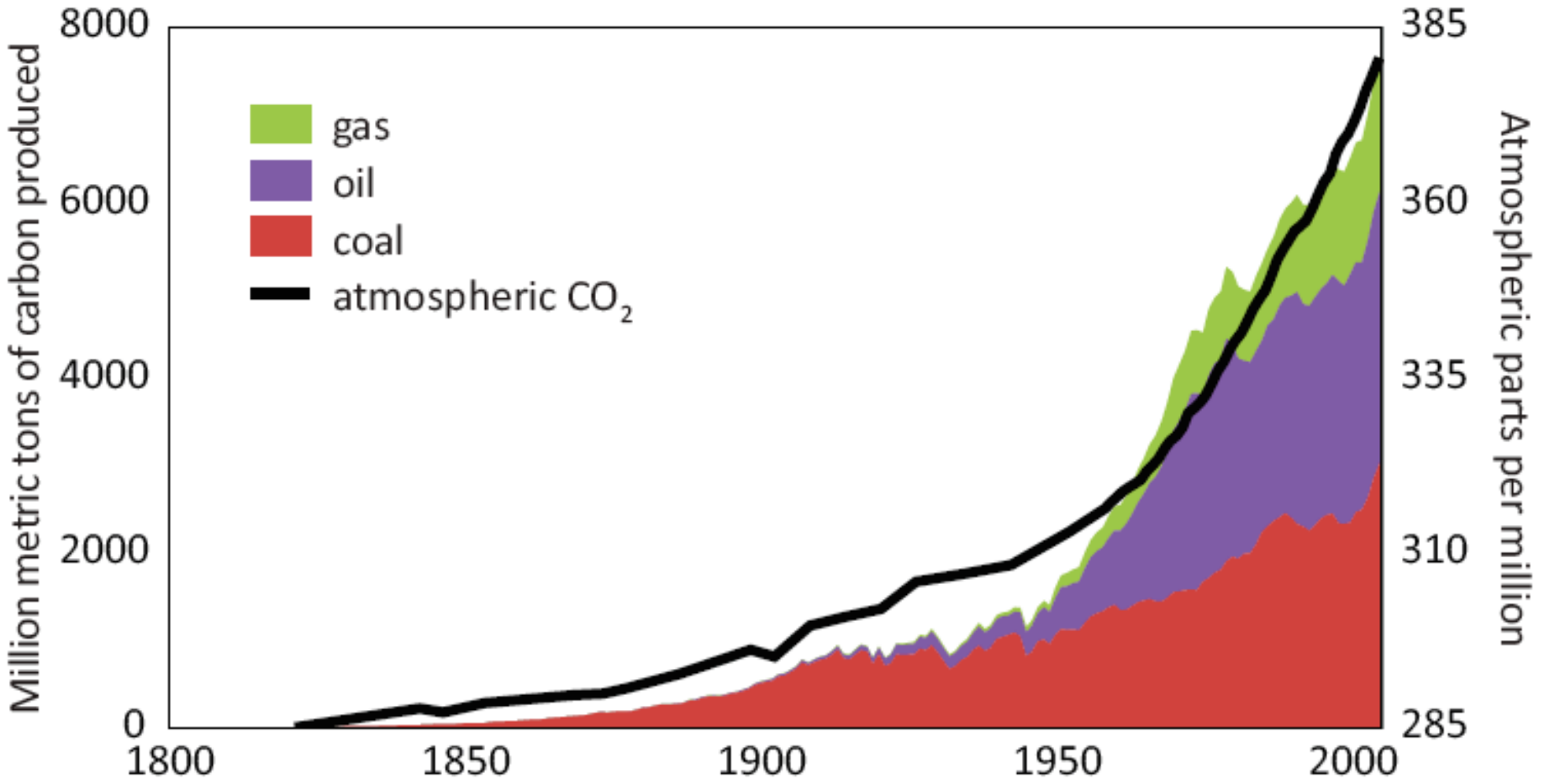
THE NATURAL GREENHOUSE EFFECT

naturally increases Earth's temperature by 70$^{o}$F

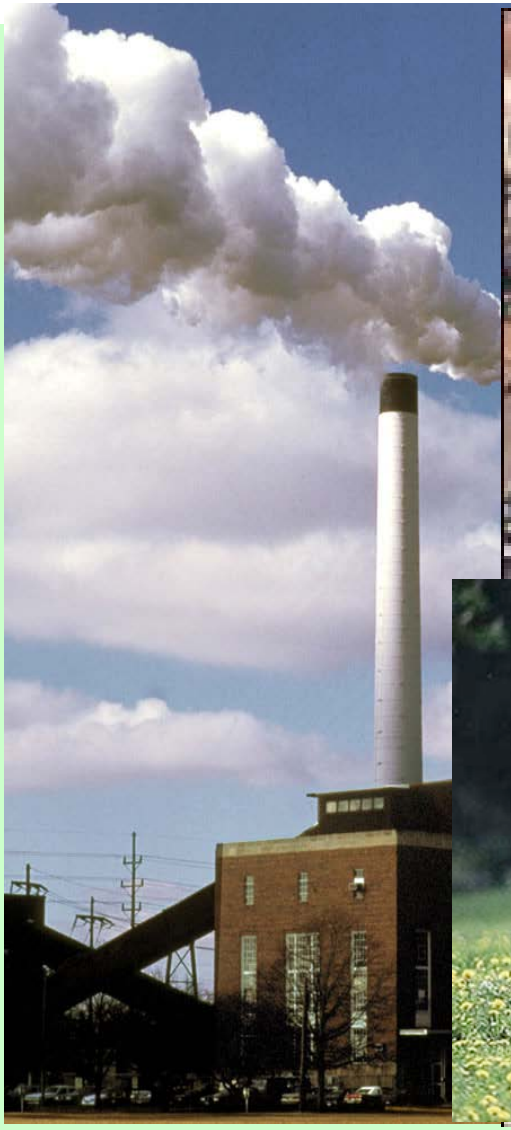
THE ENHANCED GREENHOUSE EFFECT

has artificially increased Earth's temperature by 1.4$^{o}$F

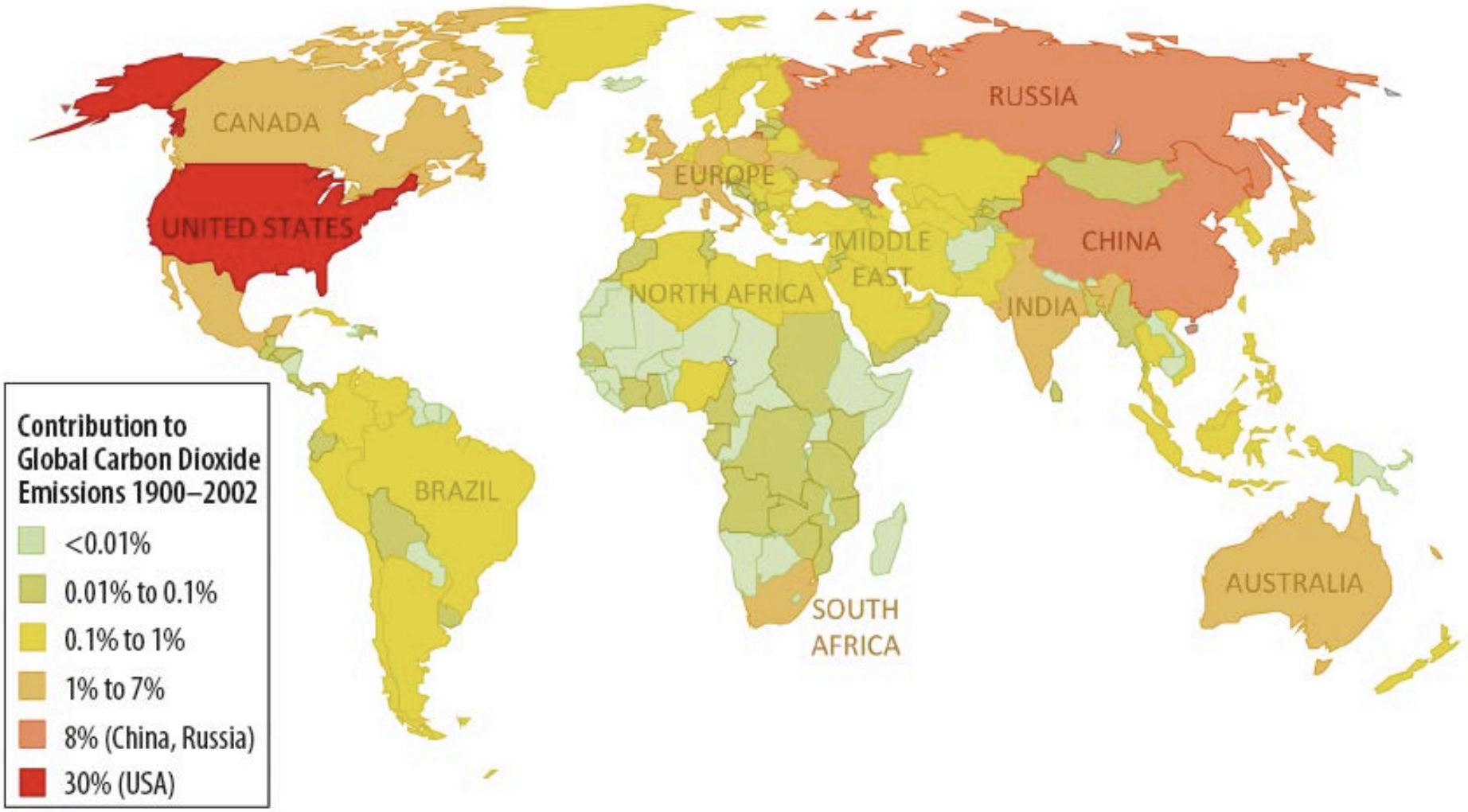
# We produce heat-trapping gases



# From our factories, cars, homes, farms

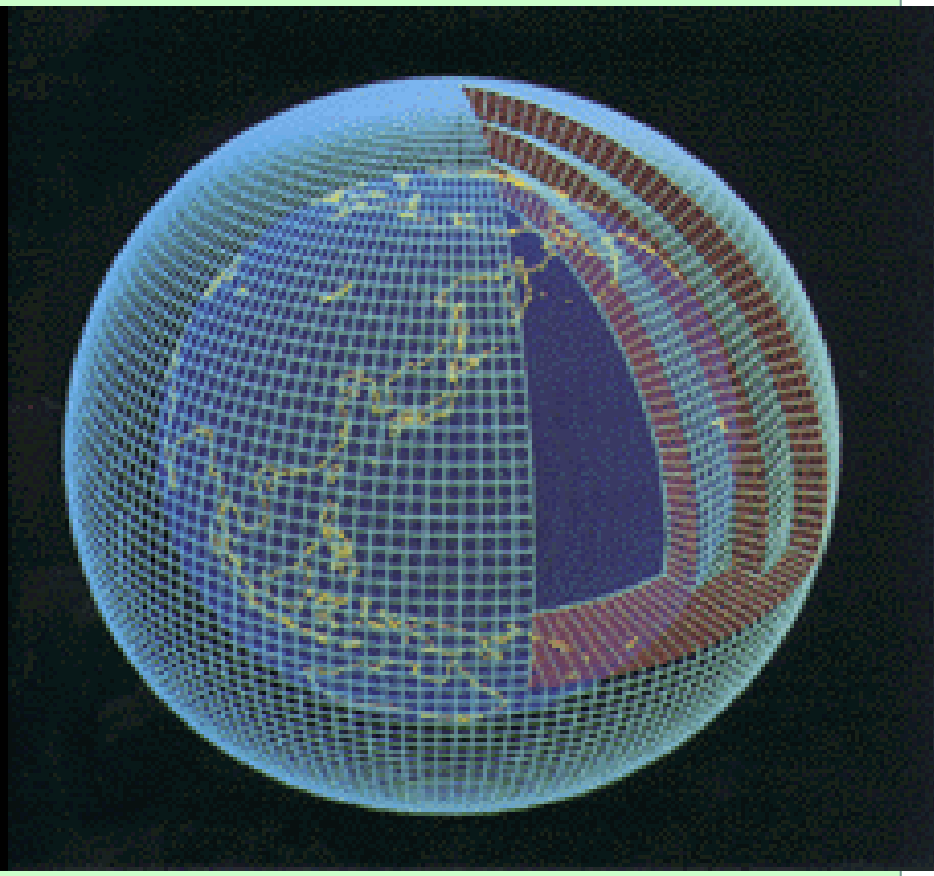


# The US is responsible for 30% of past ems

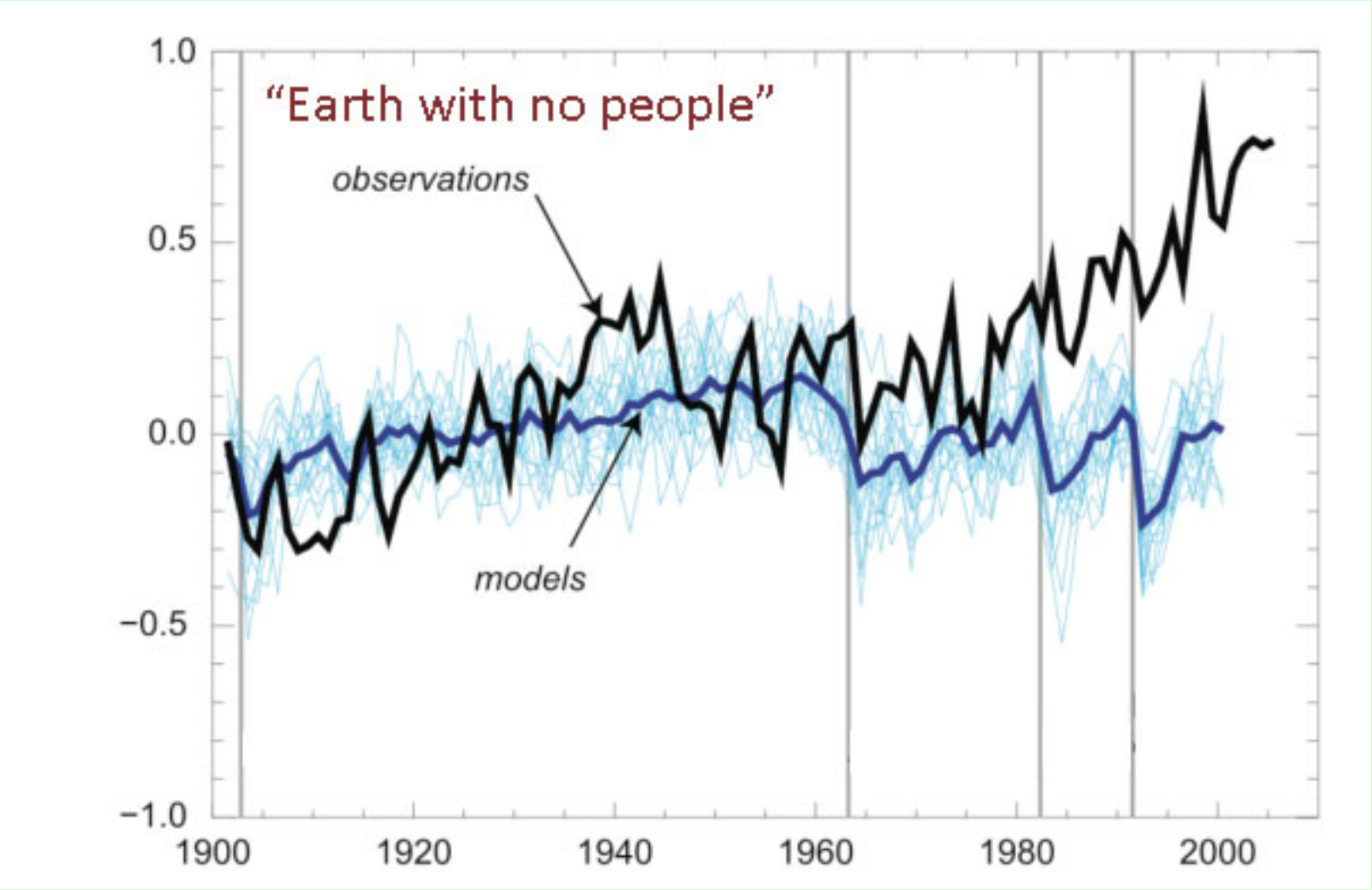



Last year, annual emissions from China caught up with those from the US.

# How do we know it’s us?



# Quantifying the human influence



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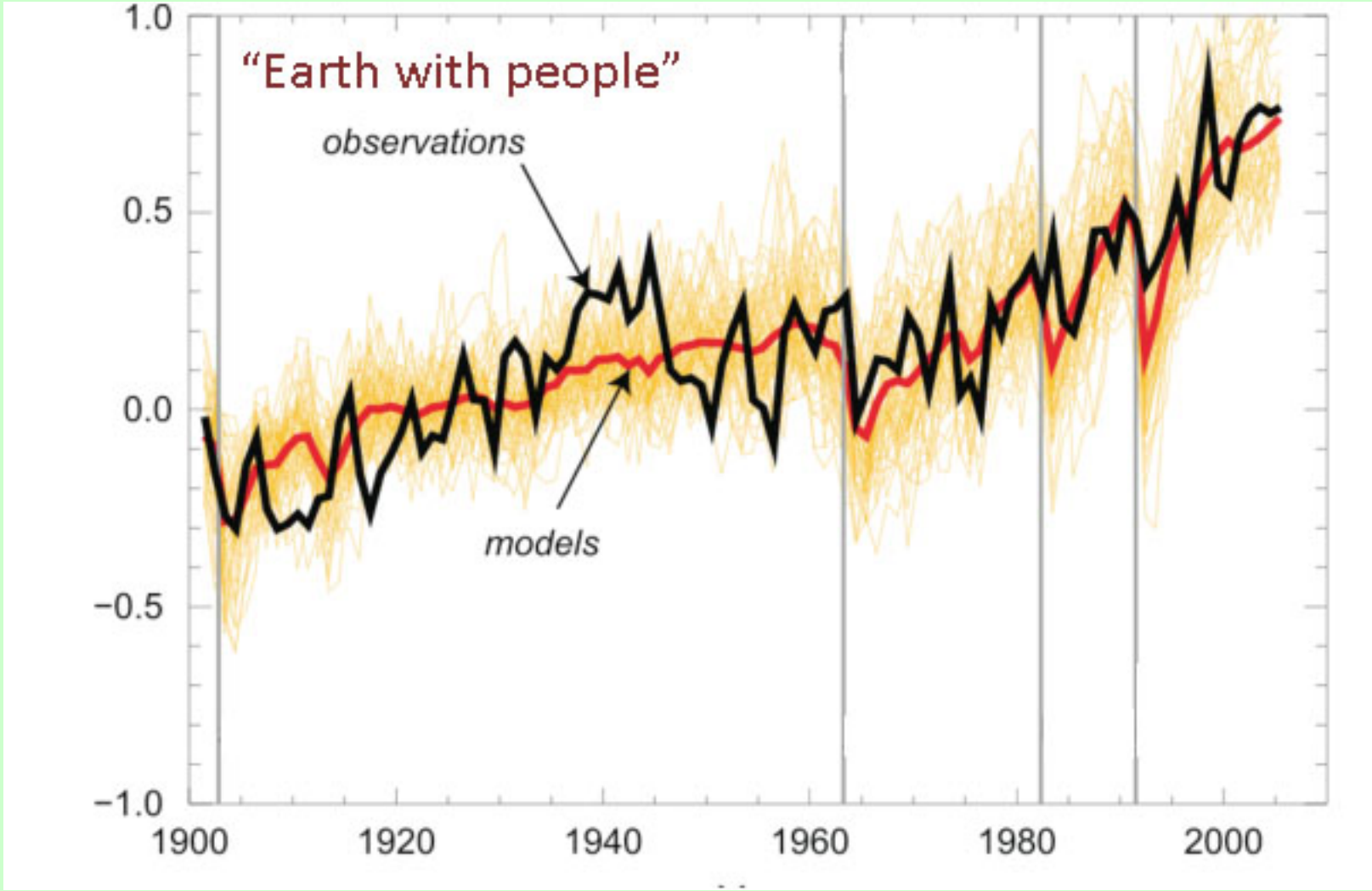
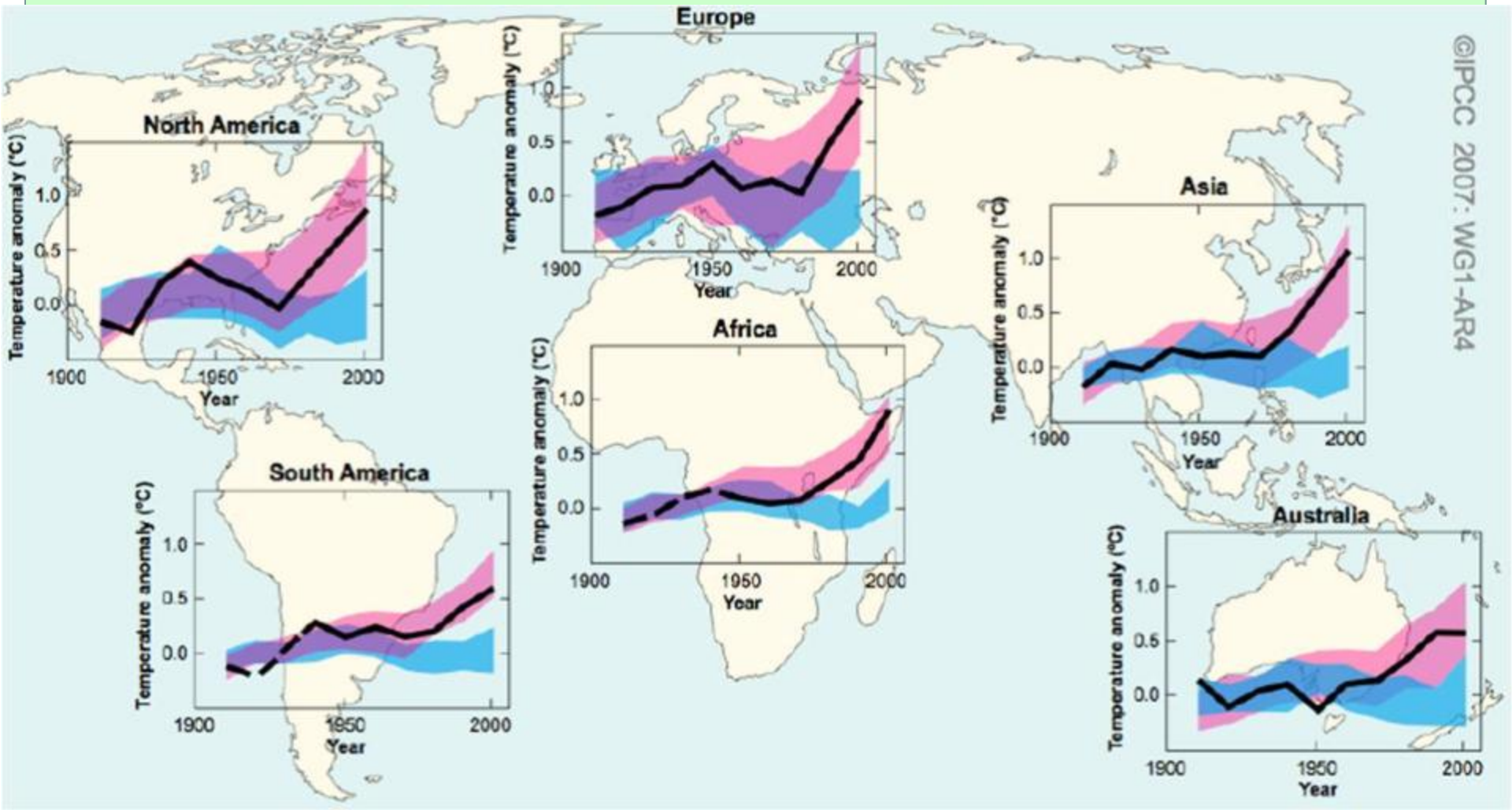


# Humans are the only explanation.

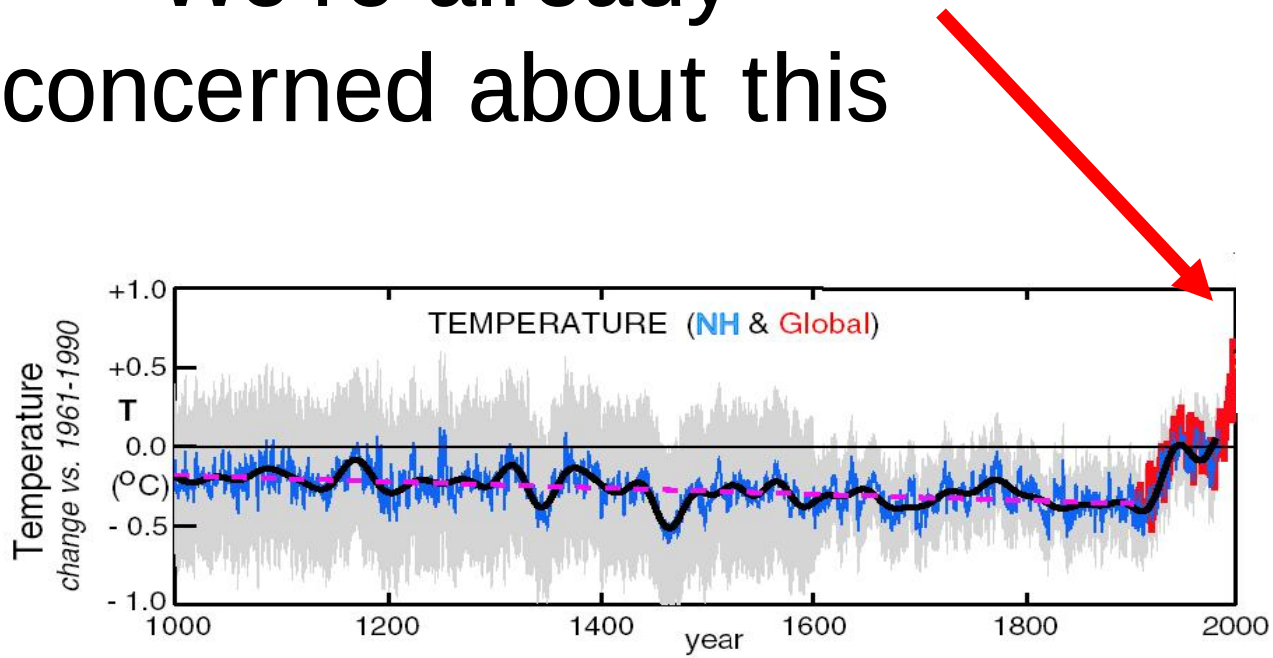


# How will climate change affect us in the future?

PART THREE

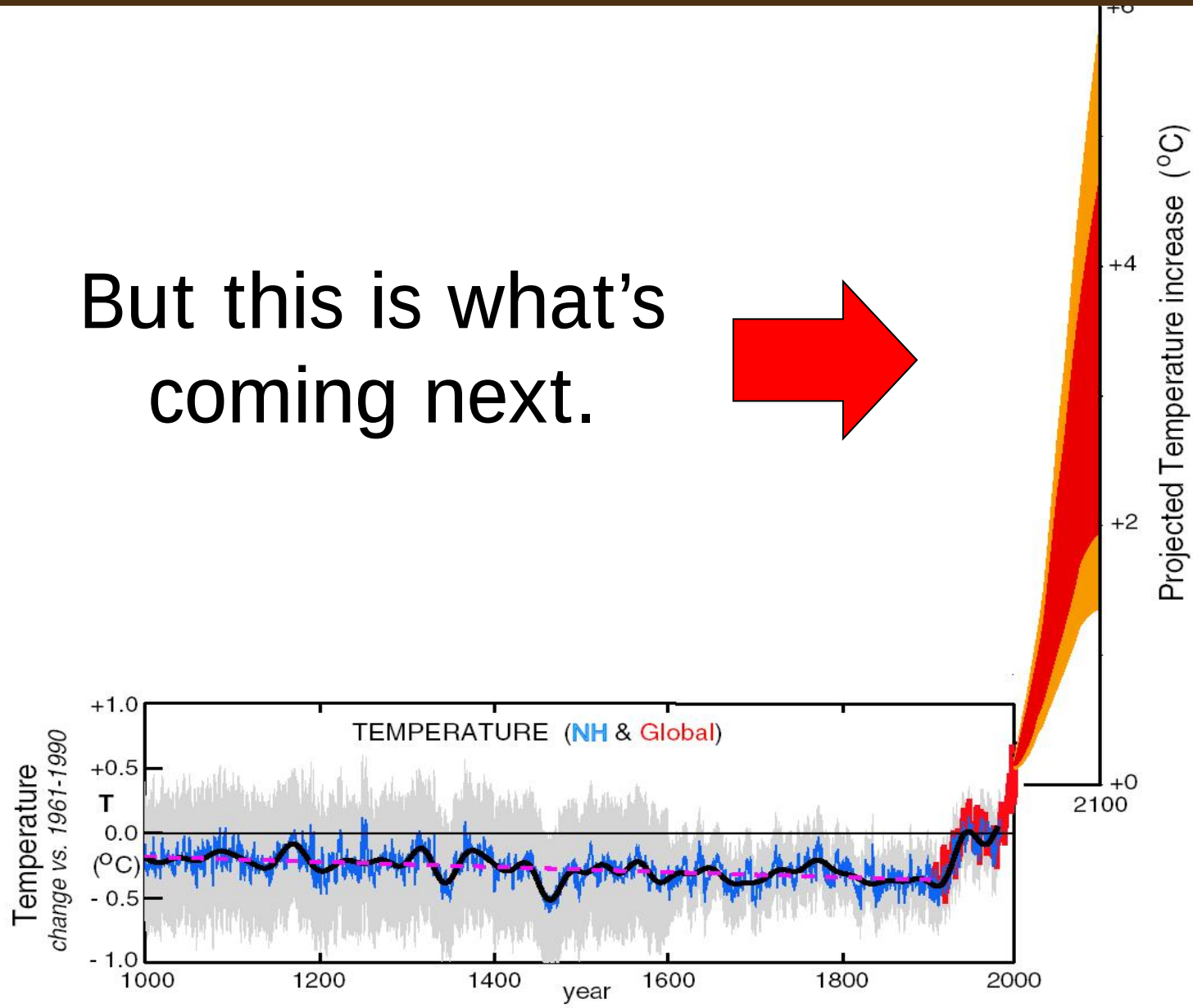
# What can we expect in the future?

We're already concerned about this

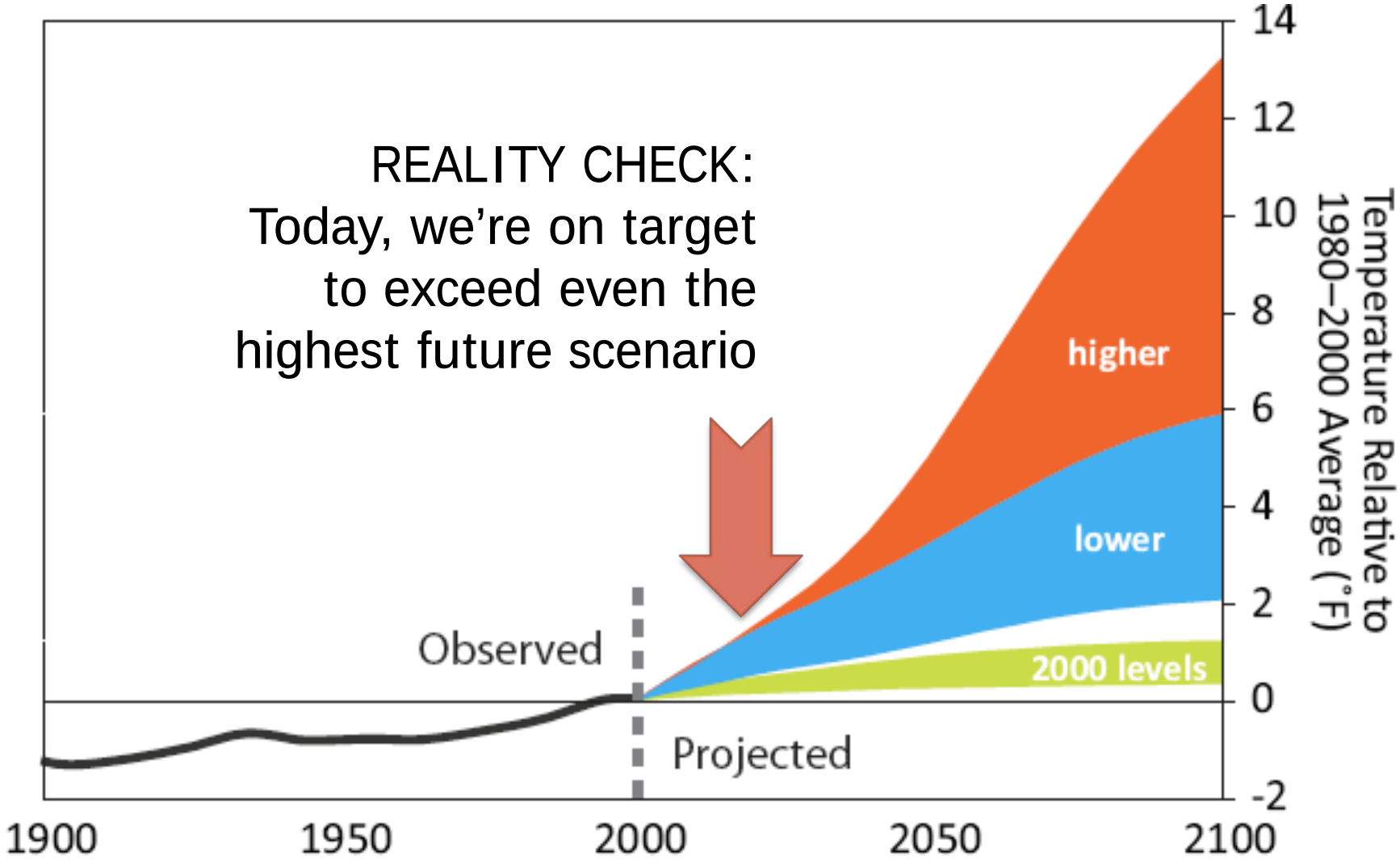


# What can we expect in the future?

But this is what's coming next.



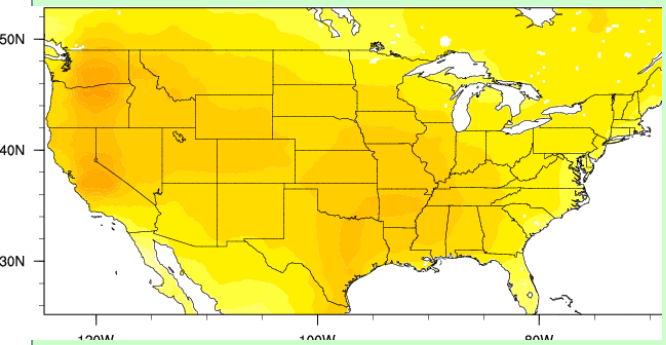
# Future change depends on our choices now



# Summer (JJA) temperature change

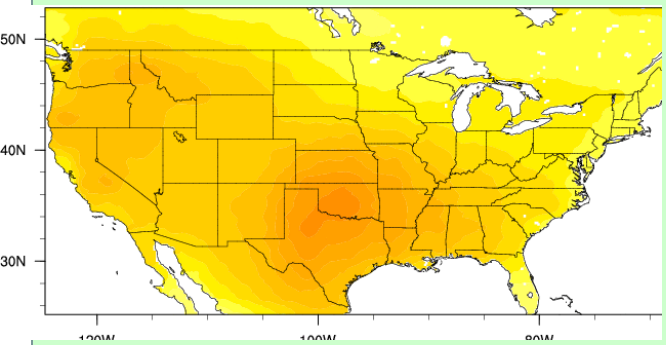
## Mid-High Emissions

2010-2039




## Lower Emissions

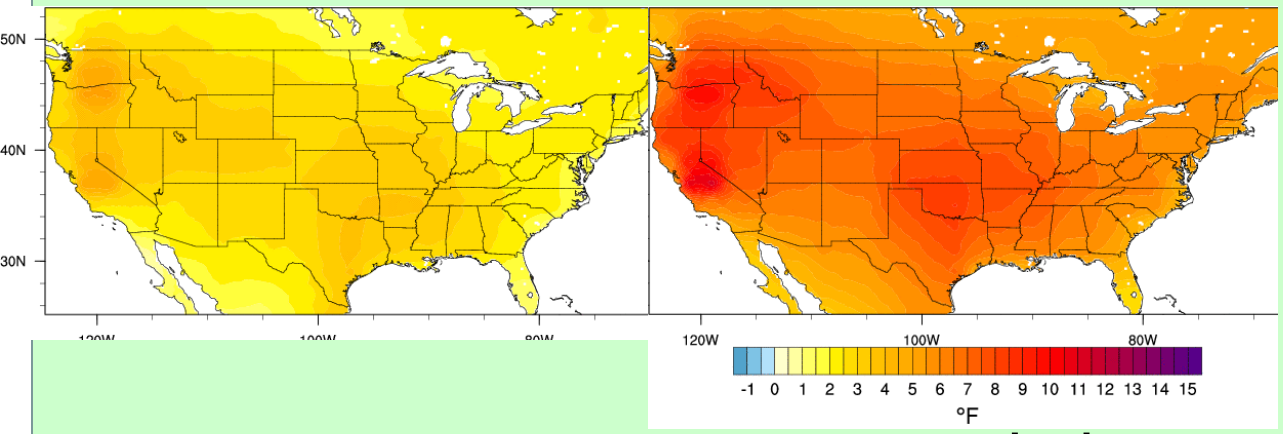
2010-2039



# Summer (JJA) temperature change

## Mid-High Emissions

2010-2039 | 2040-2069

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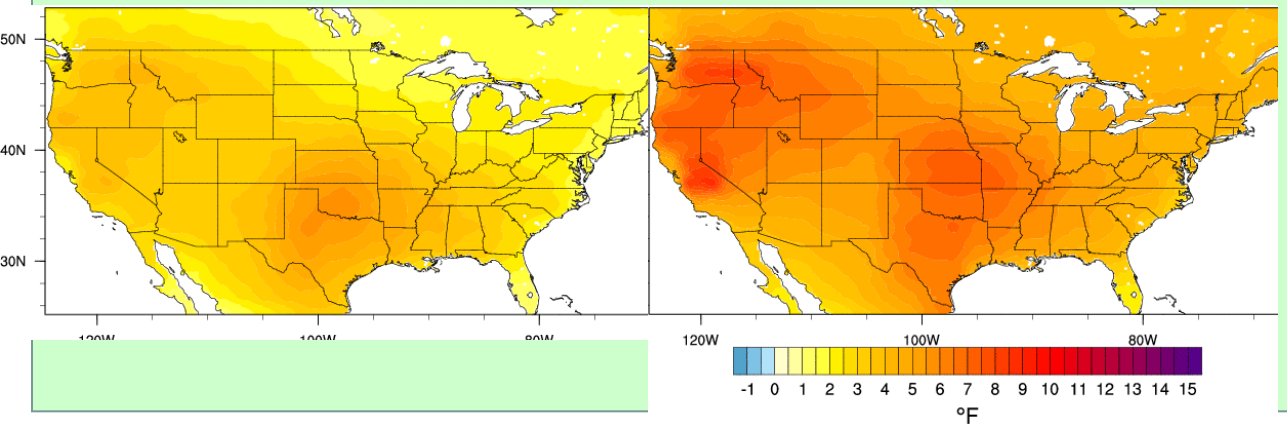
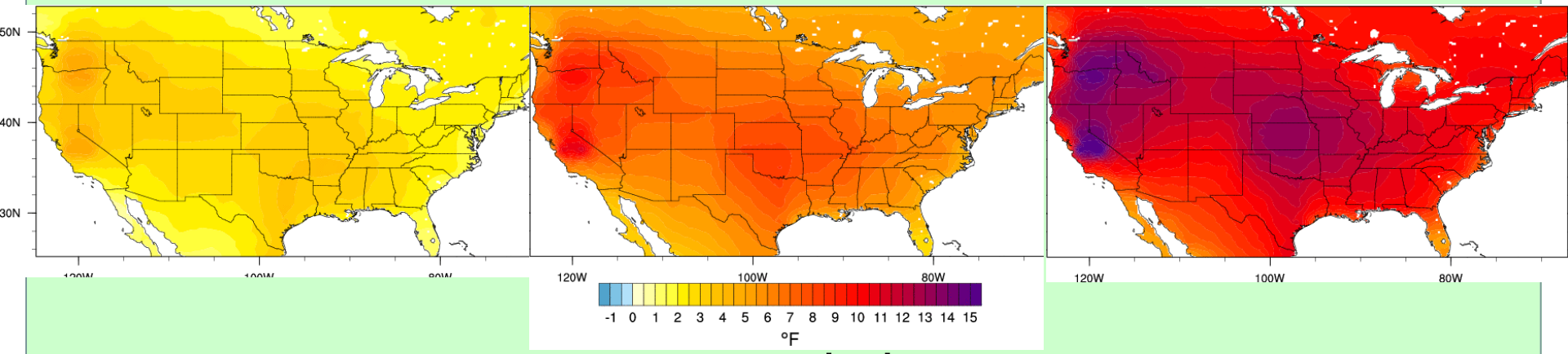


# Summer (JJA) temperature change

## Mid-High Emissions

2010-2039 | 2040-2069 | 2070-2099




## Lower Emissions

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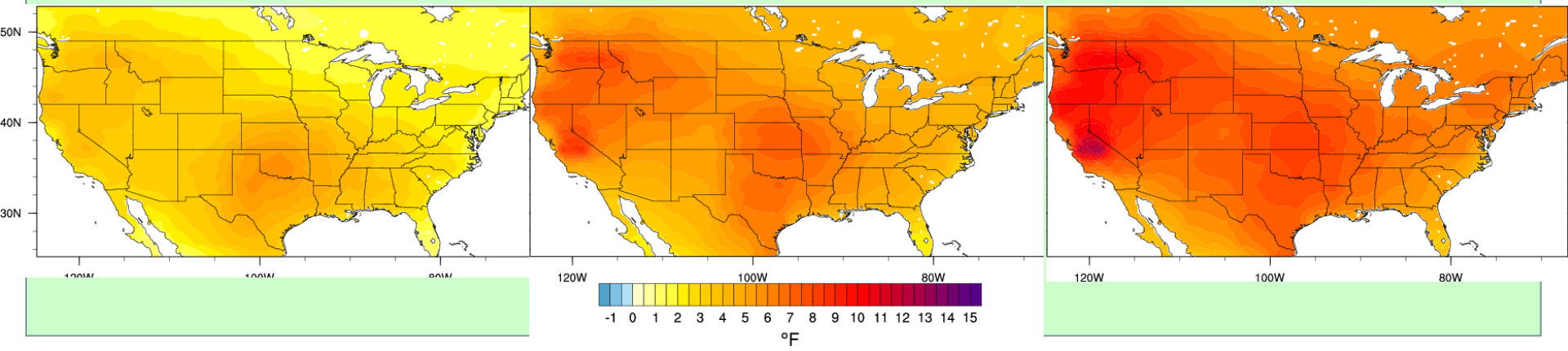
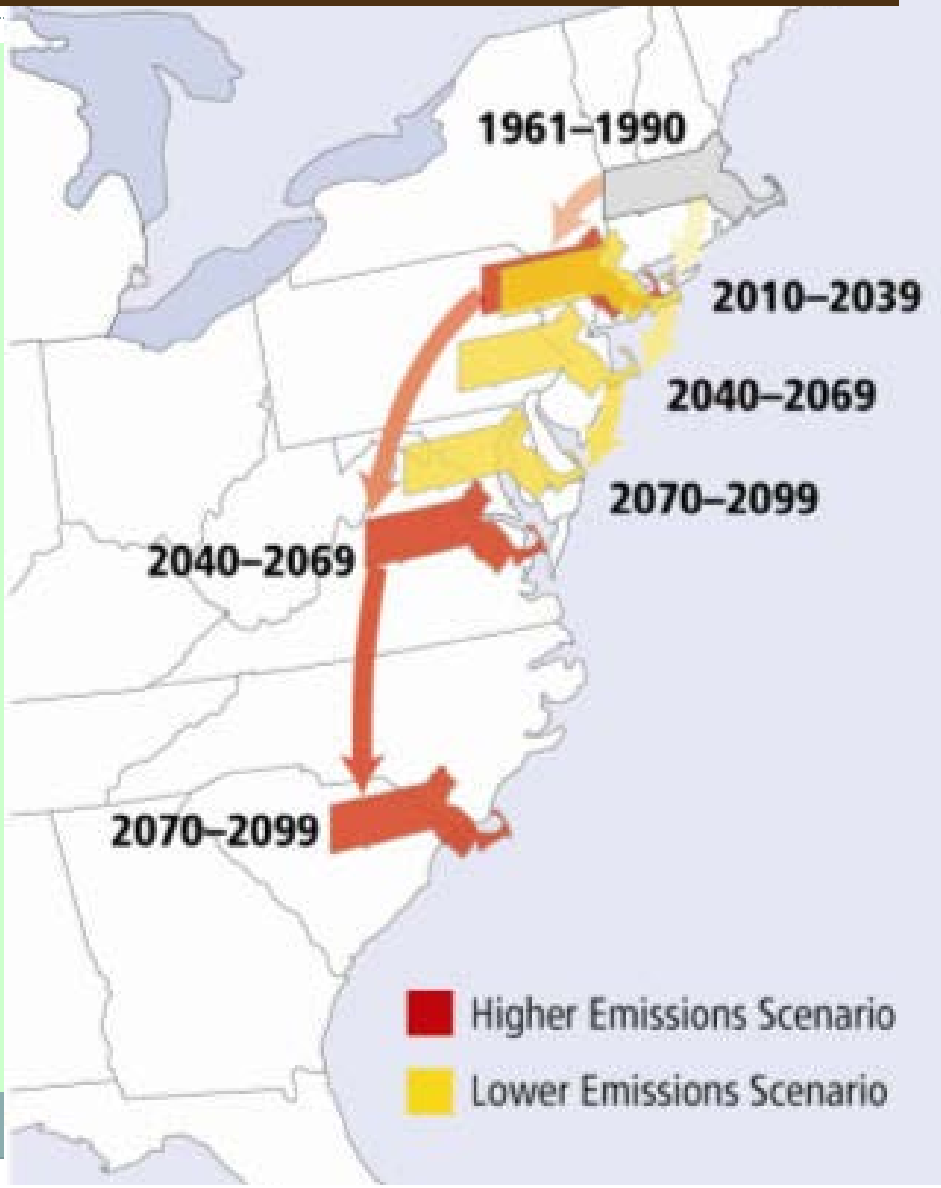


# What does this mean … for Massachusetts?

Hot and sticky summers:

MD under lower emissions

SC under higher emissions

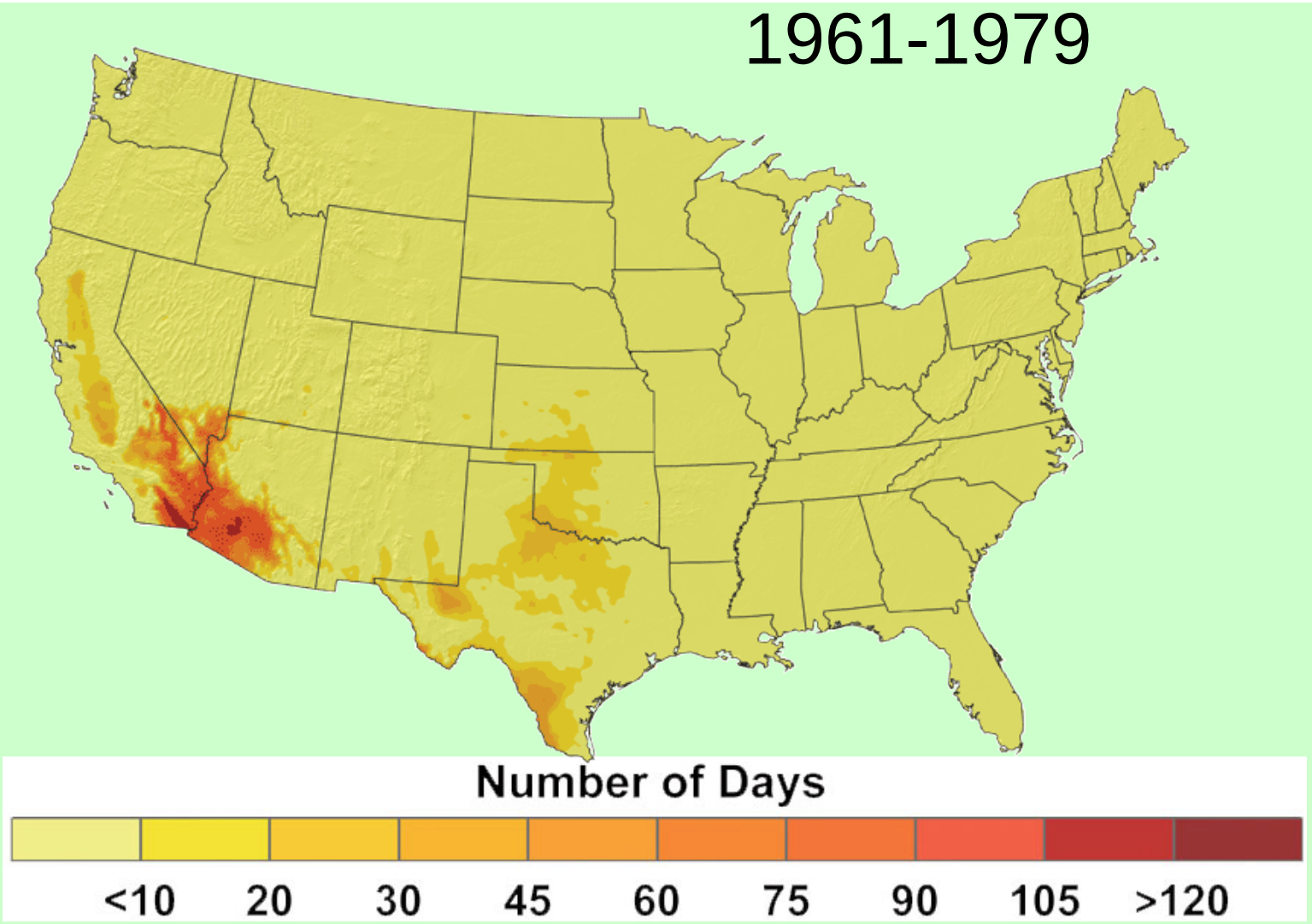


# What does this mean … for Chicago?

Summers: hot and humid

Winters: warmer, but just as much snow

# Days per year over 100oF



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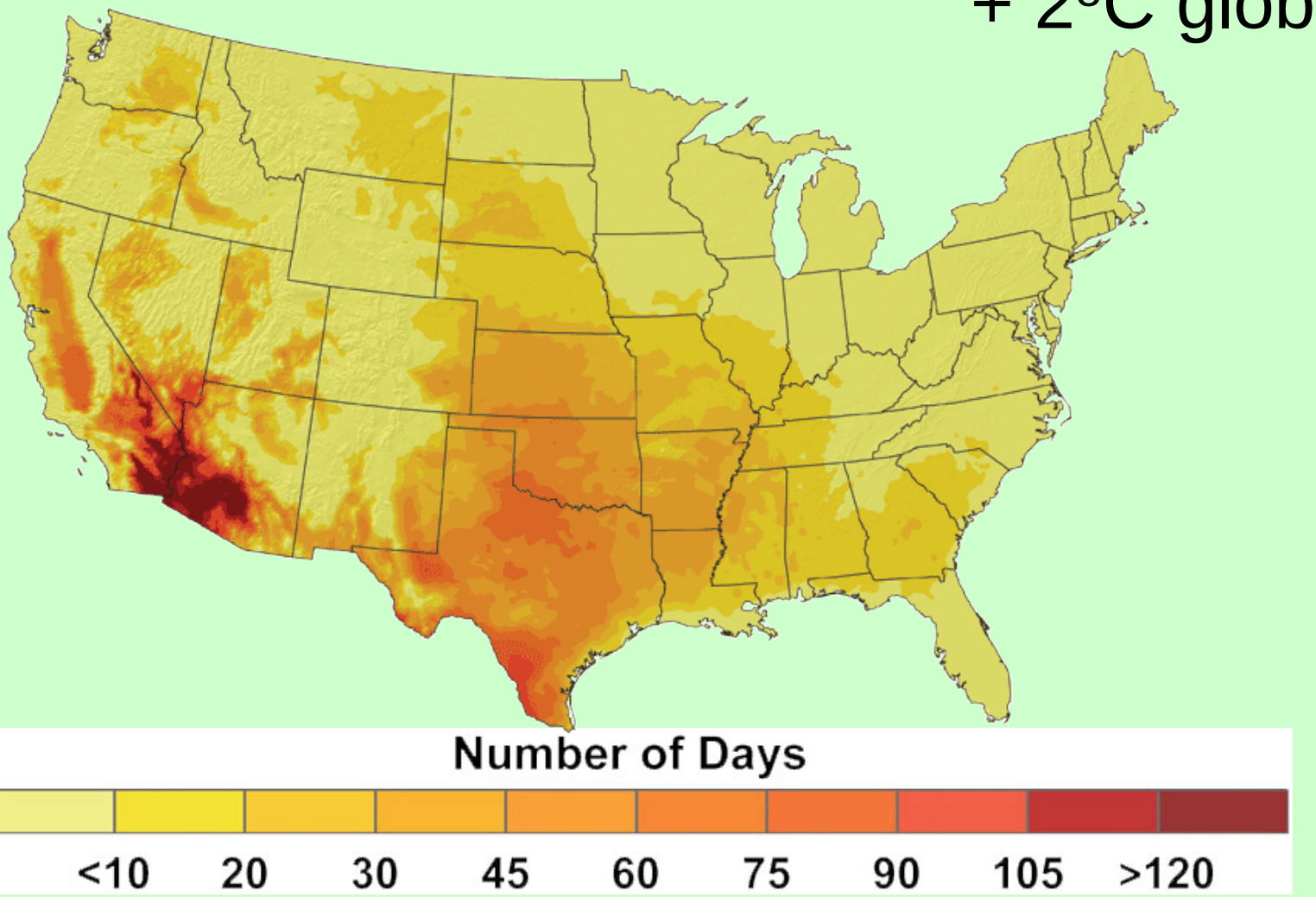

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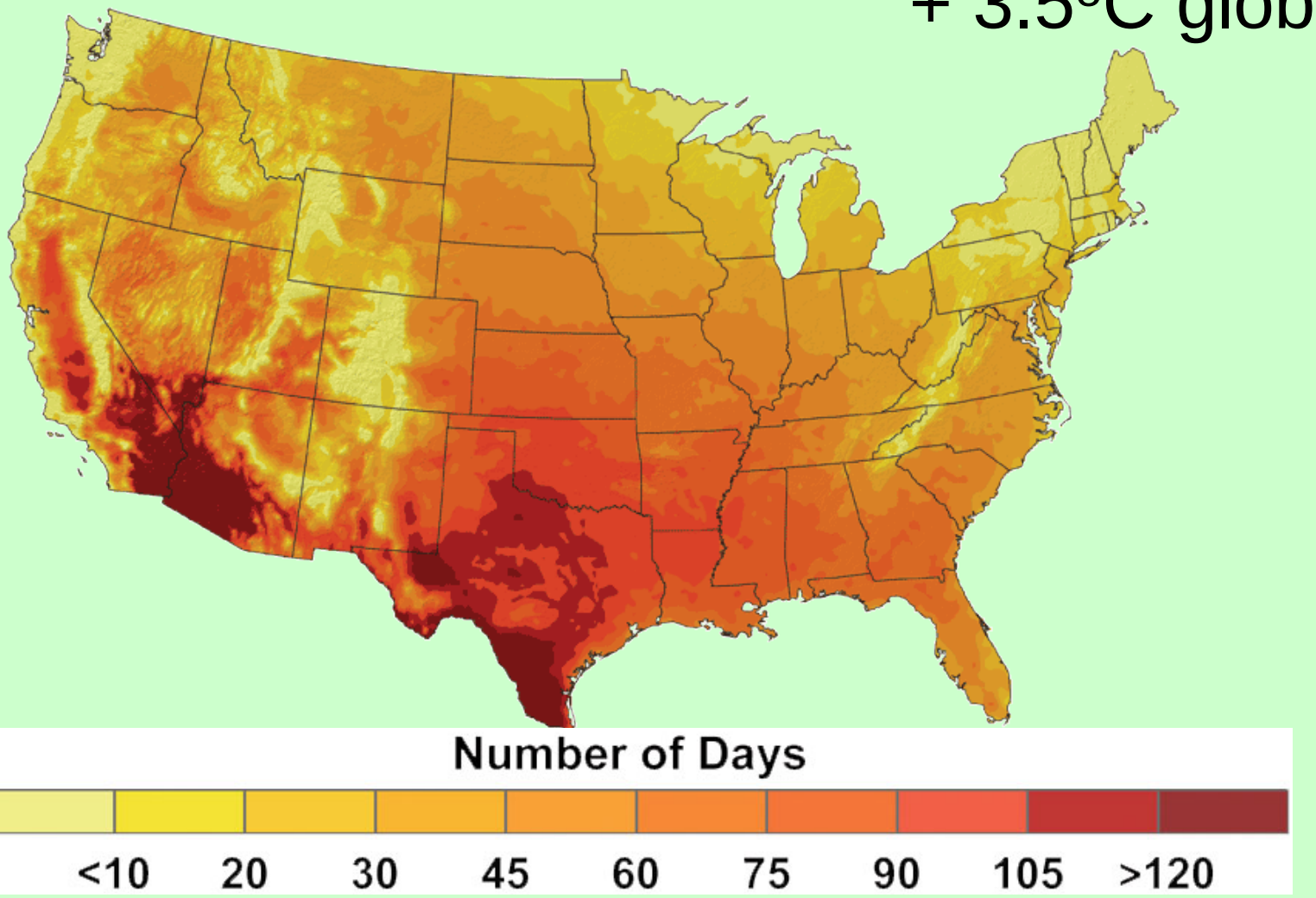
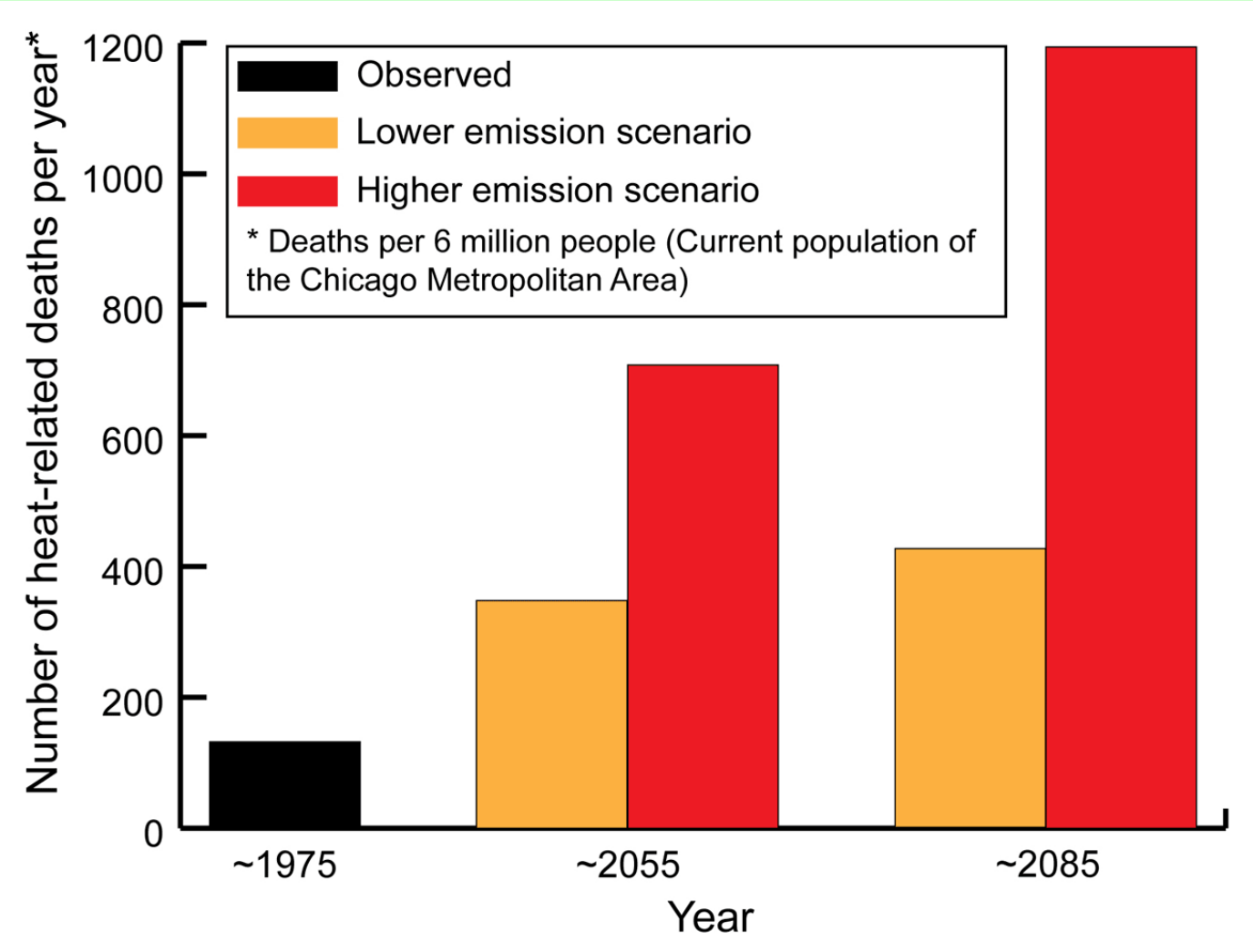


# What does this mean for … our health?

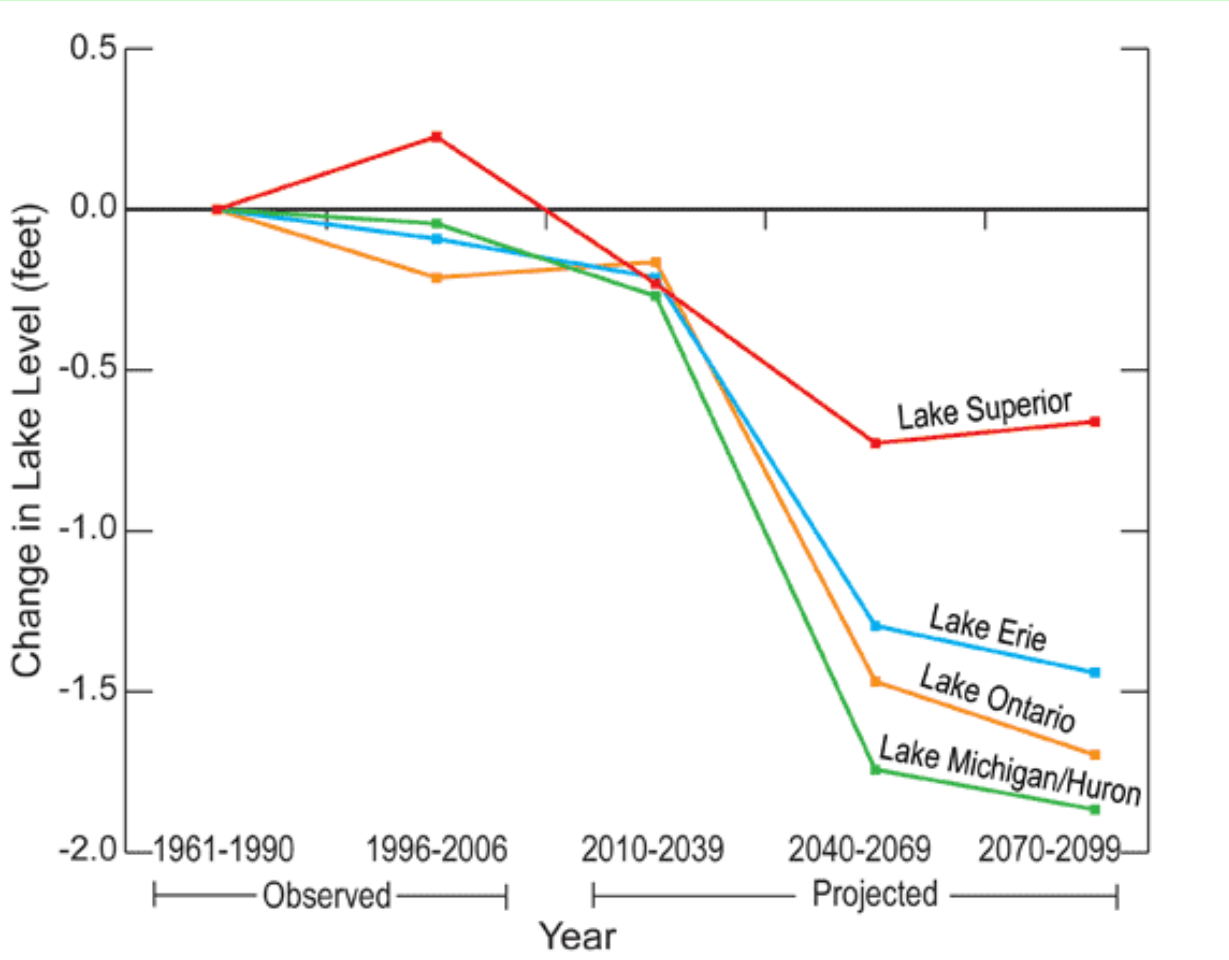


# … for our lakes?

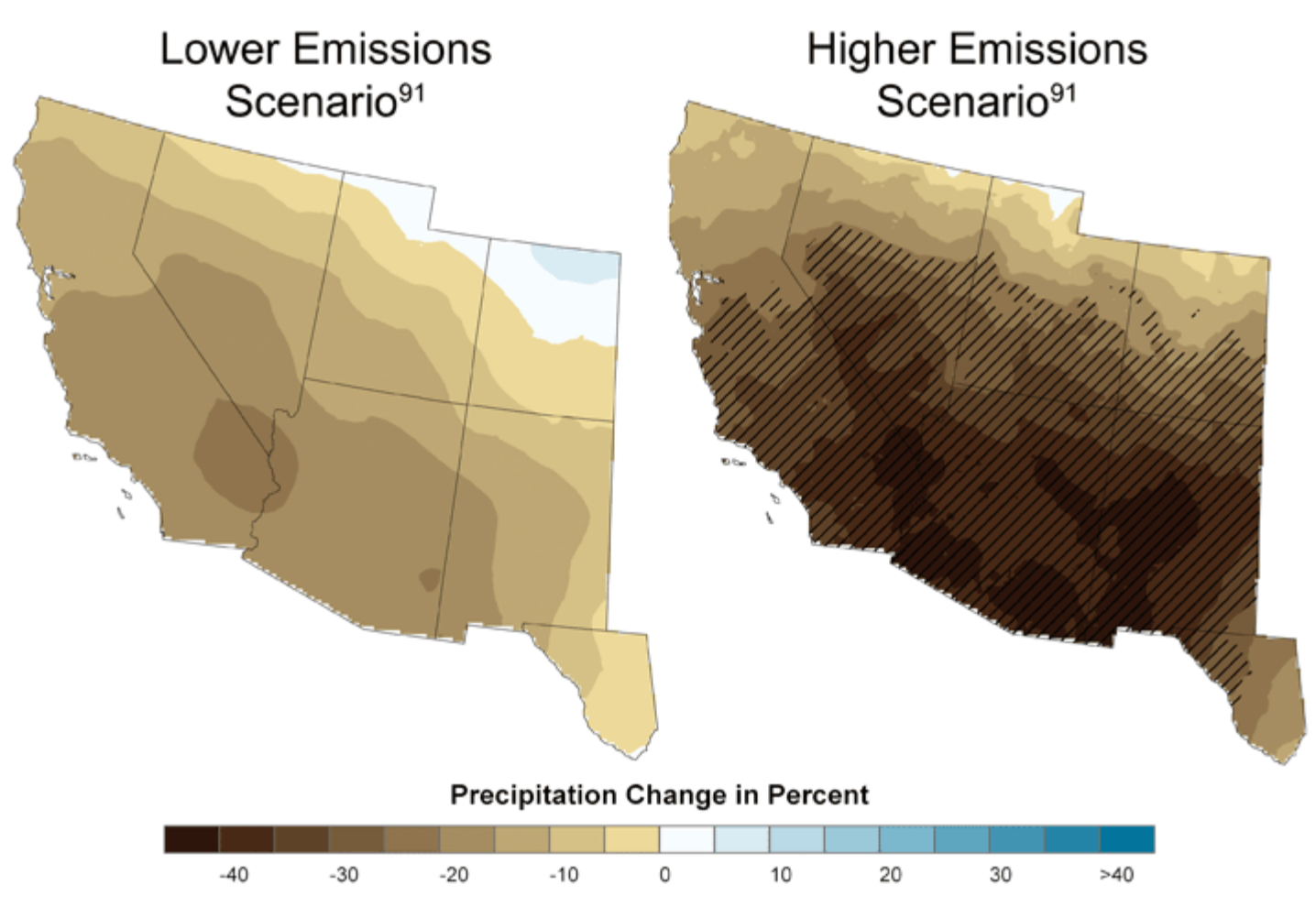
## GREAT LAKES

Levels depend on balance between precipitation and evaporation

Warmer temperatures increase evaporation

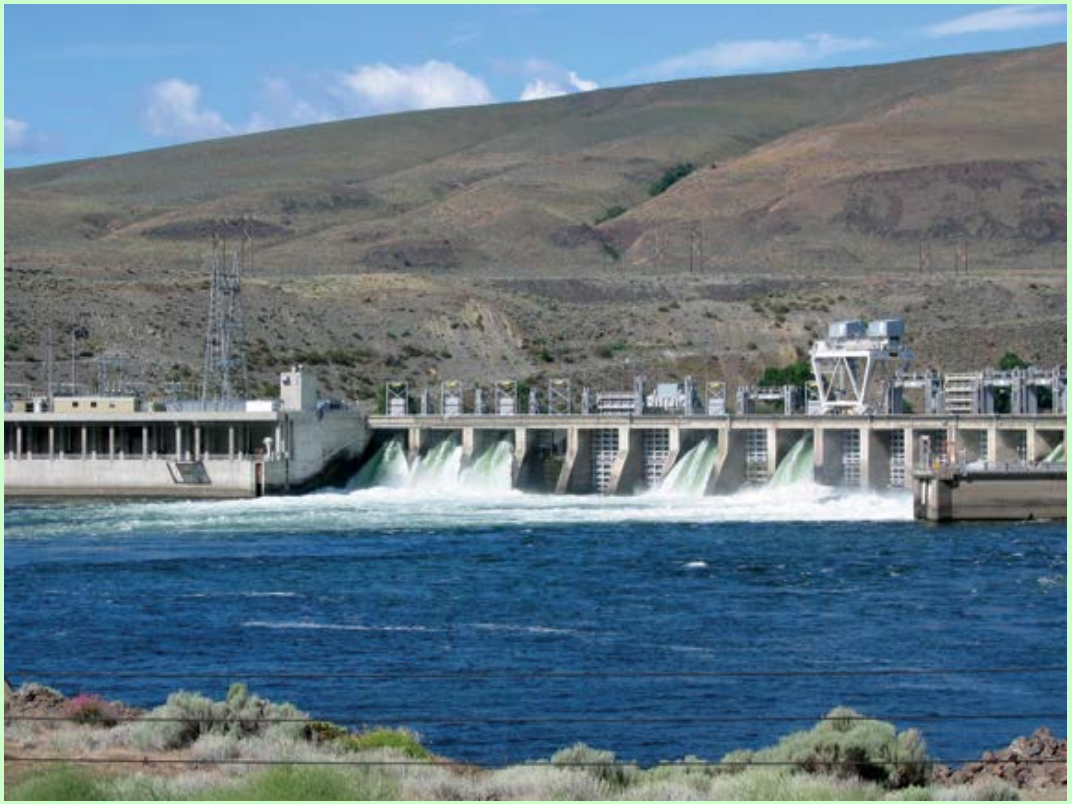


# … for our water resources?

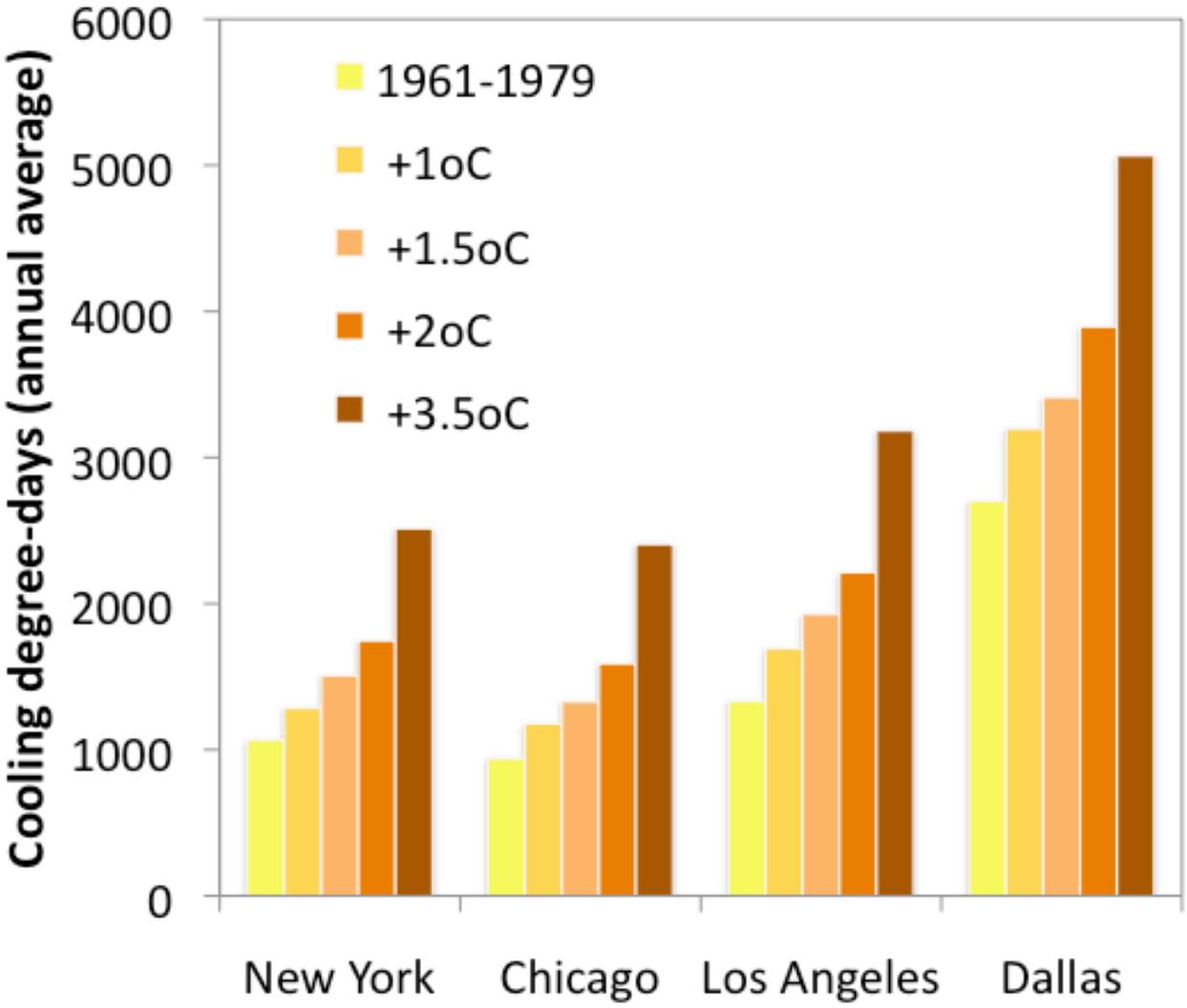



Percentage change in March-April-May precipitation for 2080-2099 compared to 1961-1979.

# ... for our energy?



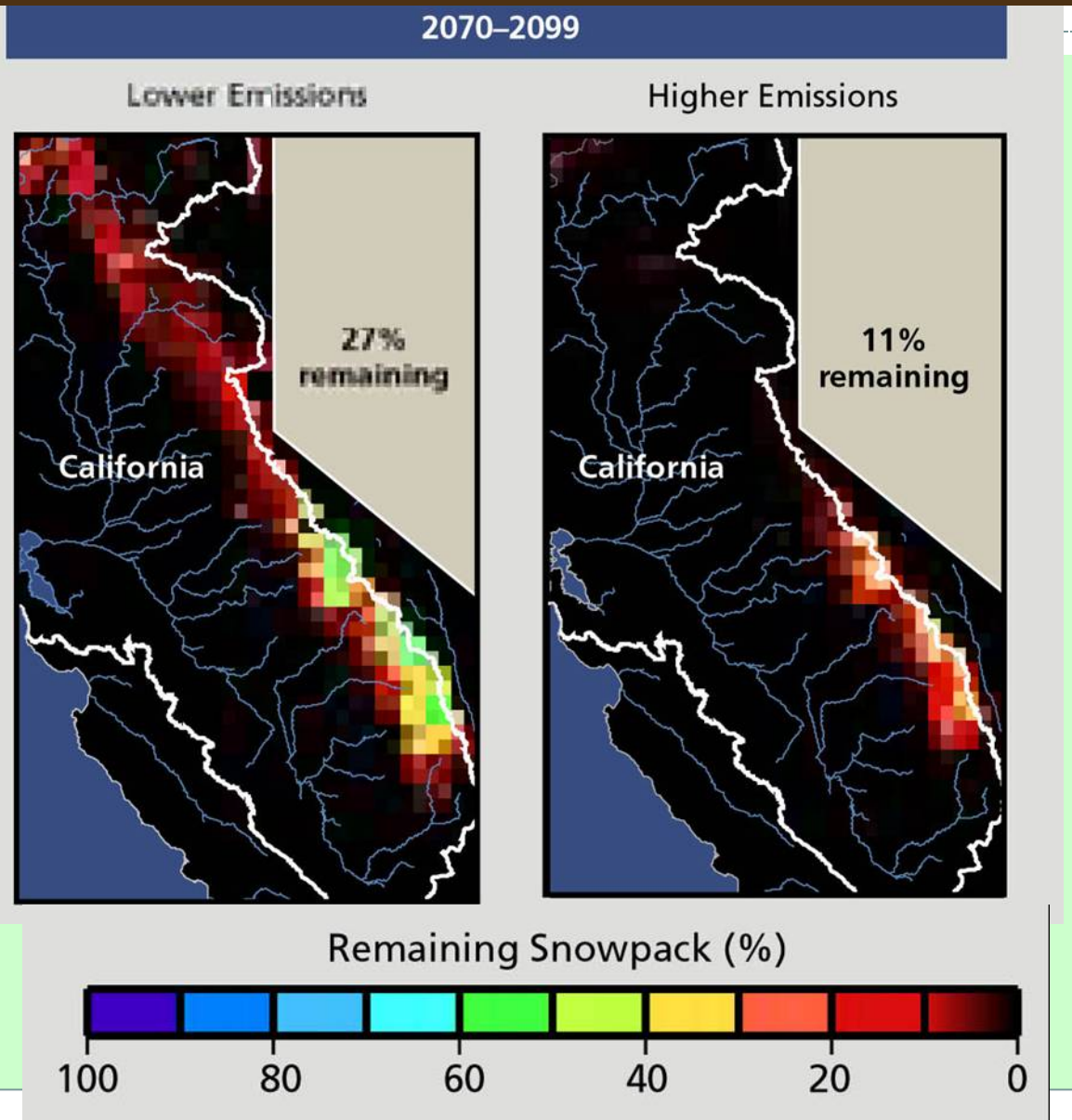
# … for our energy?



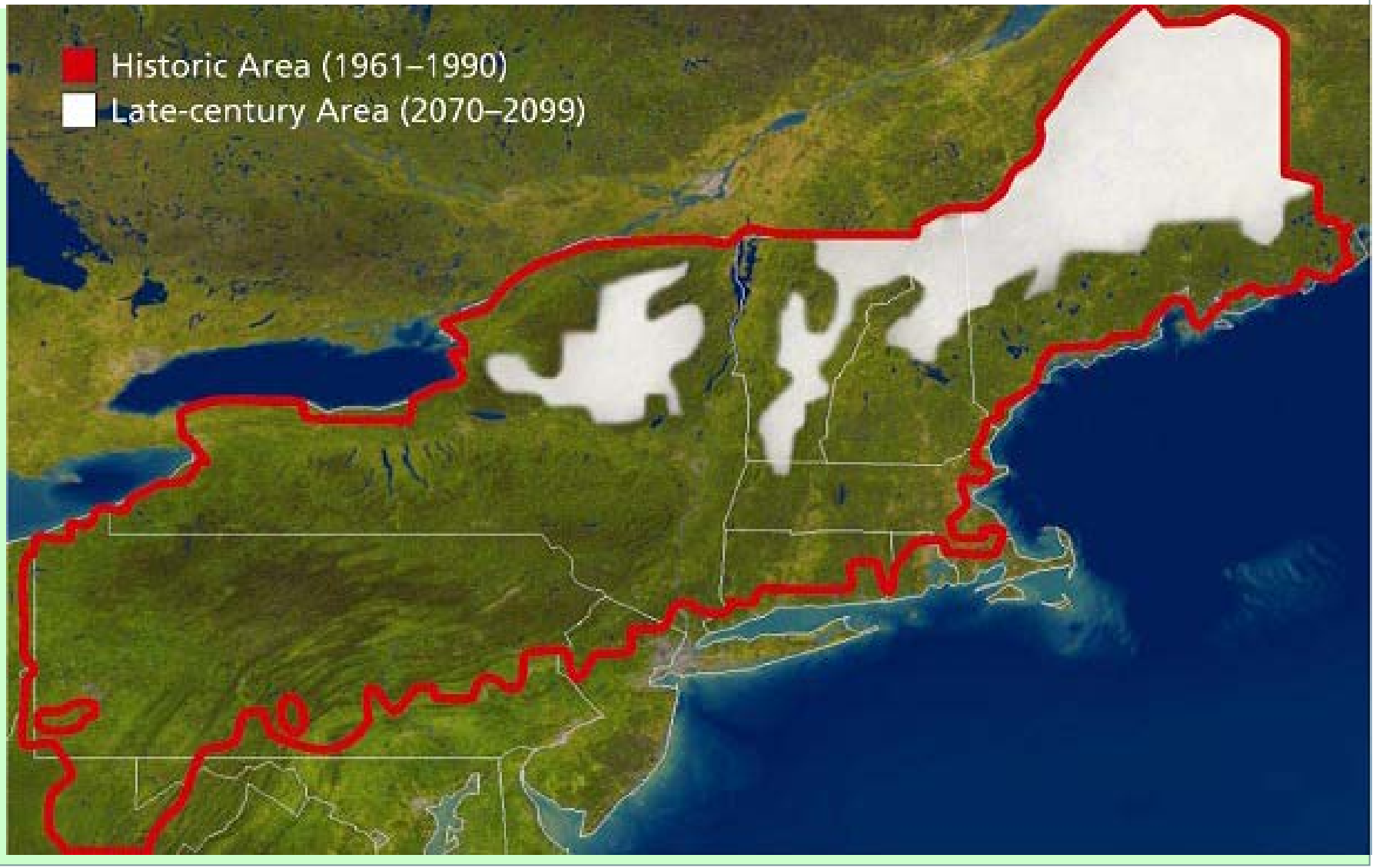
# … for California's water supply?

Half of California's water comes from mountain snow.

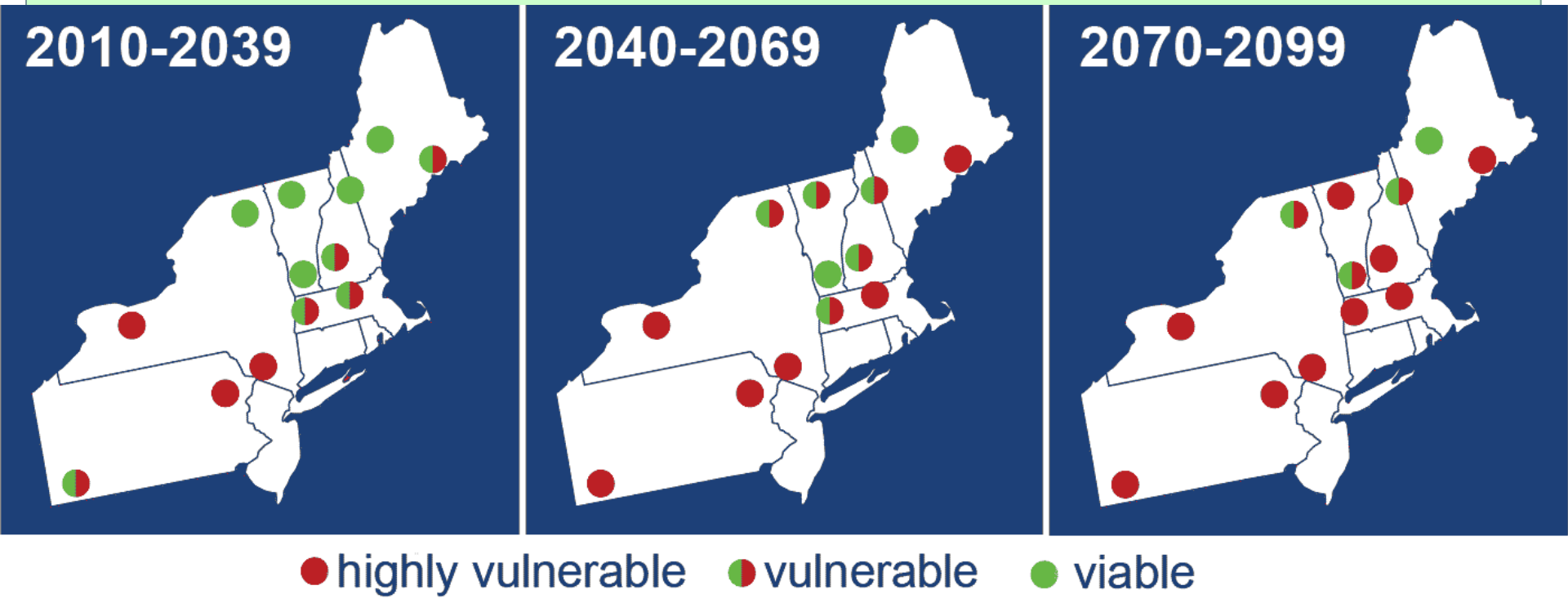
70-90% of that could be gone before the end of the century.



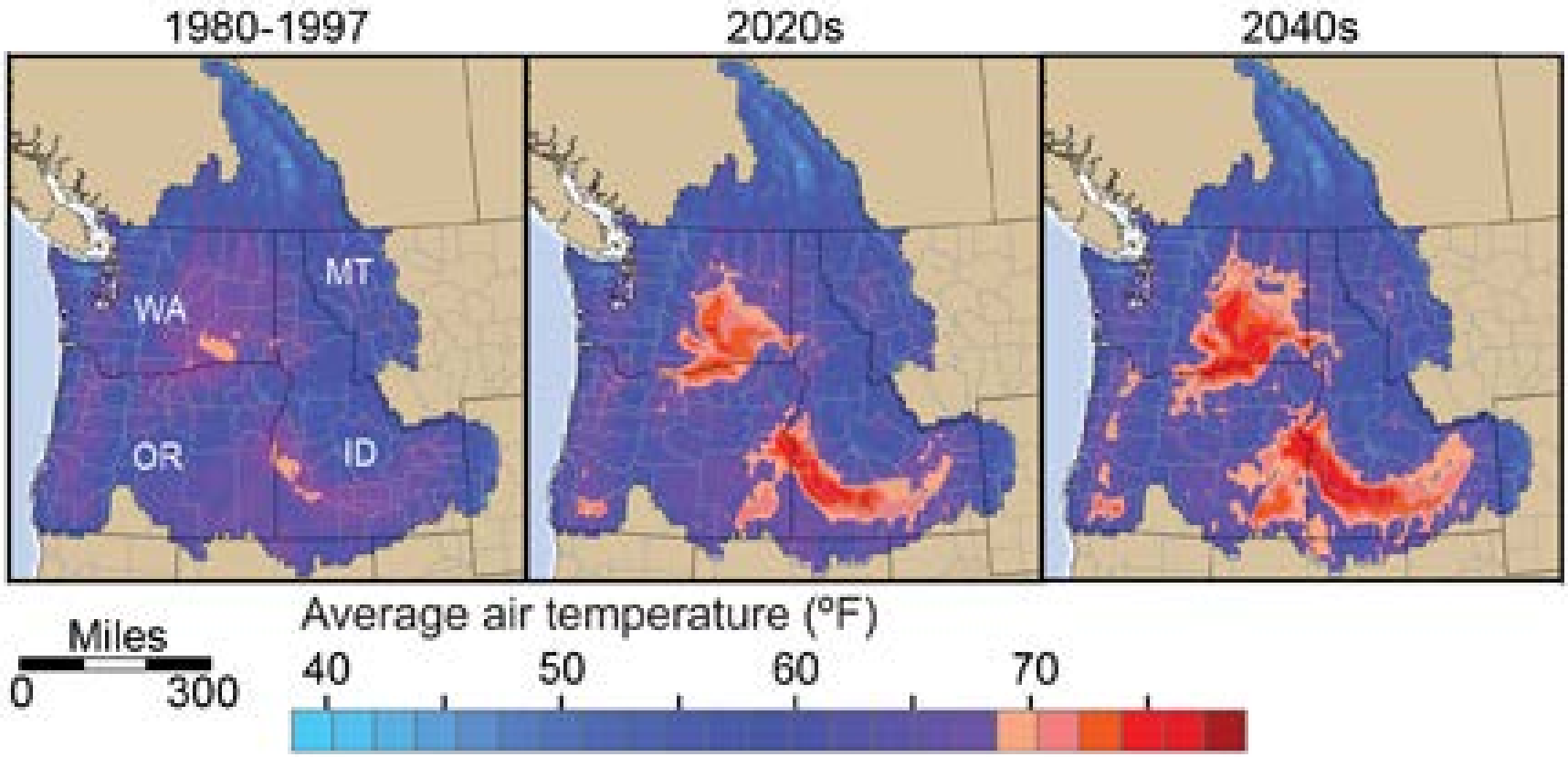
# … for snow cover in the Northeast?



# … for winter tourism?

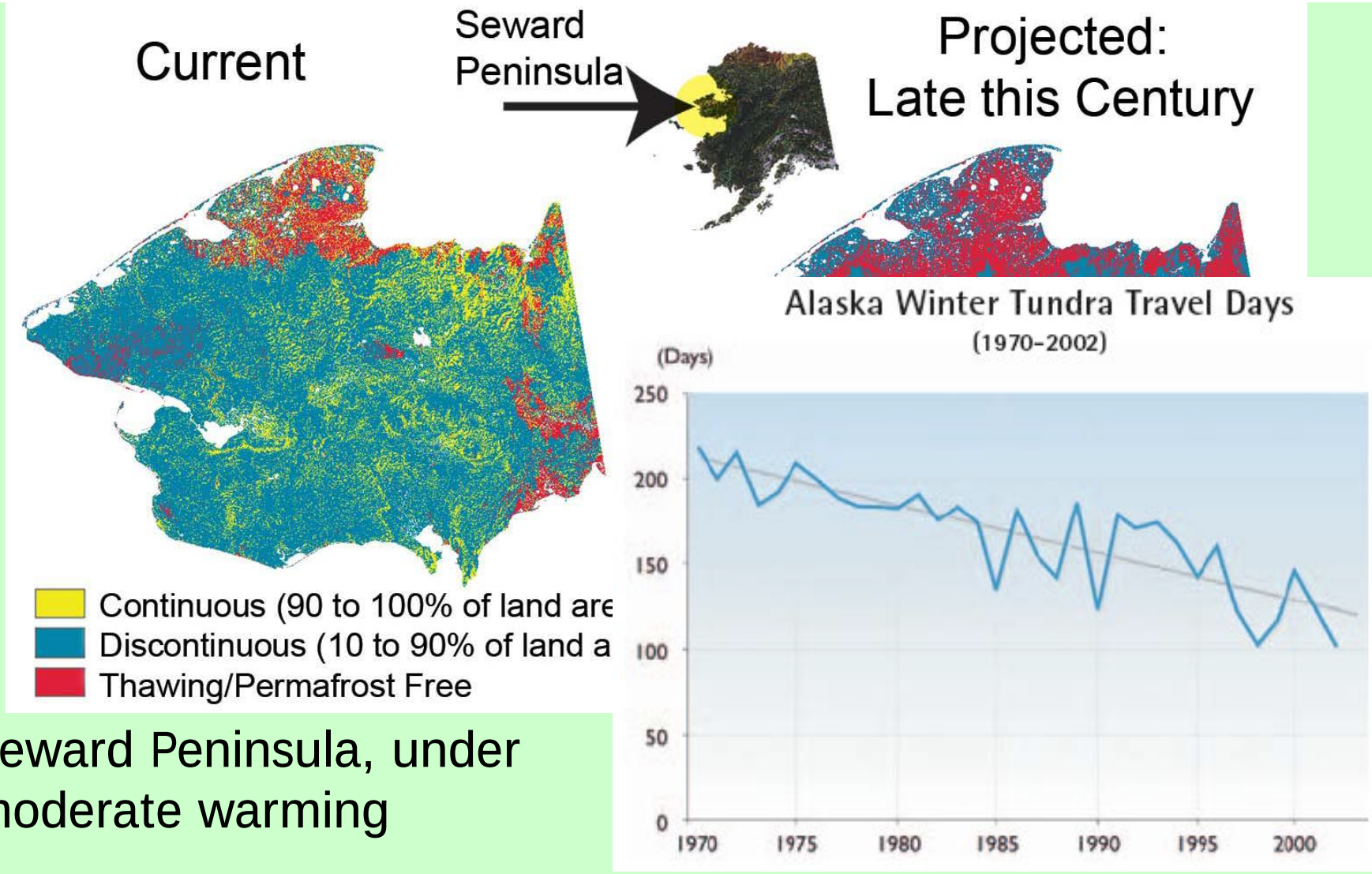


# … for cold-water fish?



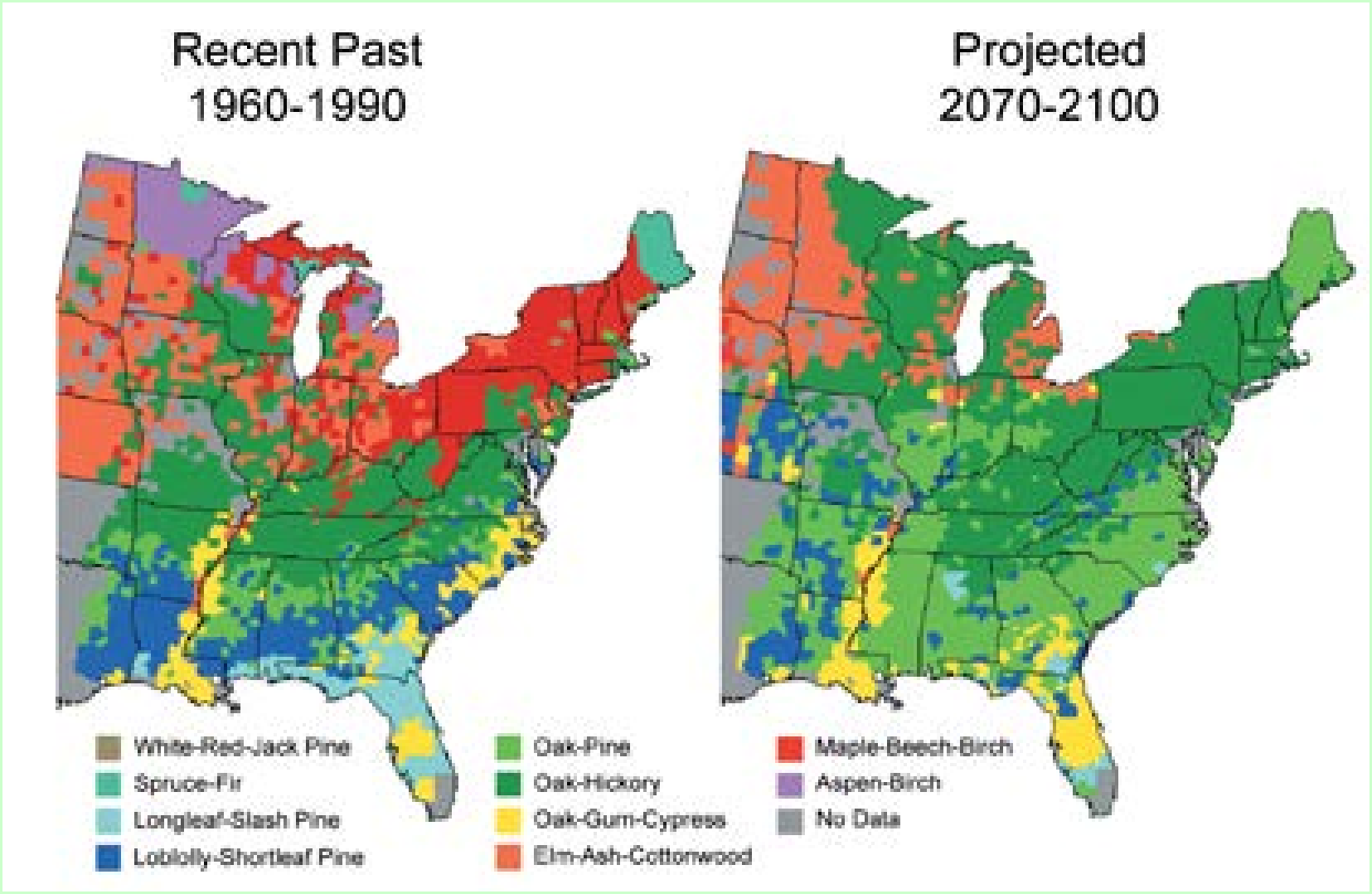

Salmon can be found where average air temperature is less than about 70 F (shown in blue).

# … for frozen ground in the Arctic?




Seward Peninsula, under moderate warming

# … for ecosystems in the eastern US?

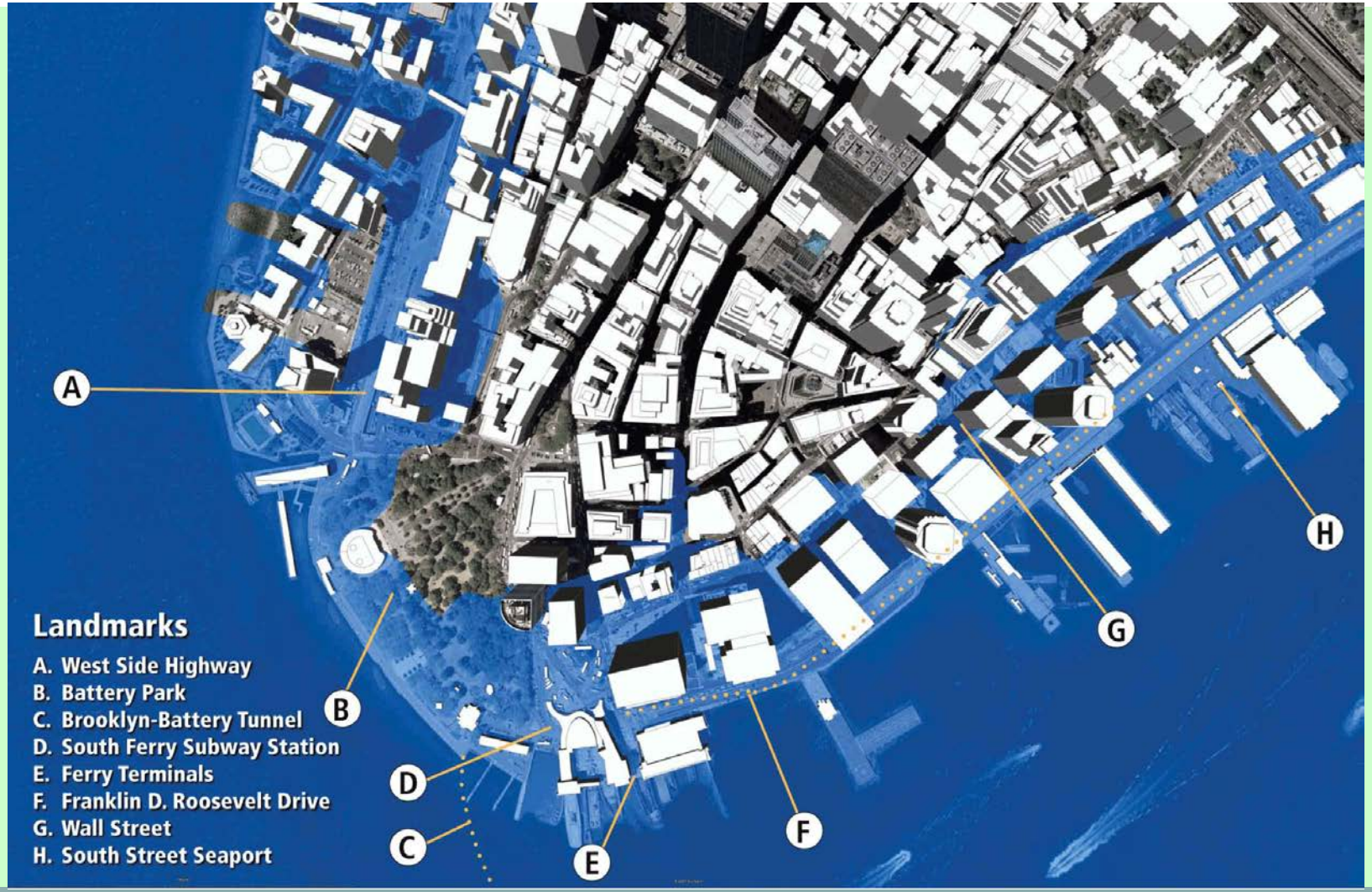


# … for our agriculture?


# ... for our coasts?


Area that would be underwater with a 3 foot sea level rise.

# … for our cities?



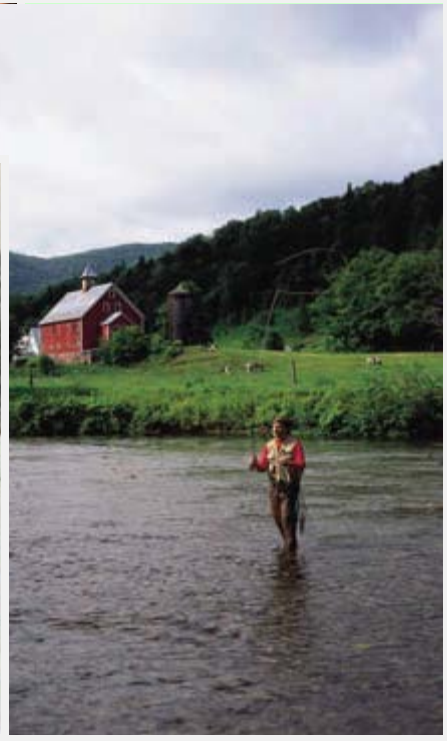

NEW YORK CITY

# … and even entire nations?

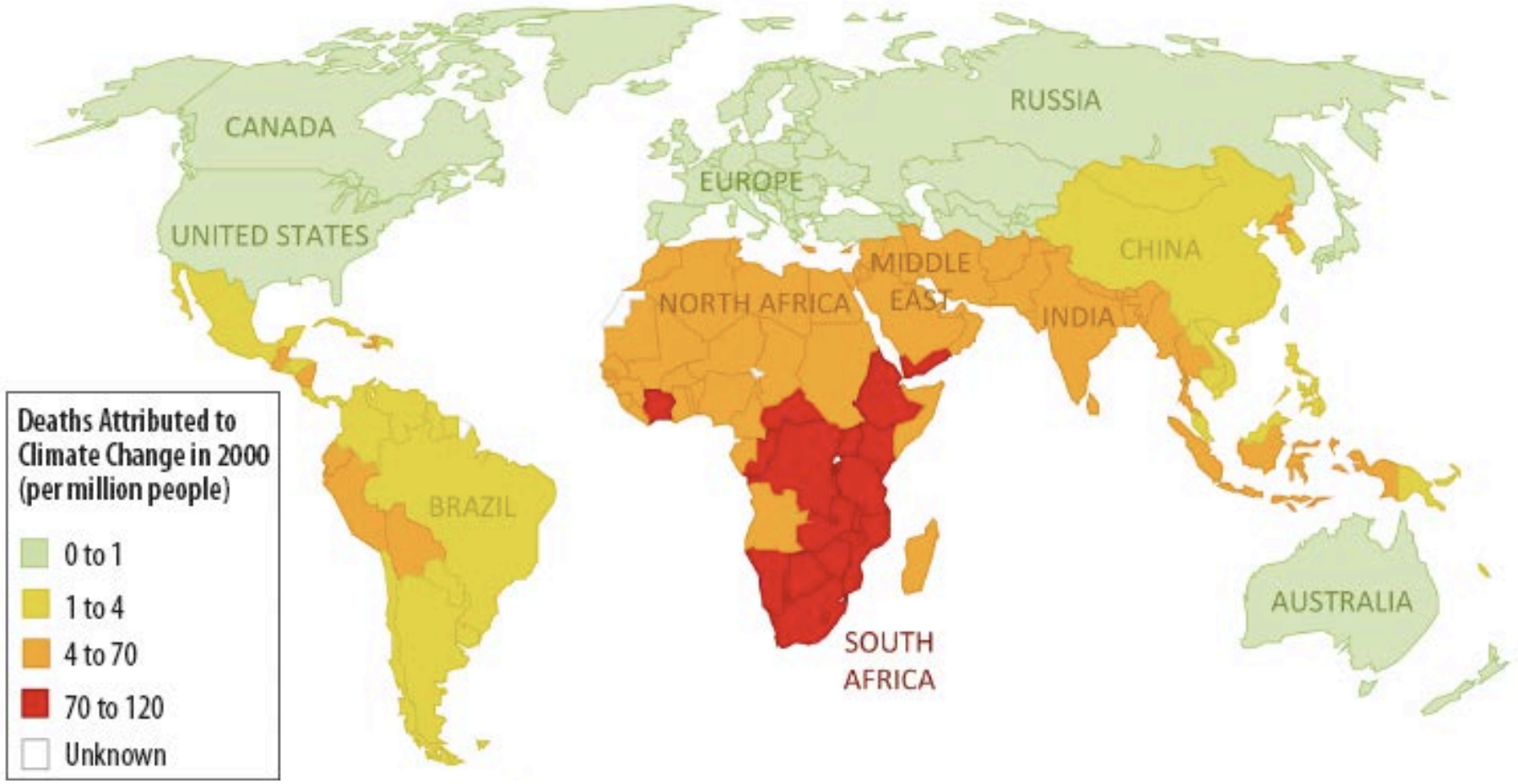
Tuvalu, South Pacific

# Climate change will alter the character of every region in the U.S.





# … and its global impacts are even larger.




In 2000: 150,000 deaths per year

In 2009: 300,000 deaths per year

300 million already at risk from climate change

# What can we do about it?

PART FOUR

# What if I think climate change is a crock?

By reducing our reliance on coal, gas, and oil, and looking to clean, renewable sources for our energy, we would:

- Clean up our air and water
- Reduce our dependence on foreign oil
- Invest in our own economy and our people
- Preserve our limited natural resources for future generations

# We have 3 choices:

"We basically have three choices: mitigation, adaptation, and suffering.

We're going to do some of each. The question is what the mix is going to be.

The more mitigation we do, the less adaptation will be required and the less suffering there will be."

**John Holdren**

President's Science Advisor; Harvard University

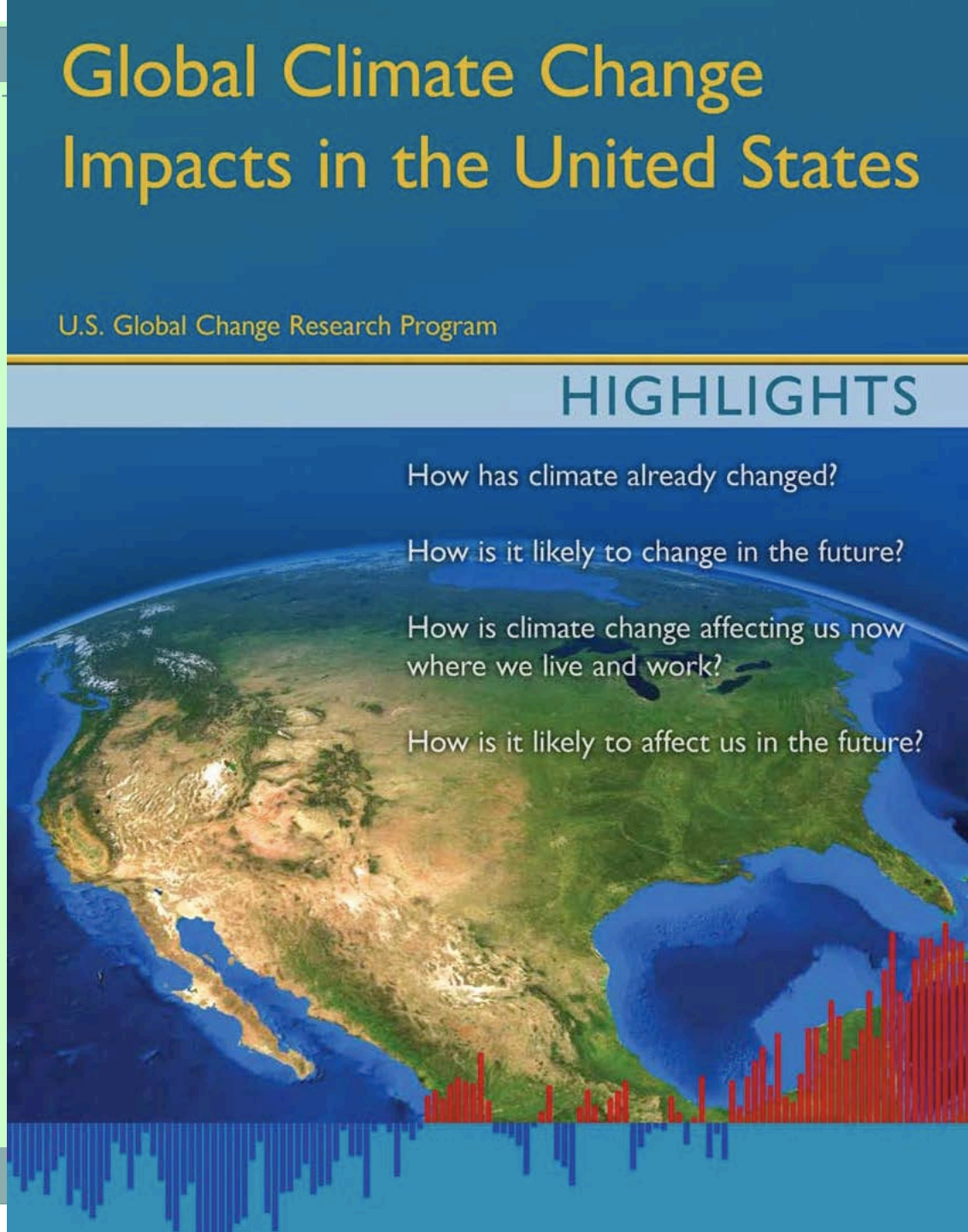
# Resource 1

**Global Climate Change Impacts in the United States**

What climate change means for the places we care about …

PDF & educational materials free online at:

www.globalchange.gov/usimpacts



# Resource 2

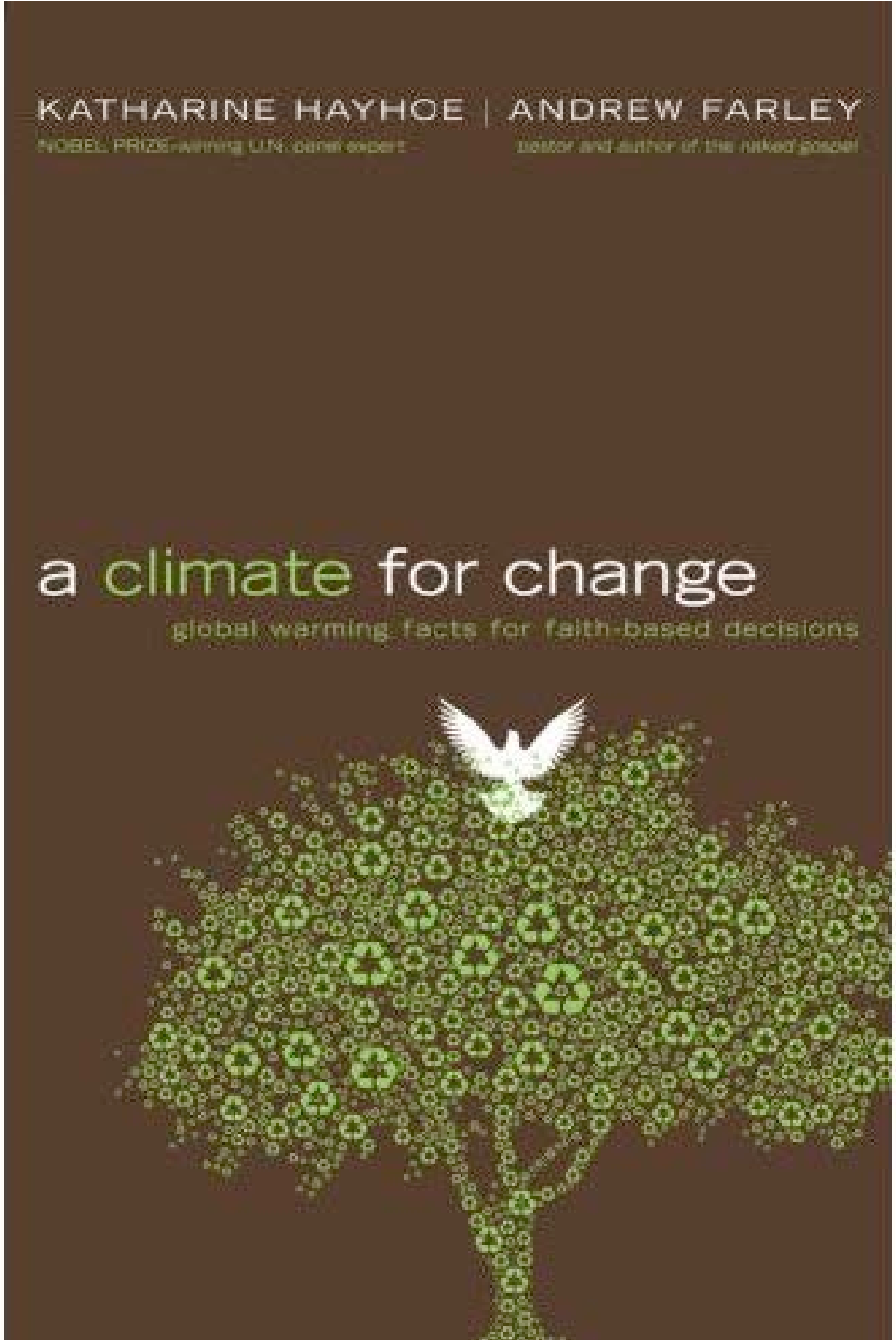
## A Climate for Change

### Global Warming Facts for Faith-Based Decisions

Why climate change is happening, and how it is affecting our world …

Free online e-book at:

www.katharinehayhoe.com



# Resource 3

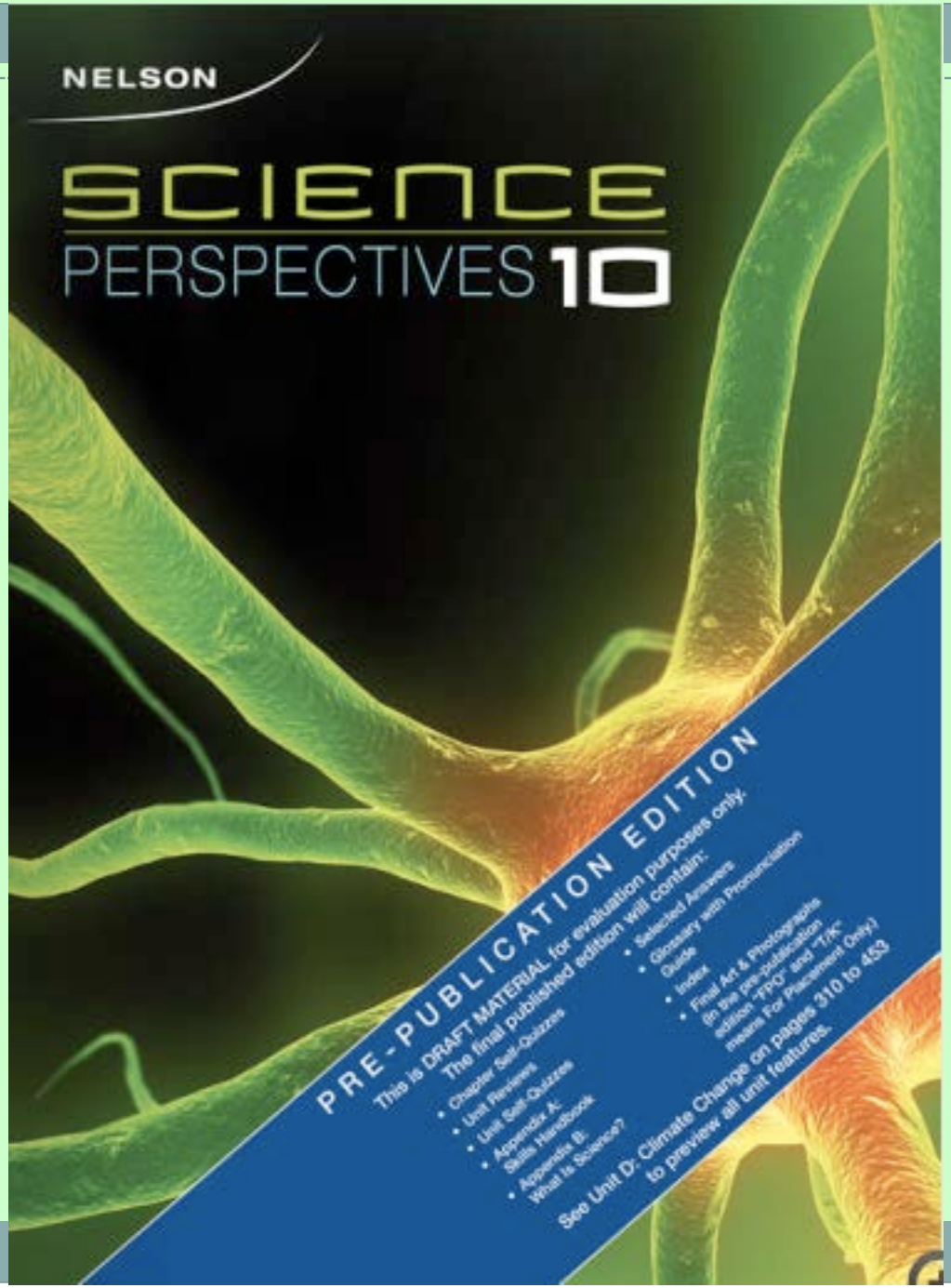
## Grade 10 Climate Change Unit

**Nelson Education**

Basic climate science for high school students

Free online ebook available at:

www.nelson.com/scienceperspectives/10/uniflip2/unitD/



# Resource 4: SKEPTICAL SCIENCE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## Solar activity & climate: is the sun causing global warming?

**The skeptic argument...**

Link to this page

"Over the past few hundred years, there has been a steady increase in the numbers of sunspots, at the time when the Earth has been getting warmer. The data suggests solar activity is influencing the global climate causing the world to get warmer." (BBC)

### What the science says...

In the last 35 years of global warming, the sun has shown a slight cooling trend. Sun and climate have been going in opposite directions.

# 2. Prepare for what we can't avoid

Conserve the resources we have

Protect ourselves from what we can

# 3. Reduce our own impact

stop using this

start using this

Each US household replacing 1 light bulb
= taking 1,000,000 cars off the road (+$30 savings per bulb)

# 4. Support fundamental change

stop using this

start using this

Renewable energy gives us clean air and water, and home-grown energy sources that will never run out. So, why not?

# Change is happening

**1992 UN Framework Convention on Climate Change**
167 nations agree to reduce heat-trapping gas emissions, to prevent dangerous human interference with climate system.

# Change is possible

# THE END

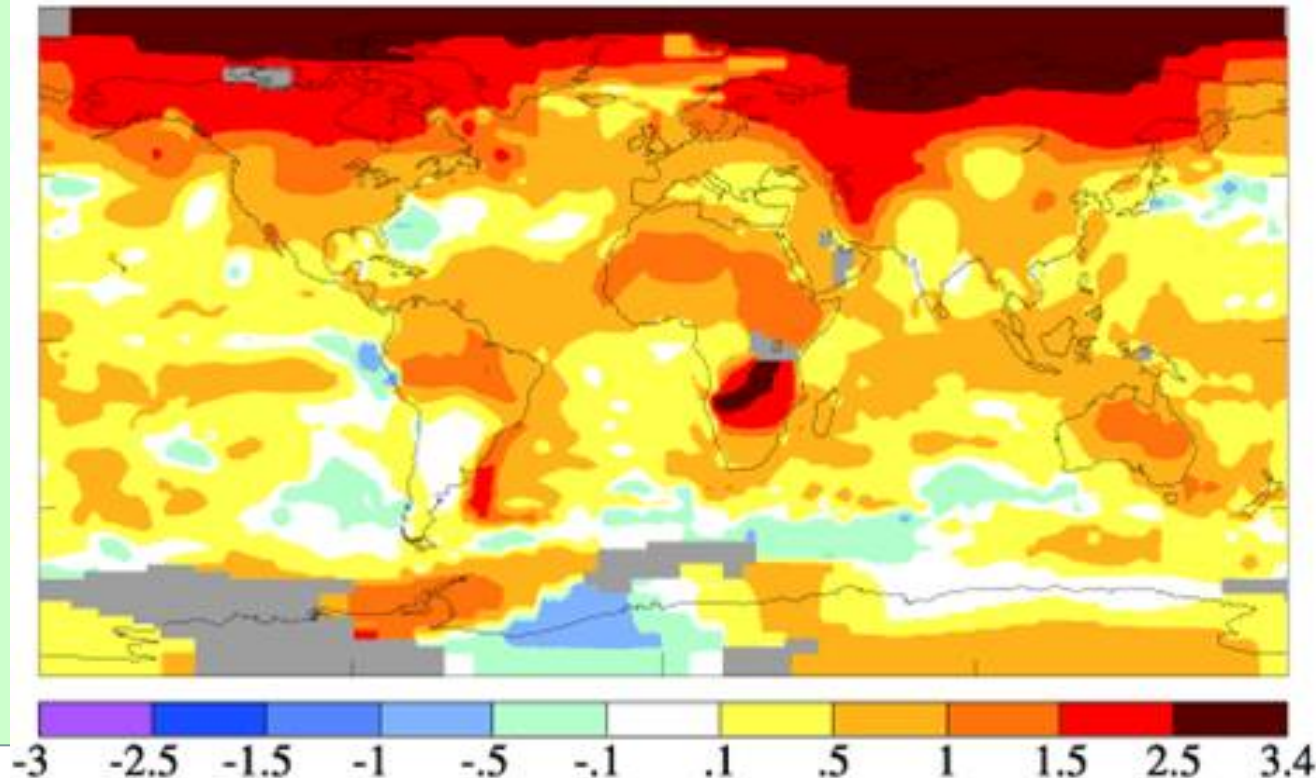
FOR MORE INFORMATION

WWW.KATHARINEHAYHOE.COM
WWW.GLOBALCHANGE.GOV/USIMPACTS

# Maybe it's just the urban heat island effect.

Where people live →

Where it's warming fastest →



# Aren’t scientists always disagreeing?

Warming of the climate system is now evident from observations. Most of the increase is very likely (>90%) due to the observed increase in heat-trapping gas concentrations due to human activities [including burning fossil fuels].

Climatic change is being brought about by human-induced increases in the concentration of atmospheric carbon dioxide, primarily through the processes of combustion [burning] of fossil fuels.

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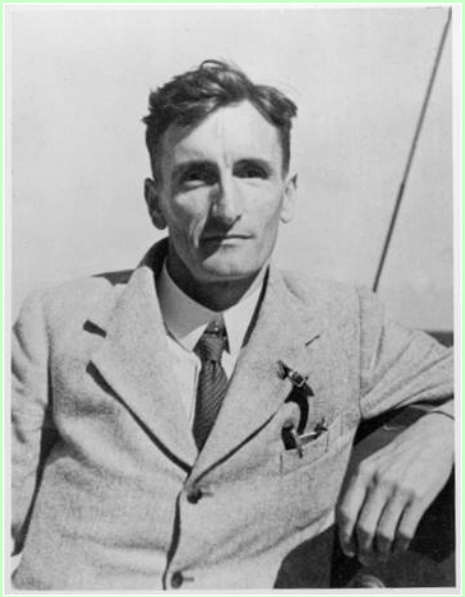
**The United Nations Intergovernmental Panel on Climate Change, 2007**



Climatic change is being brought about by human-induced increases in the concentration of atmospheric carbon dioxide, primarily through the processes of combustion [burning] of fossil fuels.

**“The Artificial Production of Carbon Dioxide and Its Influence on Temperature”**

**Guy Callendar, 1938**

# Didn’t those stolen emails disprove it?

- Everything discussed in the stolen emails had been published in the scientific literature for years
- 3 independent records of global temperature from NASA, NOAA, and Japan show same warming trends
- 26,000 physical and biological systems reflect same warming trends

BOTTOM LINE: A few personal emails have no impact on overall understanding that human activity is driving dangerous levels of global warming.

# “Natural” thermometer records