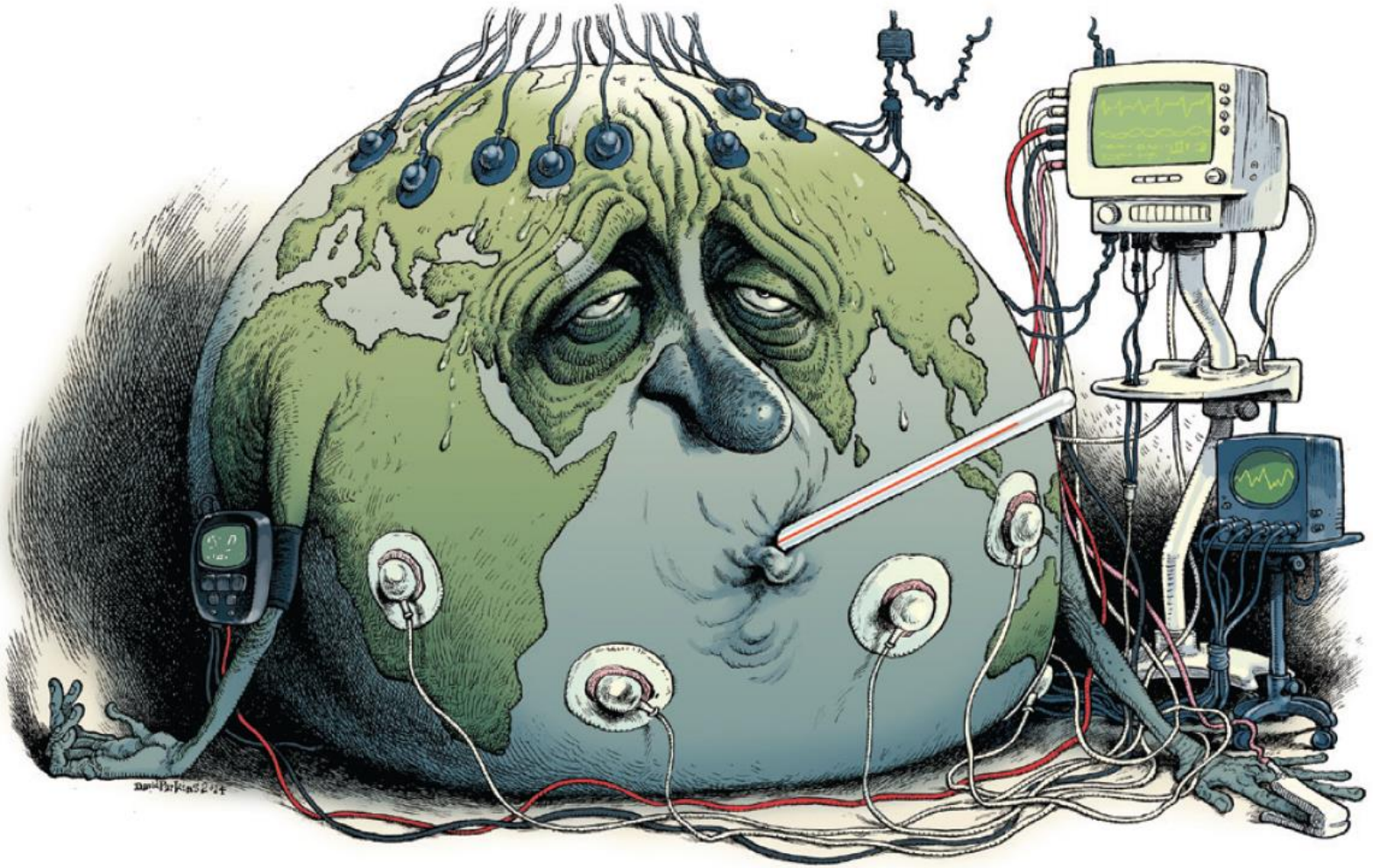
Climate Change: From Global to New York Scale

Chris Thorncroft

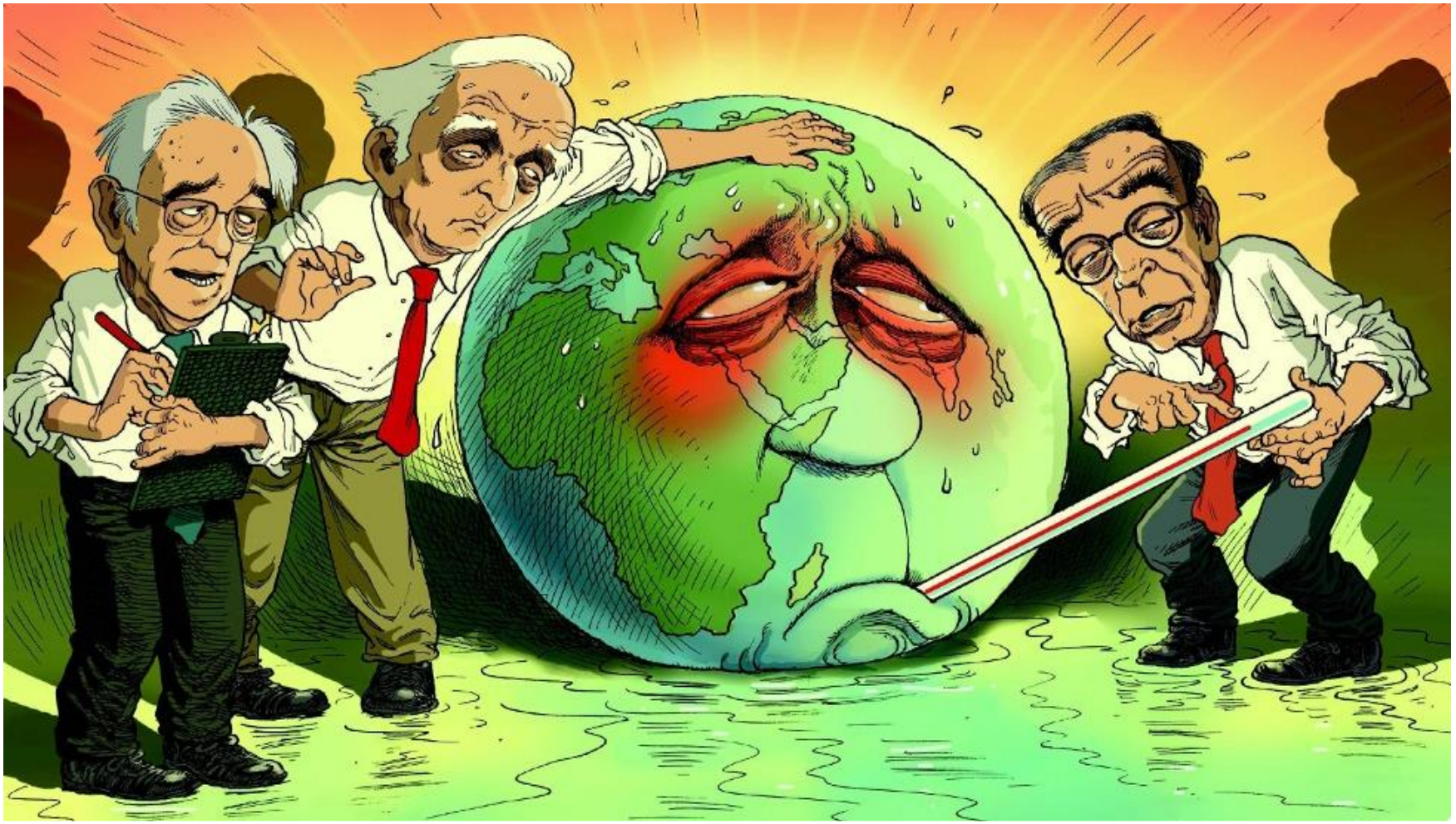
Department of Atmospheric and Environmental Sciences



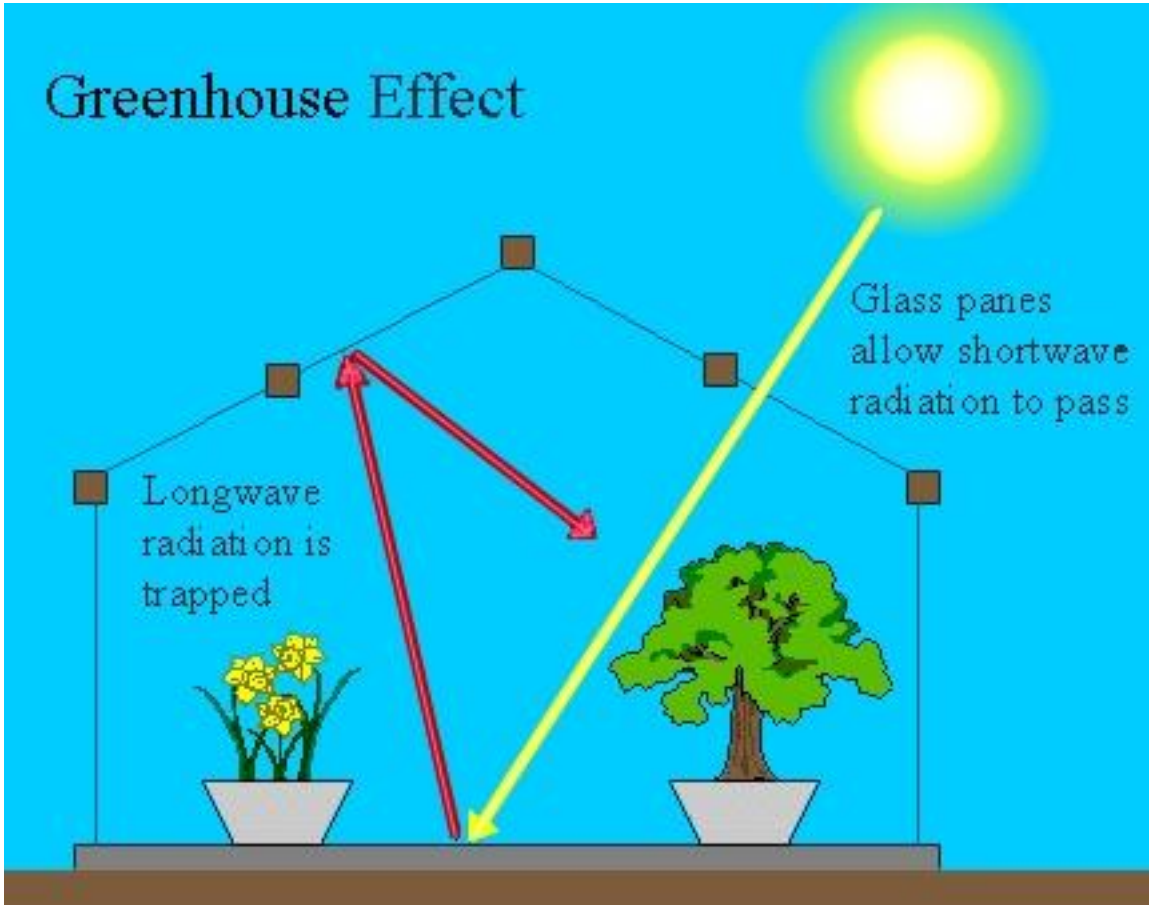

HELP CLOSE THE CONSENSUS GAP
THE PUBLIC PERCEPTION
45%
THINK THERE IS SCIENTIFIC AGREEMENT ON GLOBAL WARMING
THE SCIENTIFIC AGREEMENT
97%
OF CLIMATE SCIENTISTS ACTUALLY AGREE ON GLOBAL WARMING
When people don't realize there's a scientific consensus, they're less likely to support climate action. This underscores the importance of closing the consensus gap.
TheConsensusProject.com
the consensus project


Isaac Cordal sculpture depicting politicians
discussing global warming

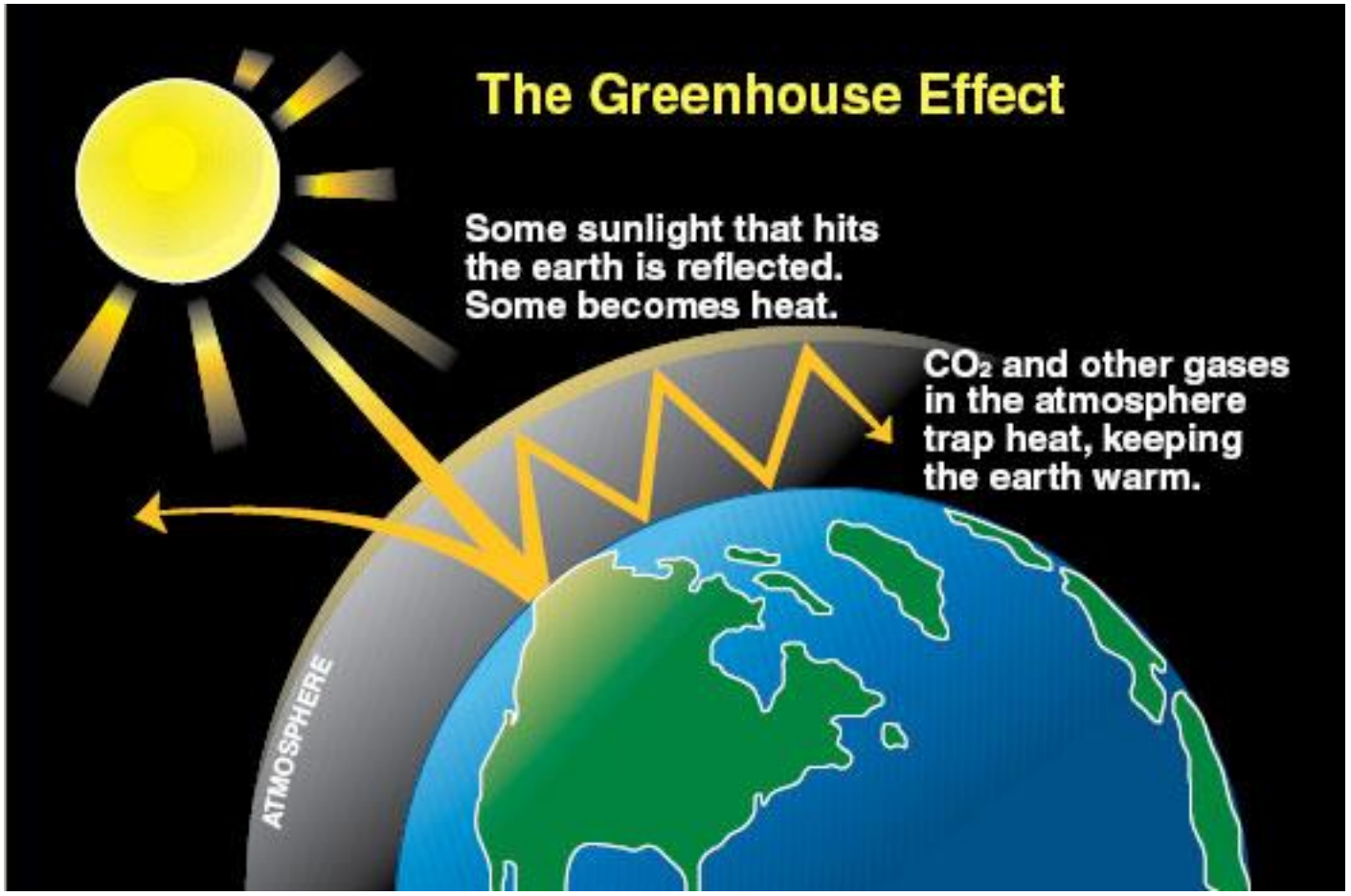
Understanding Climate Change



Greenhouse Effect 101



Greenhouse Effect 101



Greenhouse Effect 101

In the absence of greenhouse gases Earth's average temperature would be:

-18^{o}C!!!

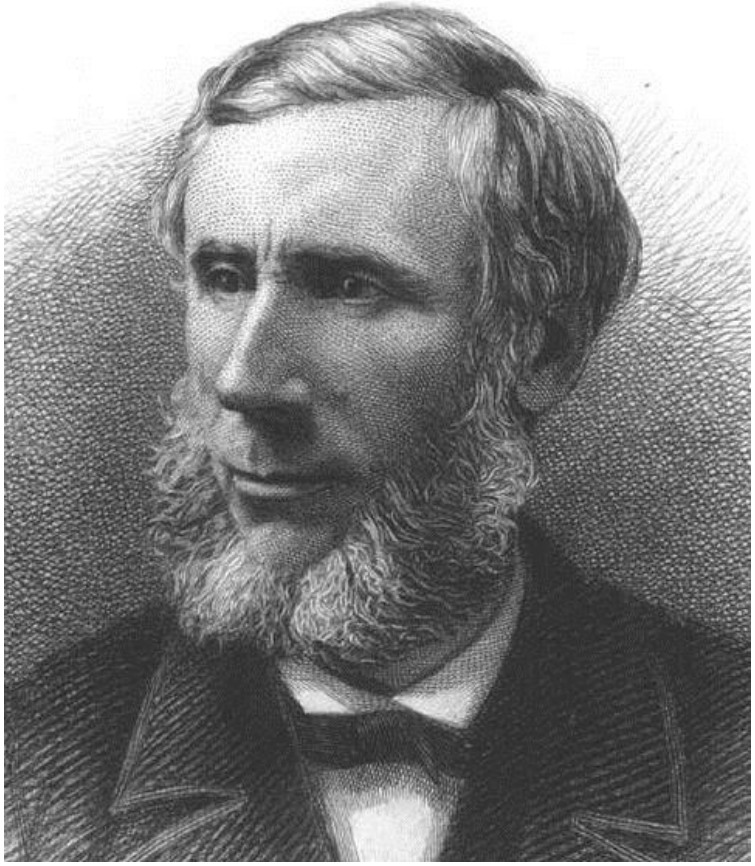
Greenhouse Effect 101

In the absence of greenhouse gases Earth's average temperature would be:

~0°F!!!

Jean Baptiste Joseph Fourier
1827: Recognized warming effect of greenhouse gases

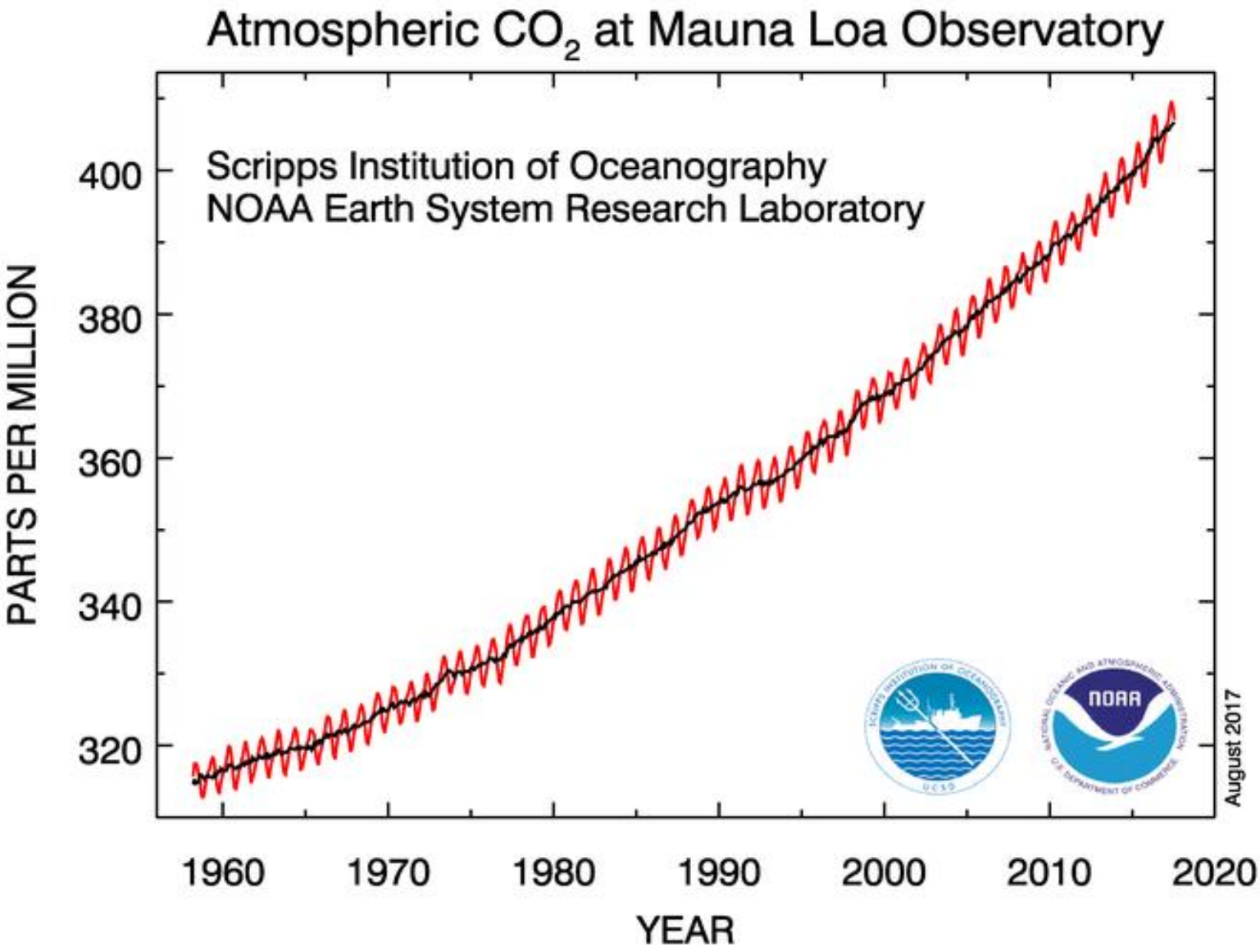
John Tyndall
1864: Measures IR absorption by CO2



Svante Arrhenius
1896:Doubling of CO_2 will warm Earth's surface by 4°C

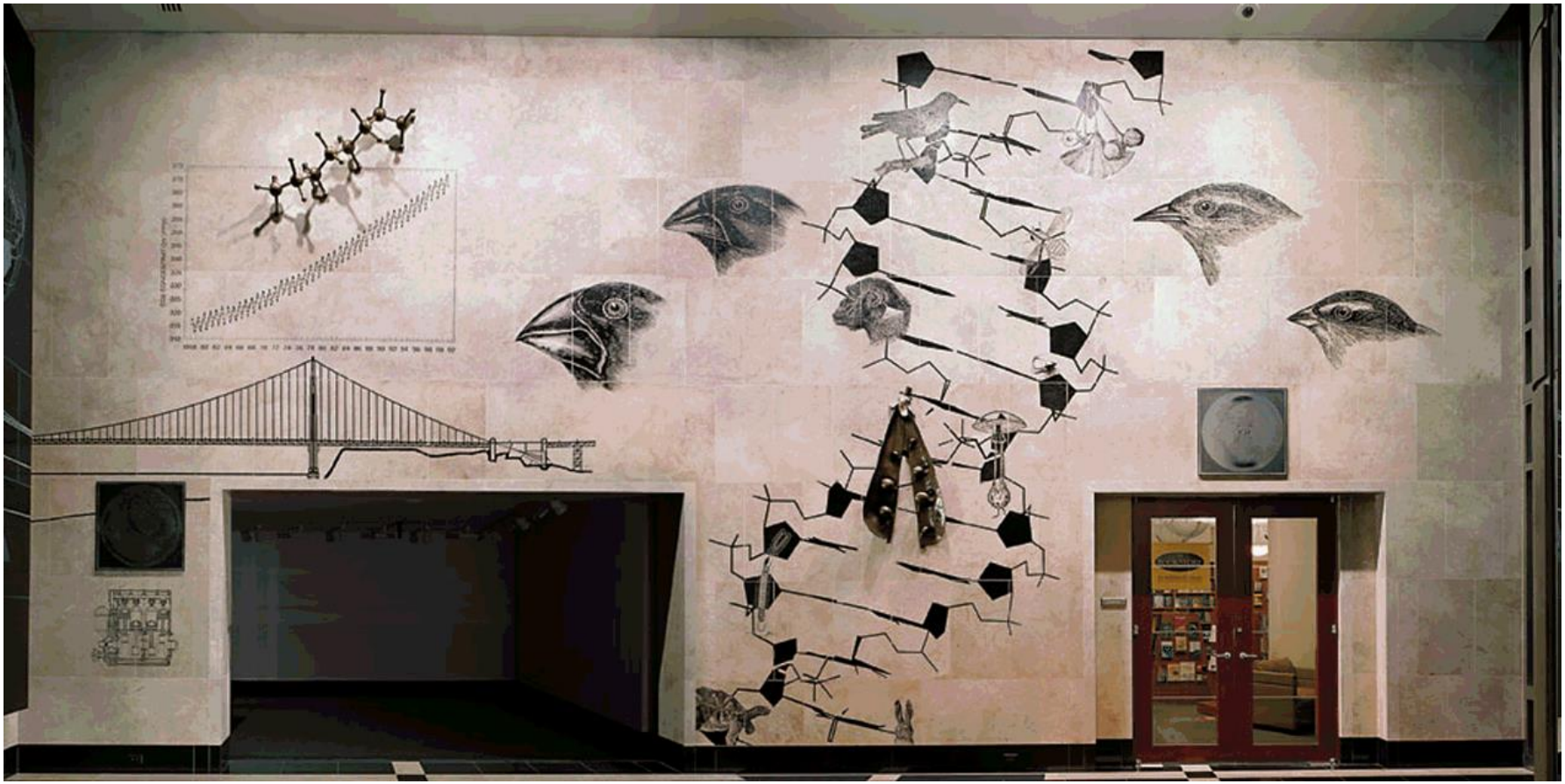
Charles Keeling
1957: starts atmospheric CO2 measurements on Mauna Loa

The Carbon Cycle



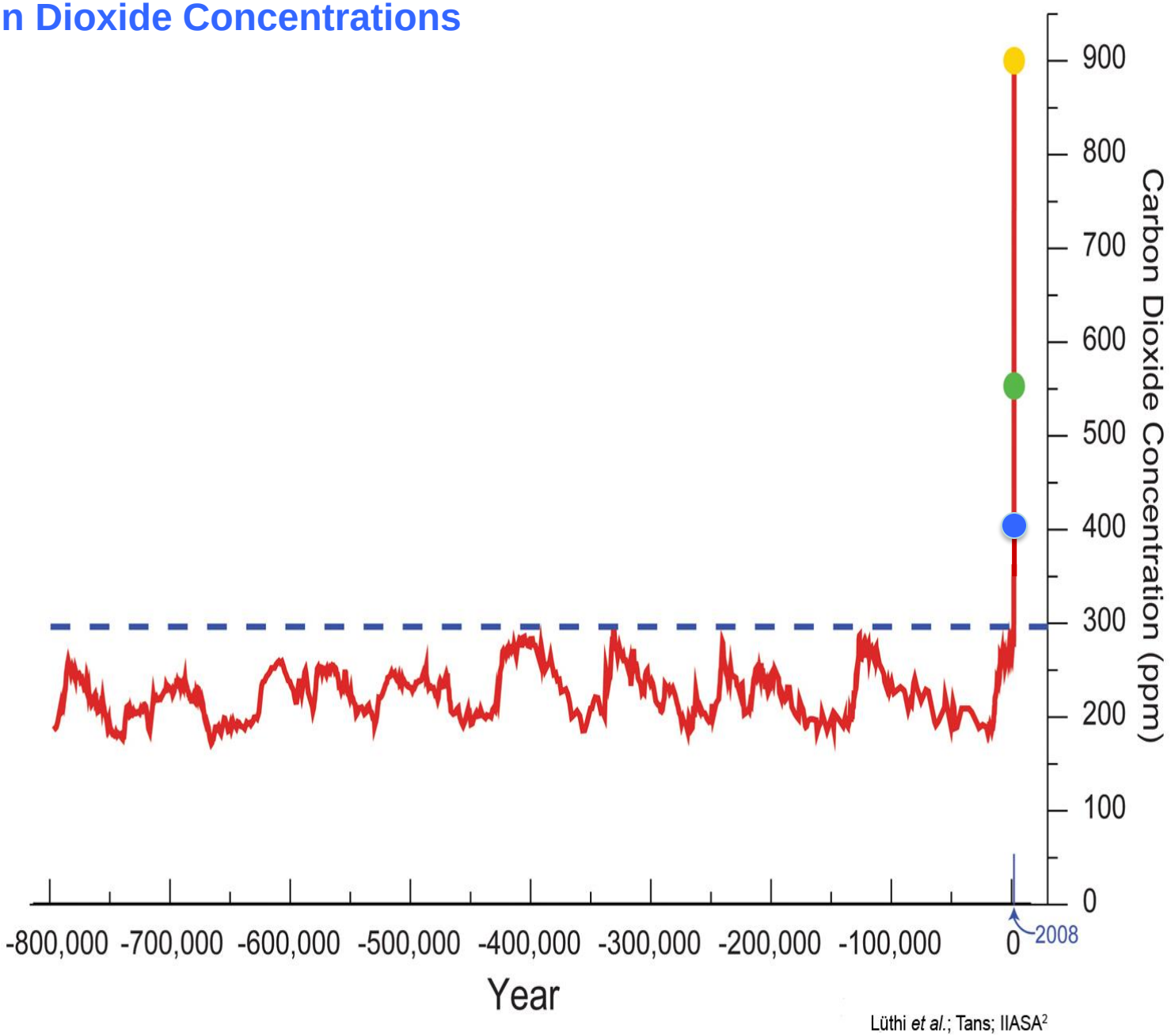
NOAA Earth System Research Lab

Detection of our increasing carbon emissions – one of the most important scientific breakthroughs of the past 150 years



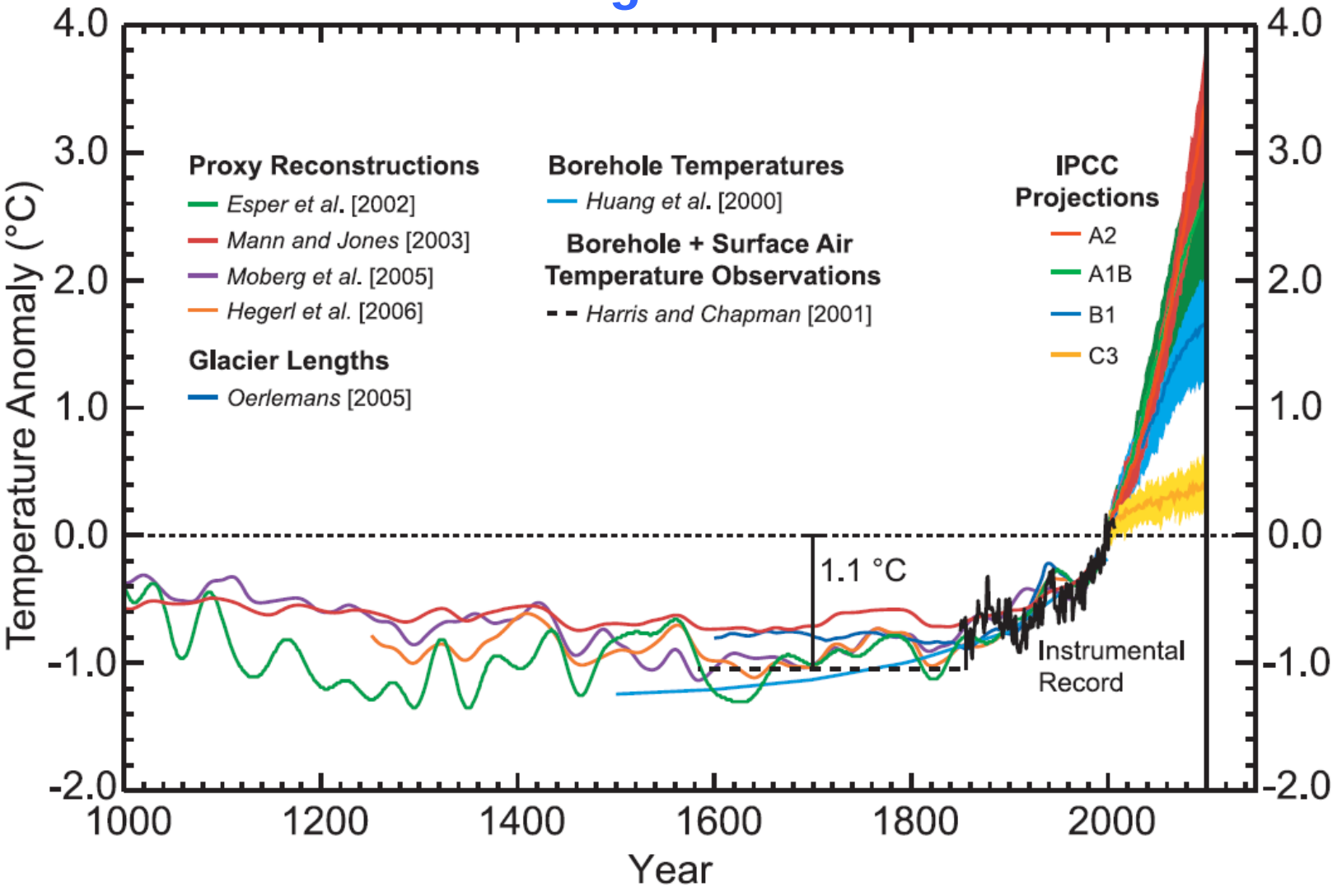
Aren’t these variations in CO2 and Temperature just part of a natural cycle?

Carbon Dioxide Concentrations



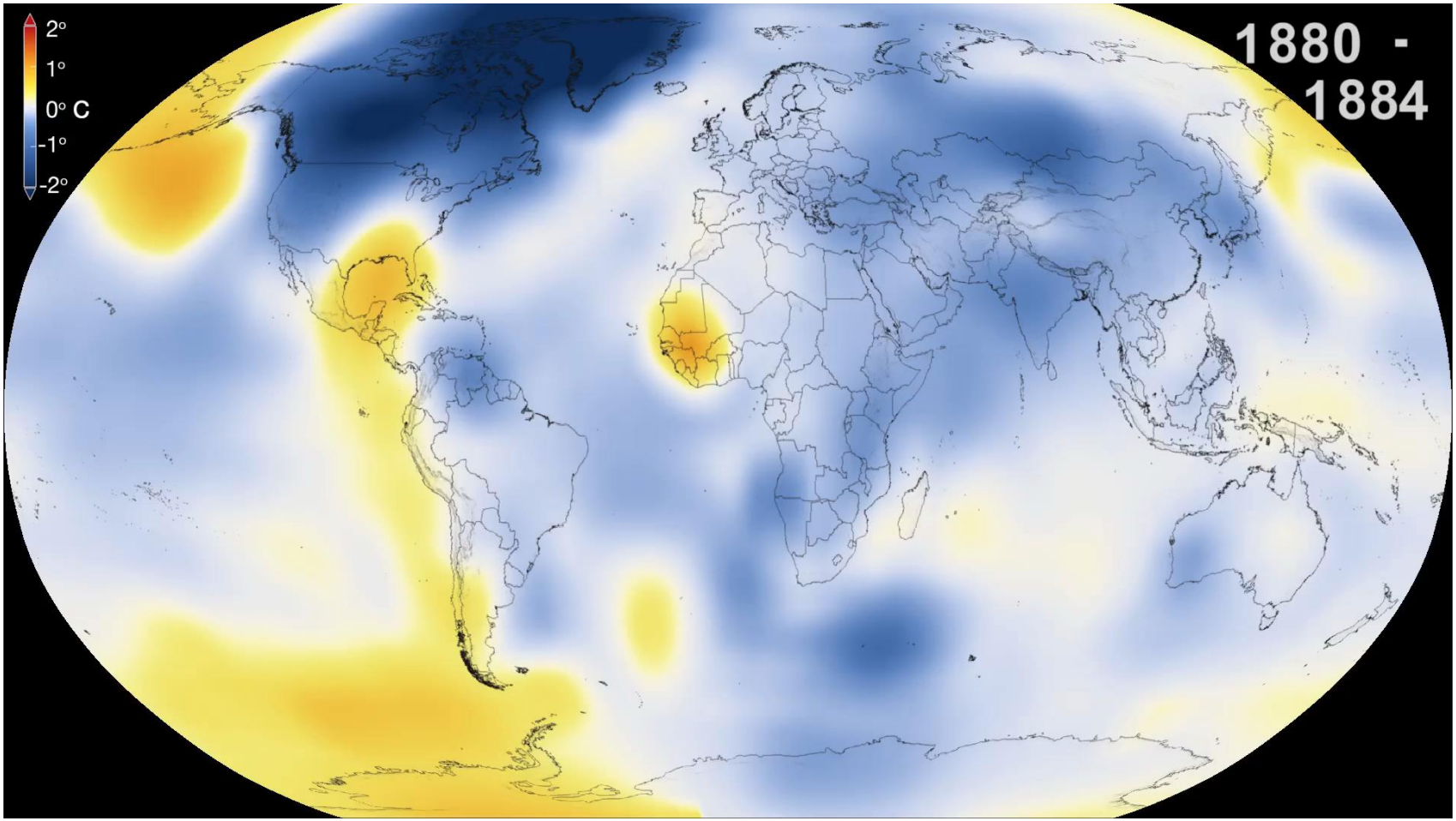
Lüthi *et al.*; Tans; IIASA[2]

What was climate like in the past and how will climate change in the future?



Chapman & Davis, 2010

Temperature anomalies



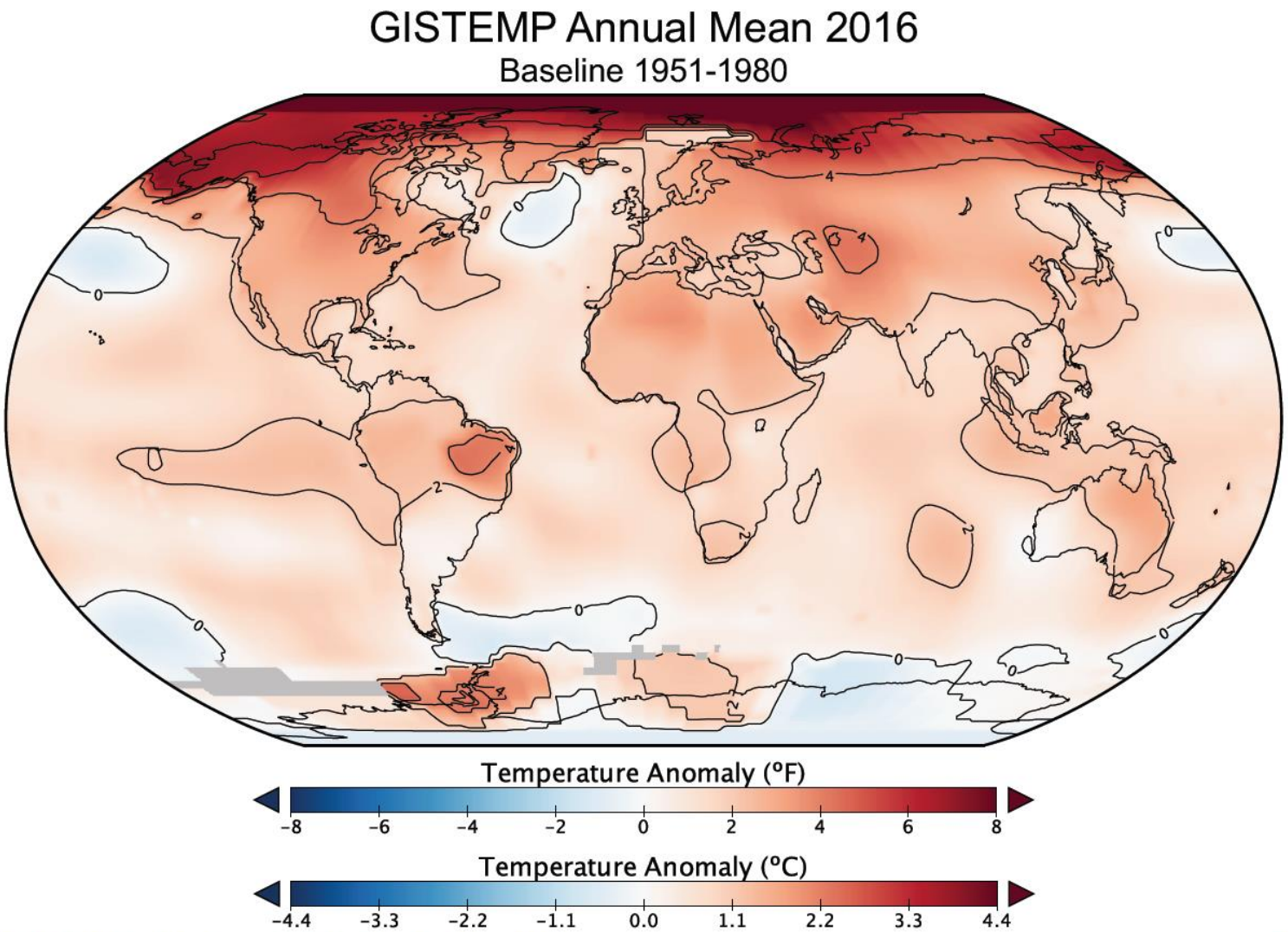
Source: NASA GISS

The year 2016 – warmest year on record

2016:

0.99°C / 1.8°F above 1951-80 average

Warmest year of NASA GISTEMP record



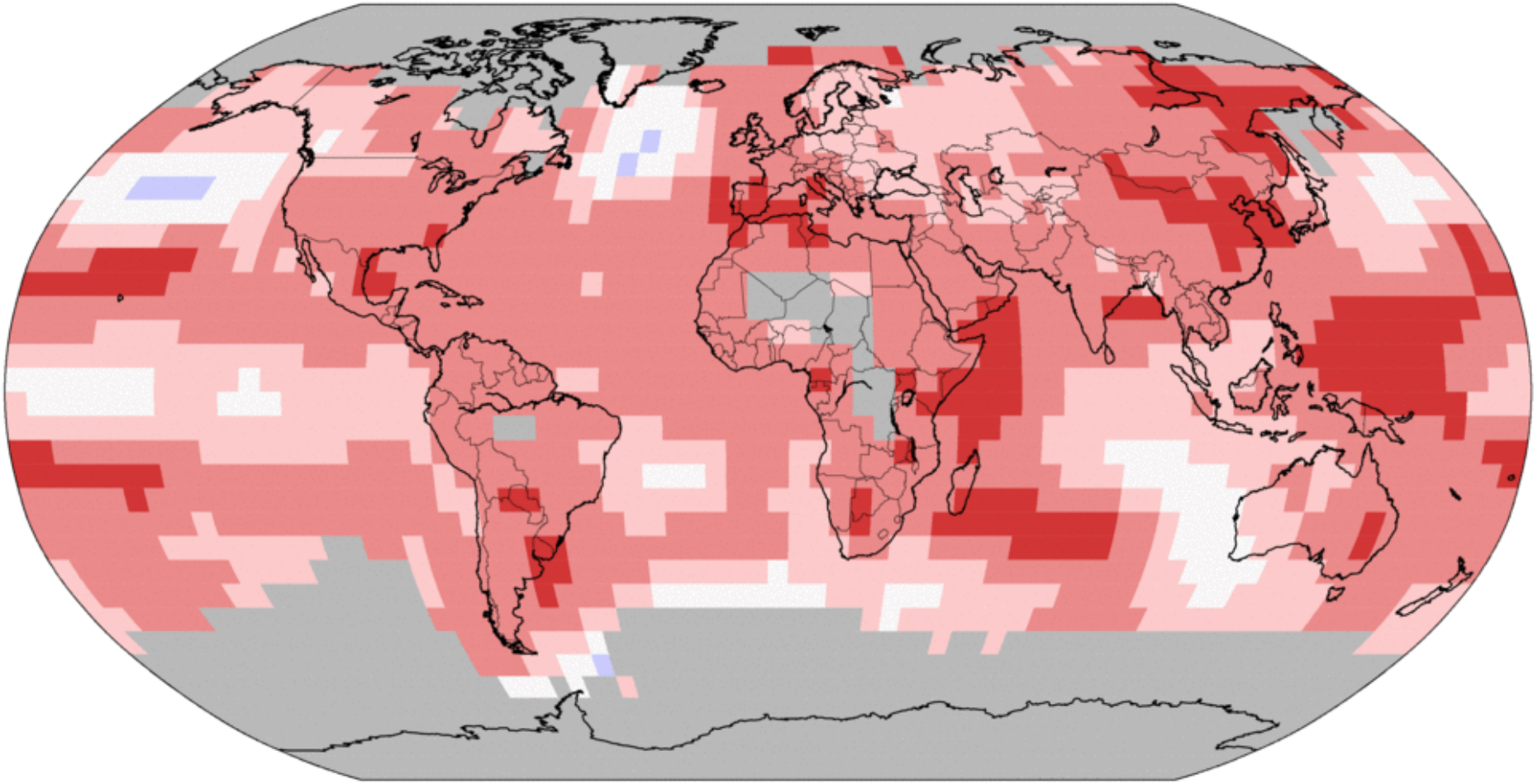
February 1985 was the last time globally averaged temperature fell below the 20th century average for a given month. So if you are younger than 32 yrs…

NOAA/NASA Global Analysis, Jan. 2017

Land & Ocean Temperature Percentiles Jan–Sep 2017

NOAA's National Centers for Environmental Information

Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0

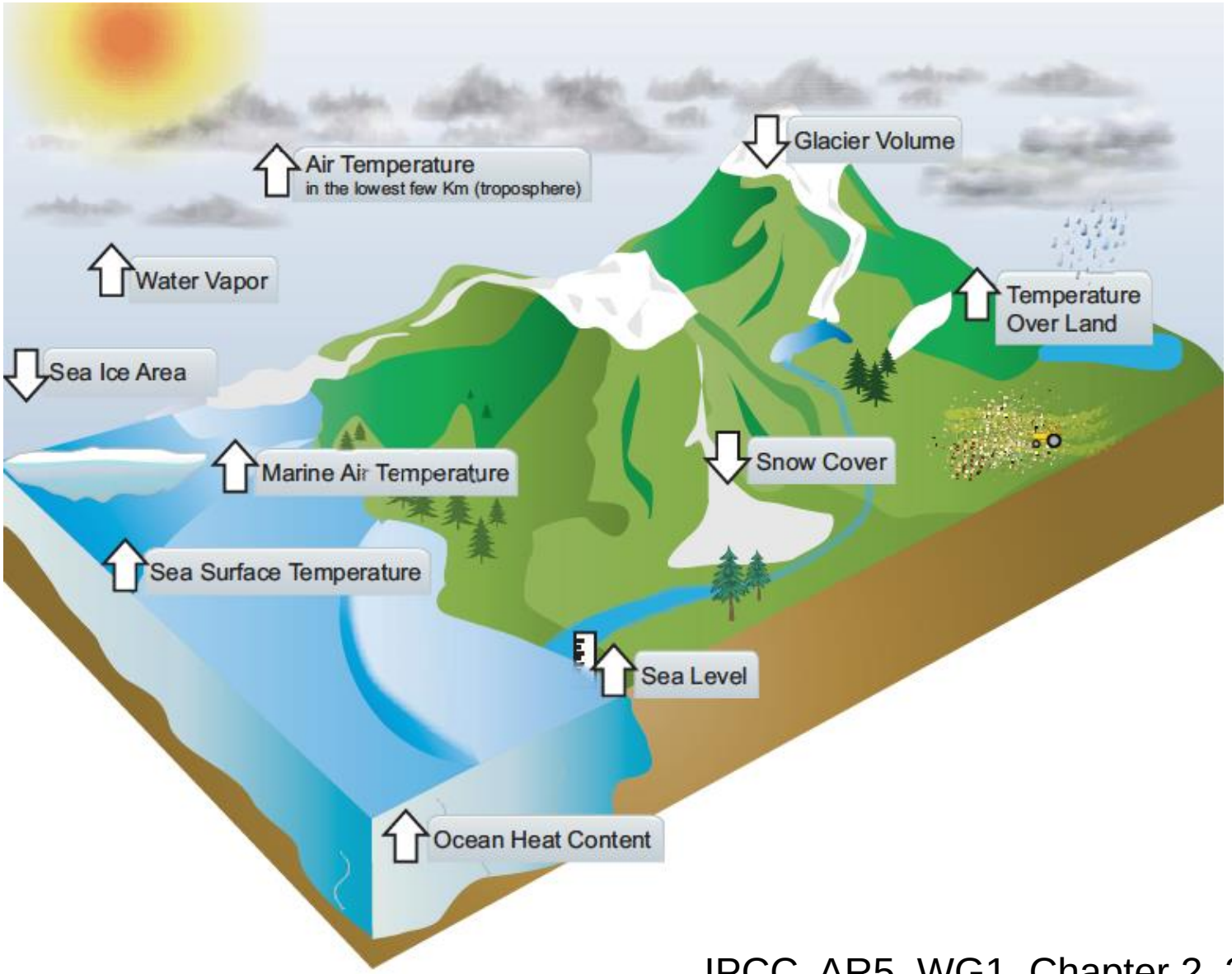


Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

Fri Oct 13 07:08:10 EDT 2017

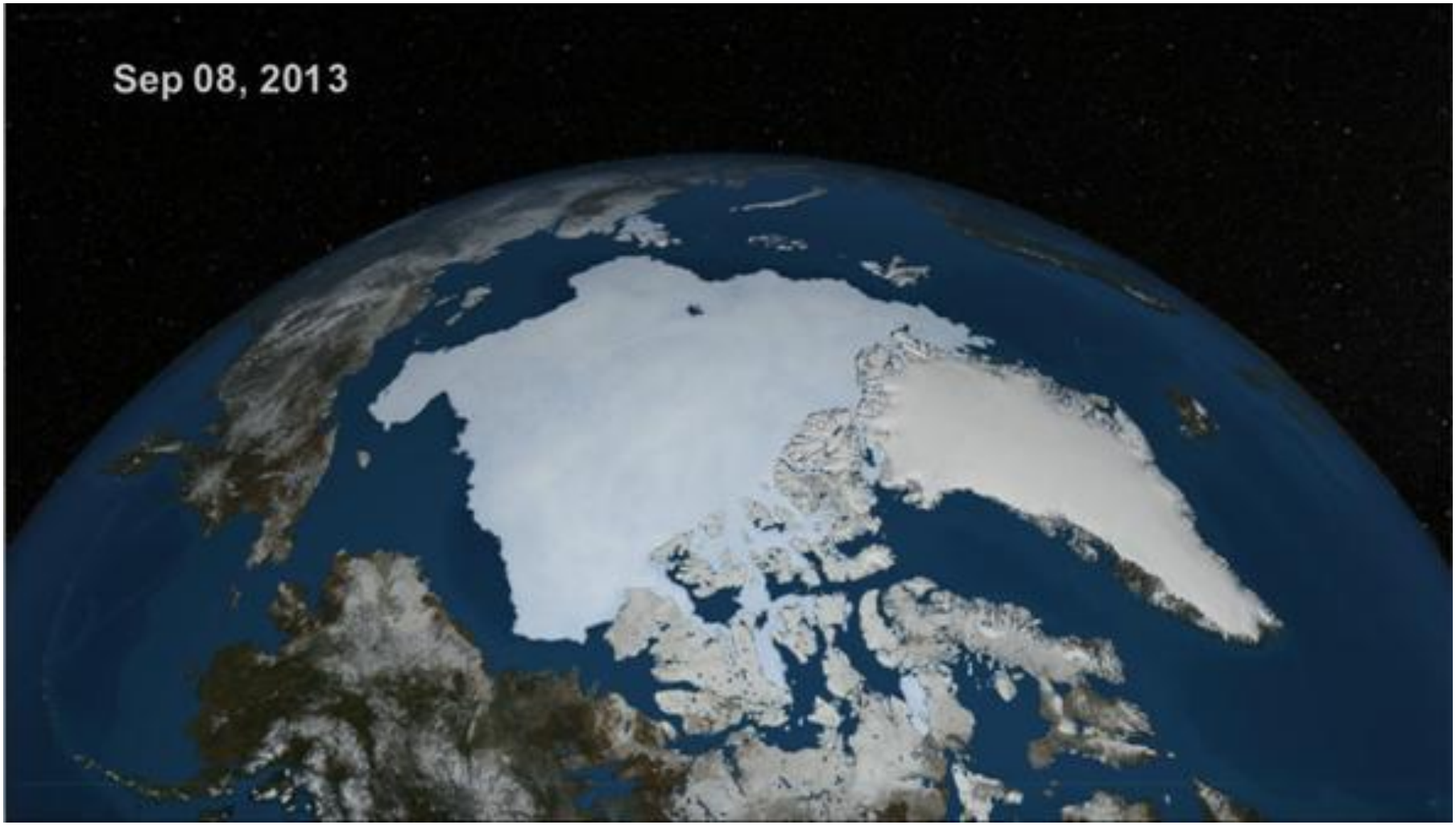
Are there serious impacts associated with global warming?

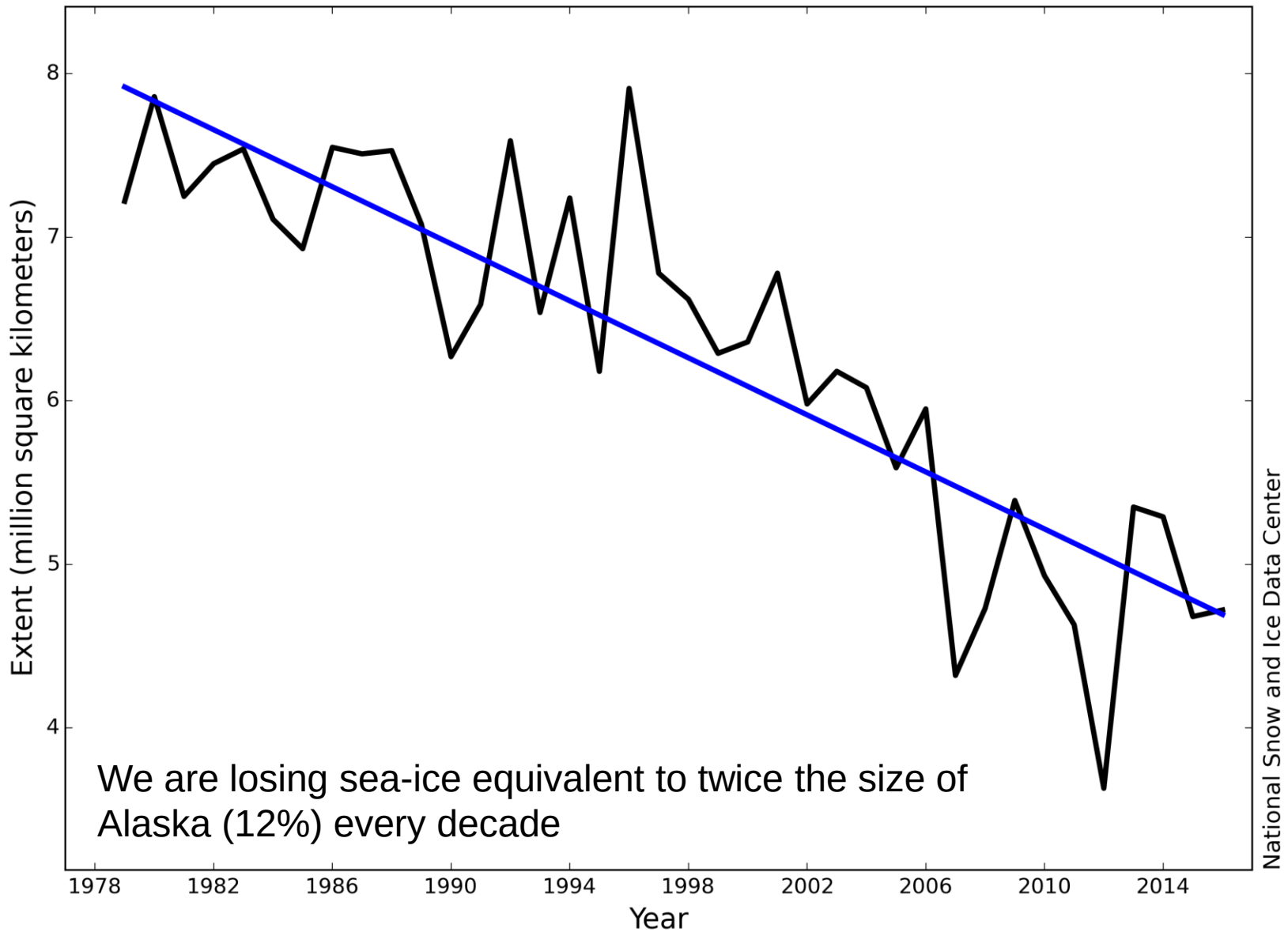
Many components of the climate system that would be expected to change in a warming world exhibit trends consistent with warming



IPCC, AR5, WG1, Chapter 2, 2013

Arctic sea-ice is declining rapidly





http://nsidc.org/arcticseaicenews/

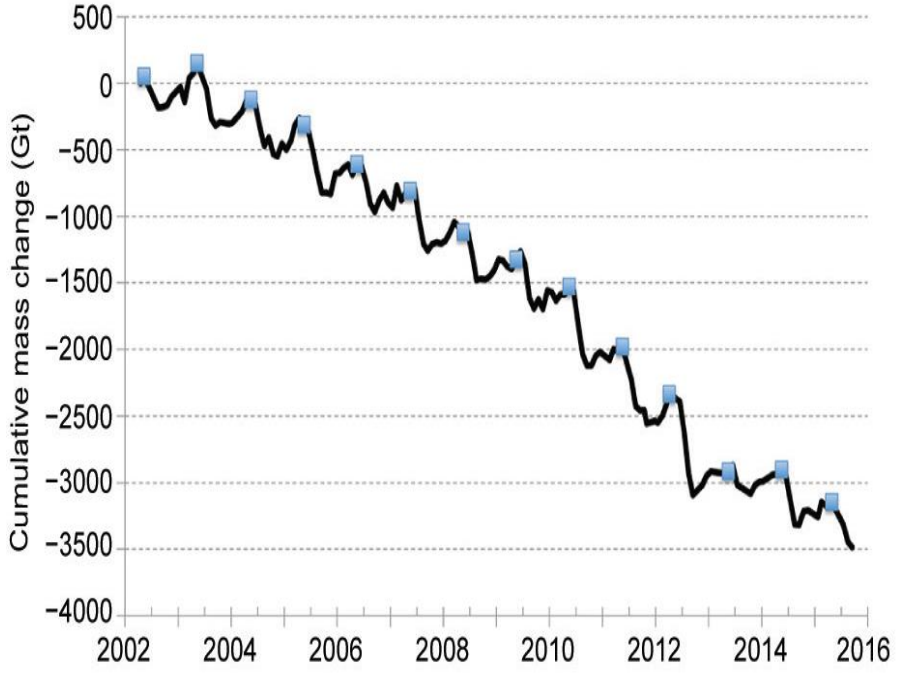
Greenland mass balance from GRACE

Mean mass loss in Greenland
2003-2014: 265 Gt / yr

Loss is accelerating:

Record mass loss in
summer (JJA) of
2012: 627 Gt

Blue symbols
denote April values
for reference



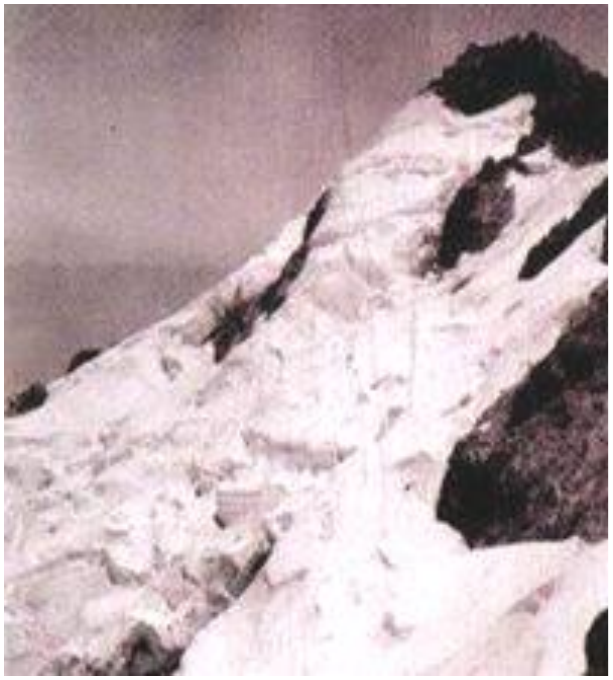
State of Climate in 2015, BAMS, Supplement 97(8), 2016

Observations of glacier retreat

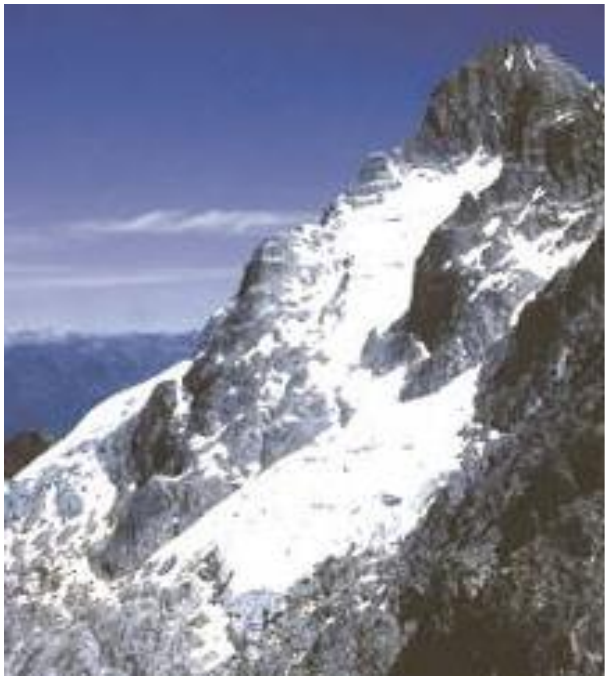
Glacier Espejo, Pico Bolivar (5002 m)
Venezuela

< 2 km^2 of ice
left in Venezuela

1910

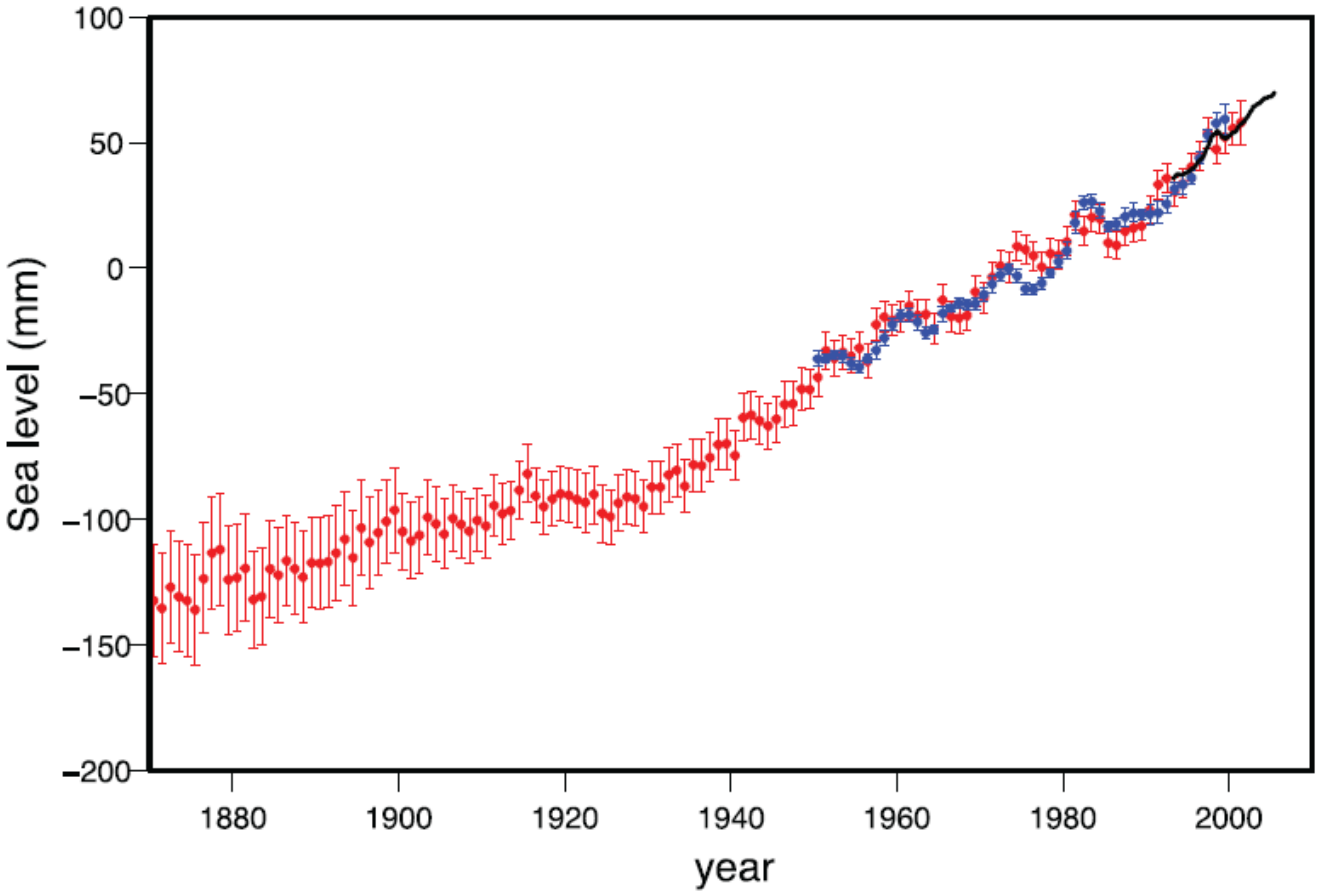


1988



2008

How much has sea level gone up in the 20th century?



Red: reconstructed (+ 90% confidence intervals)

Blue: coastal tide gauge measurements

Black: satellite altimetry

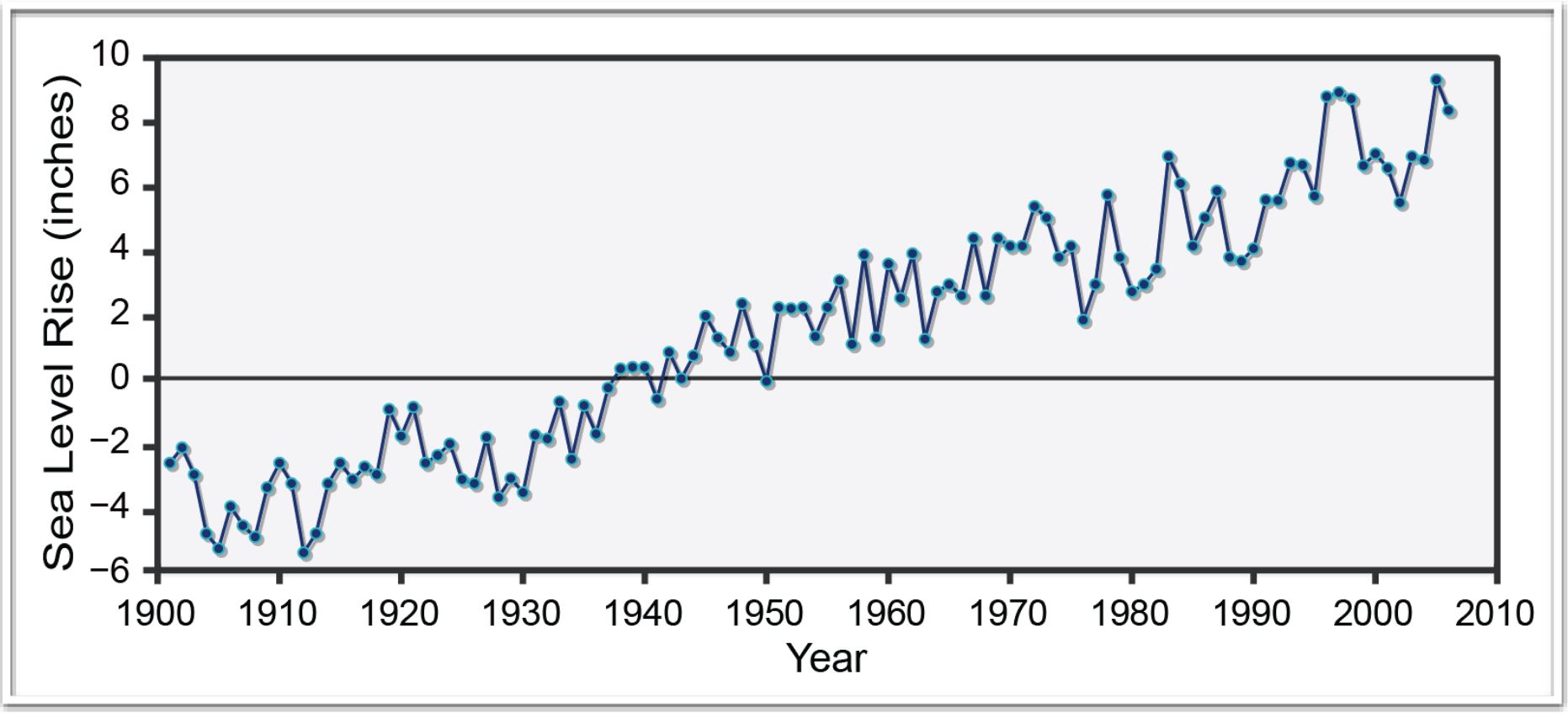
Current global sea level rise: 3.5 mm/yr

Total change over this period: ~7.9inches

IPCC, AR4, WG1, 2007;
BAMS, Aug. 2009

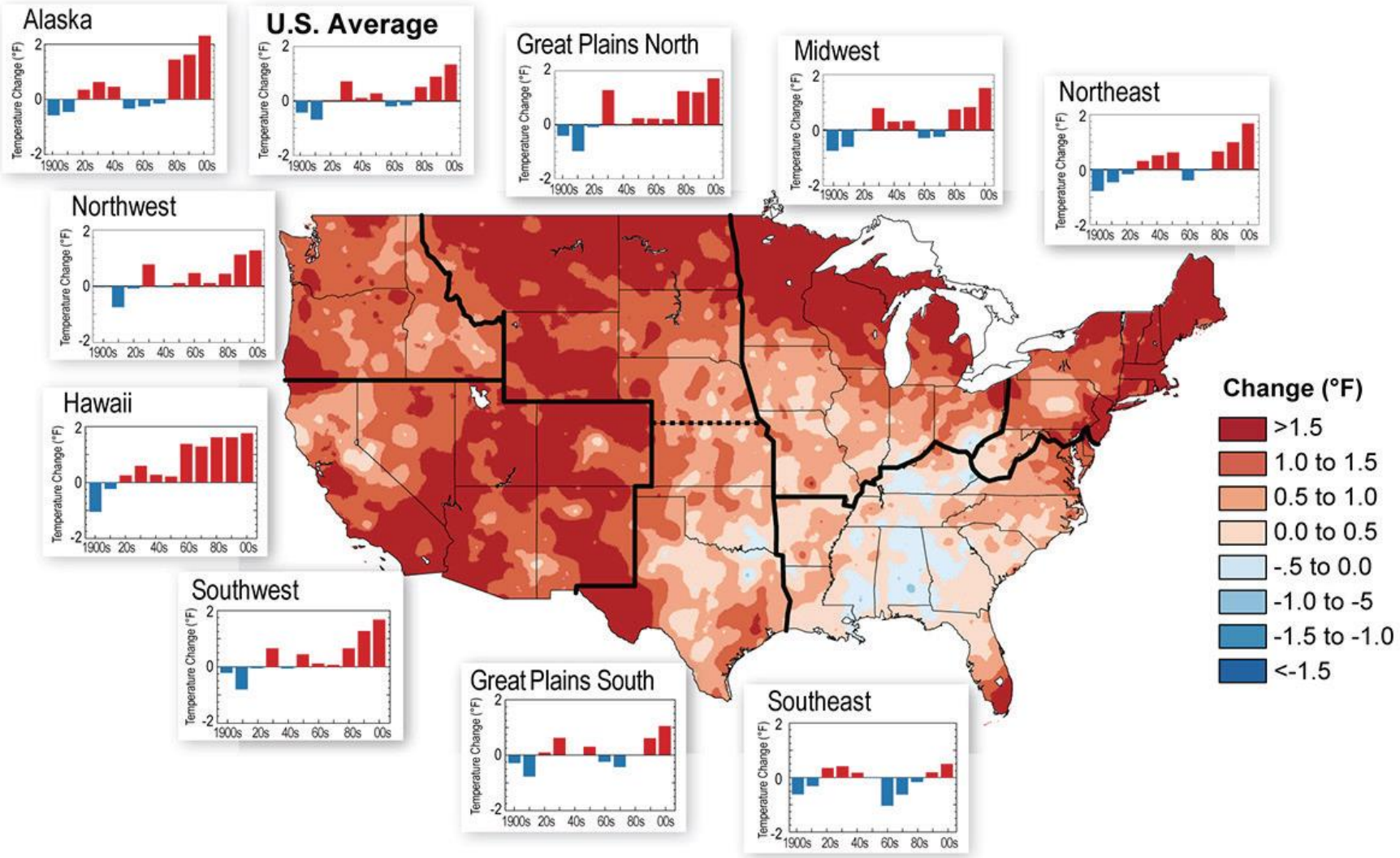
Observed Changes in the US and North East

Observed Sea Level Rise in New York City



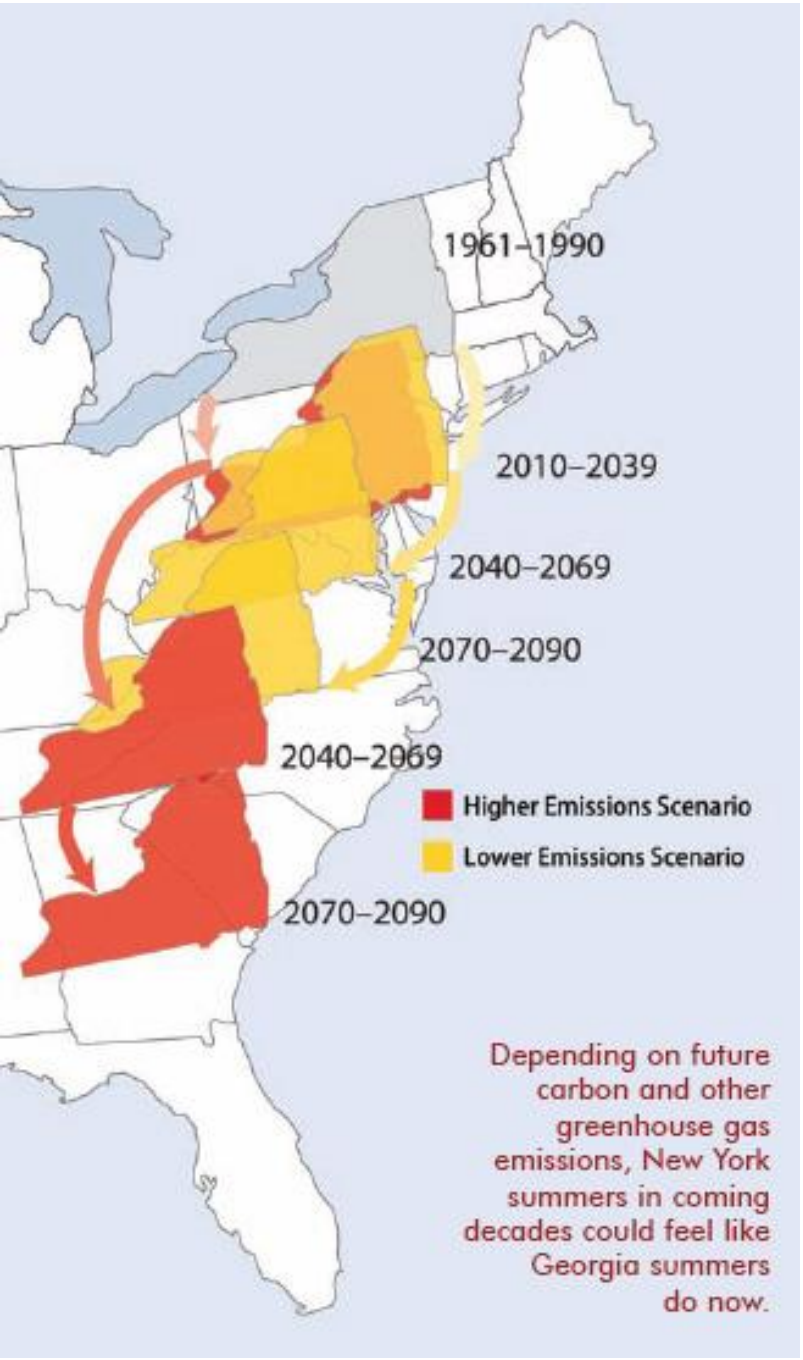
US Global Change Research Program, 2013 Draft

Observed U.S. Temperature Change



1991-2011 minus 1901-1960

US National Climate Change Assessment (2013)



"New York is on the move"

Yellow: path under low emission scenario

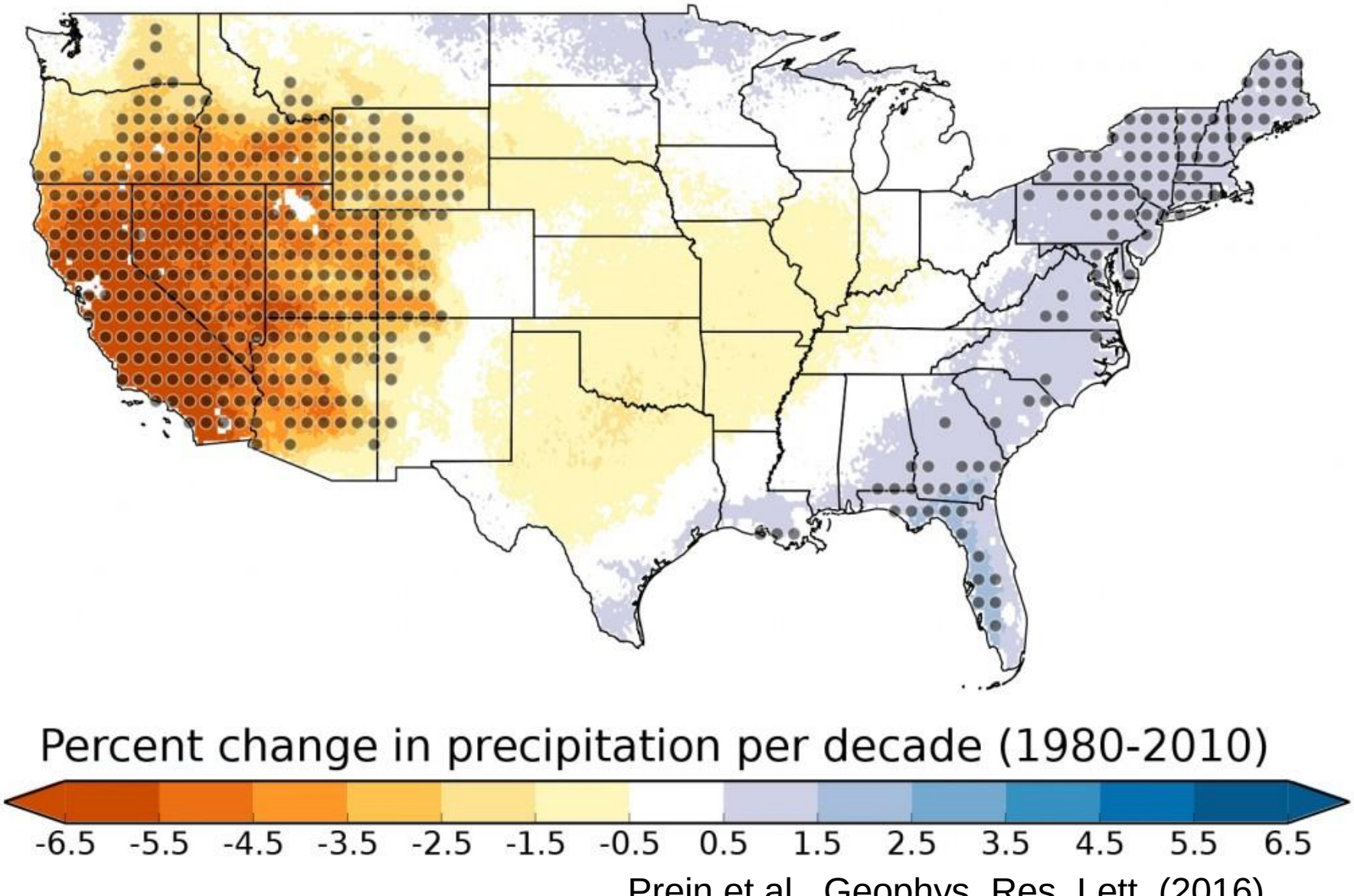
Red: path under high emission scenario

→ late this century residents in New York might experience a summer climate similar to today's summer climate in Georgia

US Global Change Research Program, 2009

Drying the Southwest

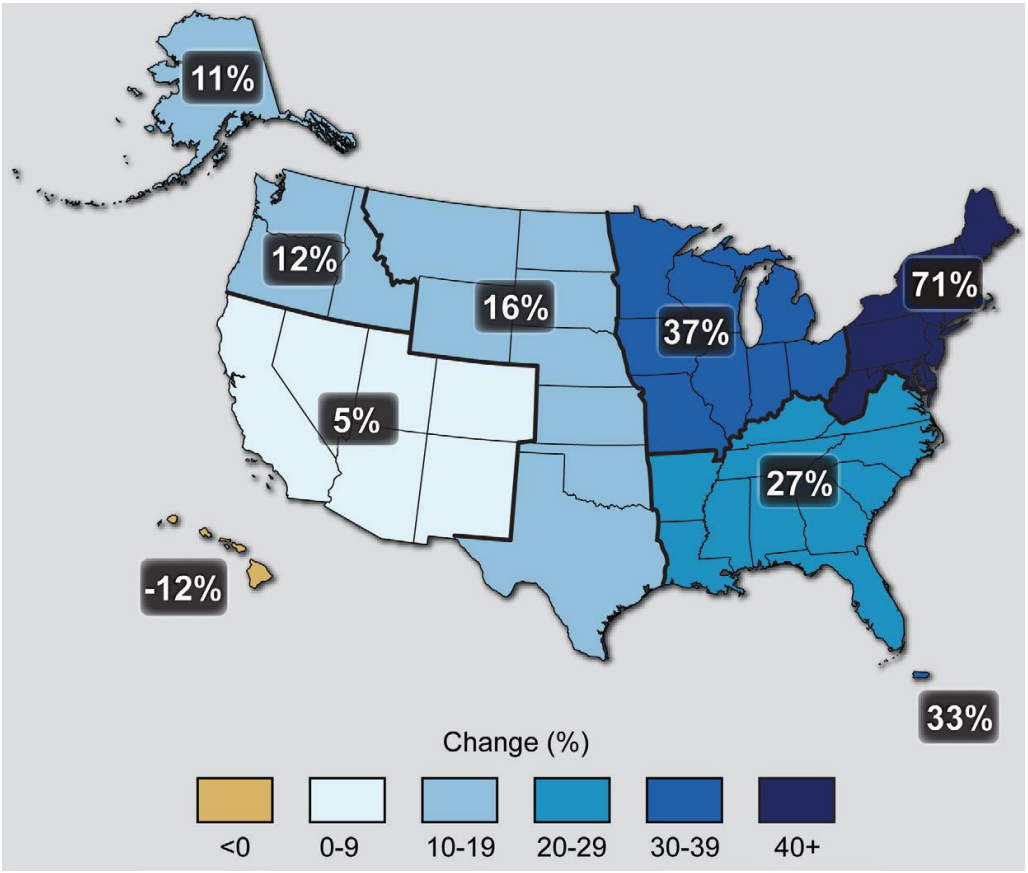
Weather systems that bring rain are becoming more rare



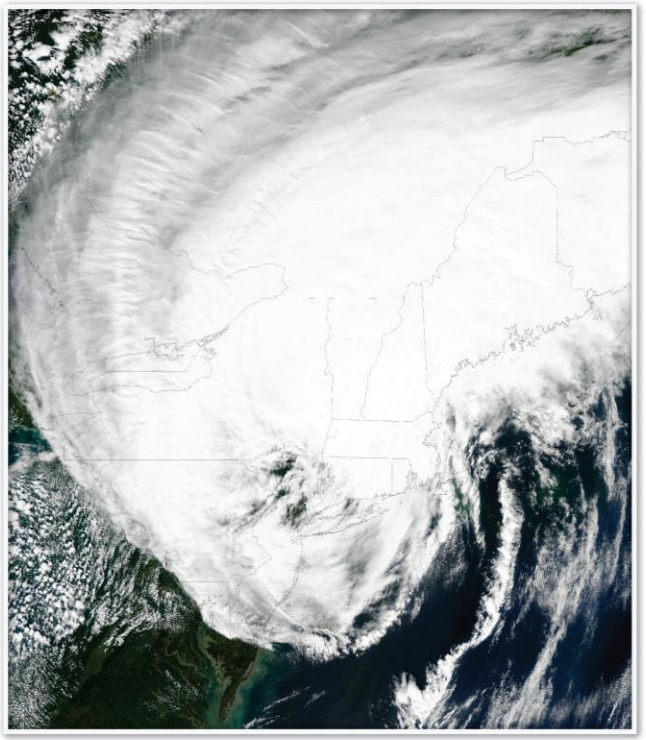
Prein et al., Geophys. Res. Lett. (2016)

Extreme precipitation events have increased in the northeast

% change in heavy precipitation events 1958 - 2012



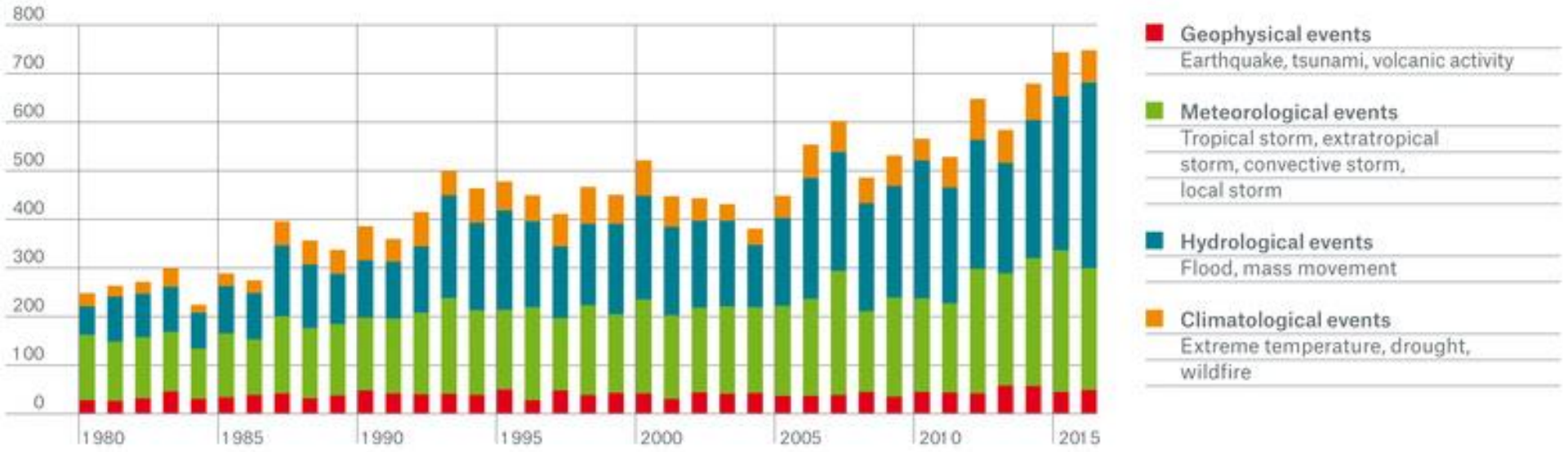
Flooding and Hurricane Irene



US Global Change Research Program, 2014

Losses due to Extreme Weather

- Global losses due to increasing frequency and intensity of extreme weather events have been increasing with time.
  - Part of this increase likely due to climate change, but how much is uncertain.
  - Part of this increase is due to increasing population (i.e., more people in harms way).

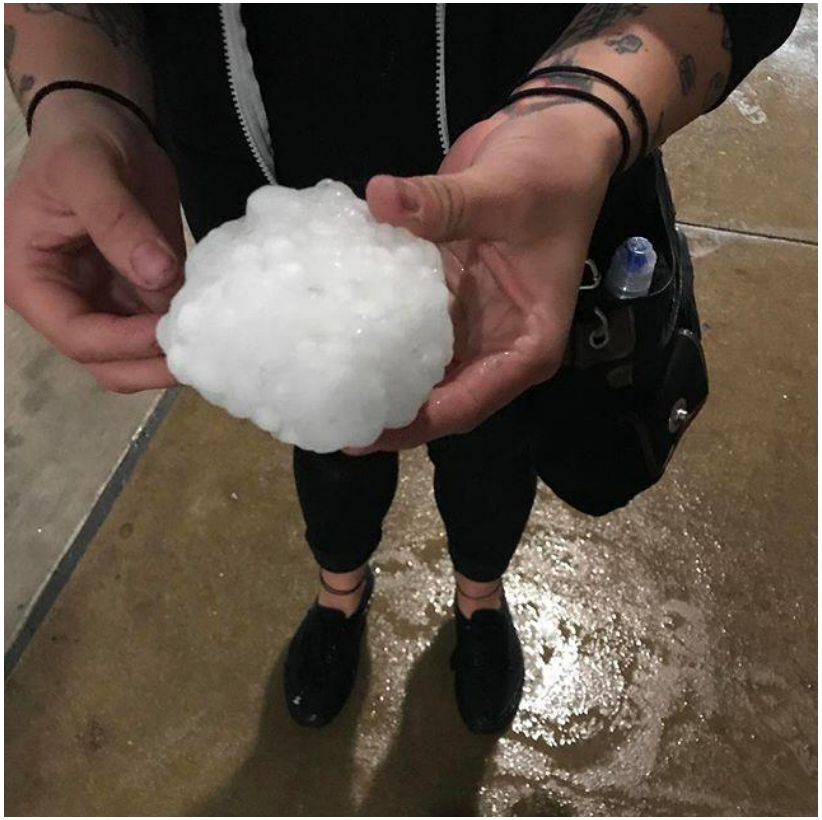


Insured losses (billions of $) due to extreme weather events (green, blue, and orange bars). Source: Munich RE.

Slide Courtesy Brian Tang

And then this happened in 2017…

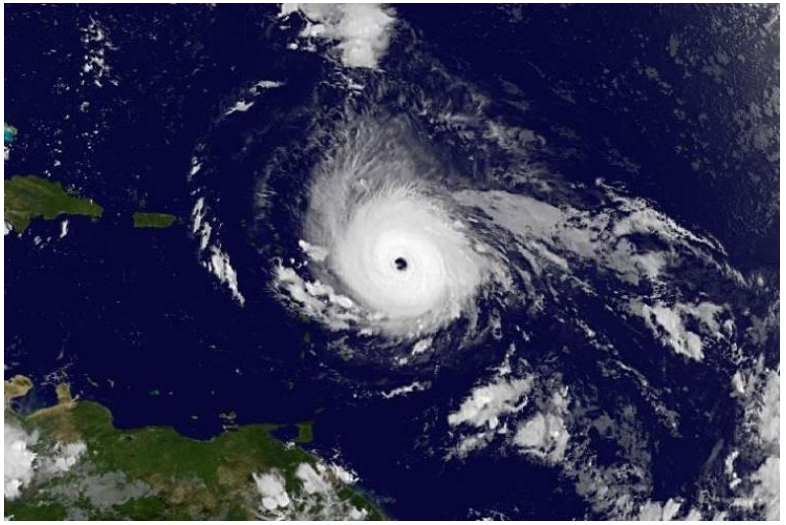
Record rains and flooding in N. California damaged the Oroville Dam.



A massive hailstorm struck the Denver metro area and was the costliest hailstorm ever to hit Colorado.

And then this happened in 2017…

Hurricane Harvey produced record amounts of rainfall and inundated SW Texas.



Hurricane Irma was the second most intense hurricane ever observed in the N Atlantic Ocean.

Hurricane Maria devastated all of Puerto Rico.

And then this happened in 2017…

Severe drought affected Montana, N Dakota, and S Dakota.

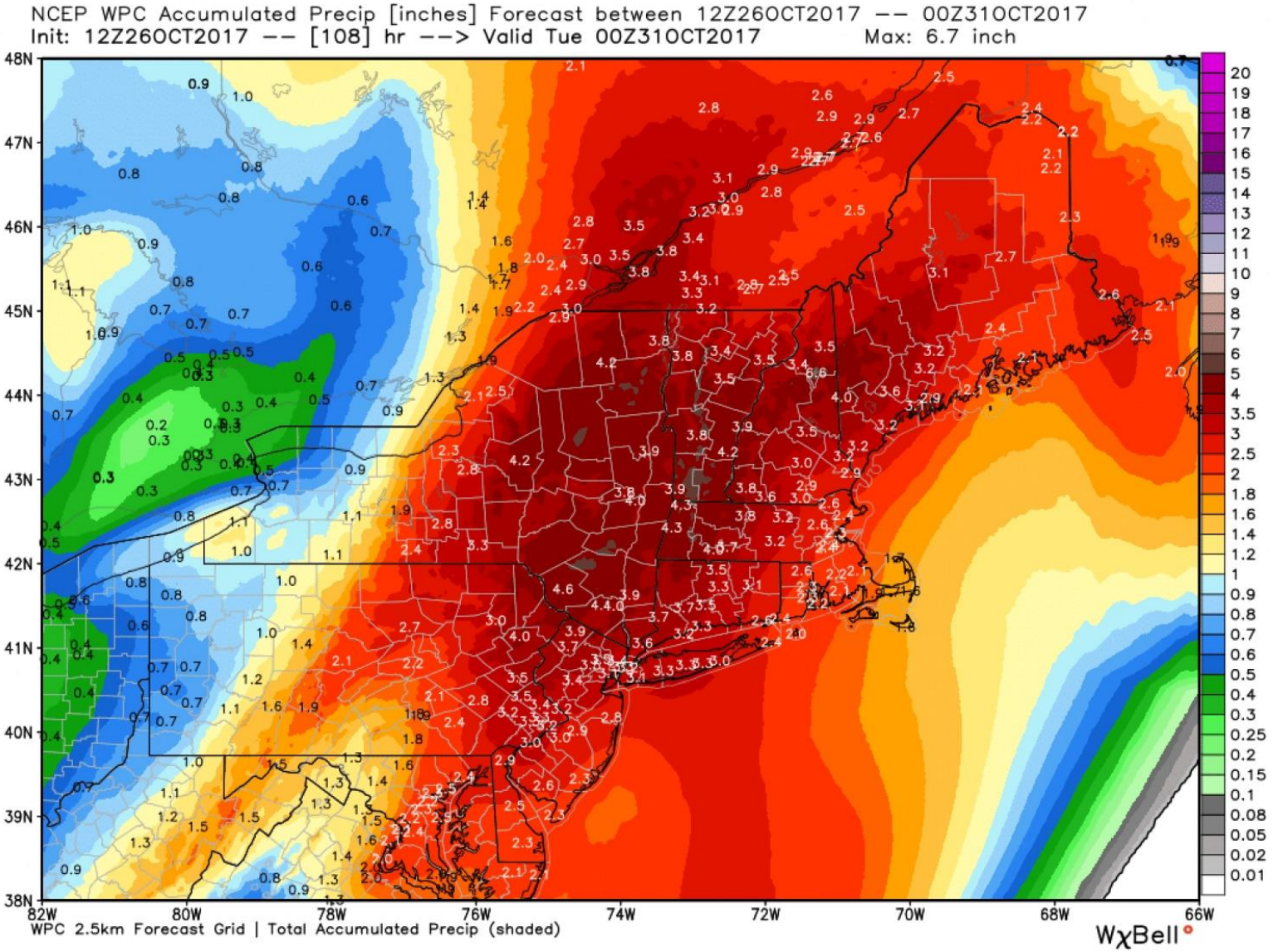
The Tubbs Fire, driven by high winds and dry conditions, burnt down many houses in Santa Rosa, CA.

And then this happened in 2017…

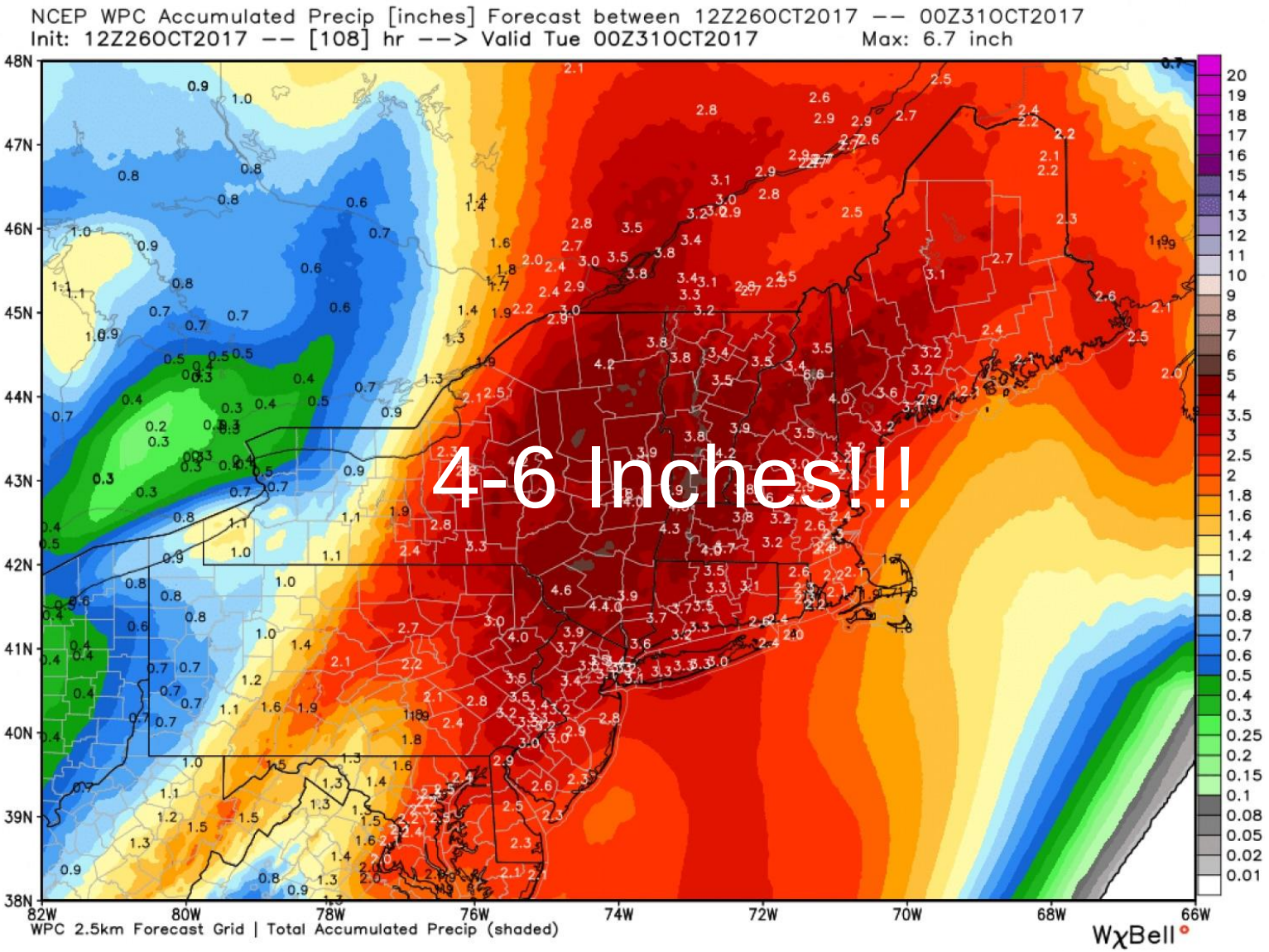
Severe drought affected Montana, N Dakota, and S Dakota.

The Tubbs Fire, driven by high winds and dry conditions, burnt down many houses in Santa Rosa, CA.

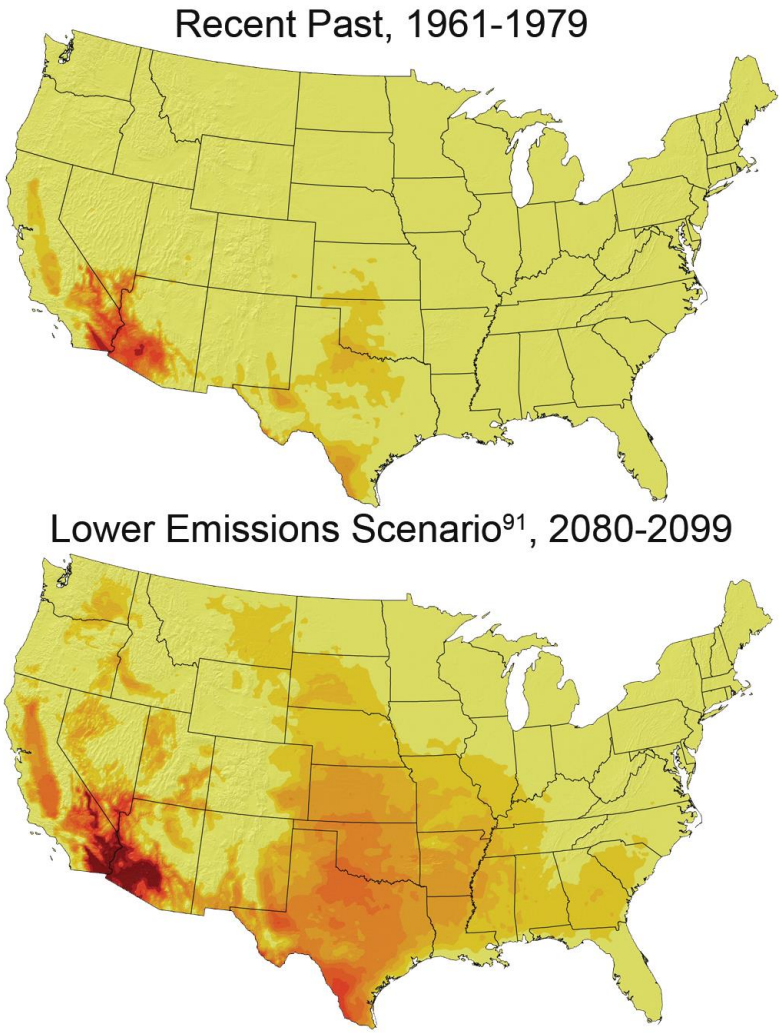
Rainfall Forecast for Sunday in the North East!

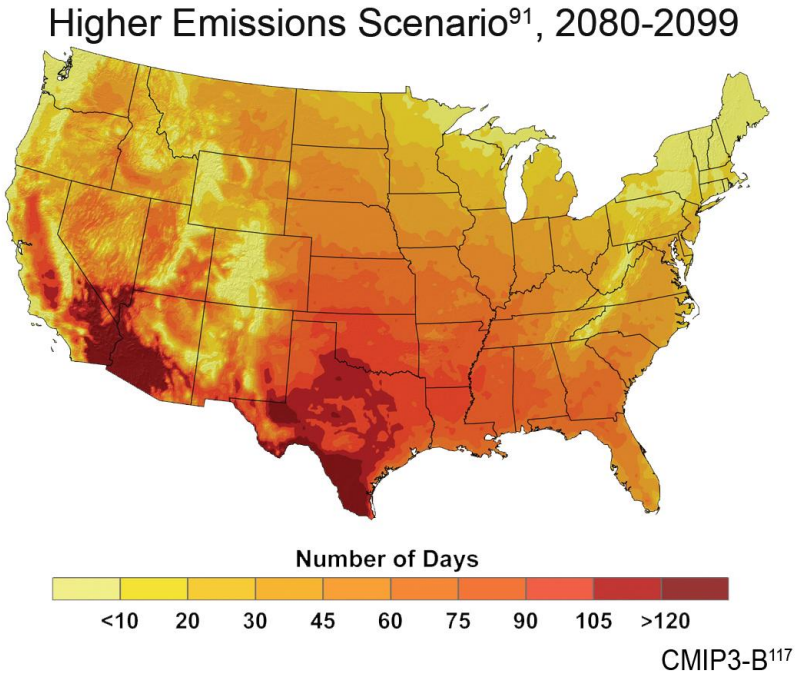


Rainfall Forecast for Sunday in the North East!



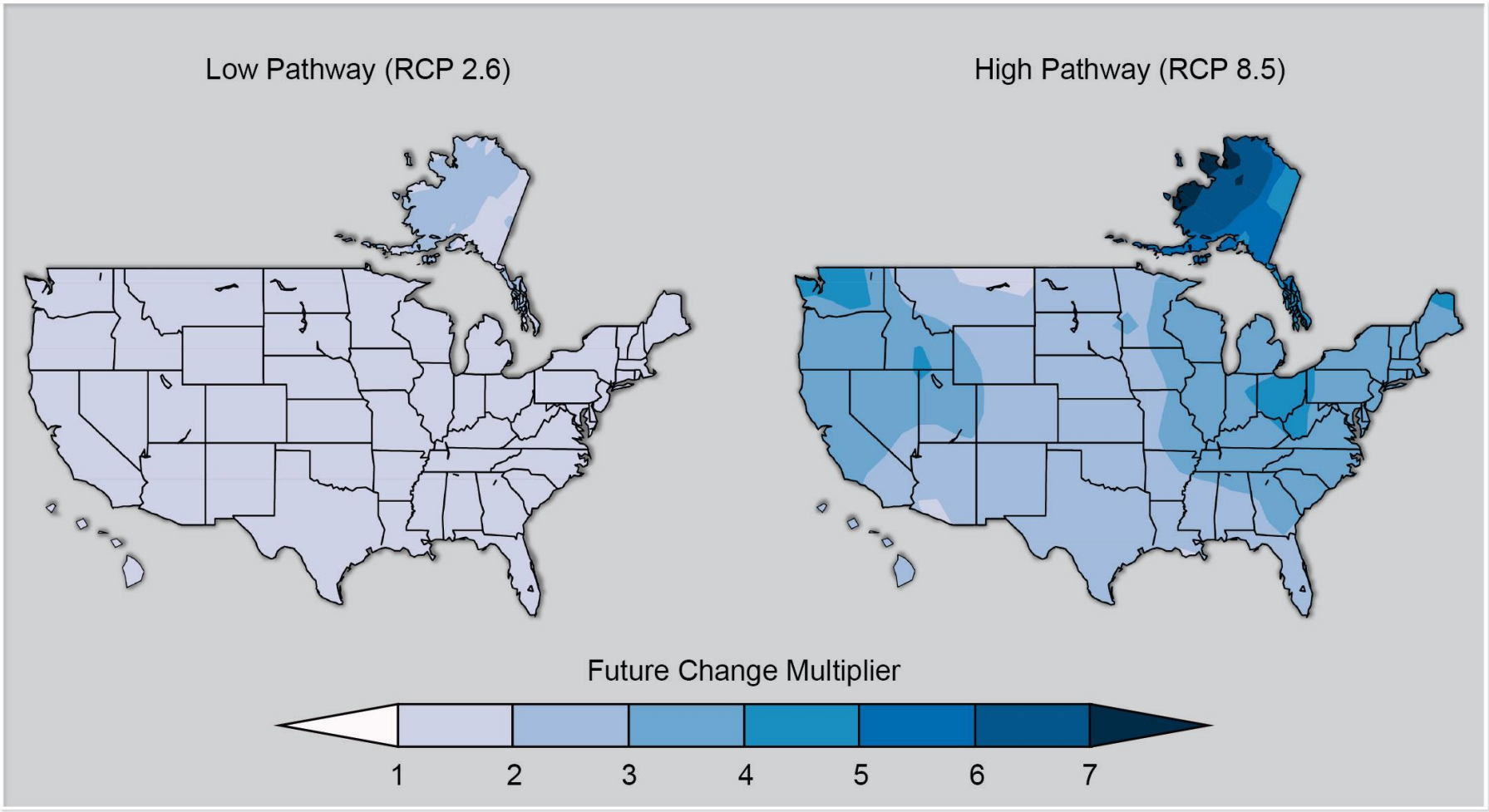
Number of days when T_{max} > 100° F





US Global Change Research Program [2014]

Rare Heavy Precipitation Events Become More Common



1-20yr events now are projected to become more likely by the end of the 21st Century.
In NE: Low-emissions: ~2 x more likely, High-emissions: ~4 x more likely

The Climate Change Challenge

'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,
Former President, American Association for the Advancement of Science
now Director of the White House Office of Science and Technology Policy (OSTP)

The US commitment to reduce greenhouse gases (COP 21 in Paris)

All major economies were asked to submit post-2020 emission reduction targets to UN by April 2015:

USA: **cut emissions by 26-28% below 2005 levels by 2025 (~4% below 1990 levels)**

Canada: **cut emissions by 30% below 2005 levels by 2030**

EU: **cut emissions by 40% below 1990 levels by 2030**

Switzerland: cut emissions by 20% below 1990 levels by 2020

Australia: **cut emissions by 5% below 2000 levels by 2020**

China: **peak emissions by 2030**

India: **reduce GDP-based emission intensity by 33-35% below 2005 levels**

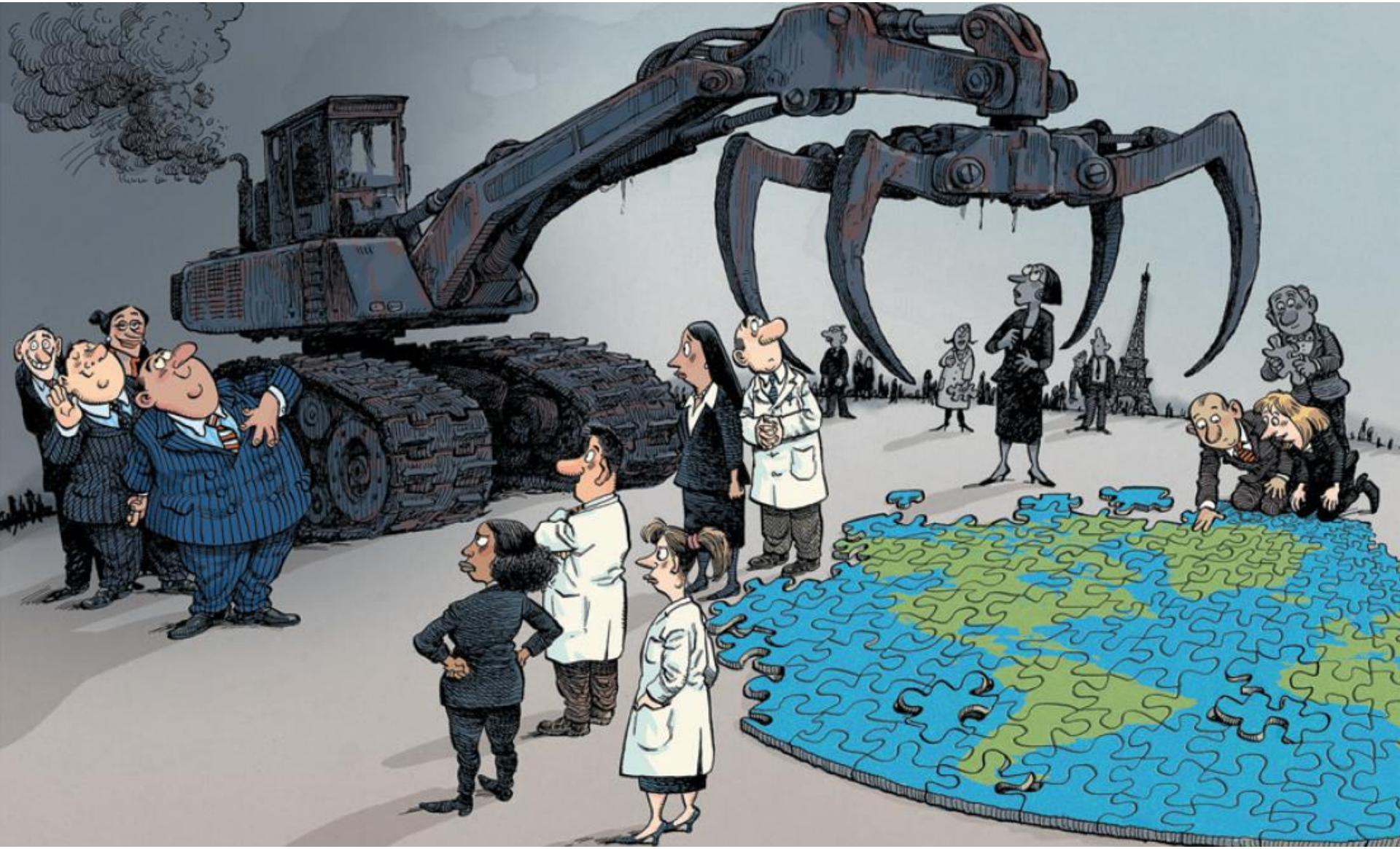
THANK YOU


AN INCONVENIENT TRUTH
A REASSURING LIE
THE CHRISTIAN SCIENCE MONITOR
Bennett

EXTRA SLIDES

Climate Change policies (from Rio to Kyoto and Paris)

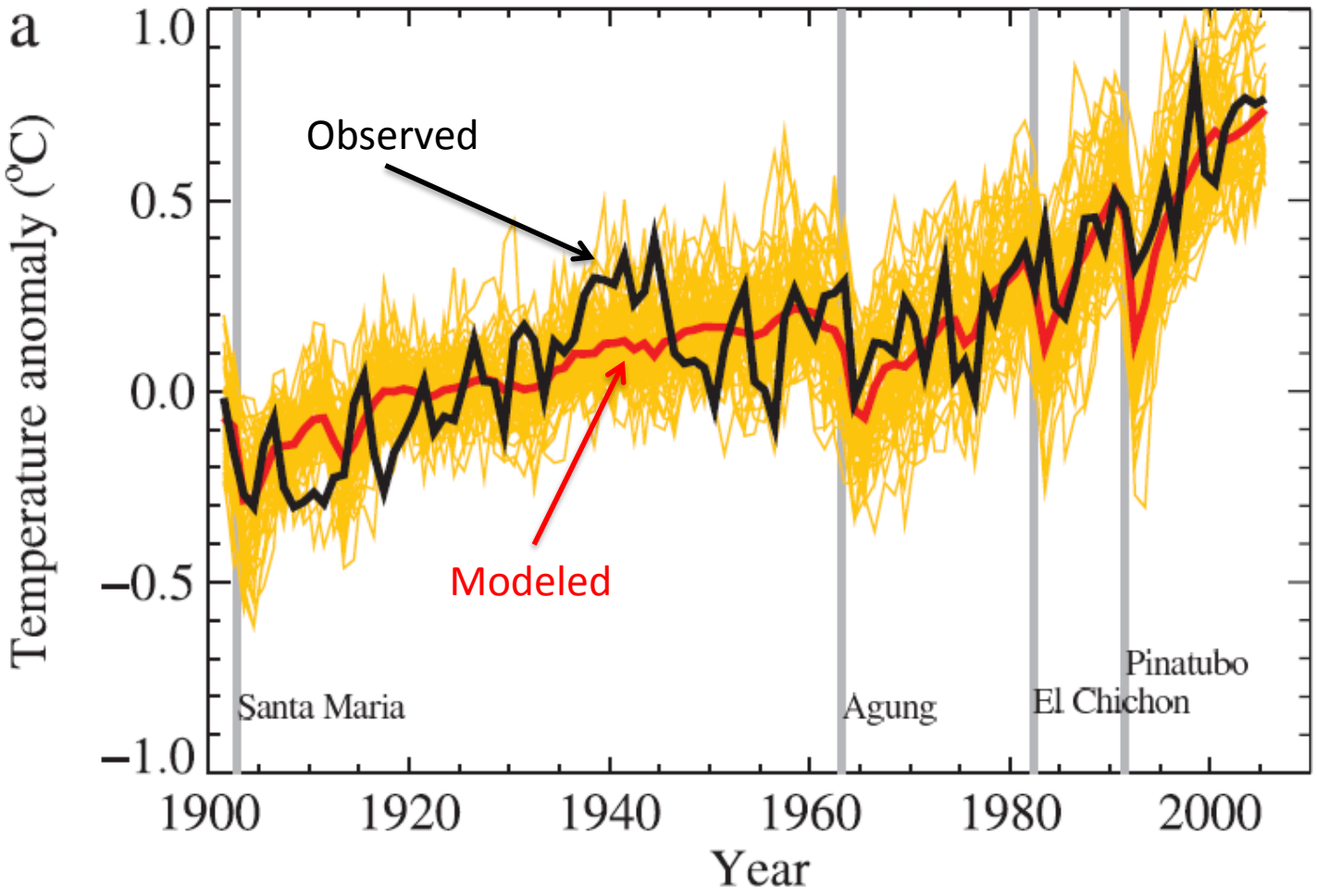
Climate Change policies (from Rio to Kyoto and Paris)



Victor and Leaps, Nature, 2015

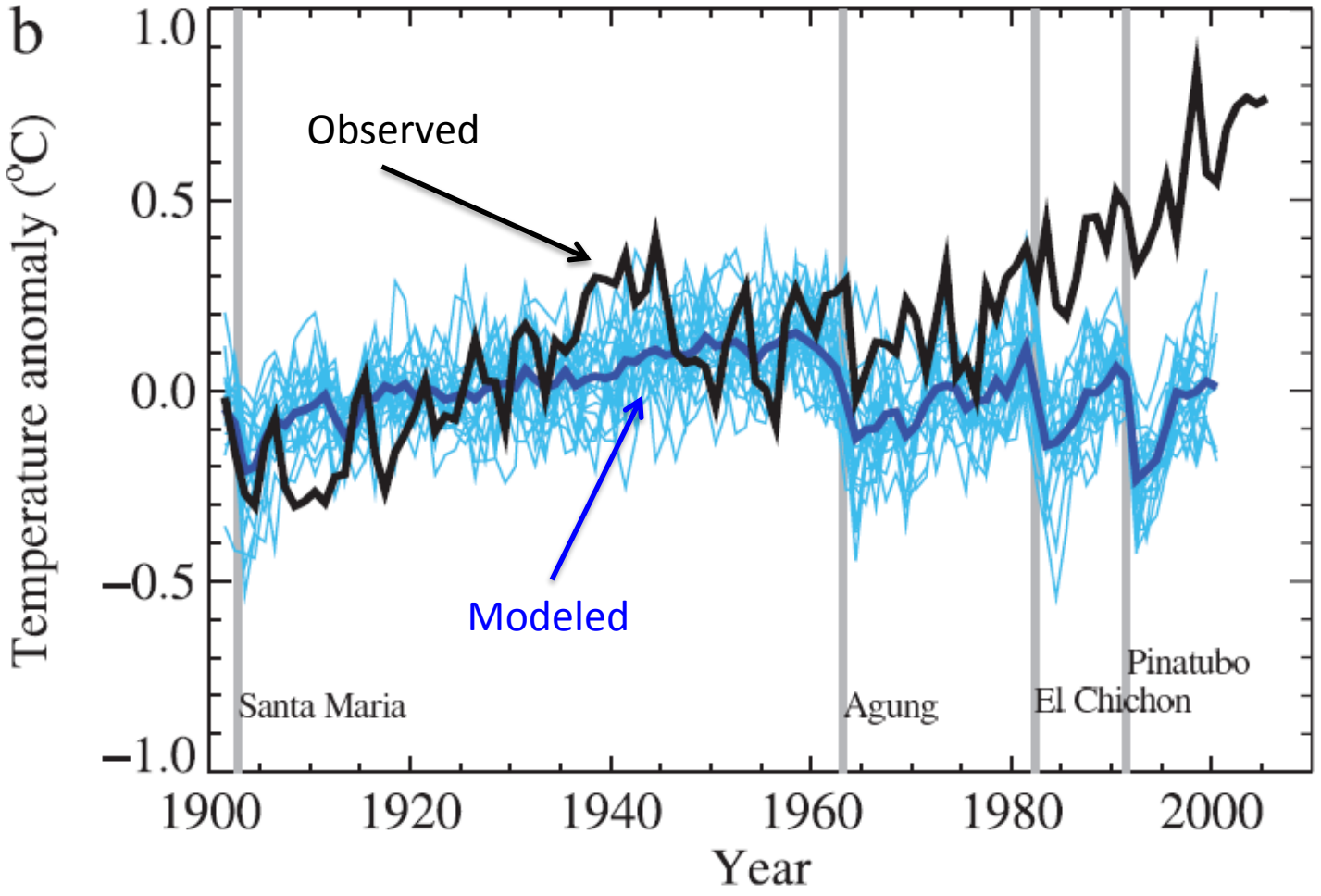
How do we know humans caused the observed warming?

Models with both natural and anthropogenic forcings can reproduce the observed global temperature changes

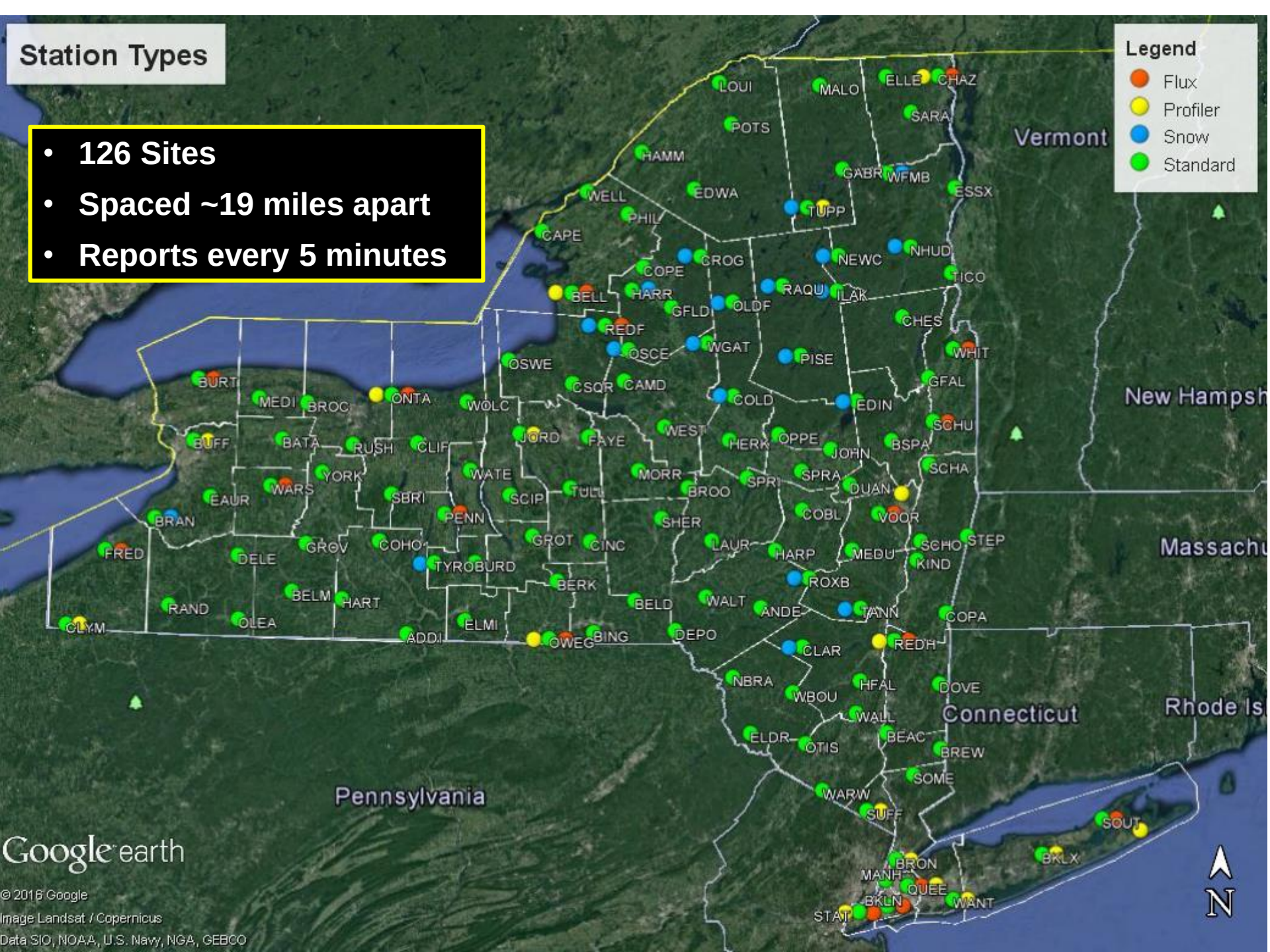


IPCC, AR4, WG1, 2007

A climate model including only natural forcings (solar + volcanic aerosol) does not explain the temporal change in global mean temperature



IPCC, AR4, WG1, 2007


Station Types
• 126 Sites
• Spaced ~19 miles apart
• Reports every 5 minutes
Legend
Flux
Profiler
Snow
Standard
Vermont
New Hampsh
Massachu
Connecticut
Rhode Isl
Pennsylvania
LOUI
MALO
ELLE
CHAZ
SARA
POTS
HAMM
GABR
WFMB
ESSX
WELL
EDWA
TUPP
PHIL
CAPE
NHUD
NEWC
COPE
GROG
TICO
RAQU
ILAK
BELL
HARR
GFLD
OLDF
CHES
REDF
WGAT
OSCE
PISE
WHIT
OSWE
GFAL
CSQR
CAMD
COLD
EDIN
BURT
MEDI
BROC
ONTA
WOLC
SCHU
JORD
FAYE
WEST
HERK
OPPE
BSPA
BUFF
BATA
RUSH
CLIF
JOHN
SCHA
YORK
WATE
MORR
SPRA
WARS
SPRI
DUAN
EAUR
SBRI
SCIP
TULL
BROO
COBL
VOOR
BRAN
PENN
SHER
STEP
GROT
CINC
LAUR
HARP
MEDU
SCHO
FRED
GROV
COHO
KIND
DELE
TYROBURD
ROXB
BERK
BELM
HART
BELD
WALT
ANDE
TANN
COPA
RAND
OLEA
ELMI
CLYM
ADDI
OWEG
BING
DEPO
CLAR
REDH
NBRA
HFAL
DOVE
WBOU
WALL
ELDR
OTIS
BEAC
BREW
SOME
WARW
SUFF
SOUT
BRON
BKLX
MANH
QUEE
BKLN
WANT
STAT
N
Google earth
© 2016 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO