

Iowa's Changing Climate: An Introduction to Climate Change Drivers, Impacts, and Solutions



Iowa's Changing Climate: What? So What? Now What?



Agenda

Introduction

What is This Climate Change?

So What Does Climate Change Mean?

Now What Can We Do?



paleBLUEdot mission:
To hasten the transition to
an authentically
sustainable, low-carbon
economy and to elevate the
public discourse



paleBLUEdot Certifications/Affiliations

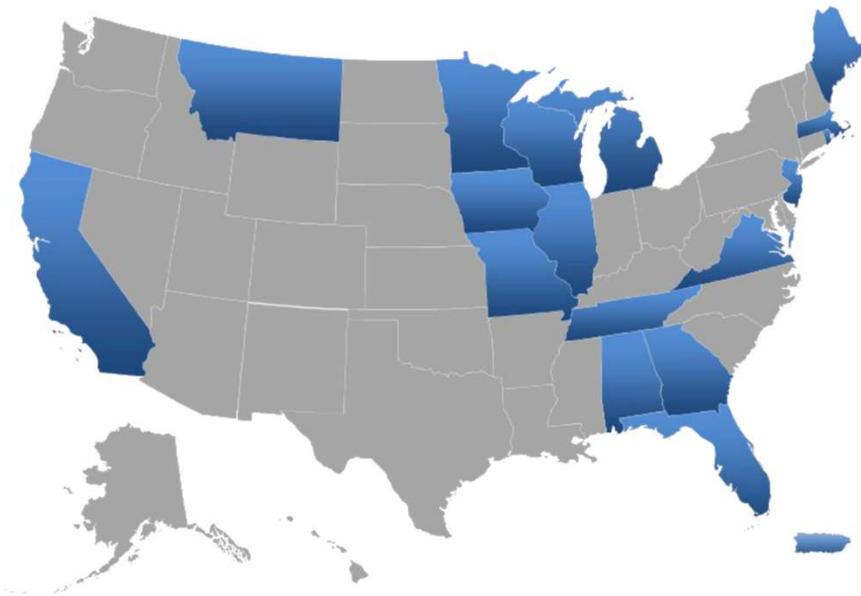
W/SBE Certified | CLIMATE ACTION RESERVE | ghg management institute | ASAP AMERICAN SOCIETY OF ADAPTATION PROFESSIONALS | Institute for Sustainable Infrastructure | Energy Star Partner

climate

sustainability + resilience

renewable energy

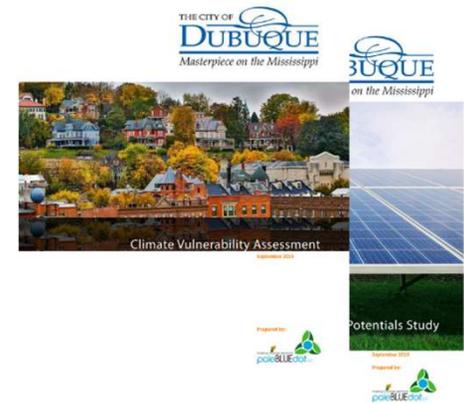
Recent Work In 17 States



Current Work In Iowa

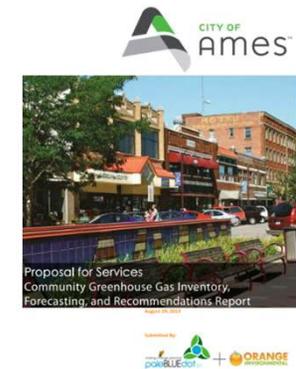
City of Dubuque:

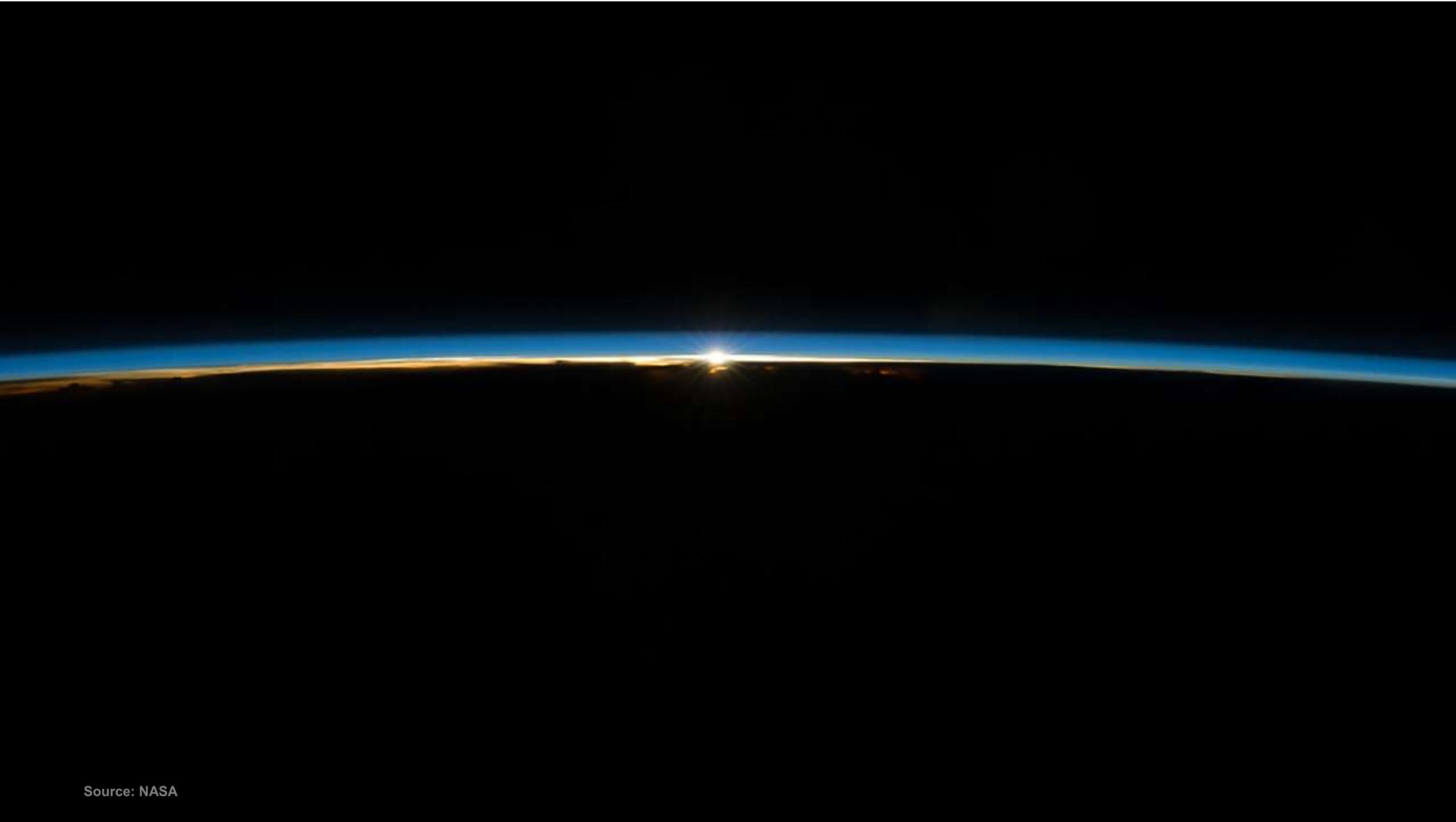
- Climate Vulnerability Assessment
- Climate Adaptation and Mitigation Plan
- Community-Wide Solar Potentials Study



City of Ames:

- Climate Vulnerability Assessment
- Community-Wide GHG Inventory
- Emissions Mitigation Reduction Strategy





Source: NASA

What...is This “Climate Change”?

Source: NASA

The role of “Greenhouse gases”

Our atmosphere is made up of both Greenhouse Gases and non-greenhouse gases



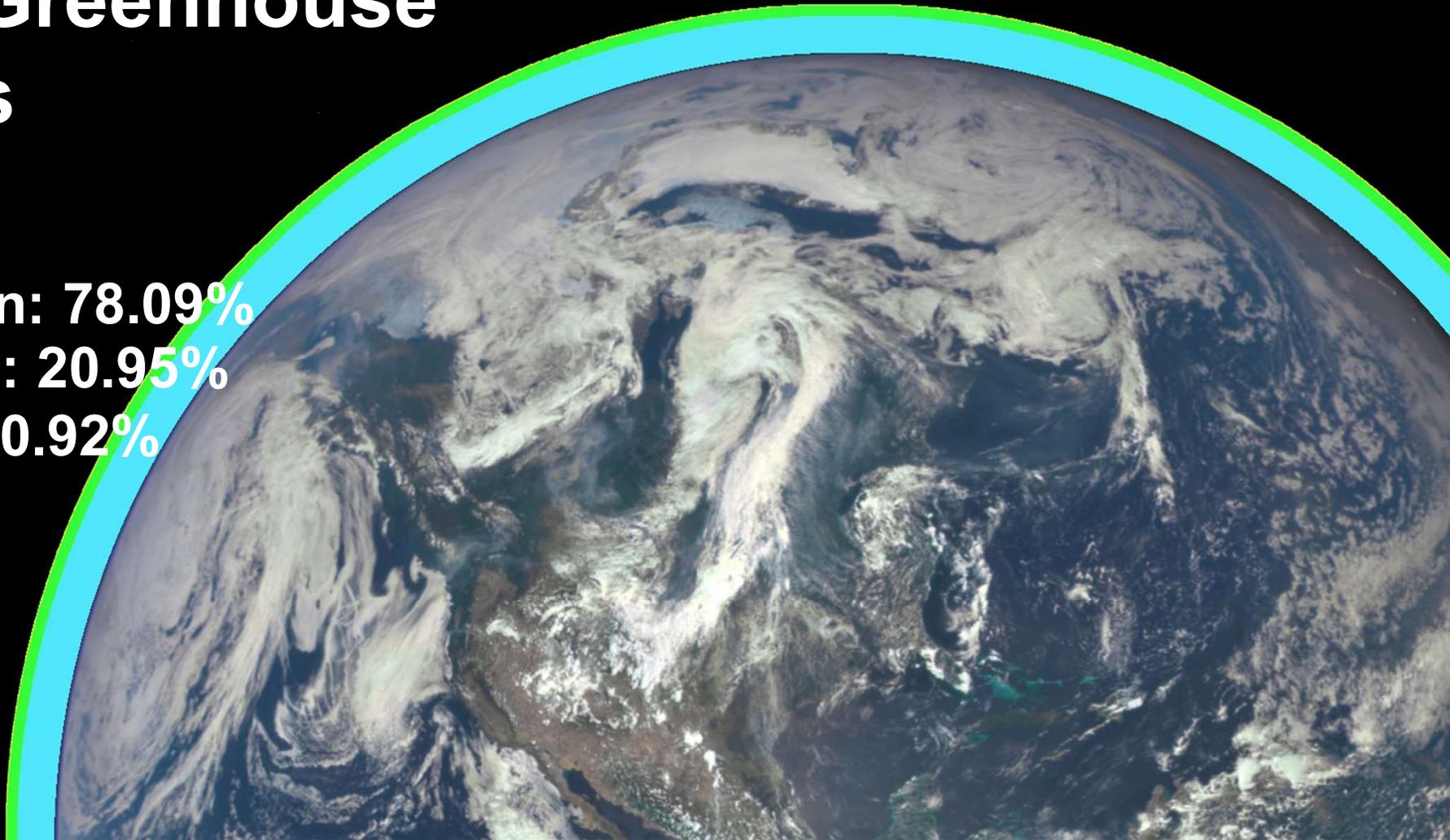
Non-Greenhouse gases

Nitrogen: 78.09%

Oxygen: 20.95%

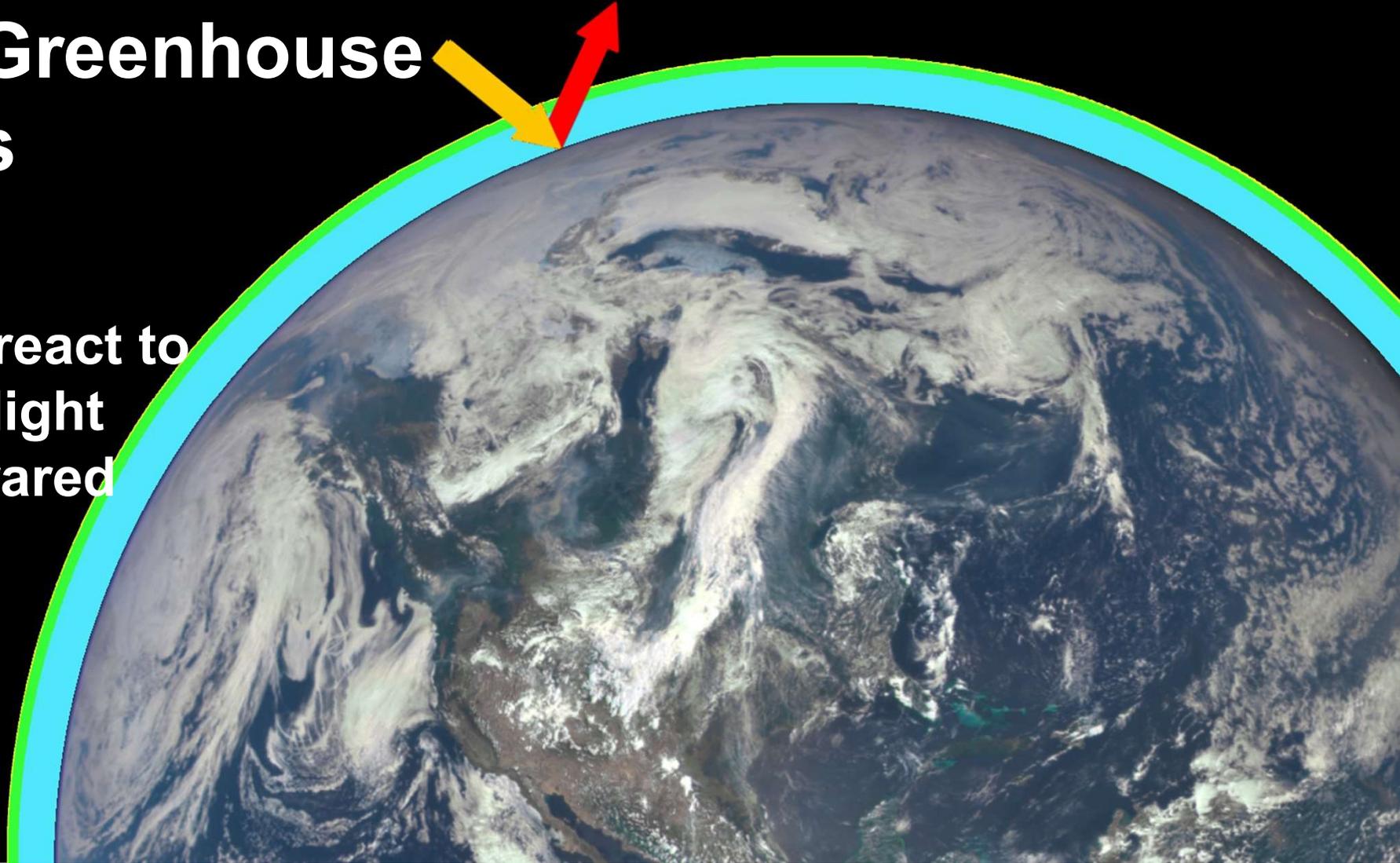
Argon: 0.92%

99.96%



Non-Greenhouse gases

Do not react to
visible light
Nor Infrared
energy.



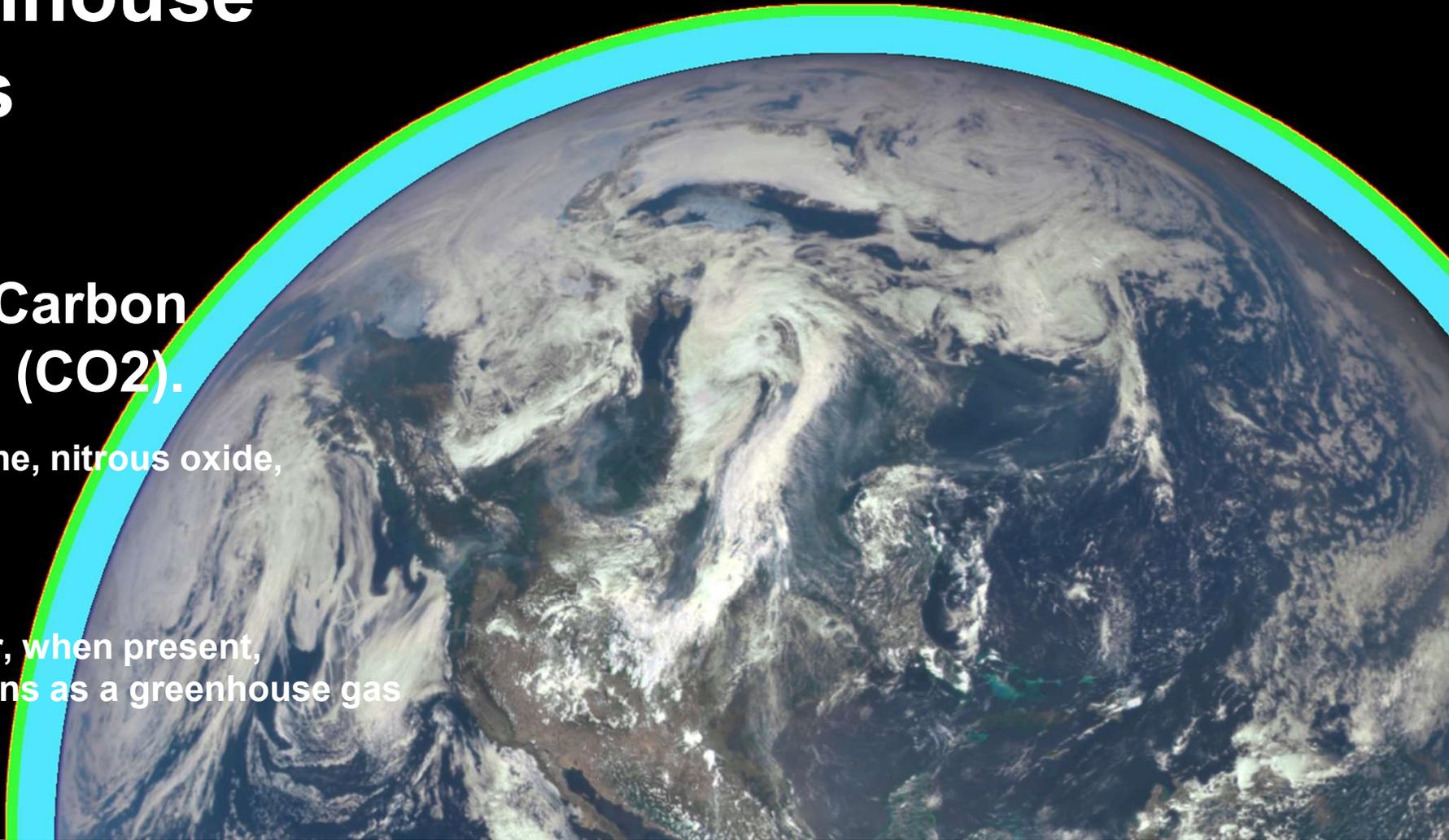
Greenhouse gases

Mostly Carbon
Dioxide (CO₂).

Also methane, nitrous oxide,
And Ozone.

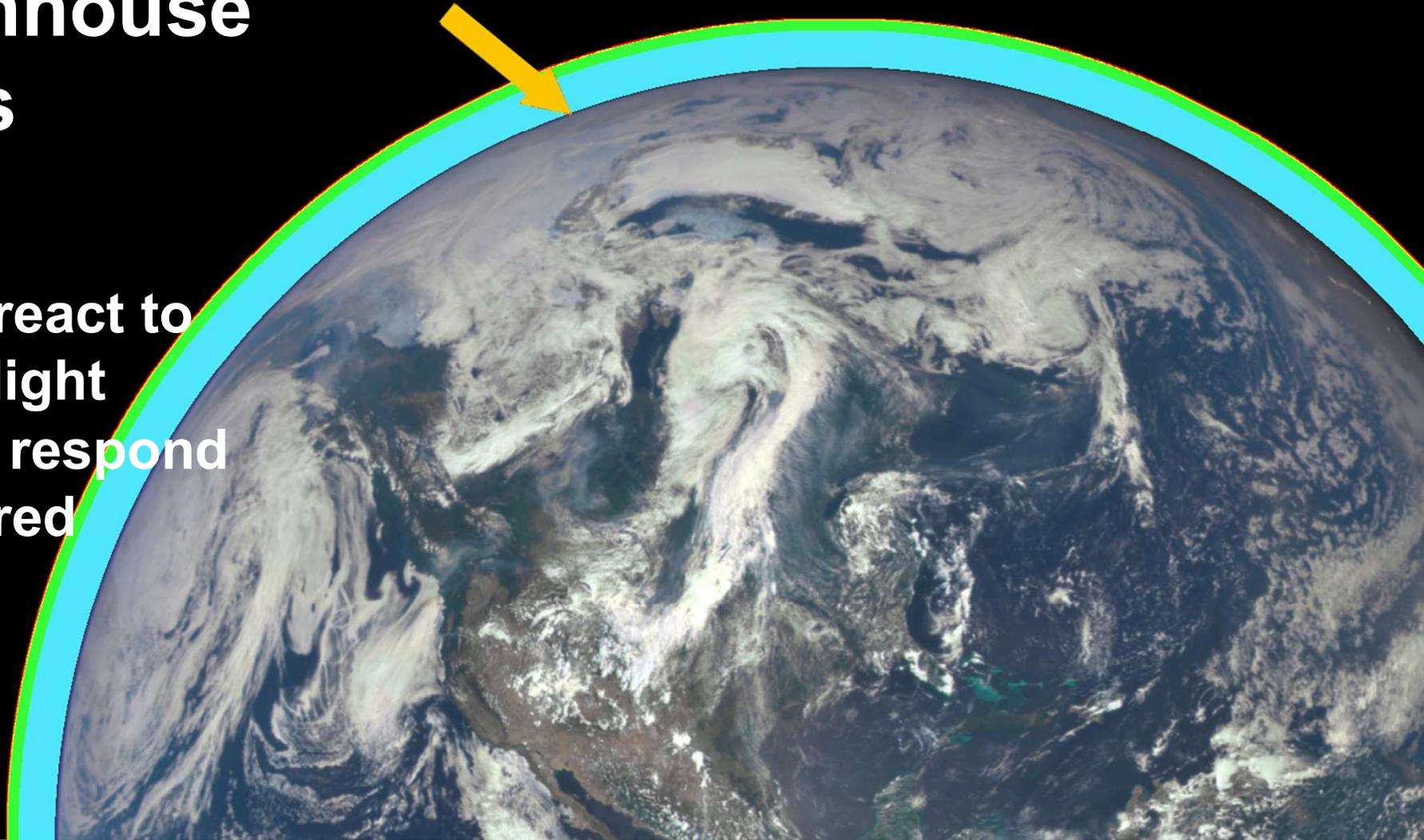
0.04%

Water Vapor, when present,
Also functions as a greenhouse gas



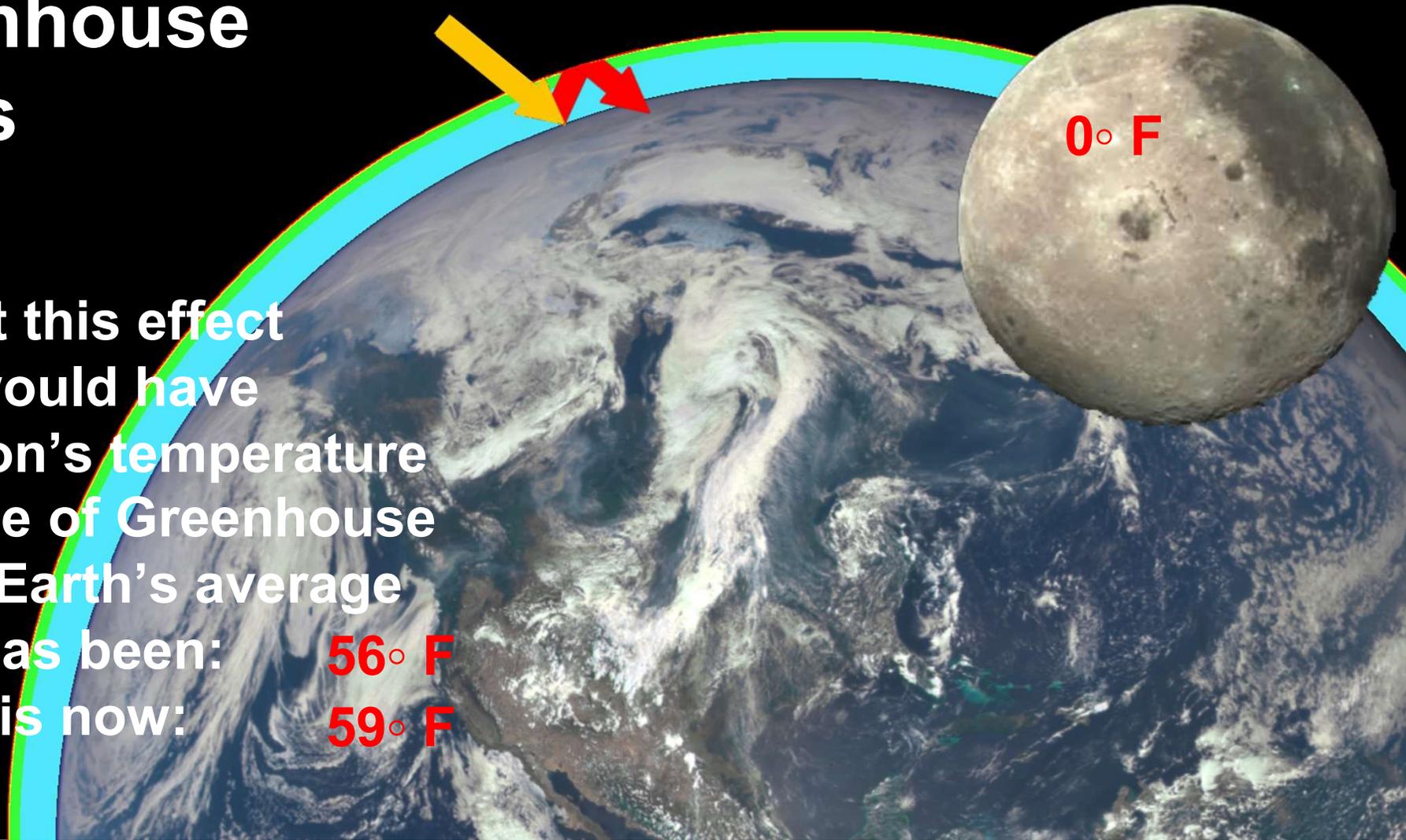
Greenhouse gases

Do not react to
visible light
But DO respond
to Infrared
energy.



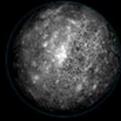
Greenhouse gases

Without this effect
Earth would have
the Moon's temperature
Because of Greenhouse
gases, Earth's average
Temp has been: **56° F**
.... But is now: **59° F**

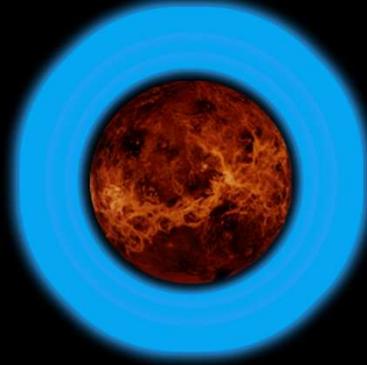




Mercury
333° F



Venus
+867° F



Earth
+59° F



Mars
-85° F



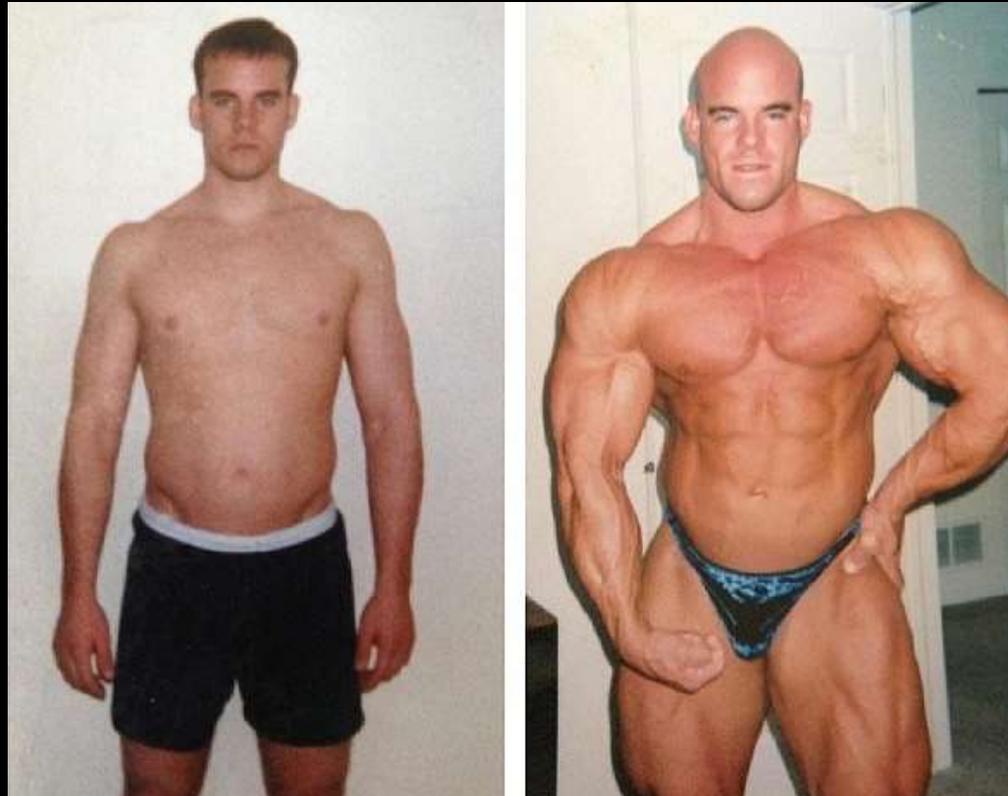
How can **0.04%** make a difference?

How can **0.04%** make a difference?



Source: NASA

How can **0.04%** make a difference?

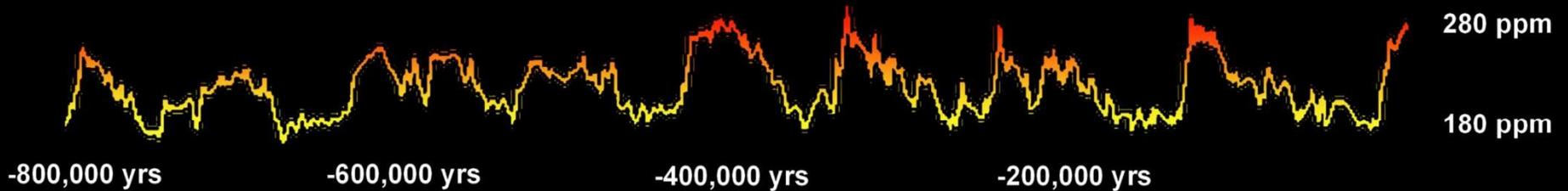


Source: NASA

**CO₂ is being released
into the atmosphere
faster than at any time in
at least the last
66 million years.**

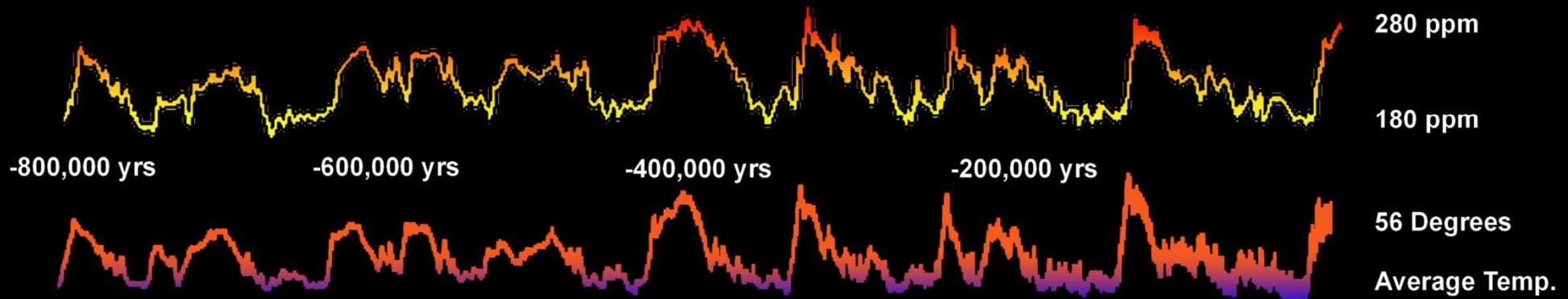
The Carbon Cycle

Though it naturally fluctuates - it has remained balanced with CO2 levels between 180 to 280 ppm



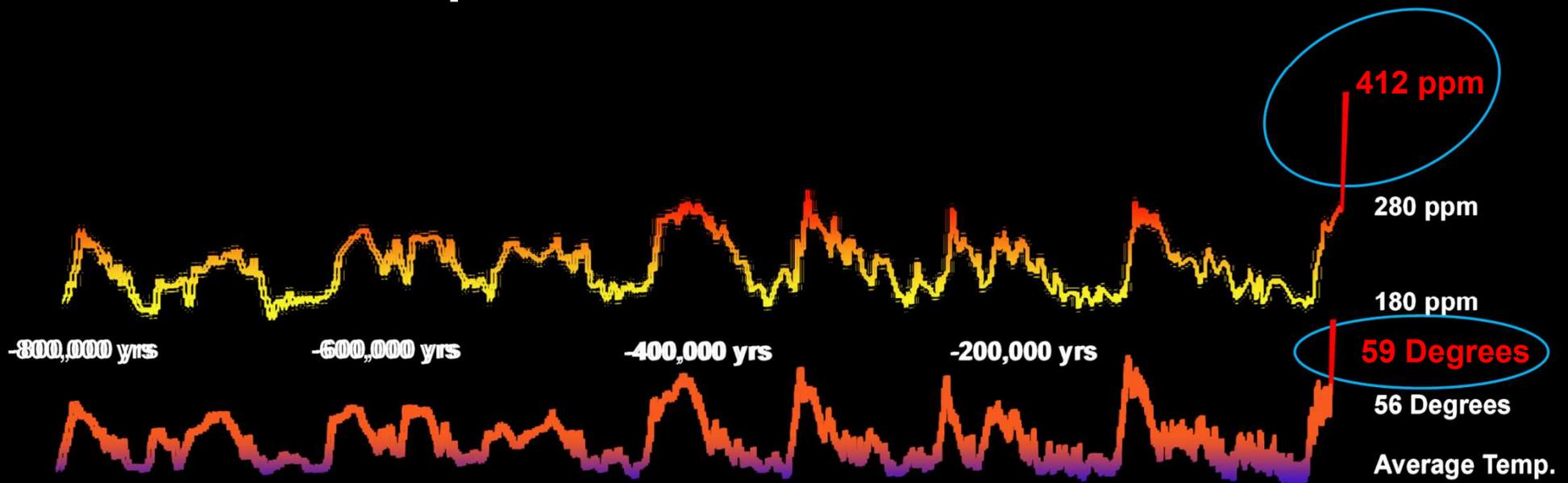
The Carbon Cycle

Global CO2 levels and temperature have been closely related for over 800,000 years.



The Carbon Cycle

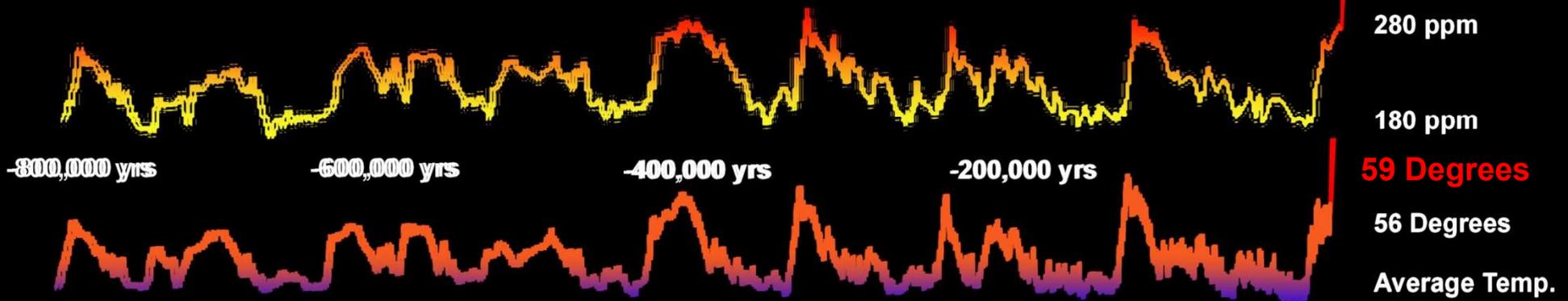
Since the Industrial Revolution and use of fossil fuels, both CO2 and temperature have increased.



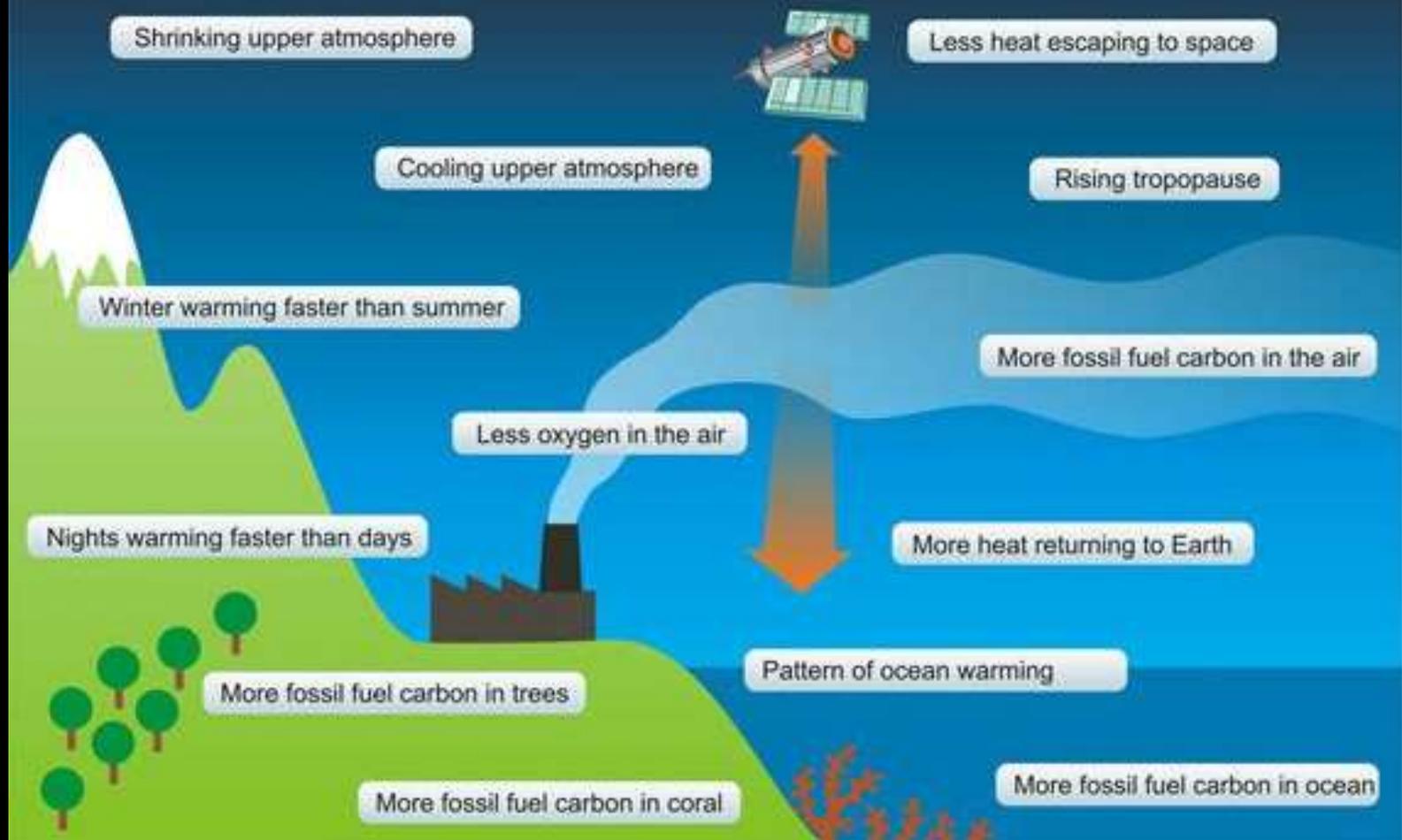
The Carbon Cycle

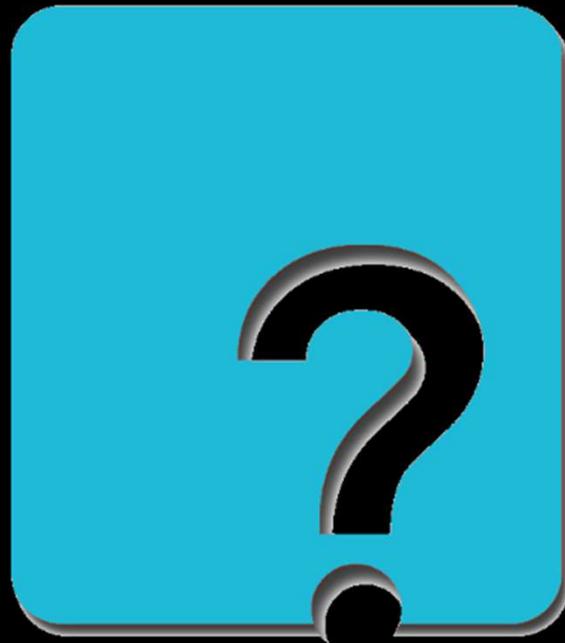
Since the Industrial Revolution and use of fossil fuels, both CO2 and temperature have increased.

Where we are headed within 40 years without reduced emissions.



How we know we're causing global warming



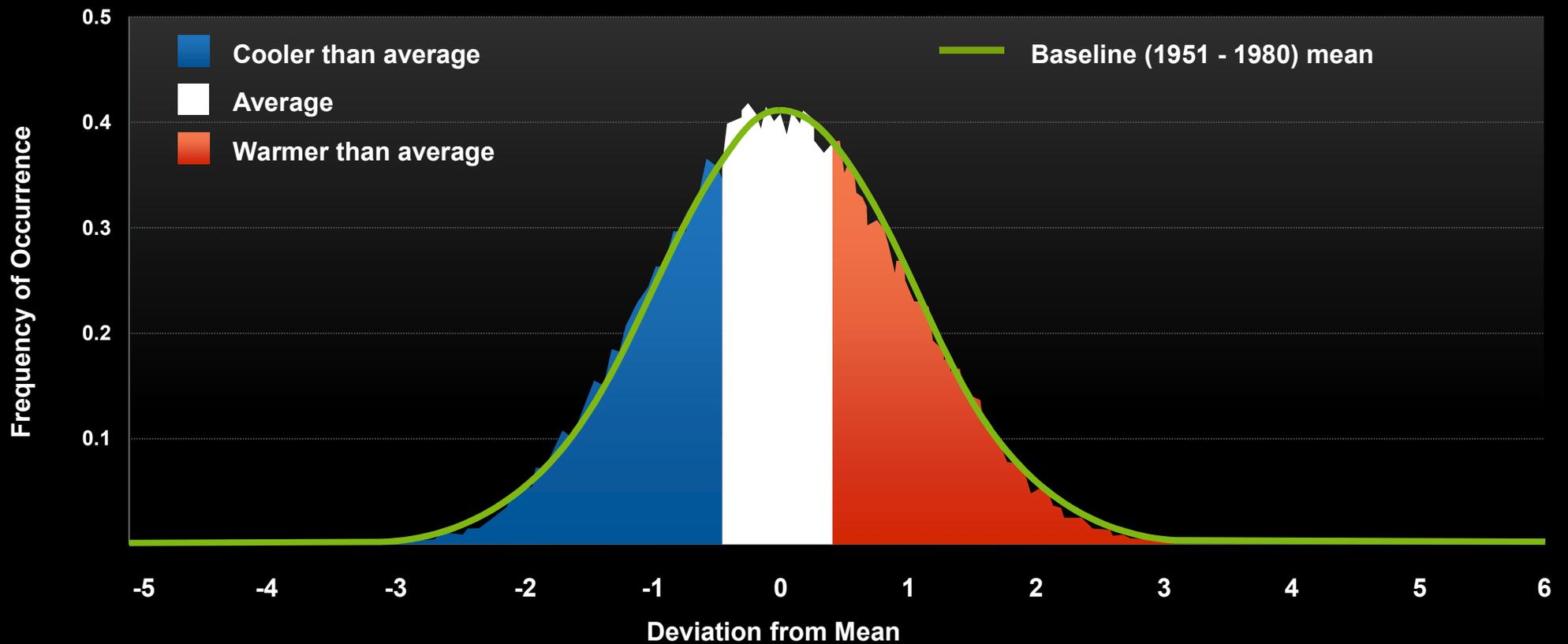




**What...“Climate Change” have we
already experienced?**

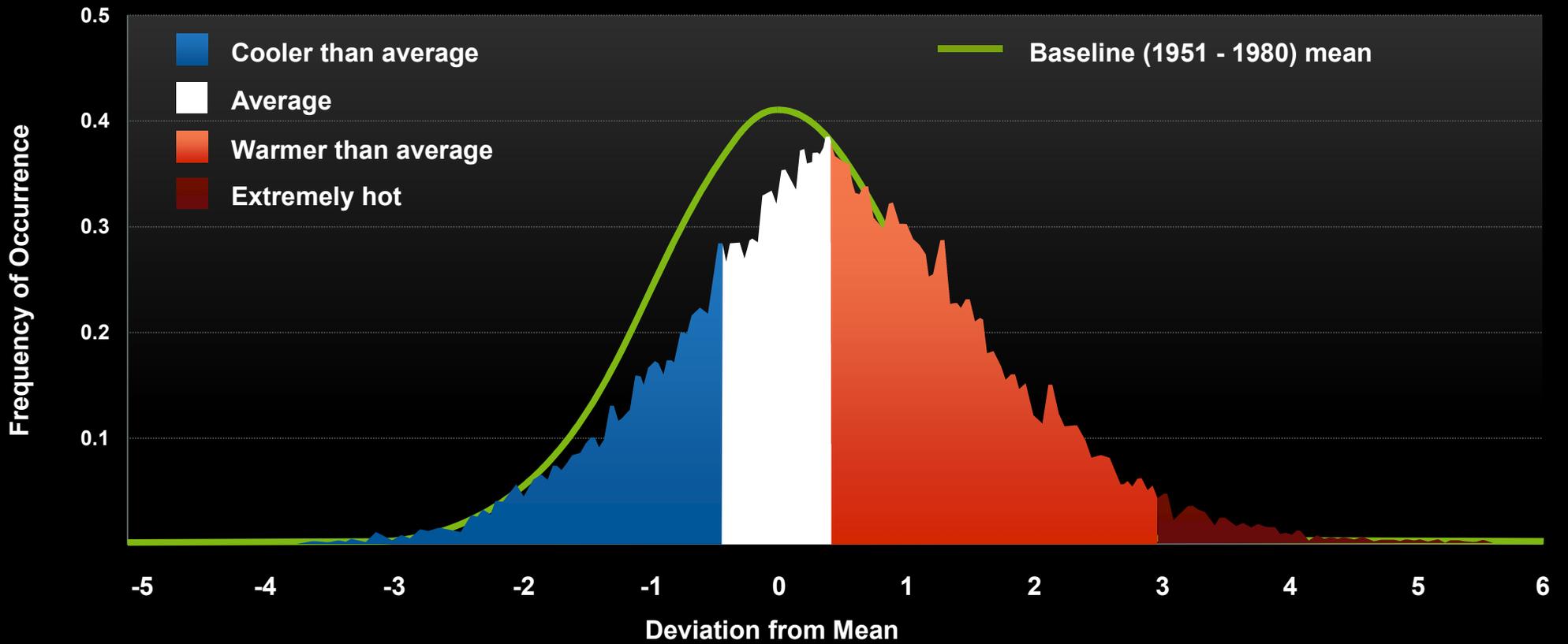
Summer Temperatures Have Shifted

1951 – 1980



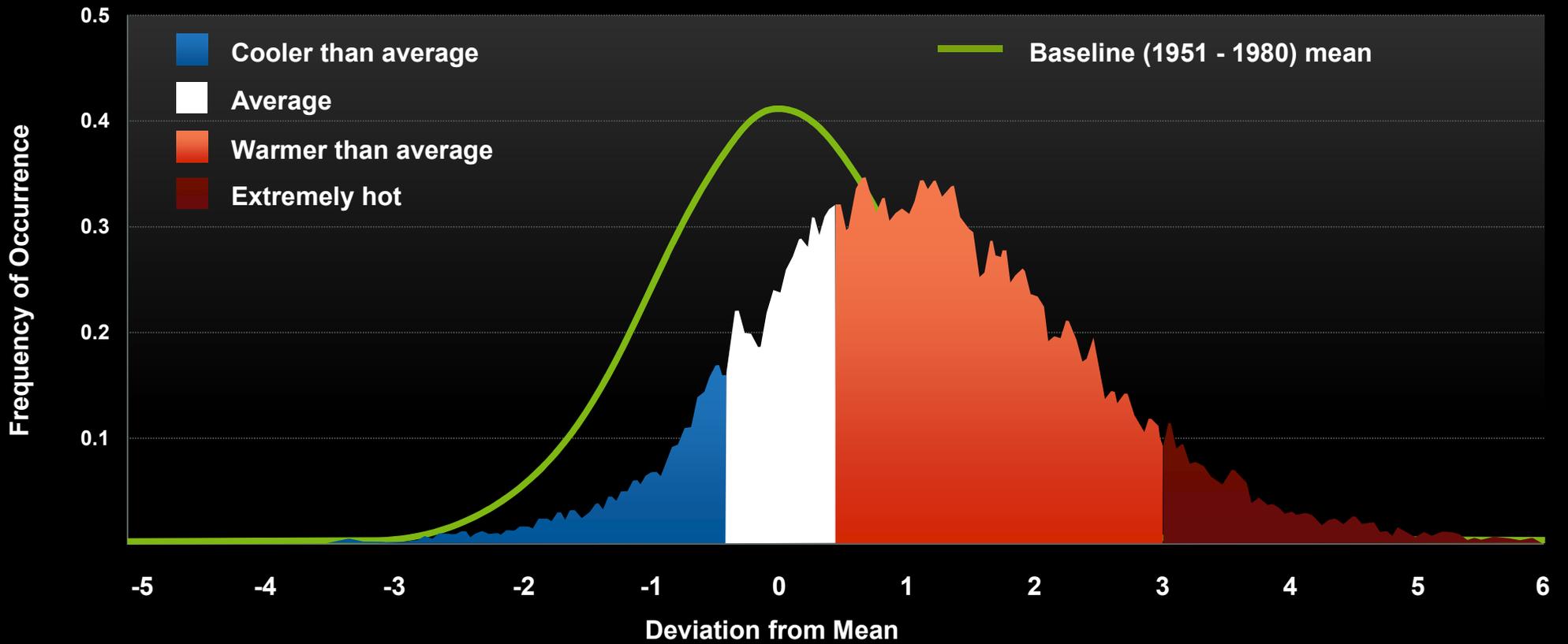
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," Proc. Natl. Acad. Sci. USA 10.1073, August 2012 – Updated 2016

1983 – 1993



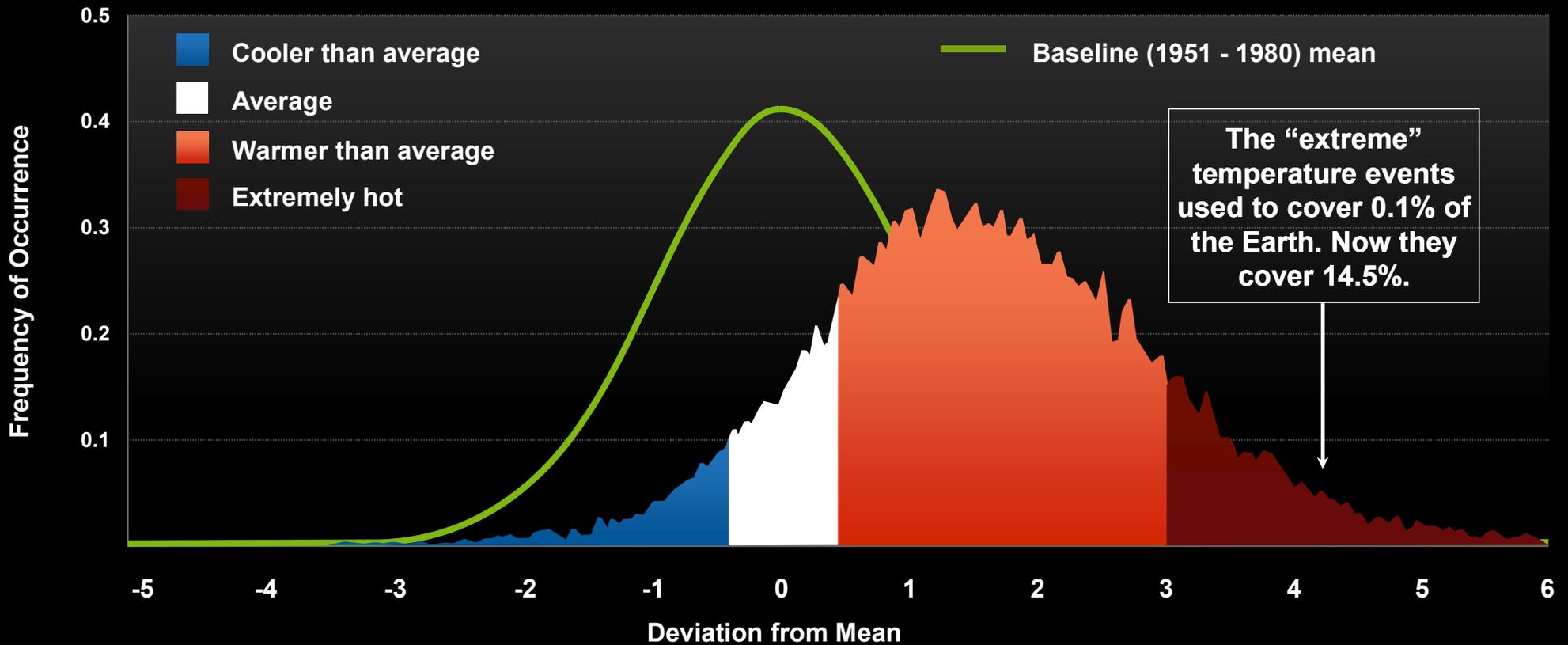
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," Proc. Natl. Acad. Sci. USA 10.1073, August 2012 – Updated 2016

1994 – 2004



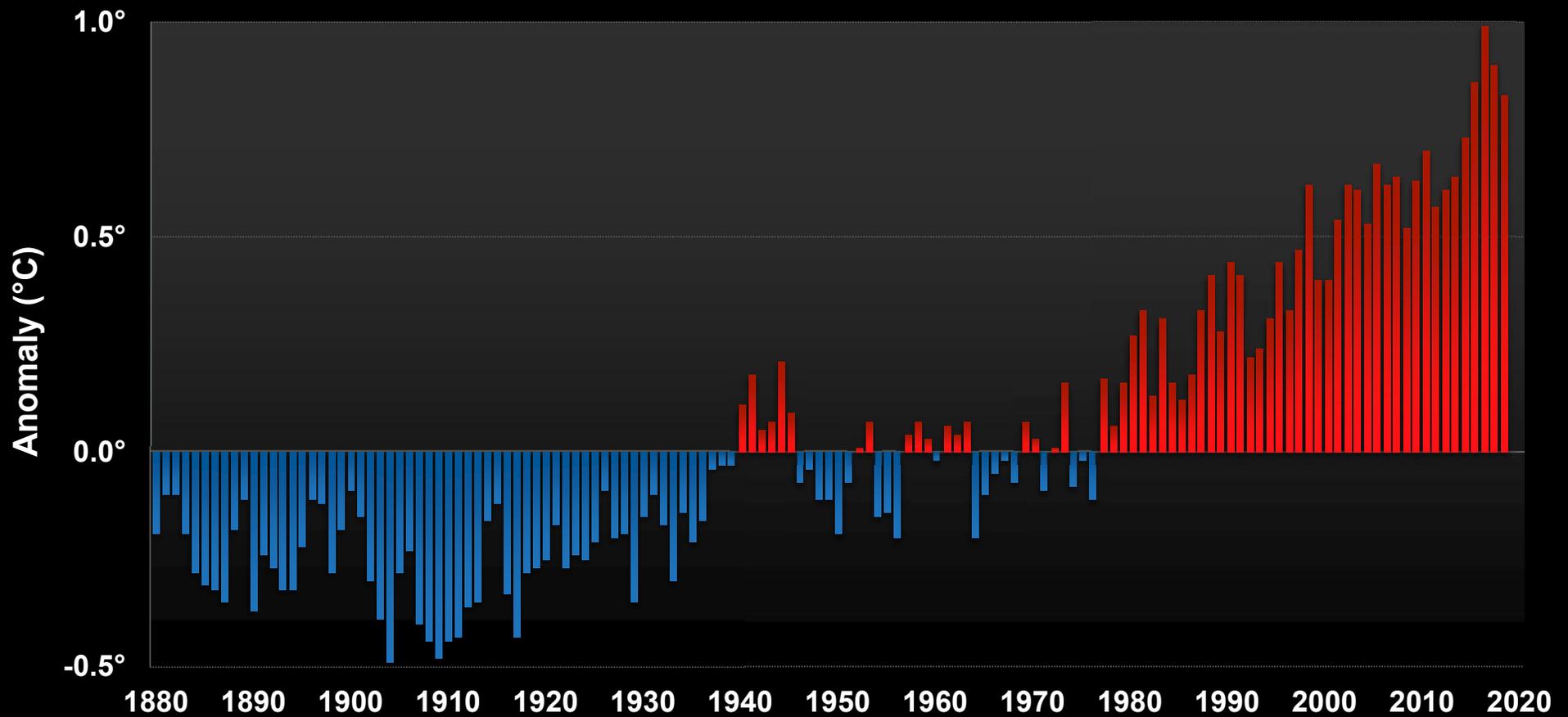
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," Proc. Natl. Acad. Sci. USA 10.1073, August 2012 – Updated 2016

2005 – 2015



Global Surface Temperature – Departure from Average

1880 – 2018



Data: National Oceanic and Atmospheric Administration

The Bloftise of 19 Albtlast Years the Resor Five Years Occurred Since the Year 2001

2016

2017

2015

2018

2014

2010

2005

2007

2013

2009

2012

2006

1998

2002

2003

2011

2004

2001

Prayagraj, India

June 15, 2019

At least 36 people died as temperatures in India reached **123° F** (50.5° C) in mid-June.

Photo © 2019 AP Photo/Rajesh Kumar Singh

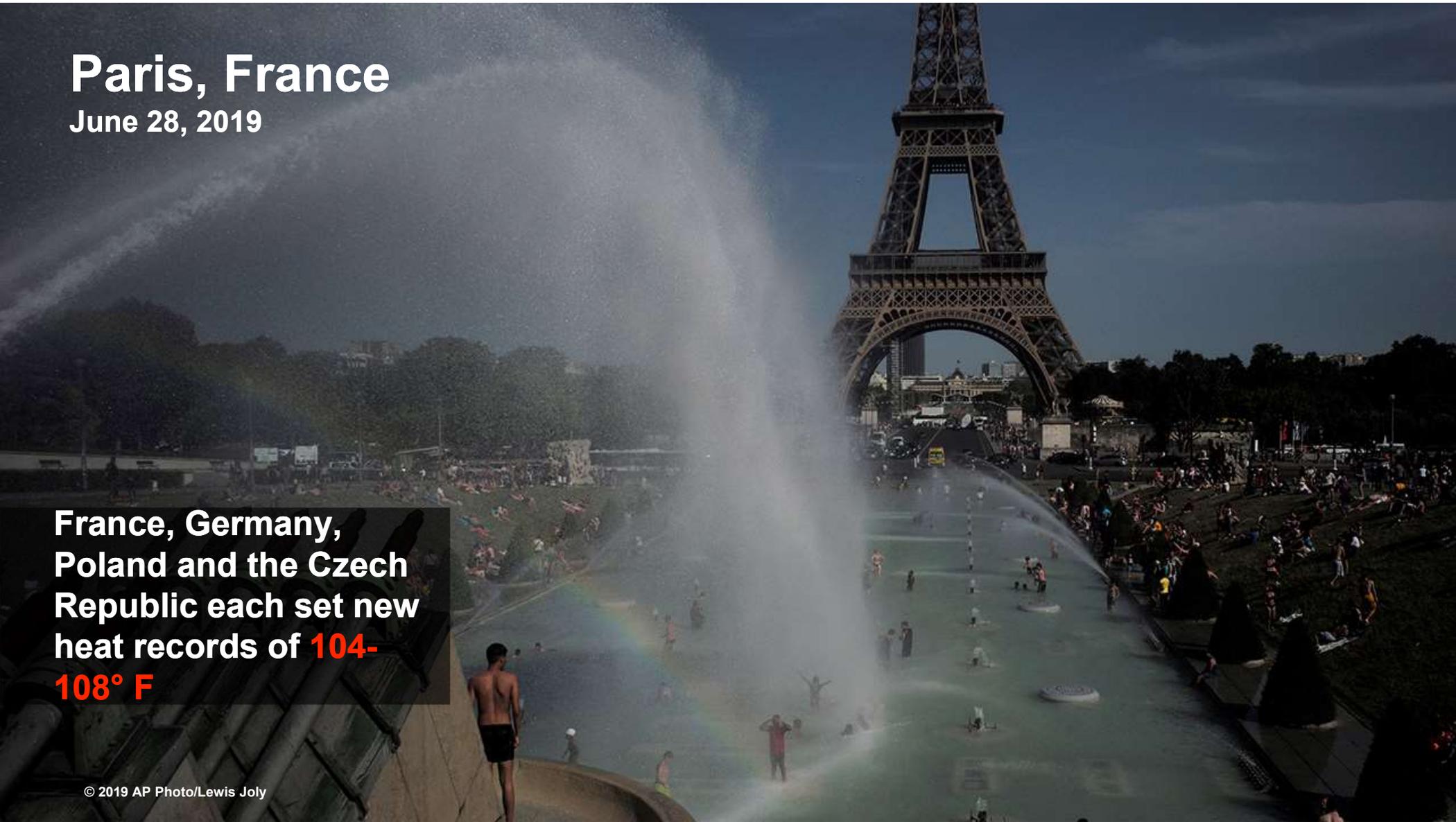


Paris, France

June 28, 2019

France, Germany,
Poland and the Czech
Republic each set new
heat records of **104-
108° F**

© 2019 AP Photo/Lewis Joly



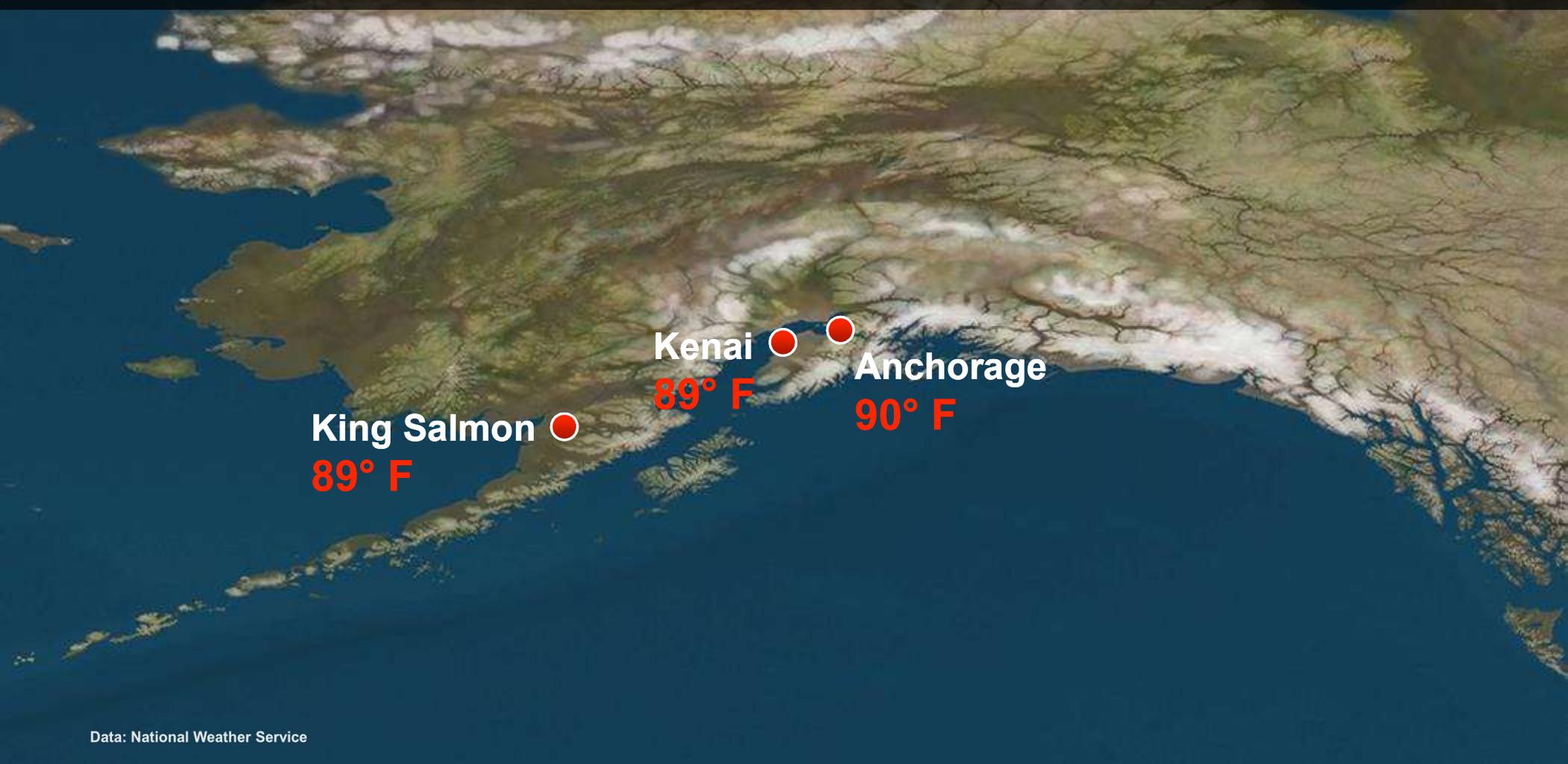
Hokkaido, Japan

May 26, 2019

Nearly 600 people were taken to hospitals as Japan set a new high temperature record for May at **103.1° F (39.5° C)**.



Three locations in Alaska set all-time heat records on July 4, 2019



King Salmon ●
89° F

Kenai ●
89° F

Anchorage ●
90° F

Data: National Weather Service

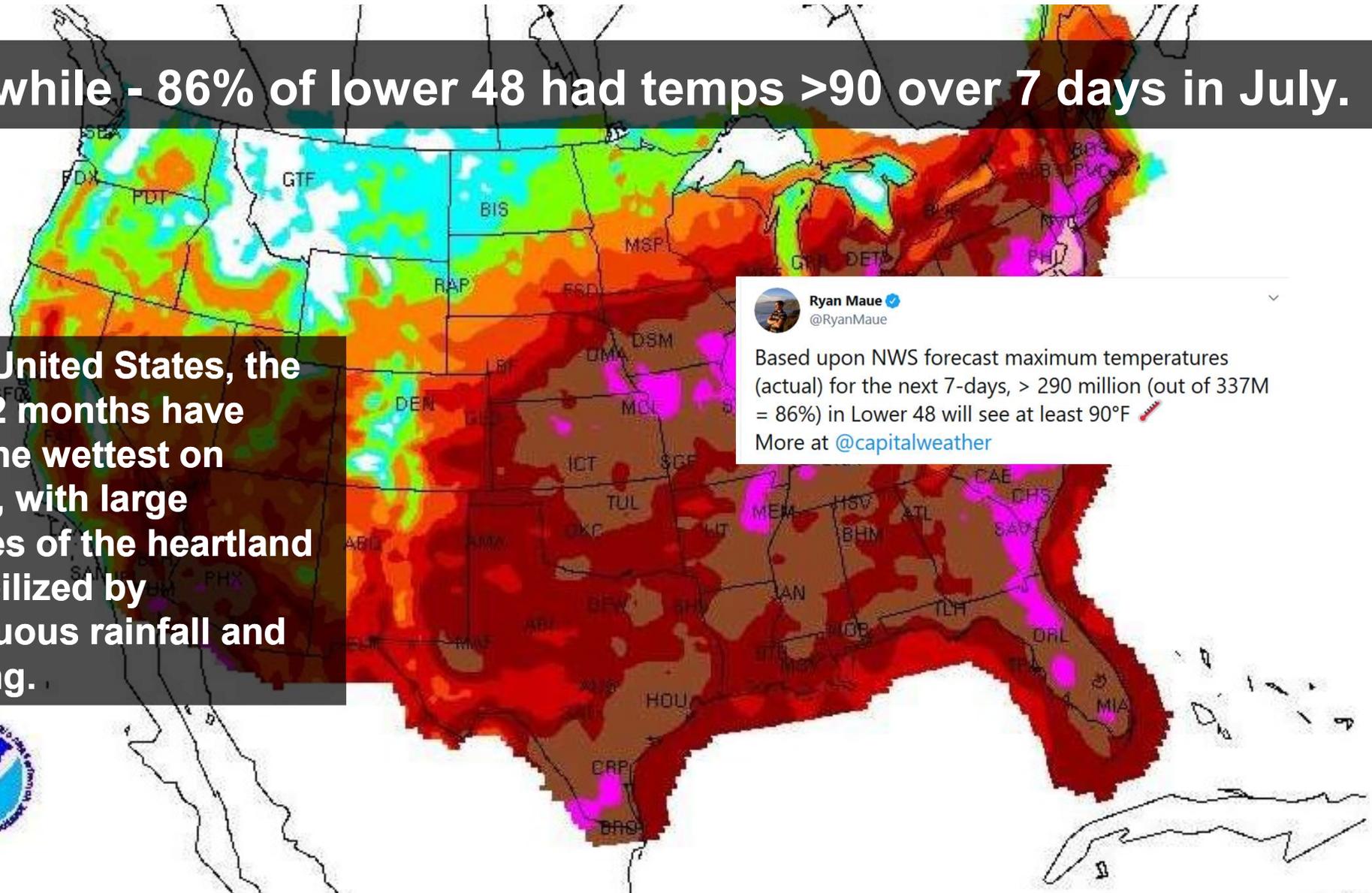
Meanwhile - 86% of lower 48 had temps >90 over 7 days in July.

In the United States, the past 12 months have been the wettest on record, with large swathes of the heartland immobilized by continuous rainfall and flooding.



Ryan Maue ✓
@RyanMaue

Based upon NWS forecast maximum temperatures (actual) for the next 7-days, > 290 million (out of 337M = 86%) in Lower 48 will see at least 90°F 🌡️
More at @capitalweather



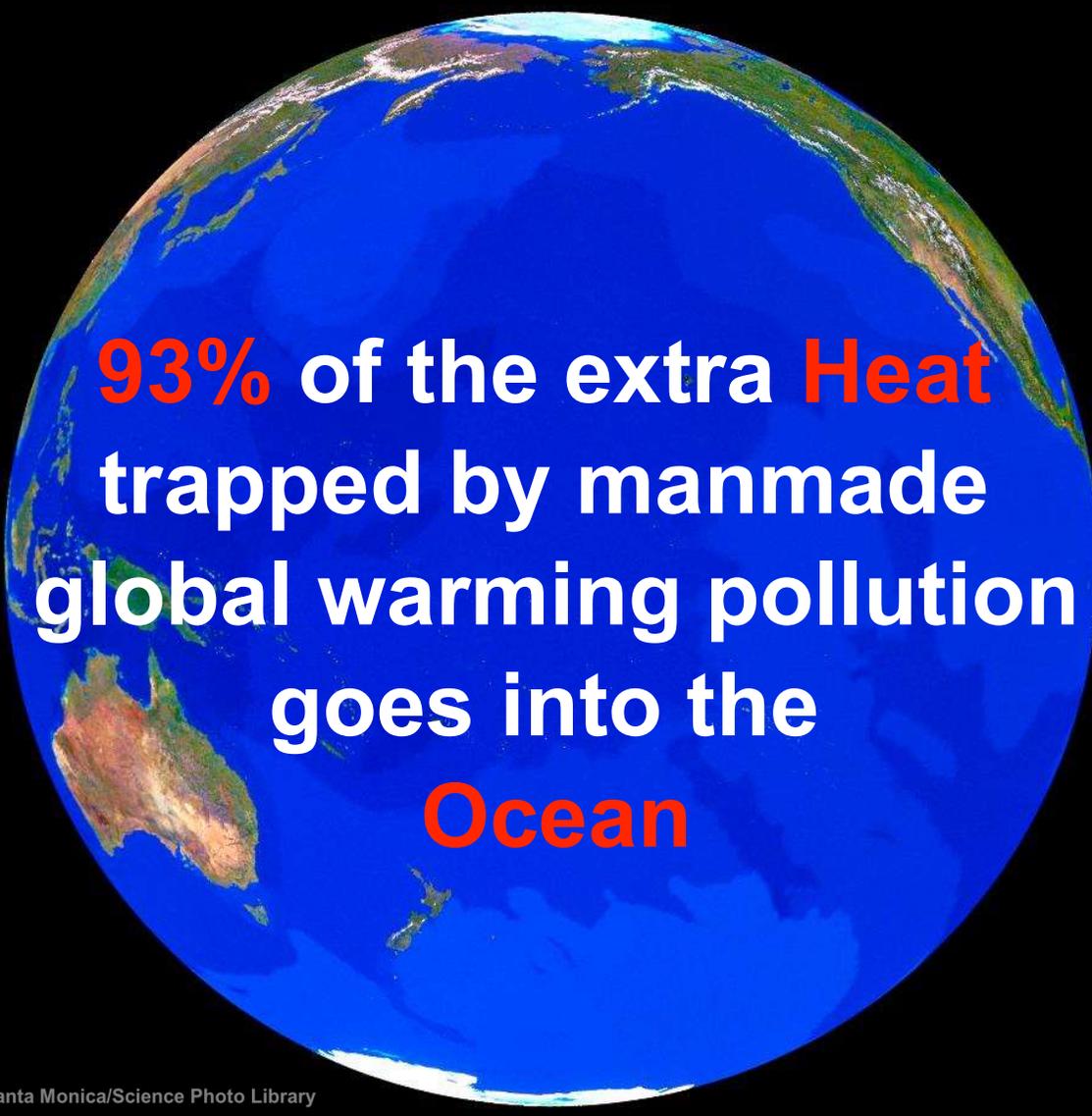
It is not just **summer** temperatures
that are changing.

The temperature at the
North Pole was **50° F** (28° C)
hotter than normal
on February 25, 2018.





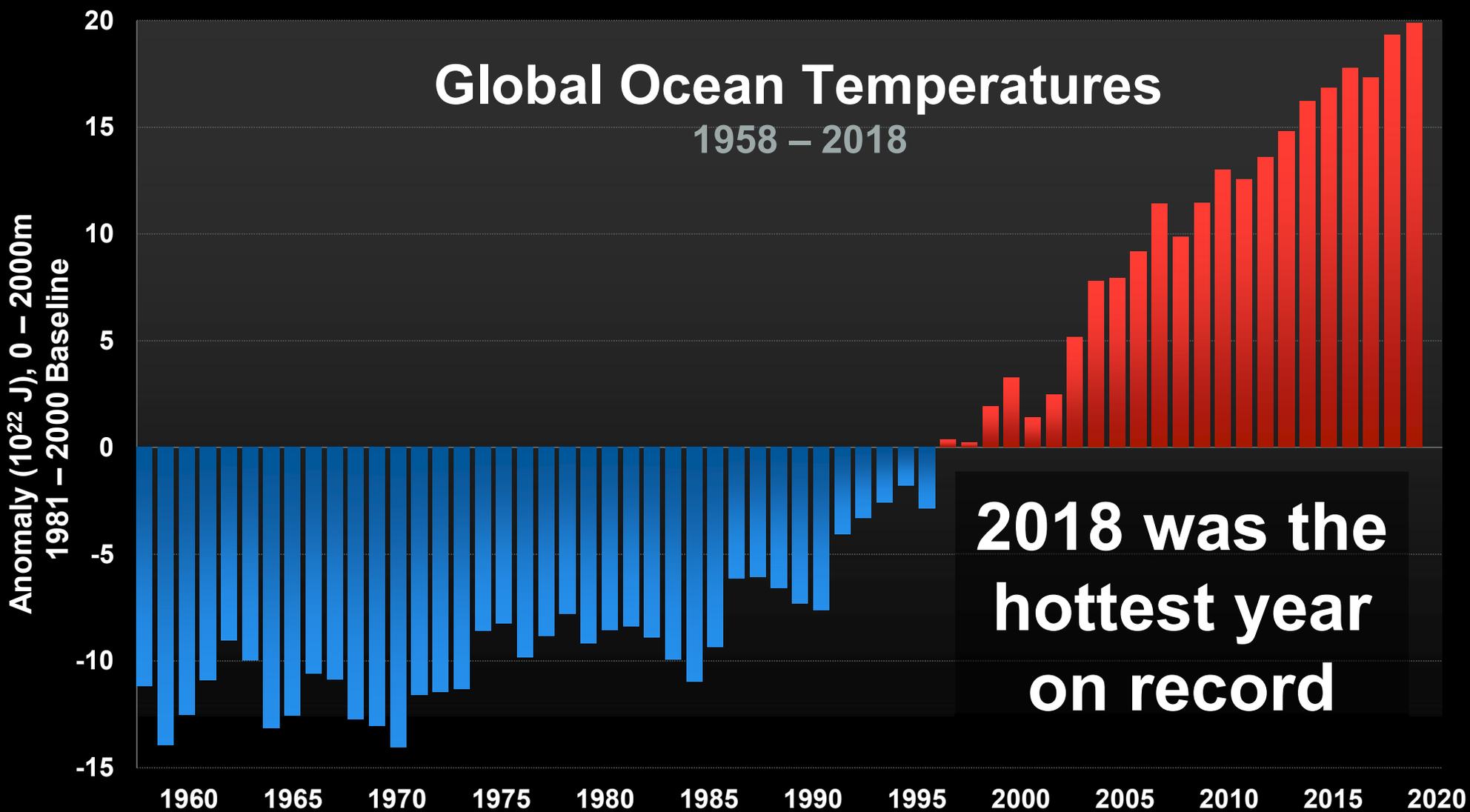
What...does a warmer arctic have to do with Iowa?



93% of the extra **Heat**
trapped by manmade
global warming pollution
goes into the
Ocean

Global Ocean Temperatures

1958 – 2018

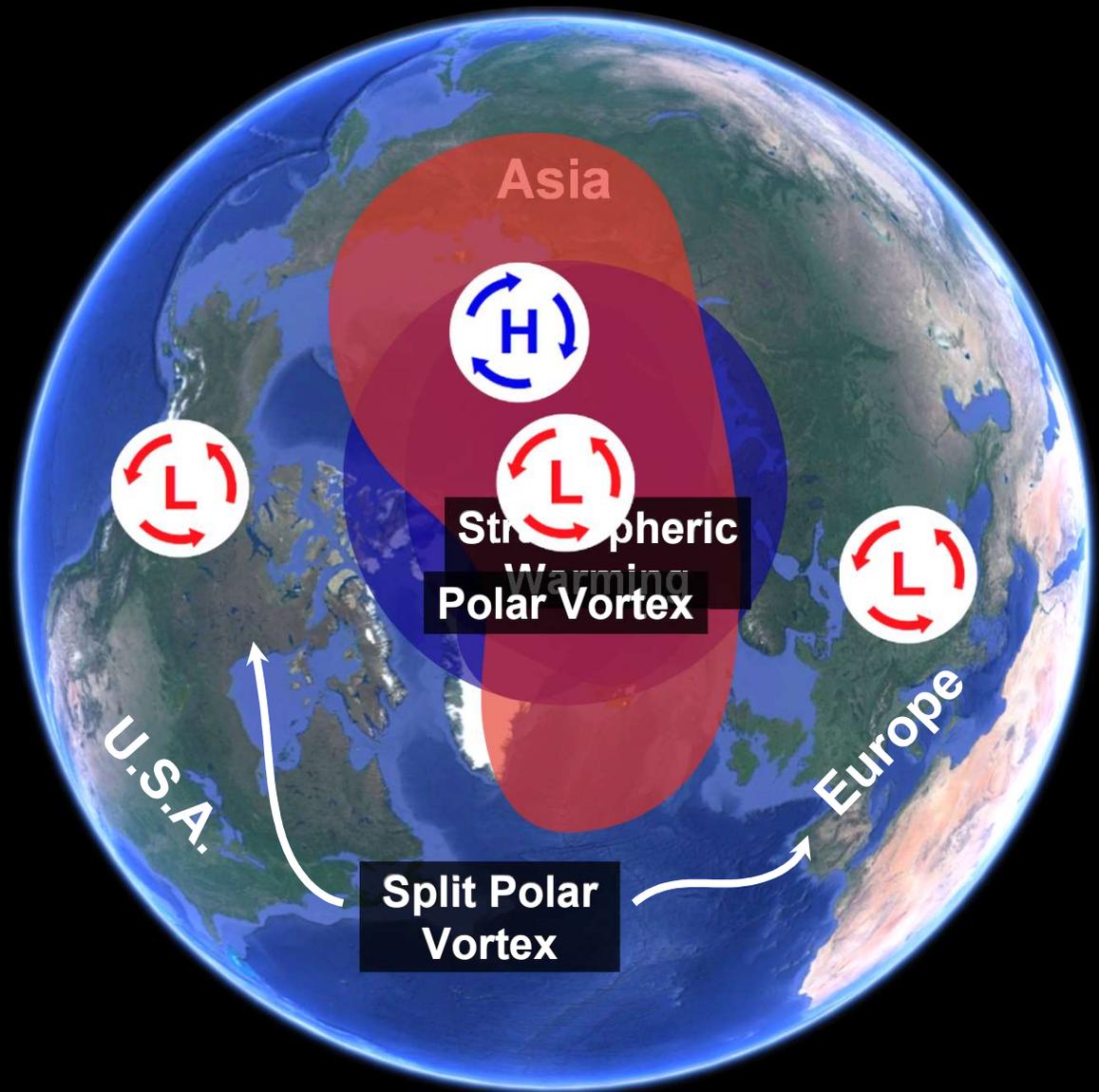


**2018 was the
hottest year
on record**

Data: Cheng, L. J., and J. Zhu, 2018: "2017 was the warmest year on record for the global ocean," *Advances in Atmospheric Sciences*, 34(3)

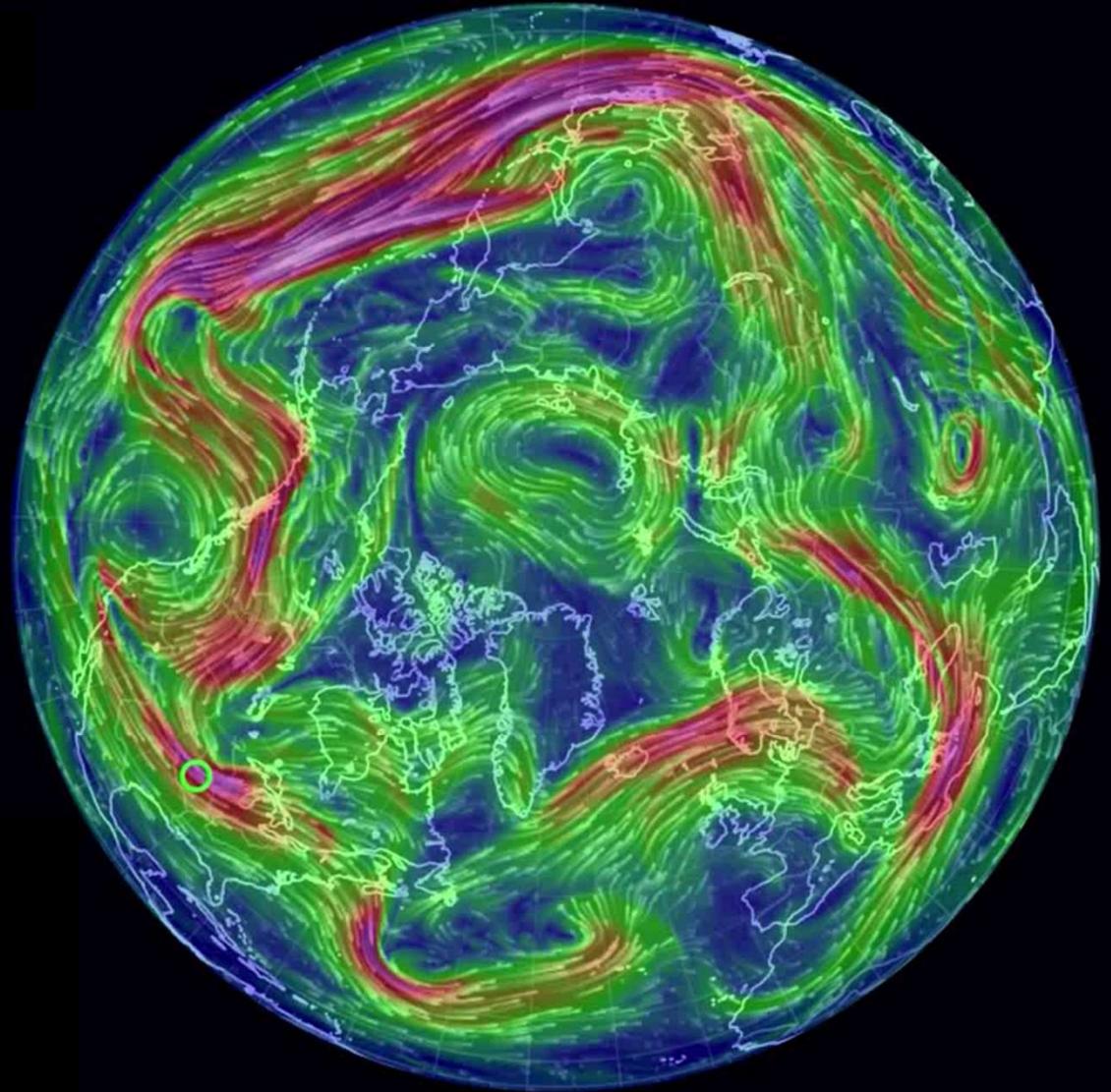
A warming ocean not only warms Arctic waters, but also increases the instance of “Sudden Stratospheric Warming” over the ocean.

In mid-February 2018, the Polar Vortex split in two, bringing bitter cold to parts of North America and Europe, and record warmth to the Arctic.



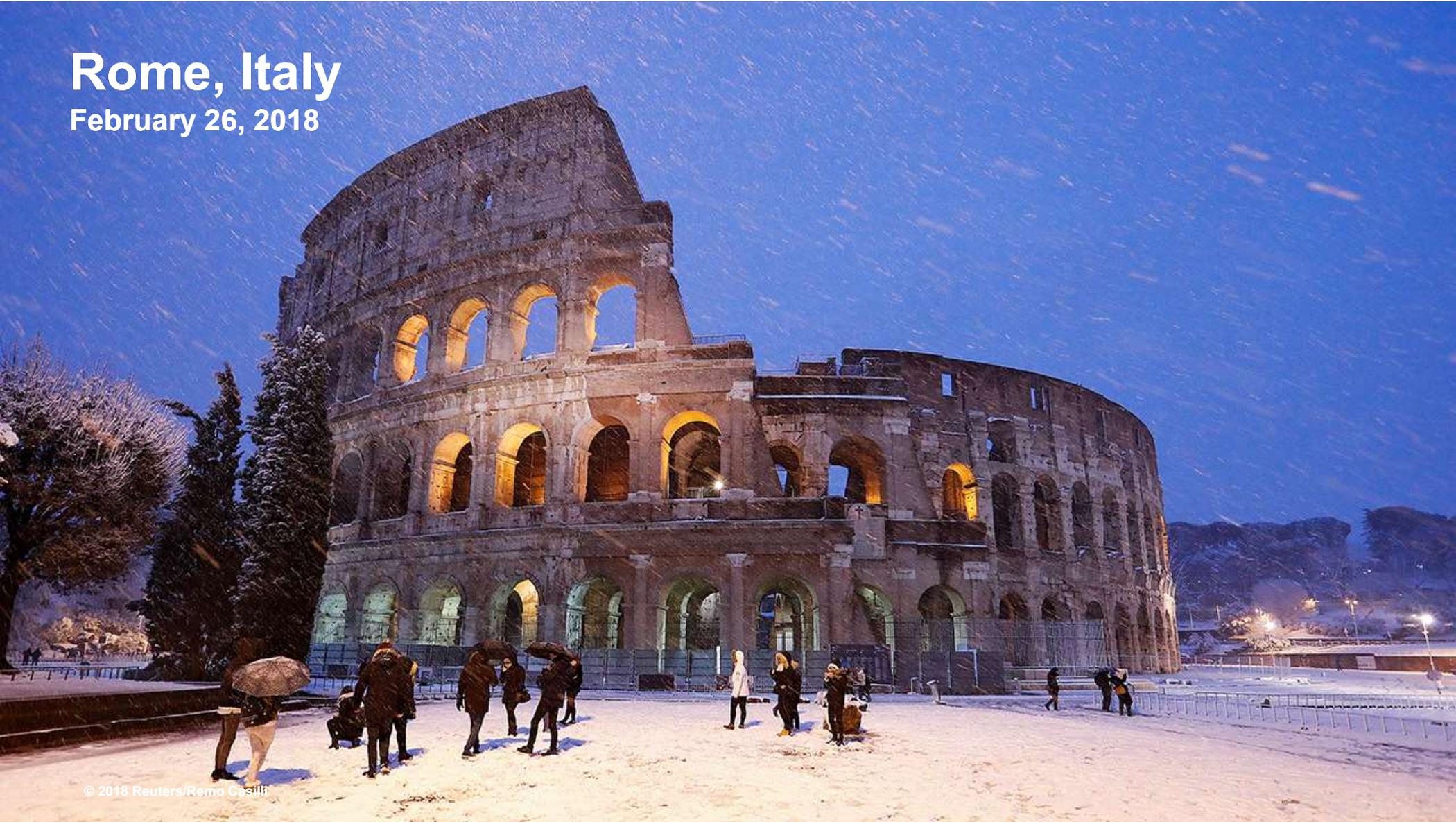
“Normal” Jet Stream

December 5, 2017

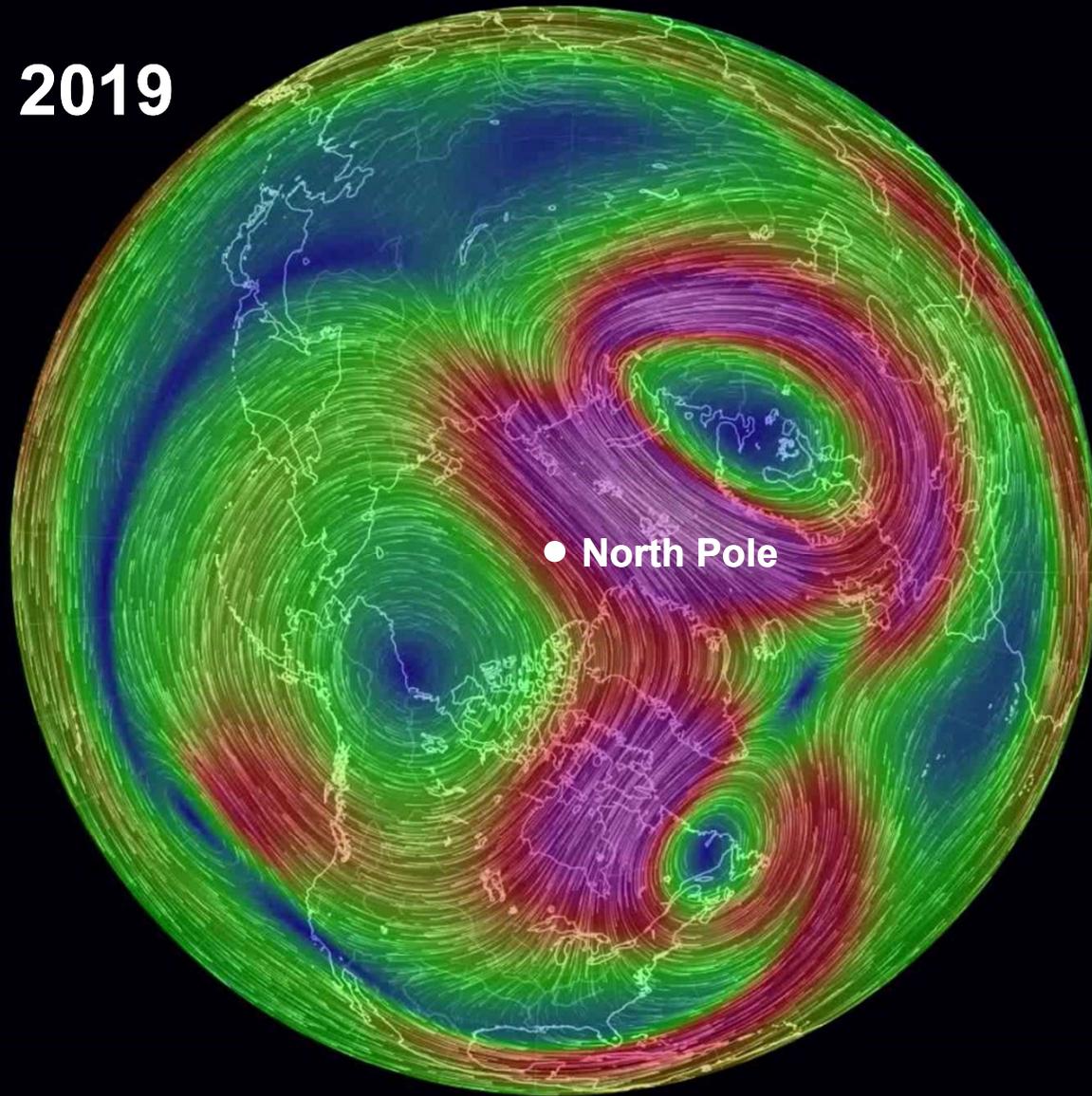


Rome, Italy

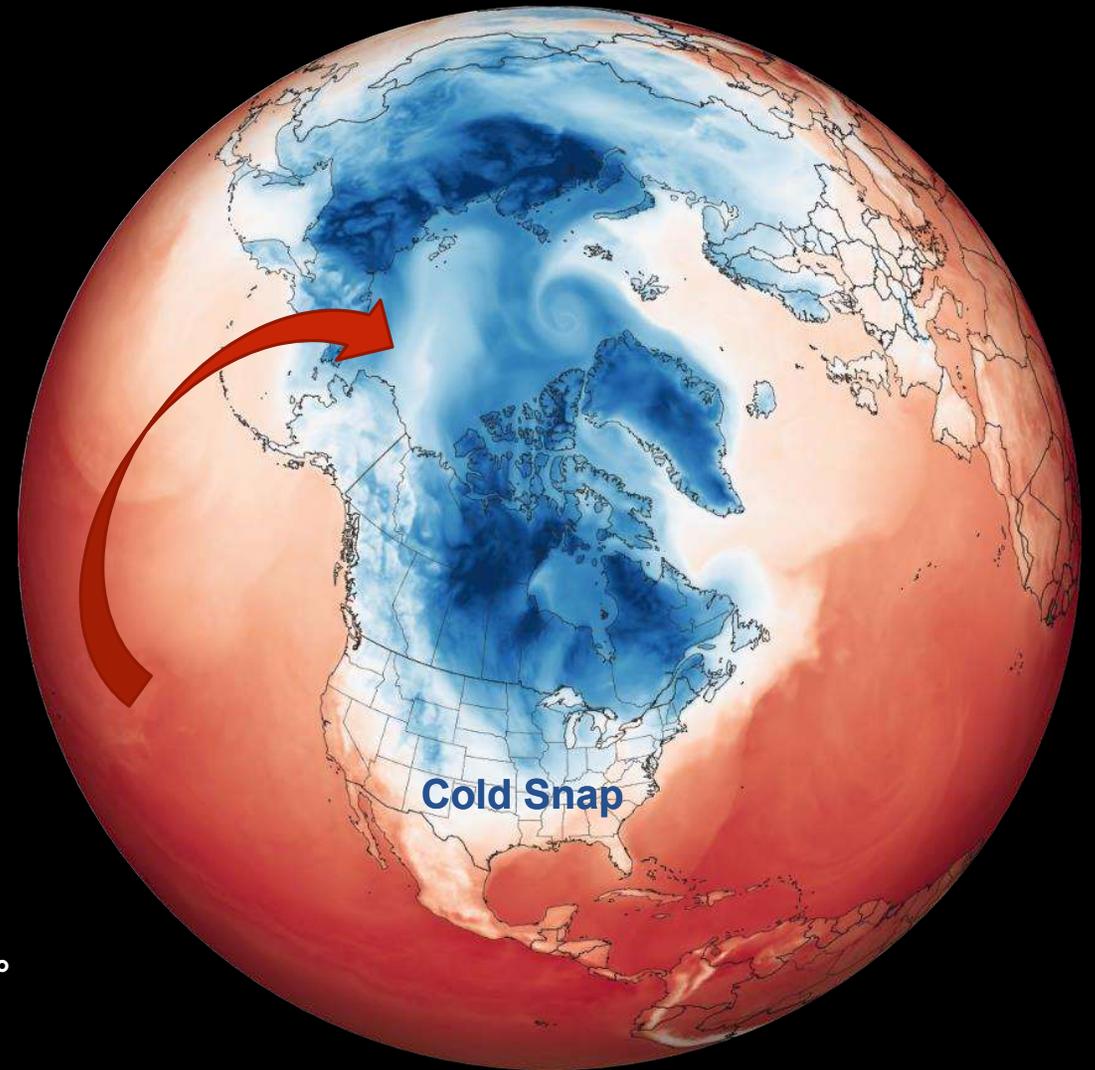
February 26, 2018



January 3, 2019



January 29, 2019



Air Temperature at 2 Meters (°F)



Source: 2019 NASA Earth Observatory

Chicago, Illinois

January 29, 2019

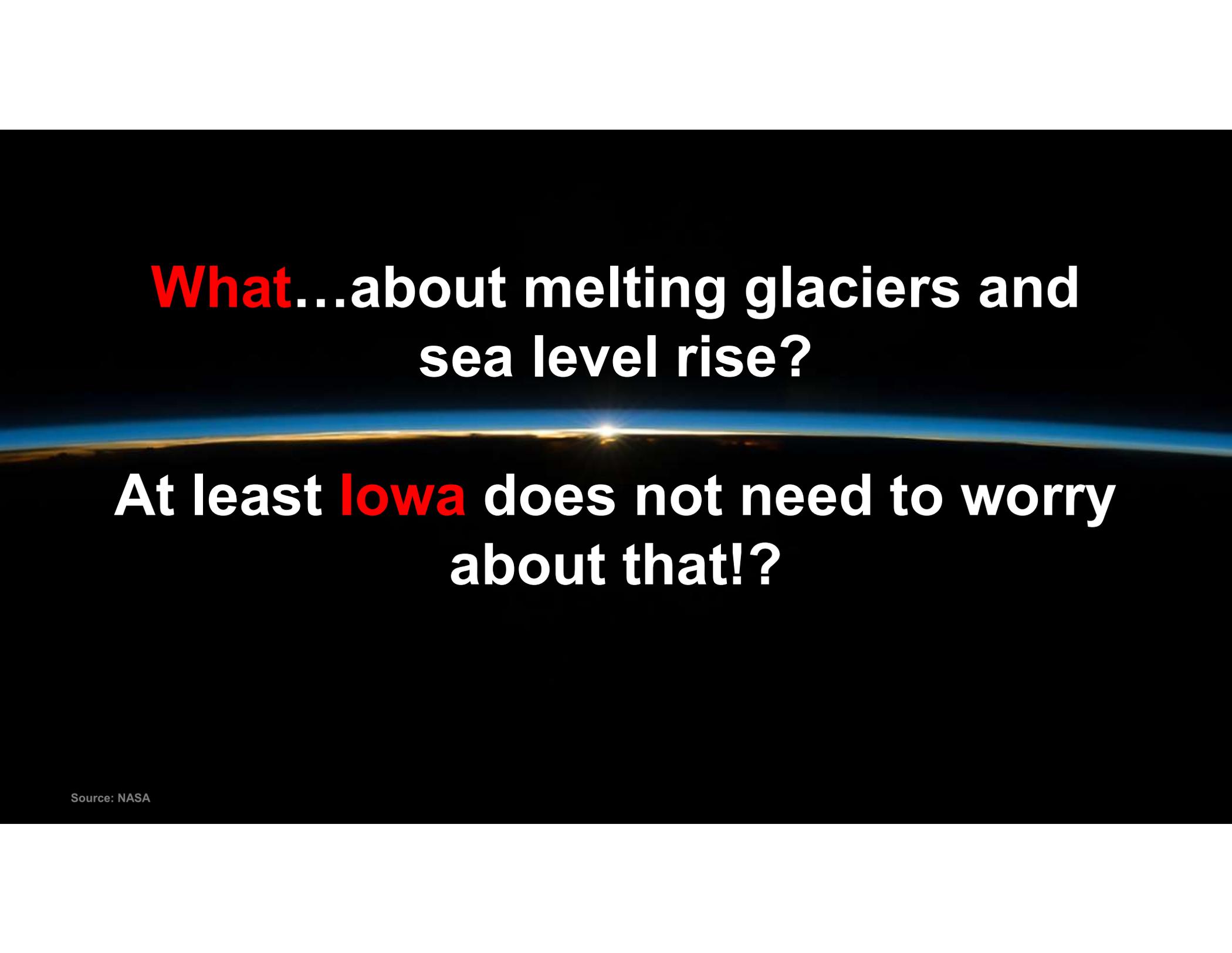


**The North Pole has now experienced
mid-winter heatwaves three years in a row:**

2016

2017

2018

A view of Earth from space, showing the horizon and a bright light source, likely the sun, creating a lens flare effect. The text is overlaid on this image.

What...about melting glaciers and
sea level rise?

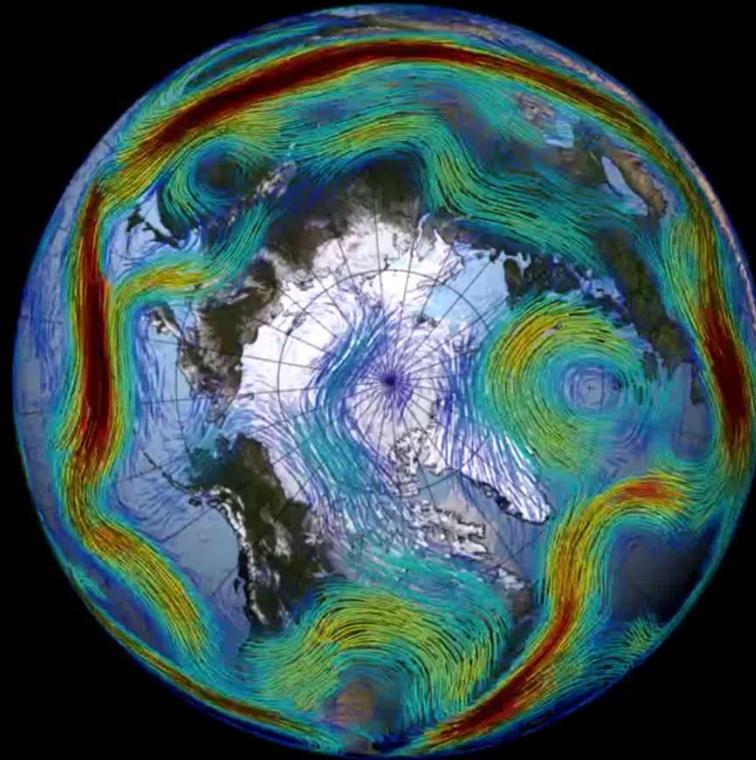
At least **lowa** does not need to worry
about that!?

A warming planet is increasing
glacier melt.

...which **decreases salinity** of ocean
water.

...which slows down **Ocean currents.**

...which impacts the world's
“jet stream”.



The jet stream is becoming “wavier”
Steeper troughs and higher ridges mean weather systems progress more slowly.
Increasing chances for long-duration extreme events
like storms, droughts, floods, and heat waves.
...in Iowa

Animation: NASA GSFC; Data: Francis, J.A., Vavrus, S.J., “Evidence linking Arctic amplification to extreme weather in mid-latitudes,” *GRL*, March 17, 2012

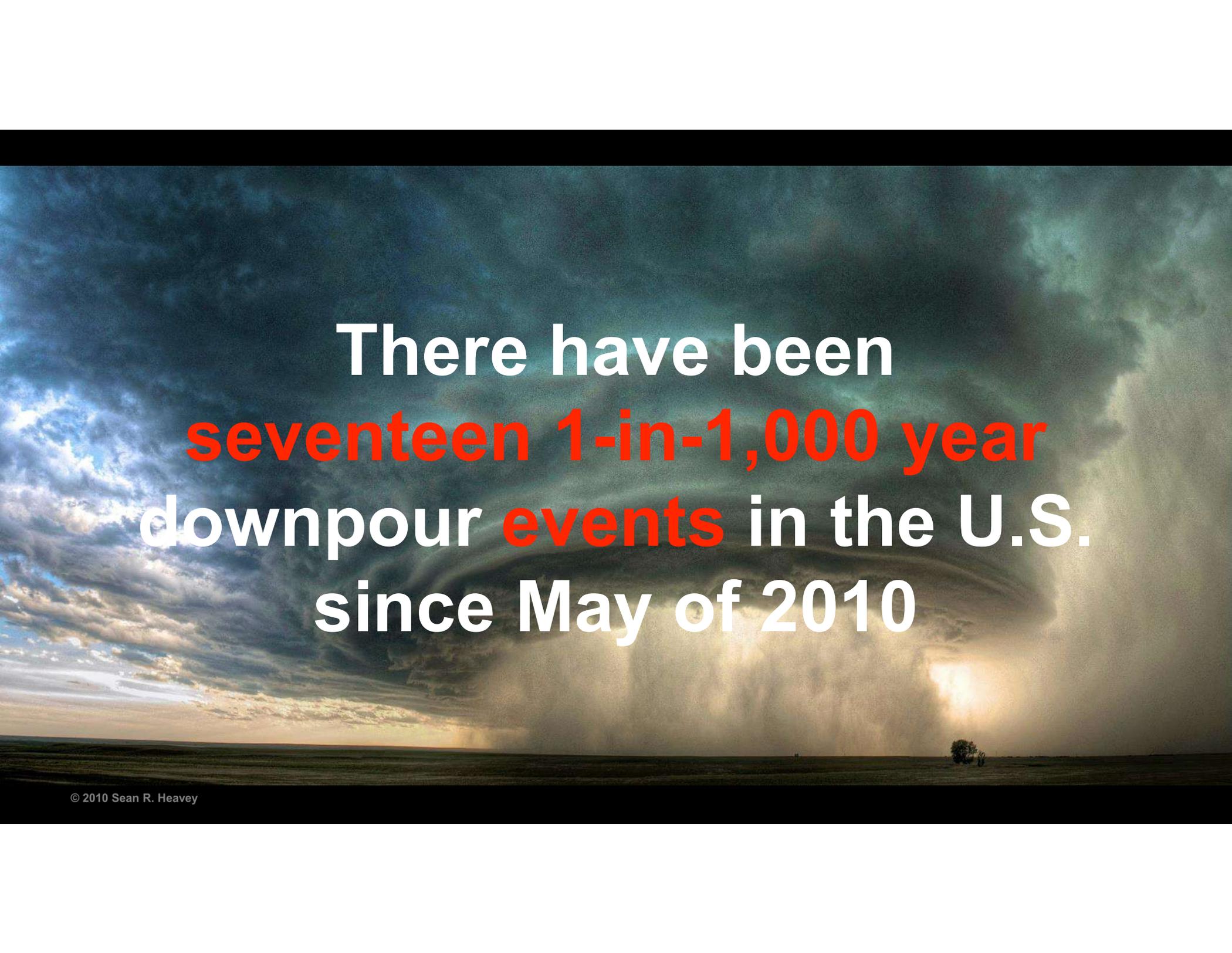


**Warmer air can
hold
a lot more water vapor**

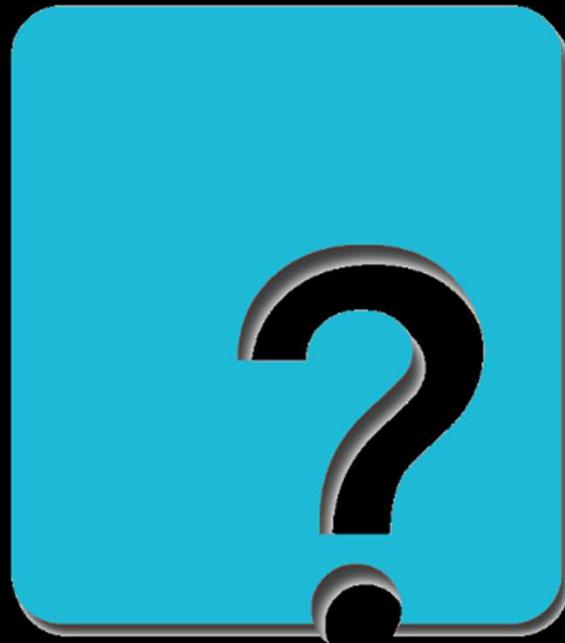
With each additional 1° (C) of temperature, the atmosphere's capacity to hold water vapor increases by 7%

There is already 5% more water vapor over the oceans than there was only 30 years ago

So the downpours get bigger



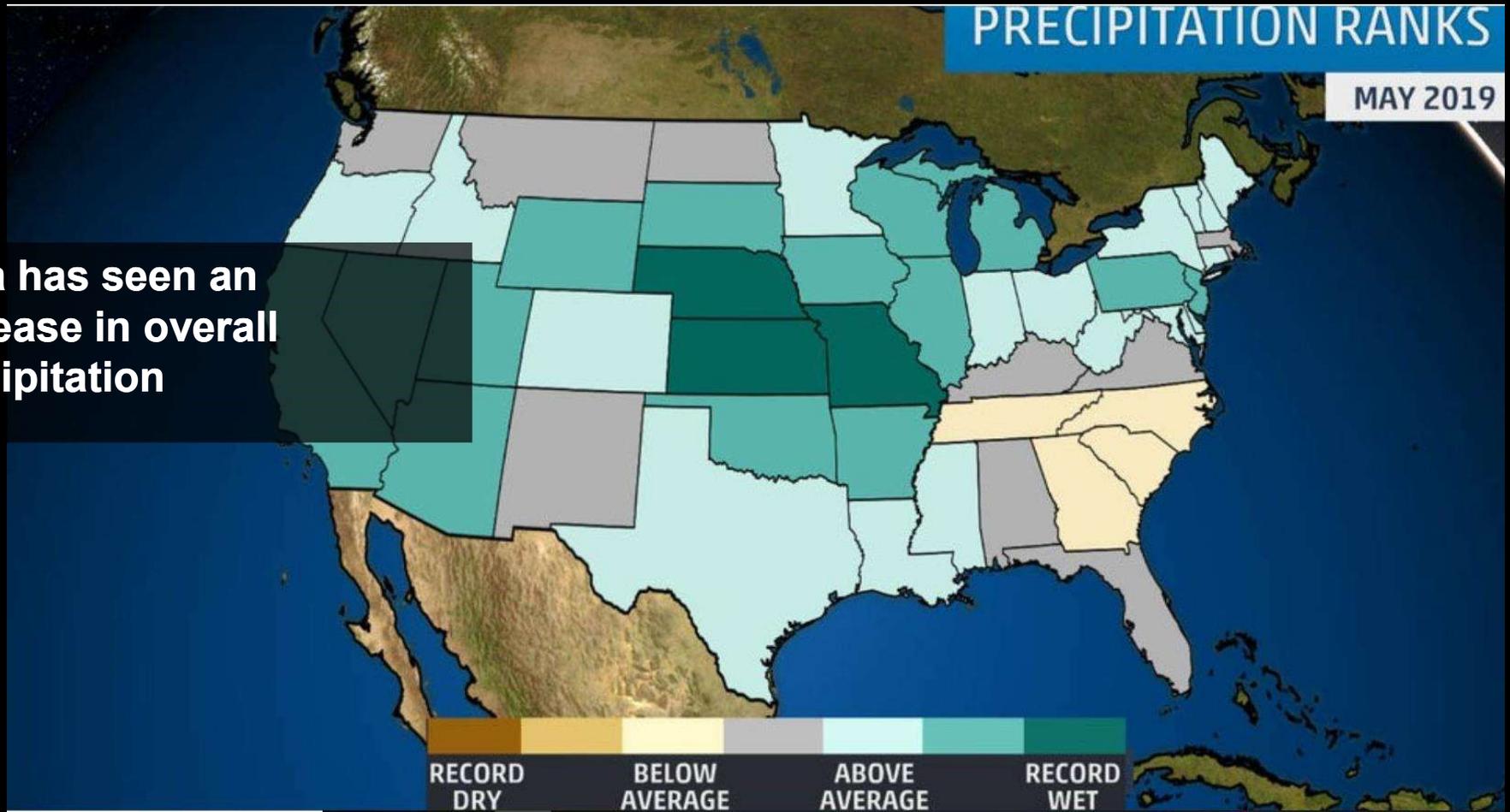
There have been
seventeen 1-in-1,000 year
downpour **events** in the U.S.
since May of 2010



What...changes has Iowa seen?

Increased Precipitation

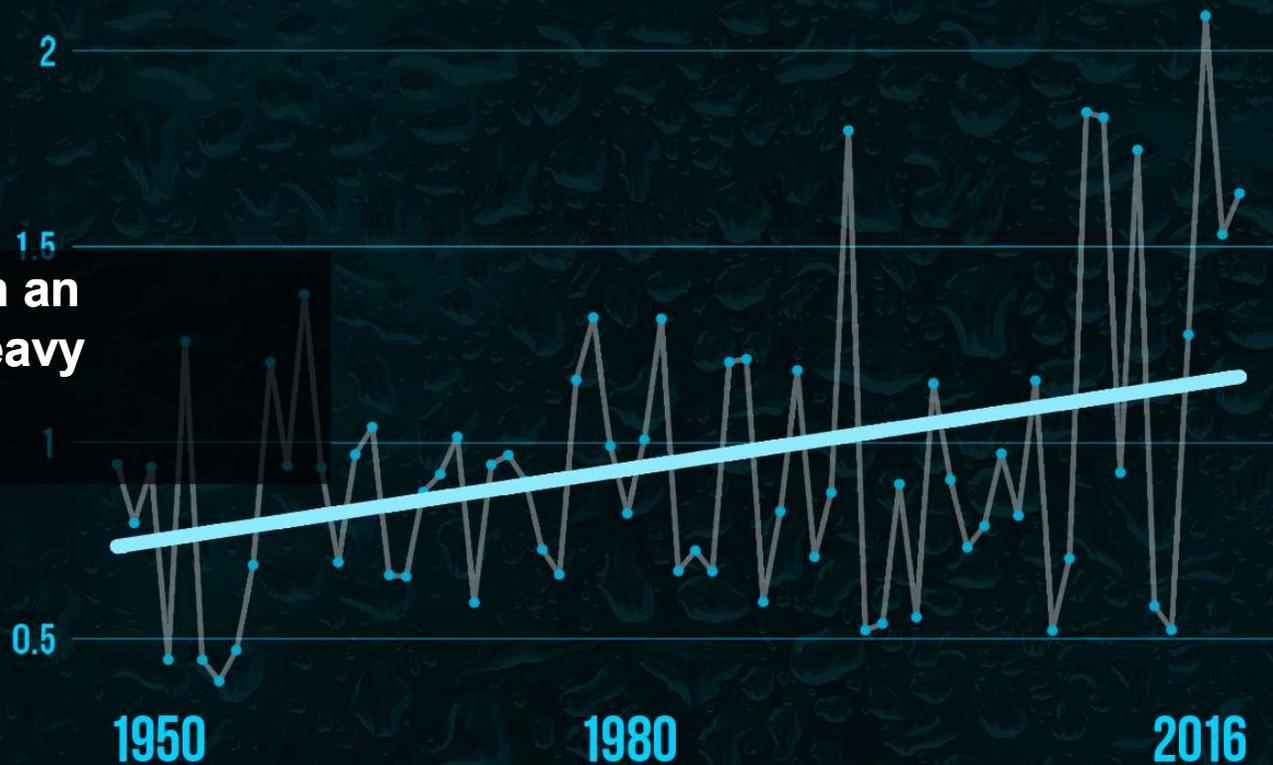
Iowa has seen an increase in overall precipitation



MORE HEAVY RAIN

Downpour Index
Iowa

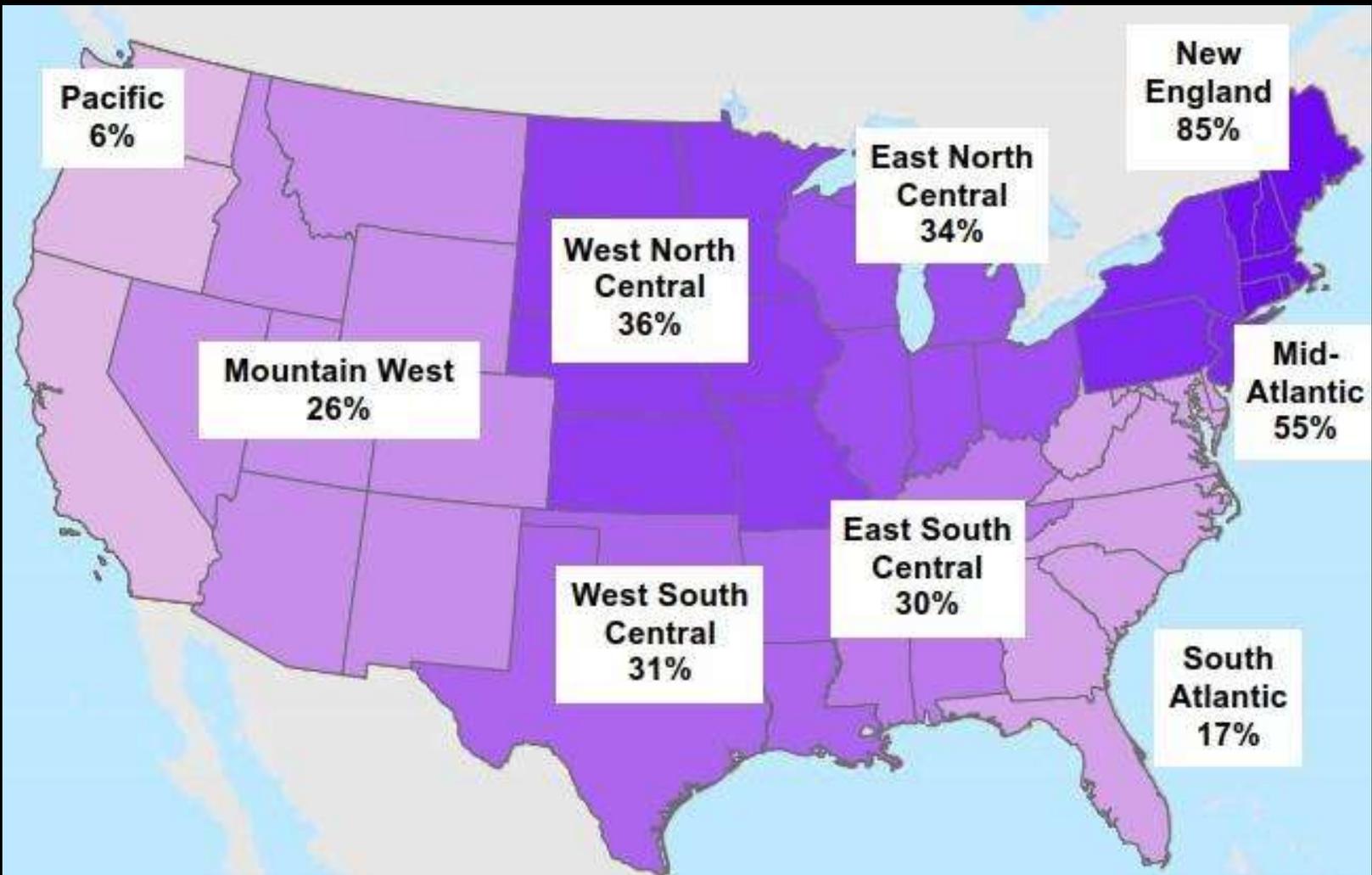
Iowa has seen an increase in heavy downpours



Index based on geographically averaged frequency of top 1% of daily rainfall events
Source: RCC-ACIS.org

CLIMATE  CENTRAL

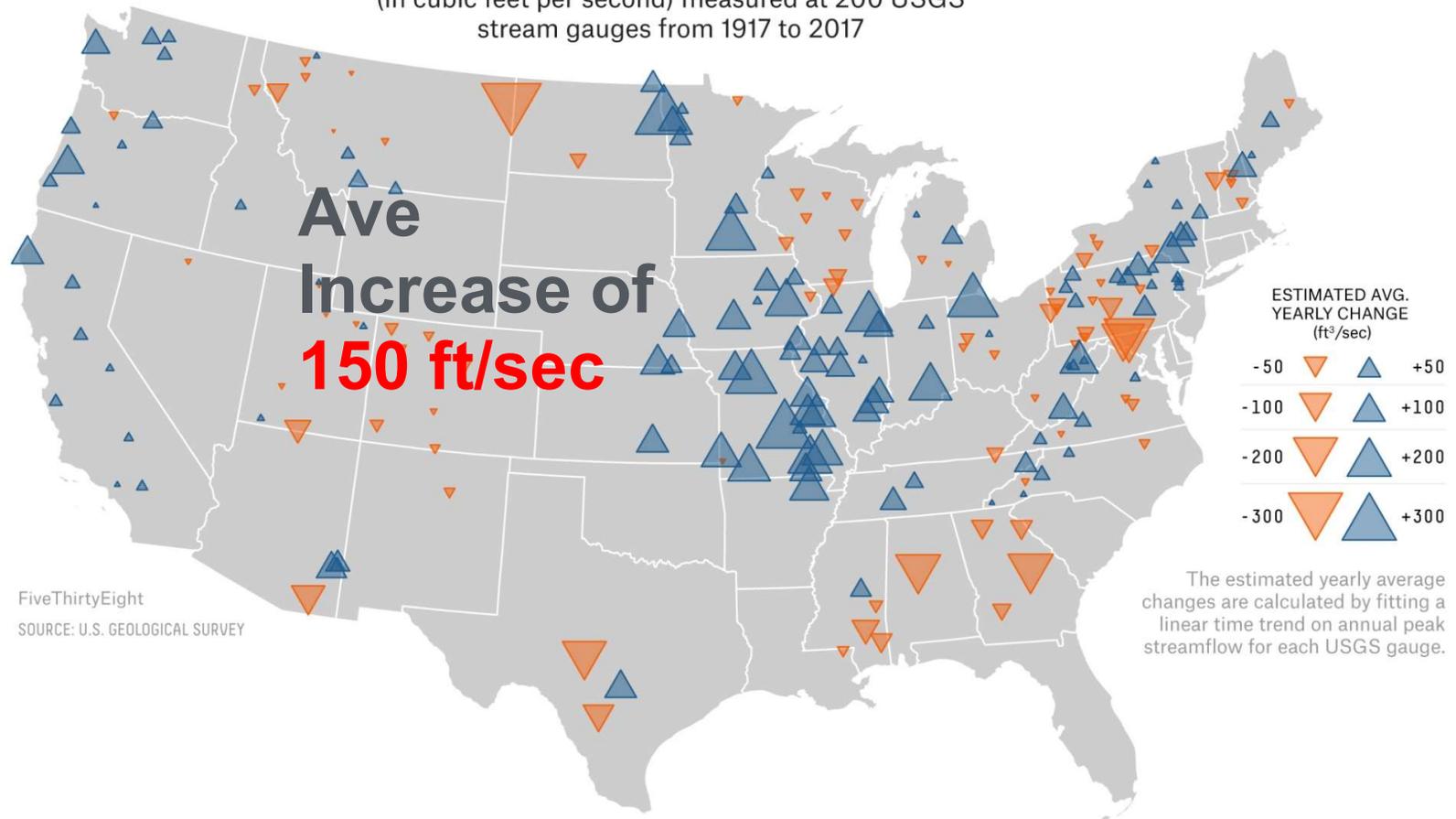
Increase in extreme rain/snow storm frequency since 1950



Iowa's Rivers Running Heavier/Faster At Peak Flows

The Midwest is getting wetter

Estimated average yearly change in peak flow of water
(in cubic feet per second) measured at 200 USGS
stream gauges from 1917 to 2017

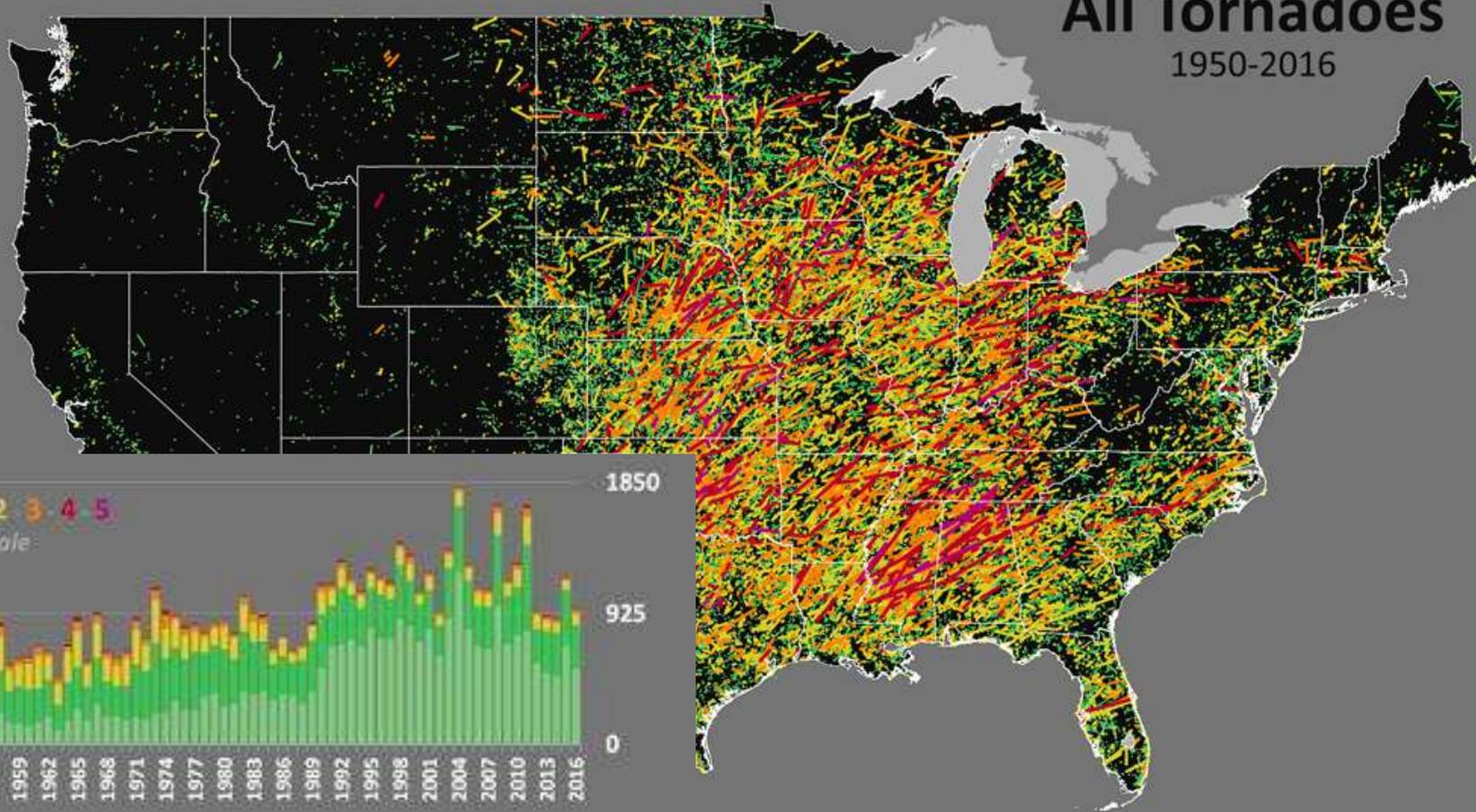


Increase in annual tornadoes since 1950

(so far only in weaker categories)

All Tornadoes

1950-2016



0 1 2 3 4 5
F/EF scale



Increase in disaster damage since 1980

BILLION DOLLAR **DISASTERS**



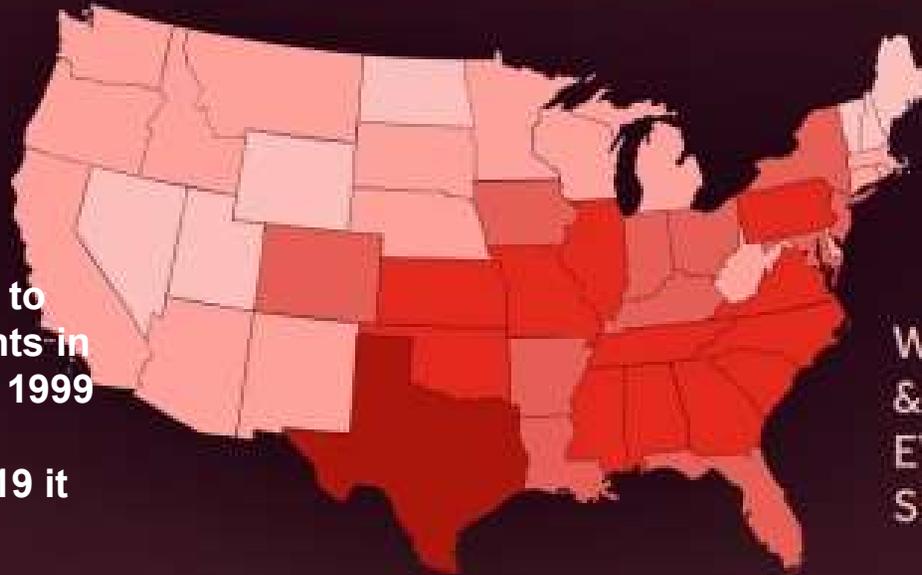
IA Emergency Declarations

1980 – 1999: 16

2000 - 2019: 31

An increase of **194%**

According to FEMA, reported damage due to extreme weather events in Linn County between 1999 and 2009 was \$0.7M; between 2009 and 2019 it was **\$4.5M**.

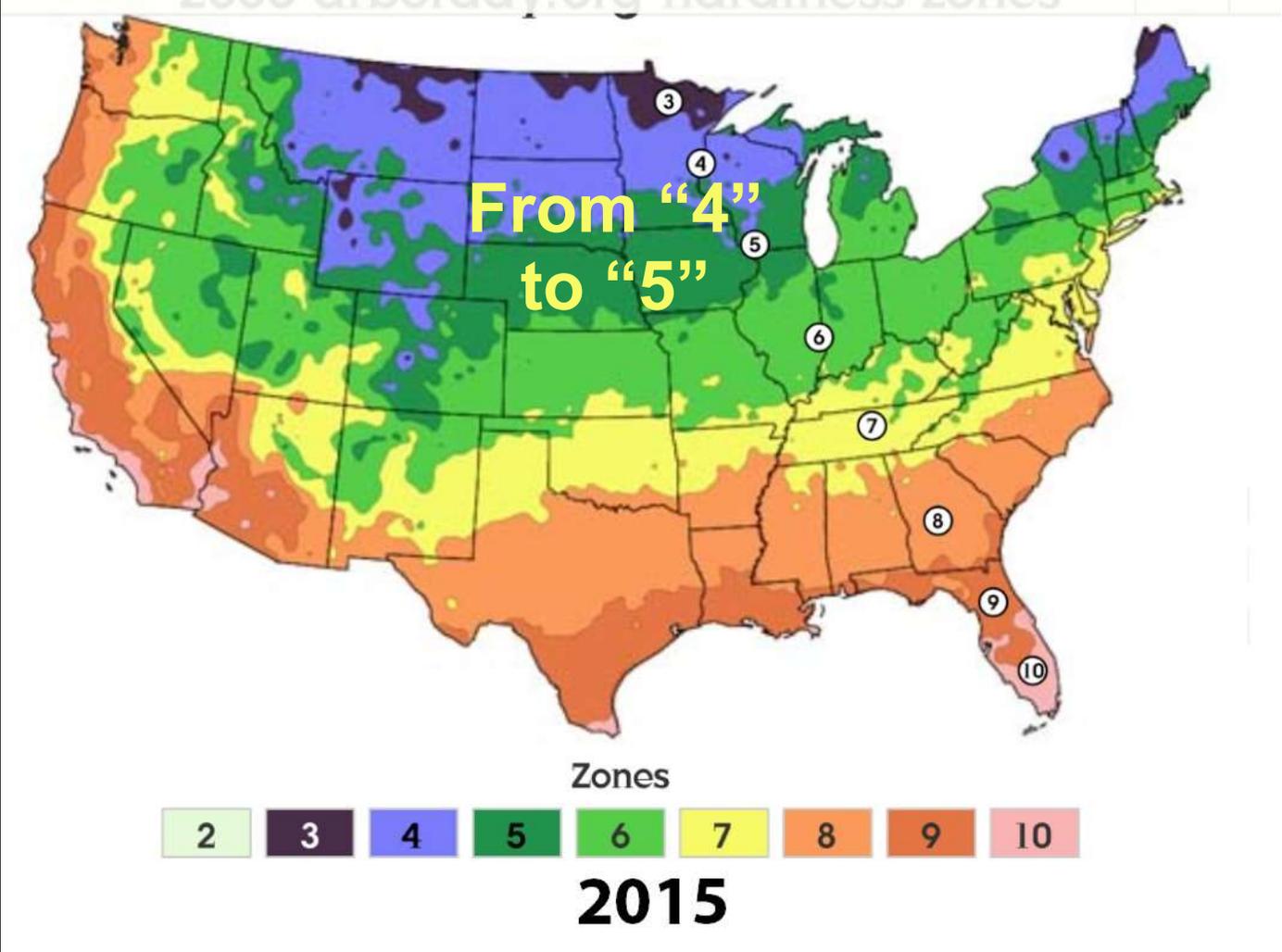


WEATHER
& CLIMATE
EVENTS
SINCE 1980

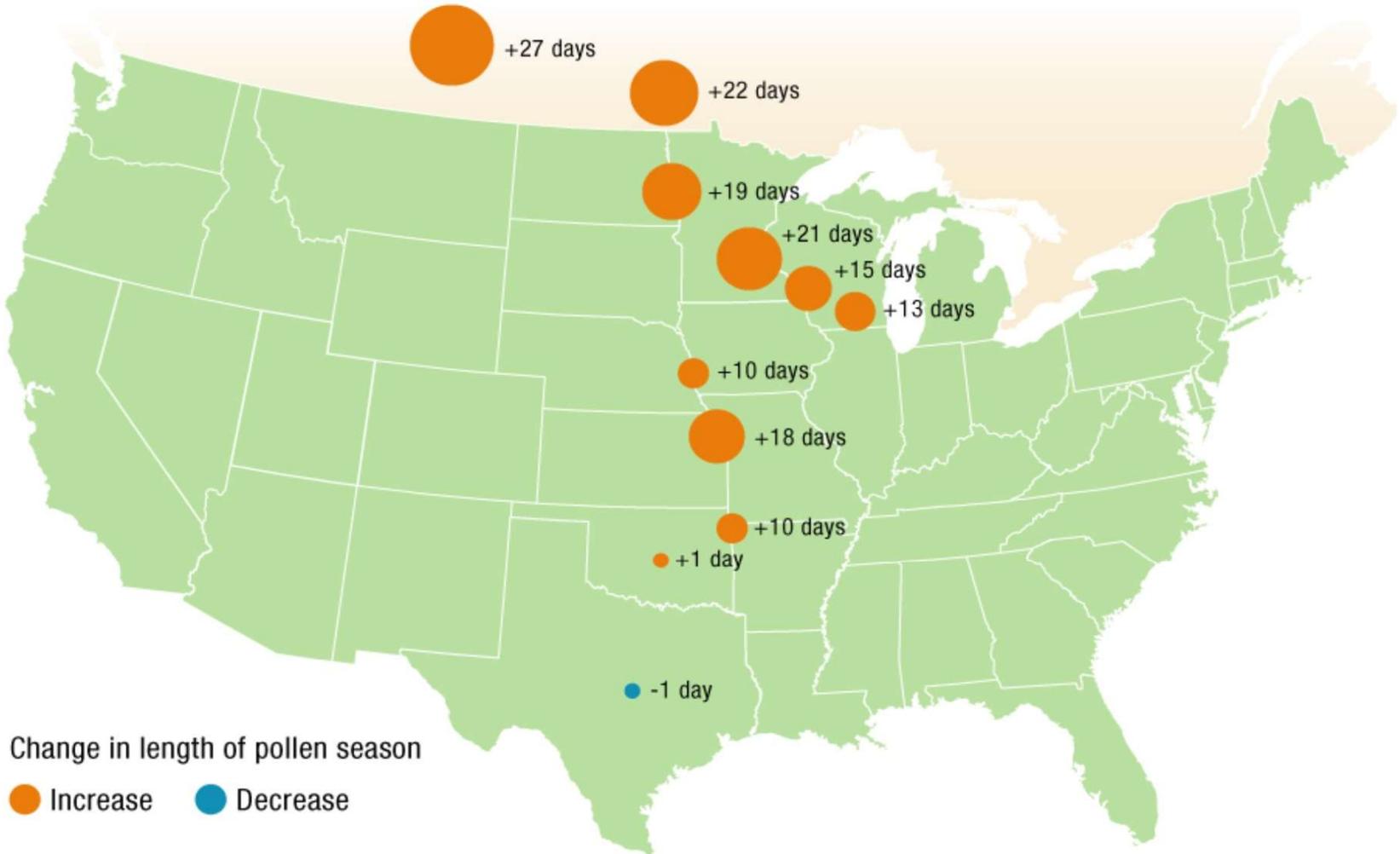
1980-2019 Billion-dollar weather and climate disasters (CPI-adjusted). Data as of October 9, 2018.
Source: NOAA/NCEI

CLIMATE  CENTRAL

Change in USDA Hardiness Zone Since 1990



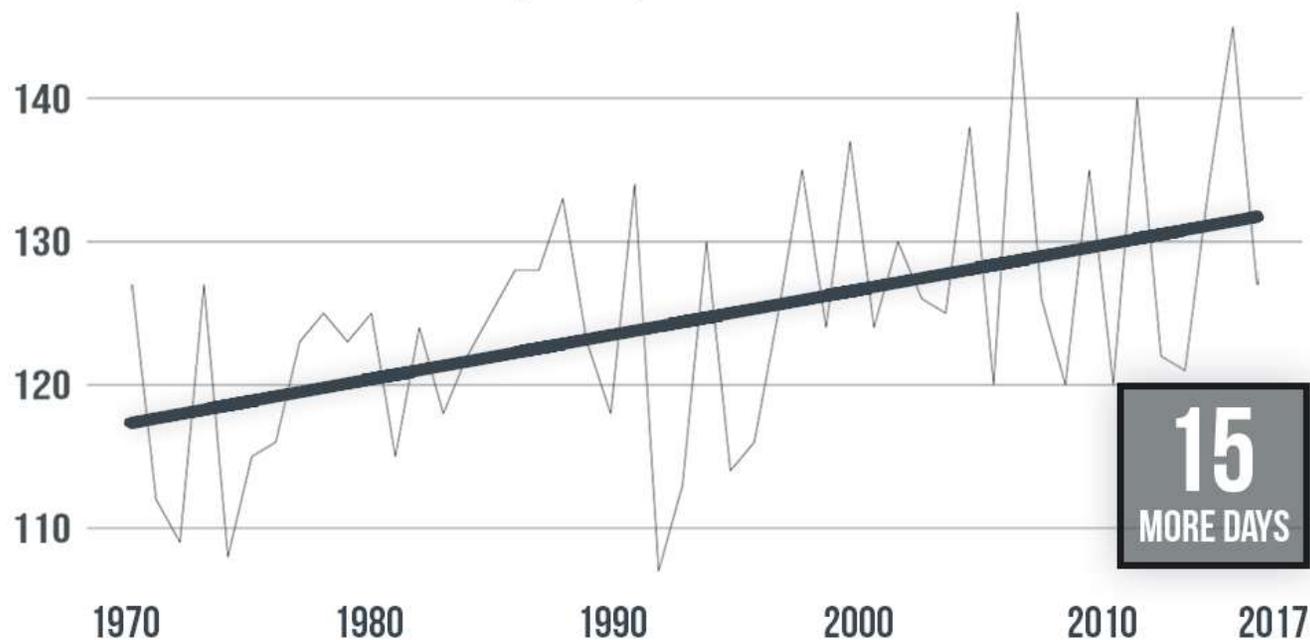
Increase in Allergy season since 1995



Increase in insect growing season and disease danger

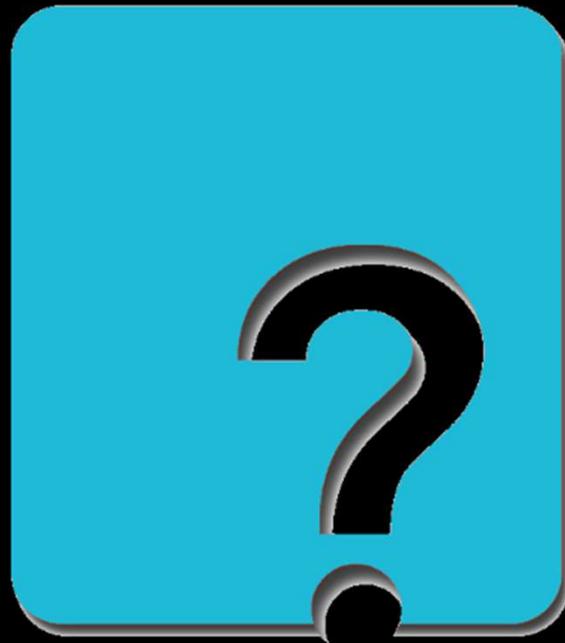
Disease Danger Days in Waterloo

Risk of disease transmission by mosquitoes



Days with average temp 61°-93° from Mar-Nov
Source: RCC-ACIS.org; Mordecai et al. 2017

CLIMATE  CENTRAL



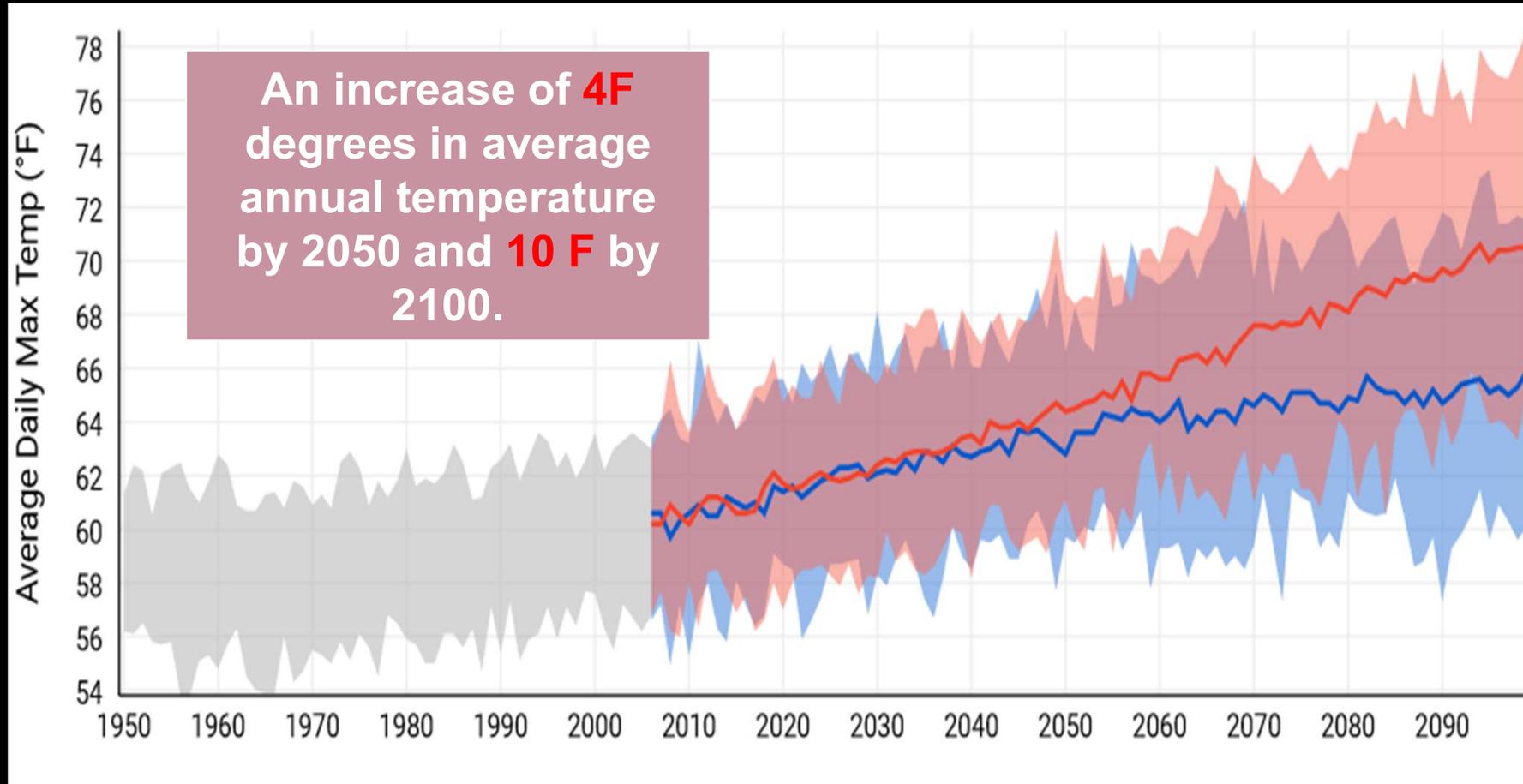
So What...

Source: NASA

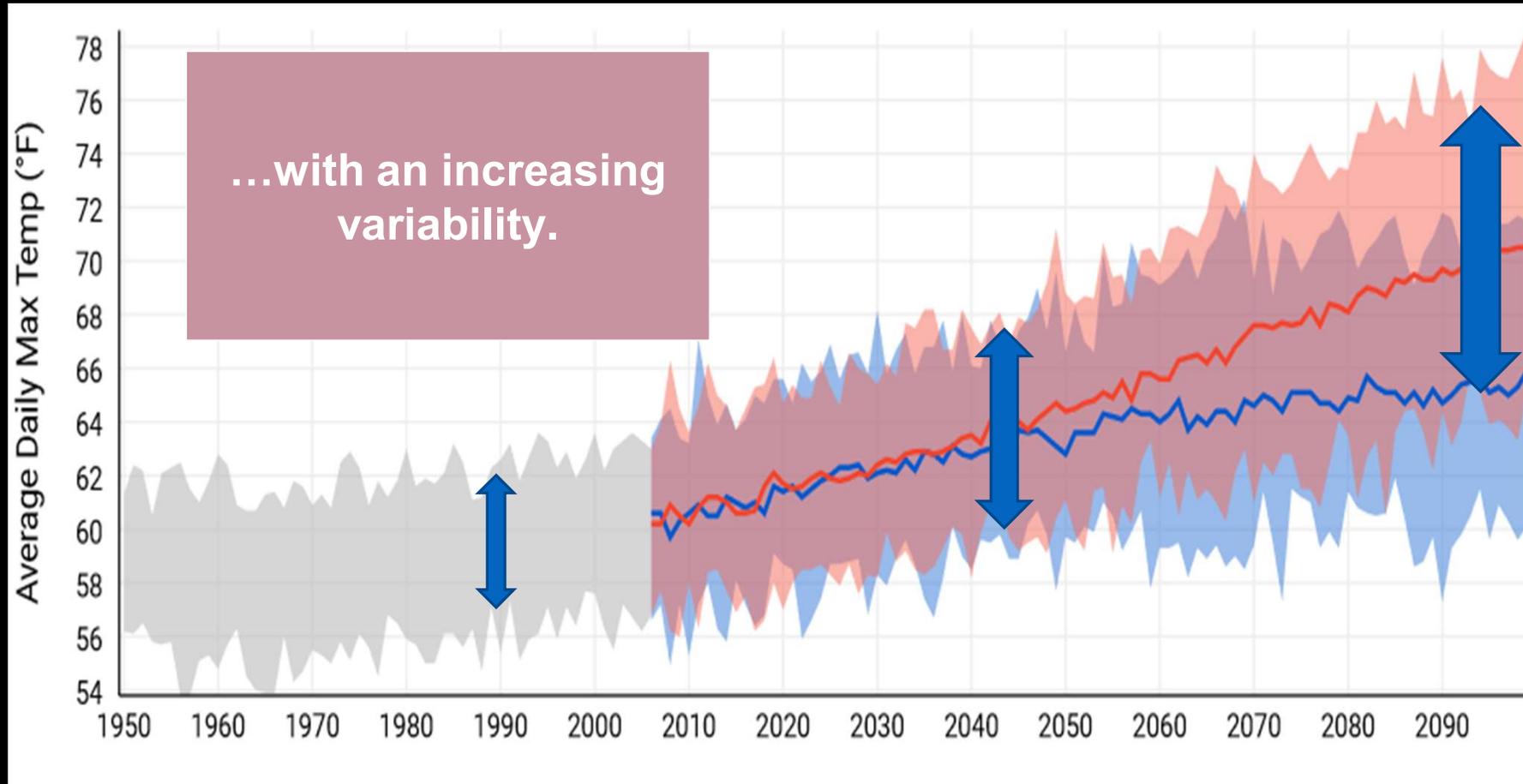


So What......does this mean for Cedar Rapids' future?

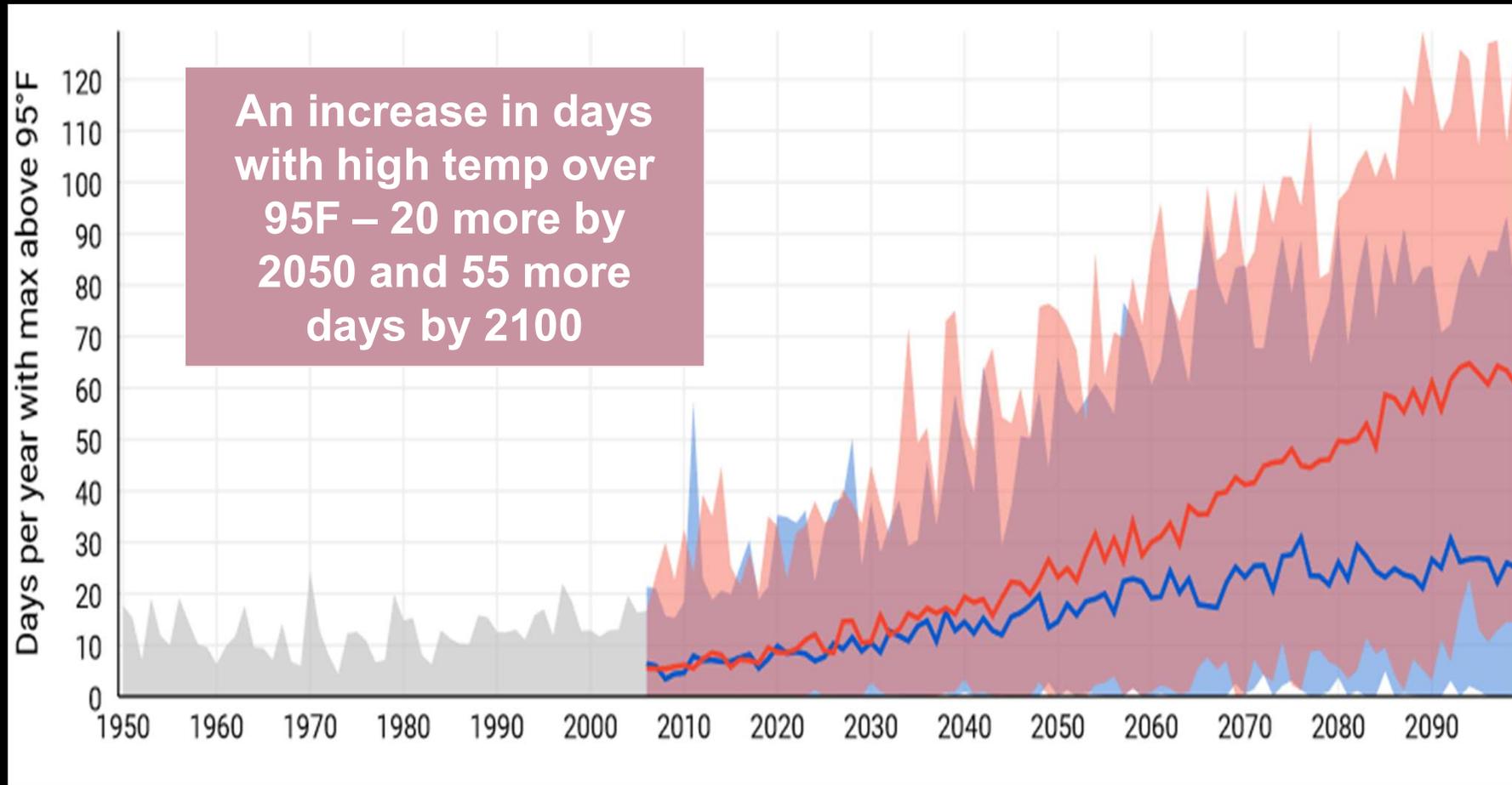
What does this mean for Cedar Rapids' Future?



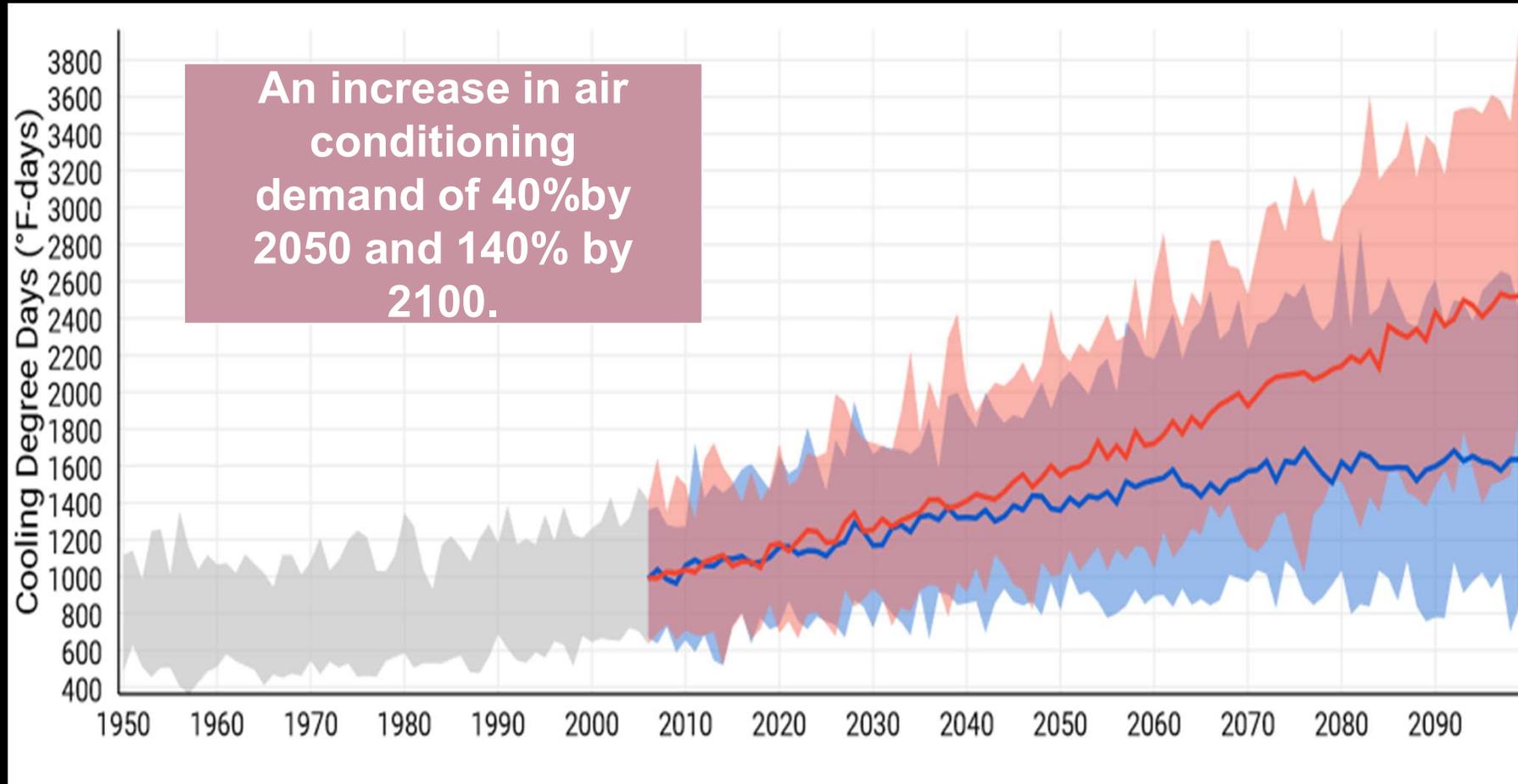
What does this mean for Cedar Rapids' Future?



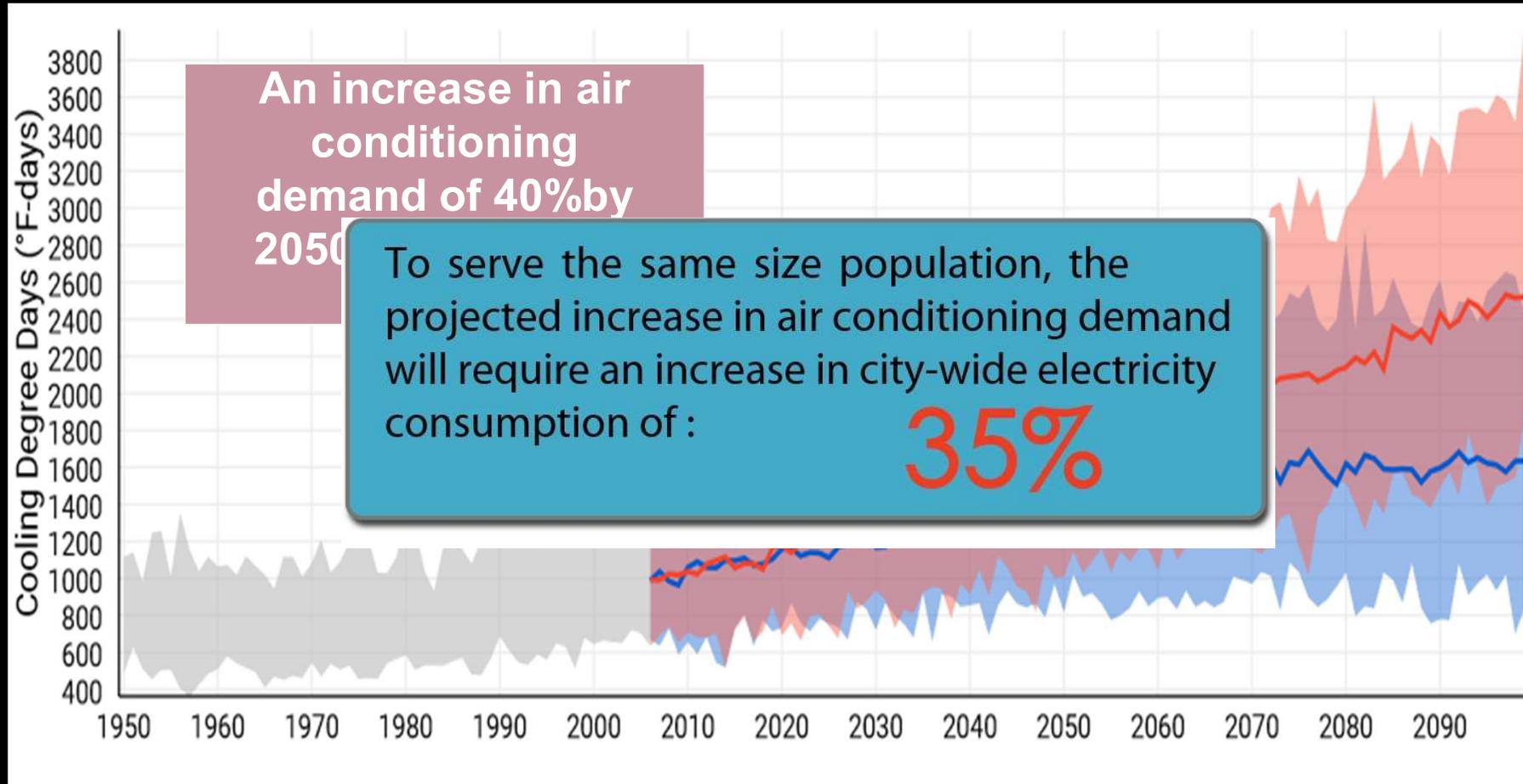
What does this mean for Cedar Rapids' Future?



What does this mean for Cedar Rapids' Future?



What does this mean for Cedar Rapids' Future?



A photograph of a road with yellow dashed lines leading into a field. The road is wet and has several puddles. In the background, there are mountains and a sign that says "ROAD MAY BE CRY". The sky is cloudy and the overall tone is somewhat somber.

The Climate Change Road Ahead For Cedar Rapids

The Climate Change Road Ahead For Cedar Rapids

11
miles Distance southward the City
of Cedar Rapids' climate
experience moves every year.

Which is equal to moving:

159
feet every day.





2020
Cedar
Rapids

2030
Leon,
IA

2040
Lathrop,
MO



2050
Nevada,
MO

2060
Miami,
OK

2070
Savanna,
OK



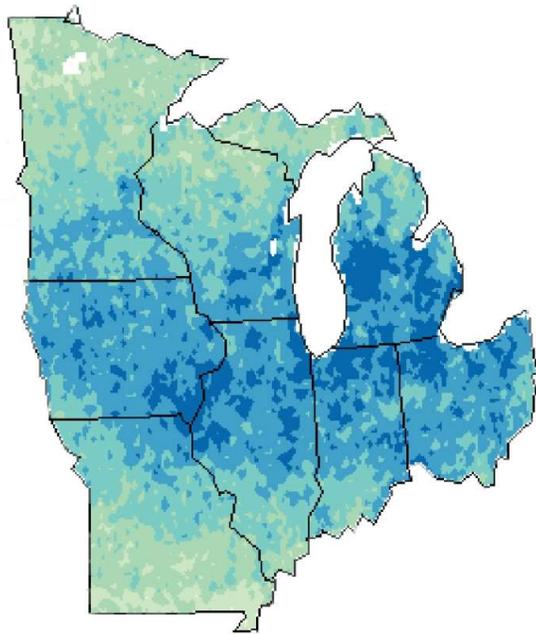
2080
Denison,
TX

2090
Angus,
TX

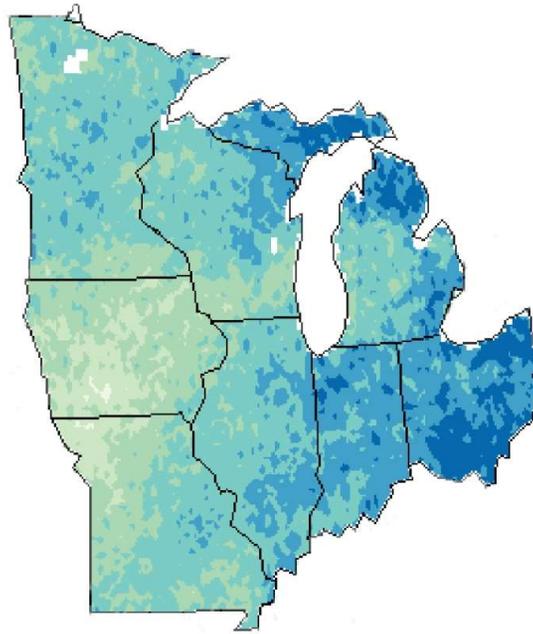
2100
Bryan,
TX

In the next 30 years... An increase in precipitation

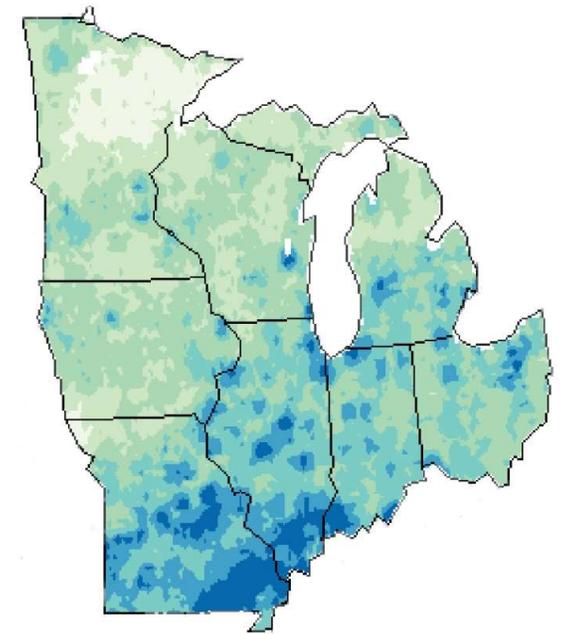
Average Precipitation



Heavy Precipitation



Wettest 5-Day Total



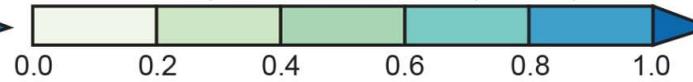
Precipitation Difference (Inches)



Difference in Number of Days

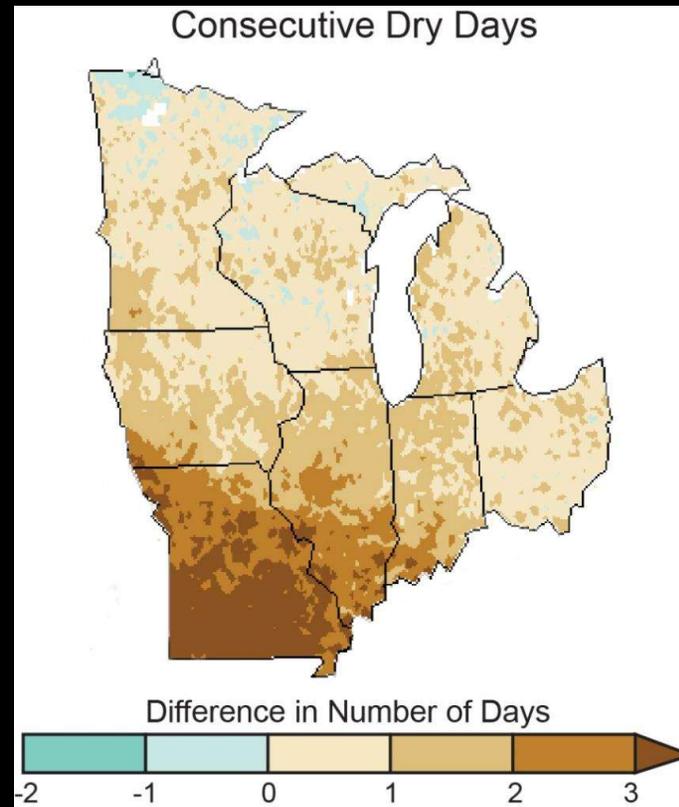


Precipitation Difference (Inches)



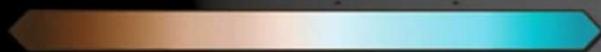
In the next 30 years... An increase in precipitation ...and drought

Drought index
of severity
increase by
up to **50%**



'business-as-usual'
emissions scenario

soil moisture



drier

wetter

2018

Source: 2015, 2018 NASA

What does this mean for Cedar Rapids' Future?

Increased Variability and Intensity:

Higher temperatures

With wider swings

Fewer days with rain

With heavier downpours

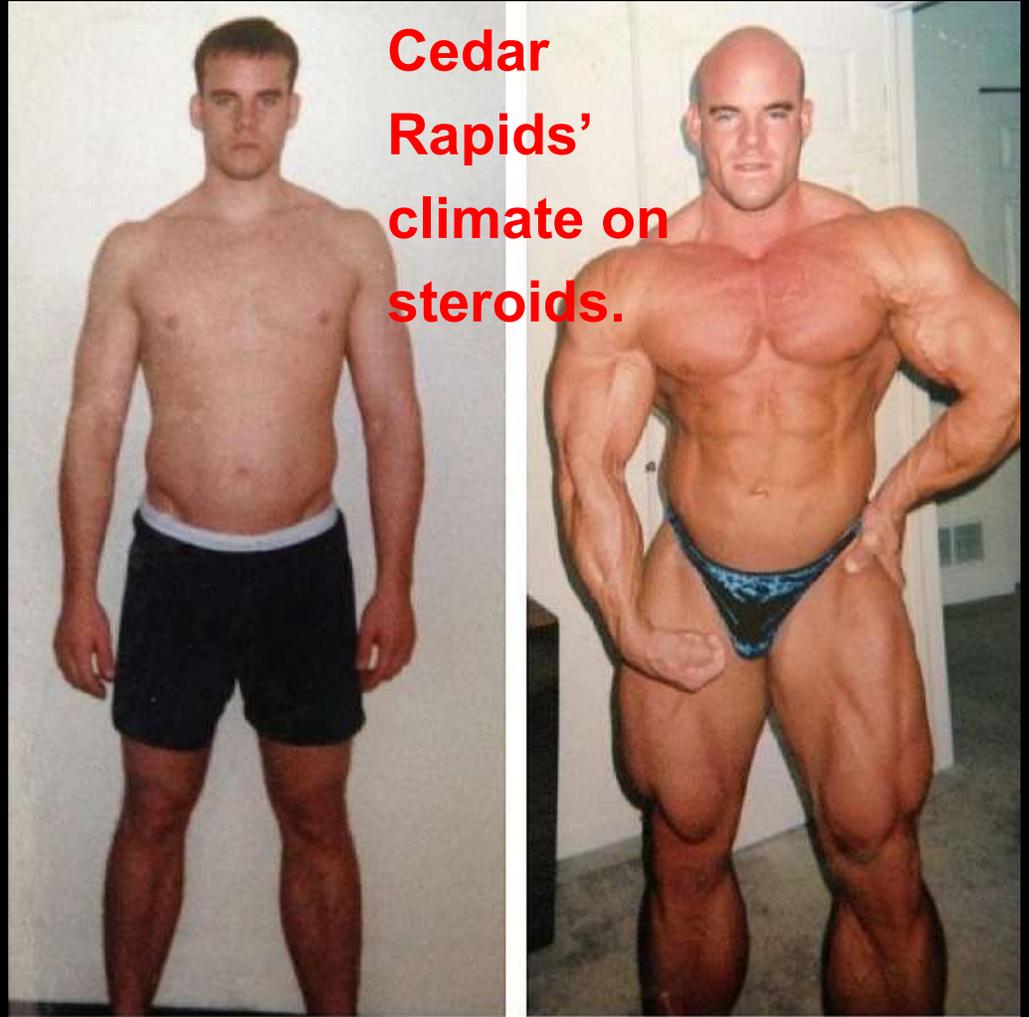
And stronger storms

Longer dry spells

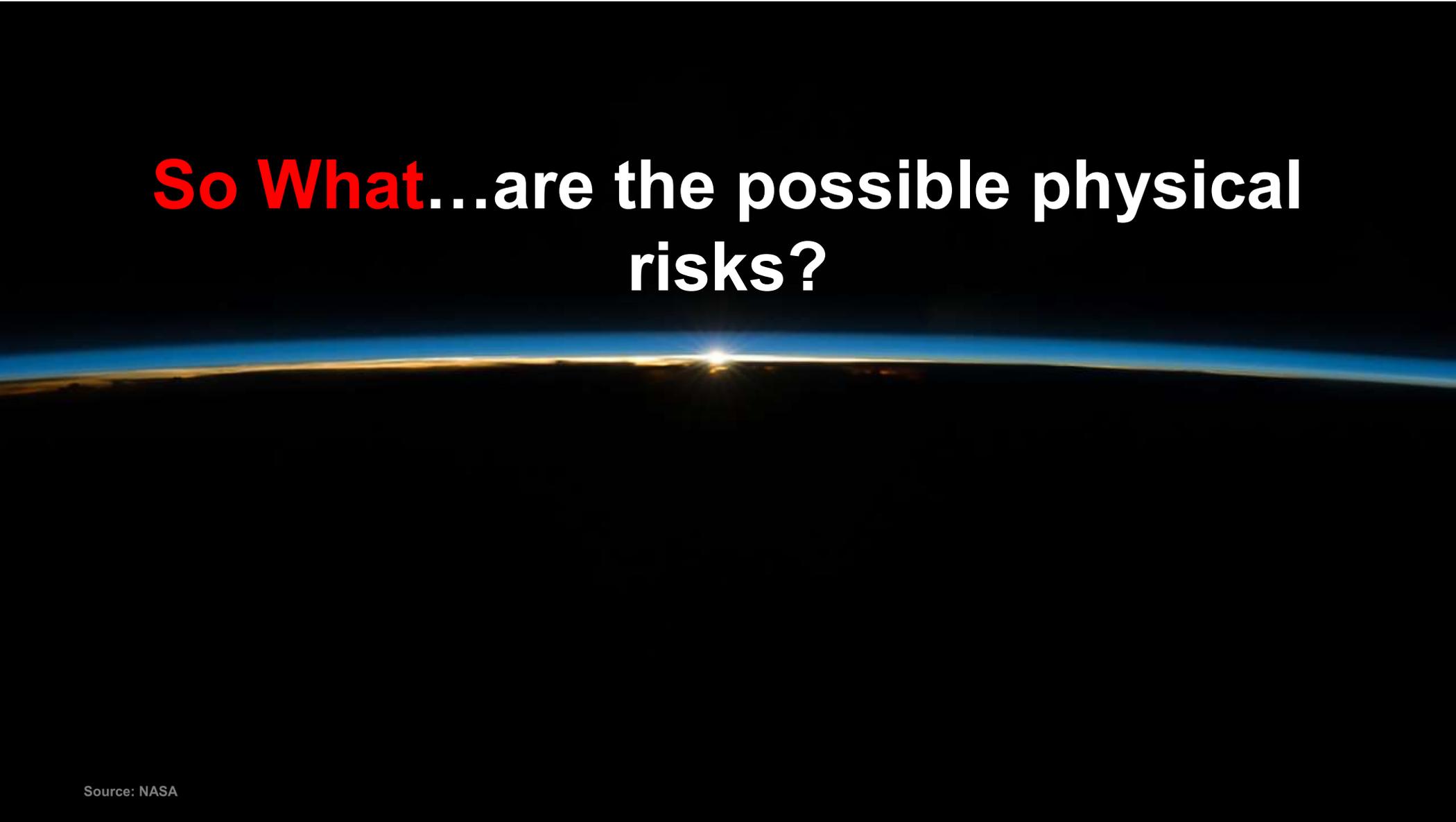
With an increase in the wettest 5-day period

Fewer days with tornadoes

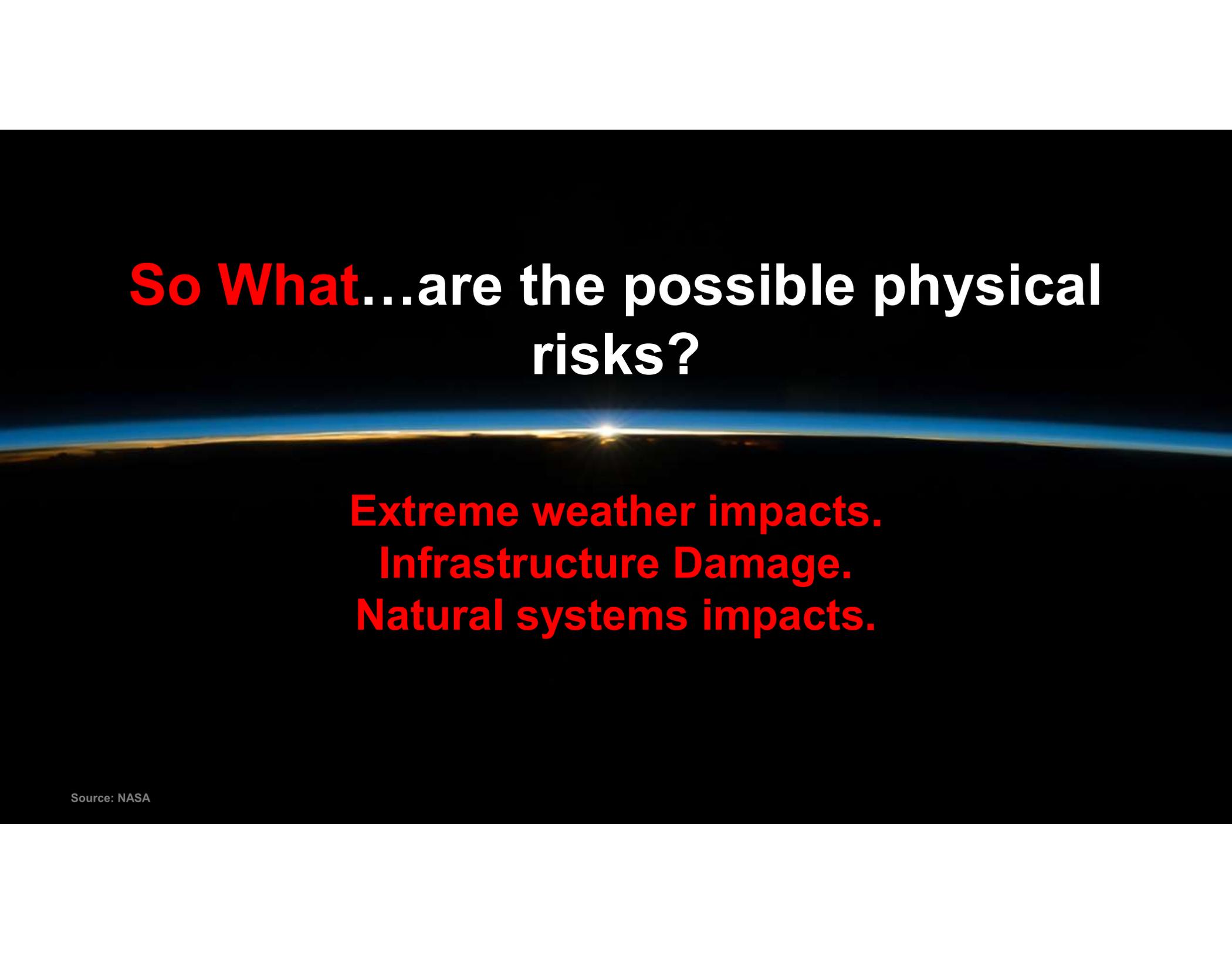
**With more tornadoes per day
...and likely stronger tornadoes**







So What...are the possible physical risks?



So What...are the possible physical risks?

**Extreme weather impacts.
Infrastructure Damage.
Natural systems impacts.**

So What kind of extreme weather impacts?

Flooding and Flash Flooding;
Drought;
Extreme heat;
Potential for extreme coldsnap;
and stress caused by increased
variability

So What kind of Infrastructure Damage?

A7 Motorway, Germany

June 30, 2019

Roads

High temperatures caused this concrete roadway to break open.

Dubuque Iowa has identical damage that occurred in their downtown streets this past summer.

Berkshire, England
July 5, 2018

Roads





Rail Lines

58 rail accidents in
United States in last
three years due to
thermal buckling.

Federal Railroad Administration

Bridges

**Flash Flooding
Ashland WI
Summer 2018**



So What kind of Natural Systems Impacts?

Minneapolis, Minnesota

July 6, 2015

Air Quality

Increased temperatures exacerbate air pollution impacts

Smoke from wildfires in Canada prompted a public health warning in the Twin Cities.

Photo © 2015 Jeff Wheeler/Star Tribune via AP

Dec 2015: St. Louis Flood

Water Quality





Lake of the Woods, Minnesota

Water Quality

Warmer summers and increased agricultural runoff increase the growth of toxic blue-green algae on lakes and ponds.

Warmer temperatures also threaten water quality for wildlife and human consumption.

Water Quality

In 2010 and 2012, two children died after encountering *Naegleria fowleri*—usually found in much warmer climates—in Minnesota lakes.



Tree Damage and Loss

Warmer/longer summers with increased pests threaten forests; increased downpour topple more trees.

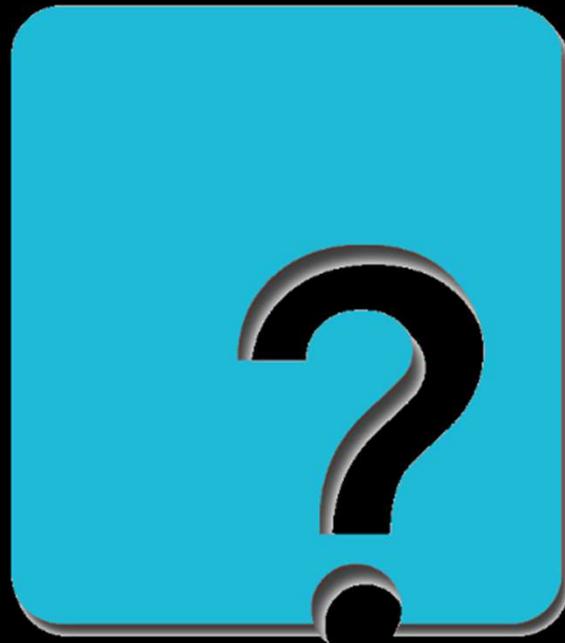
Photo © 2014 AP Photo/Minnesota Public Radio, John Enger



Warmer/longer summers with increased pests threaten forests; increased downpour topple more trees.

**Tree Damage and Loss
...and increased potential of power outage**

Photo © 2014 AP Photo/Minnesota Public Radio, John Enger



So What...are the vulnerabilities for
our populations?

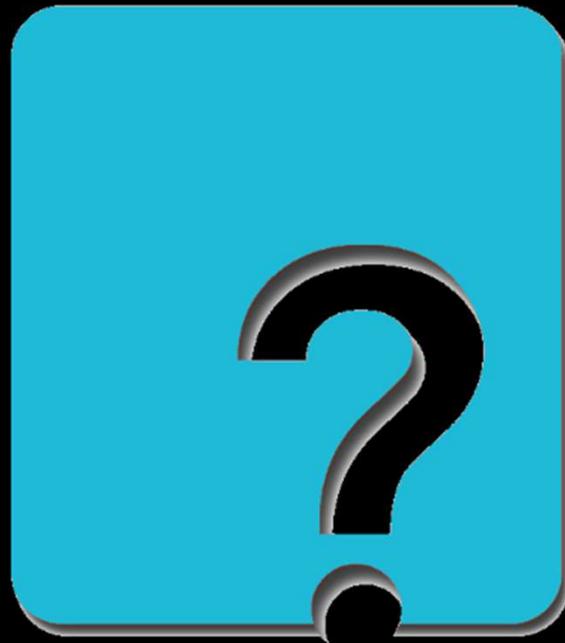
So What are the vulnerabilities for our populations?

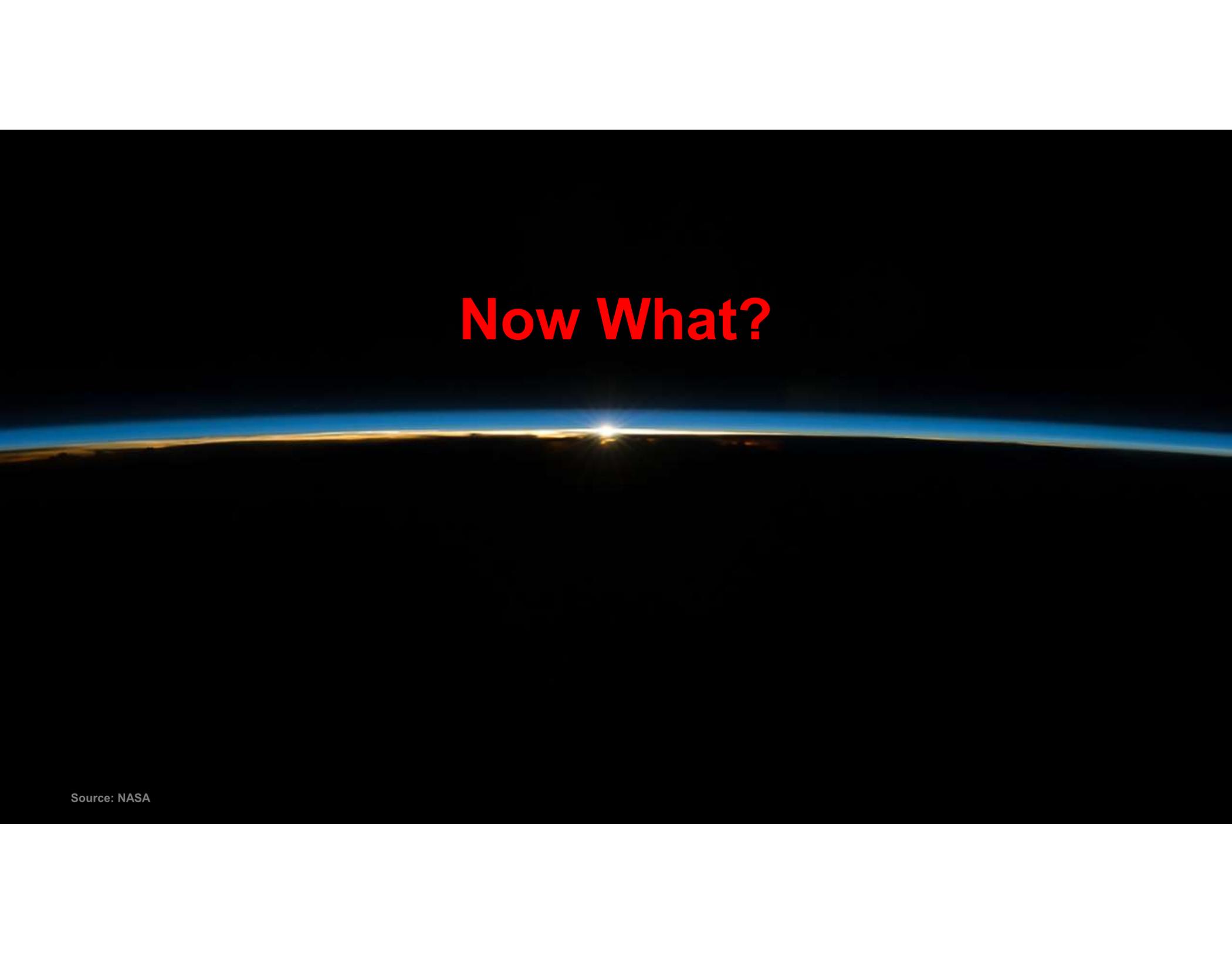
-  **Extreme Weather / Temperature**
-  **Flood Vulnerability**
-  **Air Quality Impacts**
-  **Vector-Borne Diseases**
-  **Food Insecurity and Foodborne Diseases**
-  **Water Quality/Quantity**
-  **Waterborne Illness**
-  **Wildfire**
-  **Grid Outage**

So What are the vulnerabilities for our populations?



Children Under 5
Older Adults
Those with Disabilities
Those in Economic Stress
People of Color
Limited English Speakers
Those in Climate Risk Employment
Those with Food Insecurity





Now What?

Source: NASA



Now What?

We have the solutions at hand...

Buildings + Energy

The Building Energy sector includes all residential, commercial, and industrial buildings. Greenhouse gas emissions from this sector come from **direct emissions** – from fossil fuels burned on site for heating or cooking needs – as well as **indirect emissions** – from fossil fuels burned offsite in order to supply that building with electricity. Cities and individuals can significantly reduce Building and Energy GHG emissions through a number of ways:

Renewable
Energy



Energy Efficient
Buildings



Energy Efficient
Appliances



58%

Buildings + Energy
sectors are responsible for 58% of
an average City's GHG Emissions



Learn More:
<http://bit.ly/33nv5TS>



Transportation

The Transportation sector includes the movement of people and goods by cars, trucks, trains, ships, airplanes, and other vehicles. Cities and individuals can significantly reduce transportation GHG emissions by increasing:

Electric Vehicles



Public Transit



Fuel Switching



Fuel Efficiency



Learn More:

<http://bit.ly/2CjRa9Z>



Transportation

is responsible for 29% of an average City's GHG Emissions

Solid Waste

Landfills are some of the greatest producers of methane gas, a greenhouse gas that's an estimated 35 times more potent than carbon dioxide. By diverting waste from landfills cities can reduce global emissions and the subsequent warming of the planet. Strategies for cities and individuals to reduce Solid Waste GHG emissions include:



Waste
Reduction

Recycling

Compost

Waste To
Energy

Solid Waste
is responsible for 8% of an
average City's GHG Emissions



Learn More:
<http://bit.ly/2Nq16Ff>

Water + Wastewater

According to a report by The River Network, Water related energy use totals 13% of US electricity consumption and has a carbon footprint of at least 290 million metric tons.

Meanwhile, wastewater treatment is responsible for 3% of global GHG emissions.

Strategies for cities and individuals to reduce water related GHG emissions include:

Reduce Outdoor
Watering



Use
WaterSense
Fixtures



Behavior
Change



Rainwater
Harvesting



5%

Water + Wastewater
are responsible for 5% of an
average City's GHG Emissions

Learn More:

<http://bit.ly/2Ci7FTN>



**Energy
Efficiency Jobs**



**Clean Energy
Jobs**



**Transit
Jobs**



**Job Training
and Skills**



**Consumer
Savings**



The Climate Economy

The link between climate change, economical scarcity and poverty is straightforward. Low income individuals and those living in poverty in our communities are especially prone to the impacts of climate change. Climate Change Solutions for Cities can reduce our contributions to global greenhouse gas levels, deal with the risks posed by climate change, and achieve economic growth and opportunity.

Transformative change is needed now in how we build our cities, produce and use energy,

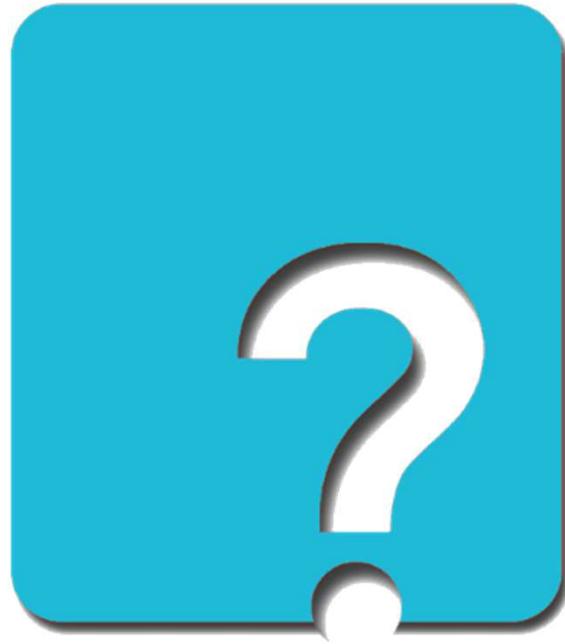
transport people and goods, and manage our landscapes. And the challenge is urgent. Luckily, all of the climate change solutions available to our cities represent opportunities to improve our quality of life, improve health outcomes, and provide opportunities for new jobs and economic development. Cities can support the advancement of a Climate Economy in a number of ways - learn more:

Learn More:

<http://bit.ly/2NKKB5y>



Climate Economy



Now What?

Knowing that we have solutions at hand, we can act

- **At the individual level**
- **At the community level**
- **At the State level**
- **At the Federal level**

Now What?

Individual Level

- **Understand your own Carbon Footprint and look for reduction opportunities**
- **Explore renewable energy options (on-site solar, renewable energy credits, on-bill options with your utility)**
- **Increase use of public transportation, explore electric vehicle options, car pool, bike/walk more**
- **Consider purchasing habits more closely: Reduce where you can, explore second hand and re-use options.**

Now What?

Community Level

- **Urge your City to engage in Climate Planning:**
 - **Conduct a GHG Inventory**
 - **Conduct a Vulnerability Assessment**
 - **Establish Climate Goals (IPCC Recommendations: 45% reduction by 2030, 80% or 100% reduction by 2050)**
 - **Create and implement a Climate Mitigation and Adaptation Plan**
- **Conduct a Ground Cover Study and implement a Carbon Sequestration and Heat Island Mitigation Plan**
- **Explore Climate Economy opportunities**
- **Execute solar group purchasing programs (at residential and commercial scales)**

Now What?

State Level

- **Vote Climate.**
- **Consider joining groups active in promoting action:**
 - **350.org**
 - **Interfaith Power and Light**
 - **Citizen's Climate Lobby**
- **Advocate for improved Renewable Energy legislation**
 - **PACE Financing**
 - **Community Solar / Aggregate Net Metering**
 - **PPA and Solar Lease legislation**
 - **Improve Renewable Portfolio Standard and Solar Carve Out legislation**

Now What?

Federal Level

- **Vote Climate.**
- **Consider joining groups active in promoting action:**
 - **350.org**
 - **Interfaith Power and Light**
 - **Citizen's Climate Lobby**

Contact

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Co-founder

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Thank you!

FAQ's

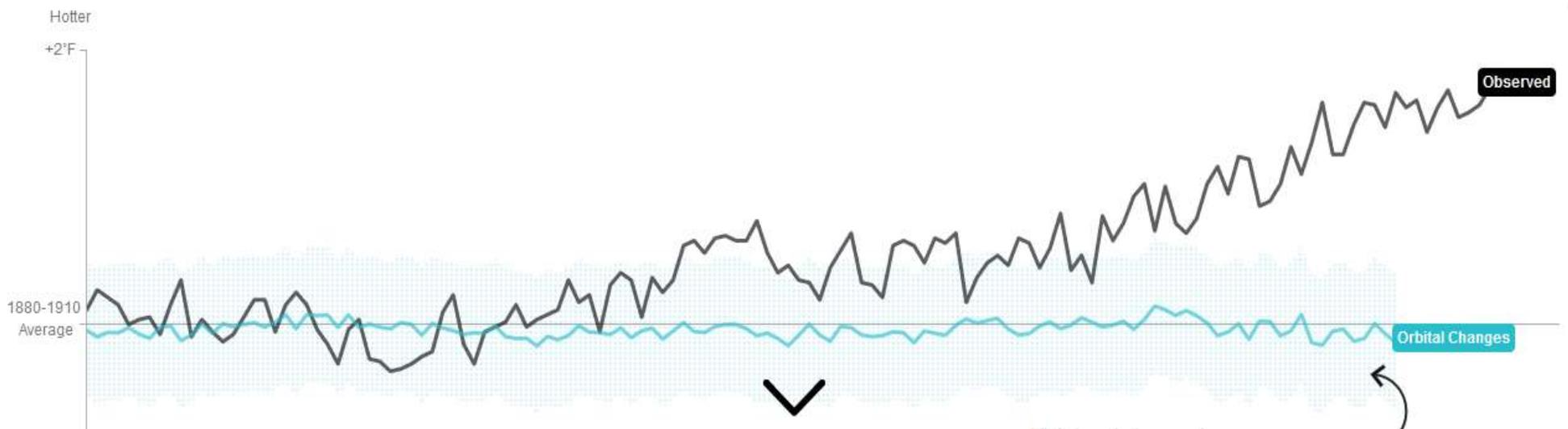
Isn't Climate Change Caused by

- **Earth's Orbit**
- **The Sun**
- **Volcanoes**
- **Deforestation**
- **Ozone Pollution**
- **Aerosol Pollution**

FAQ's – Earth's Orbit

Is It the Earth's Orbit?

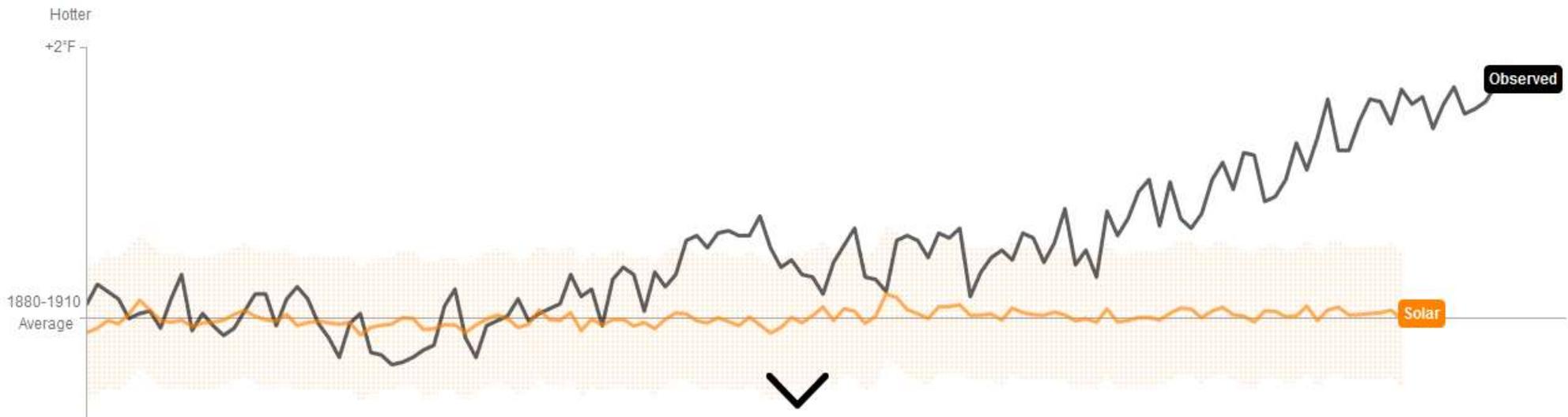
The Earth wobbles on its axis, and its tilt and orbit change over many thousands of years, pushing the climate into and out of ice ages. Yet the influence of orbital changes on the planet's temperature over 125 years has been negligible.



FAQ's – The Sun

Is It the Sun?

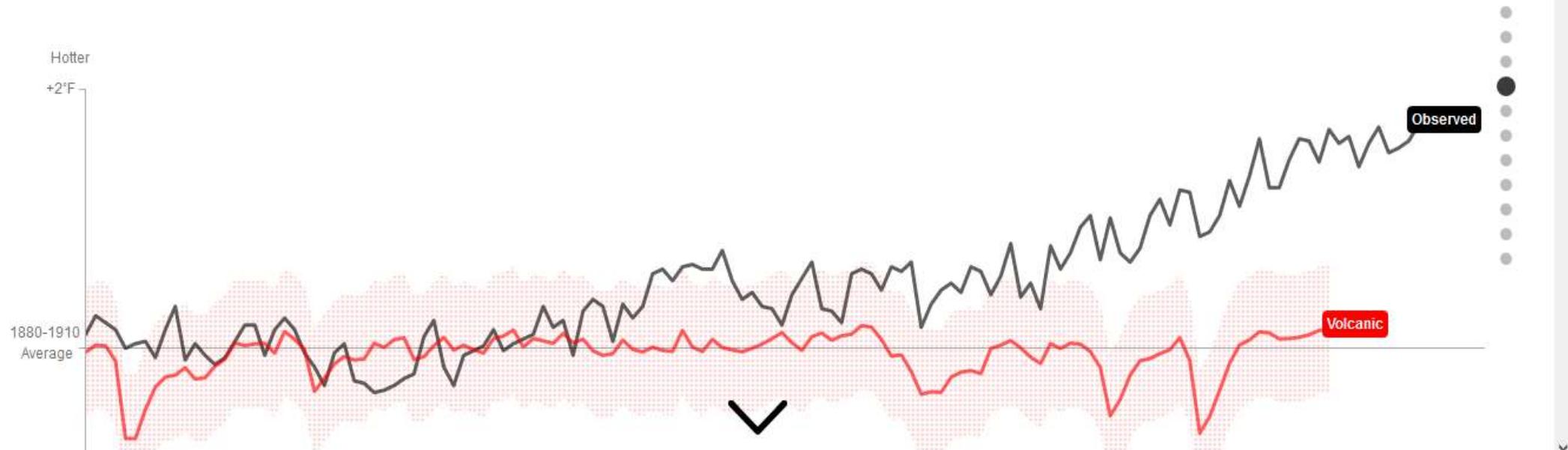
The sun's temperature varies over decades and centuries. These changes have had little effect on the Earth's overall climate.



FAQ's – Volcanoes

Is It Volcanoes?

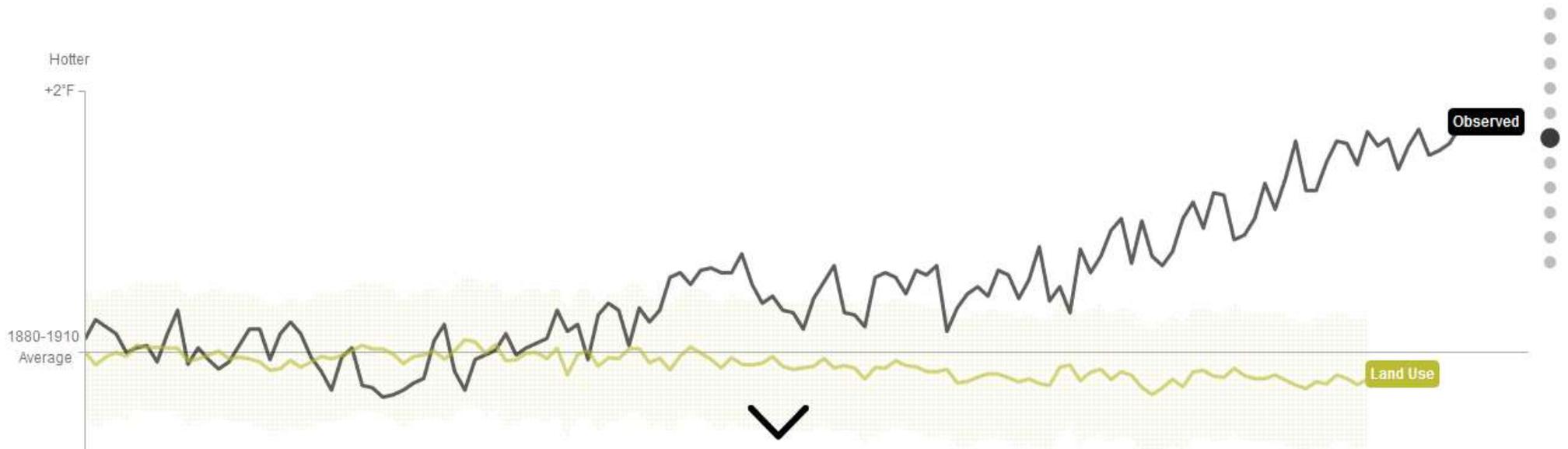
The data suggest no. Human industry emits about 100 times more CO₂ than volcanic activity, and eruptions release sulfate chemicals that can actually cool the atmosphere for a year or two.



FAQ's – Deforestation

So If It's Not Nature, Is It Deforestation?

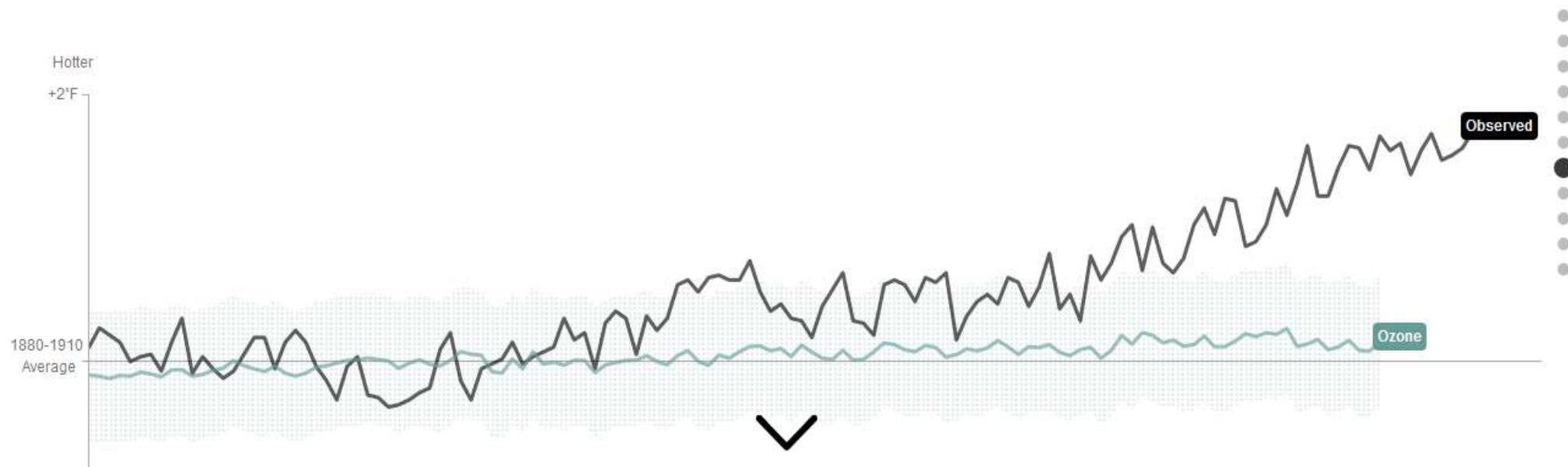
Humans have cut, plowed, and paved more than half the Earth's land surface. Dark forests are yielding to lighter patches, which reflect more sunlight—and have a slight cooling effect.



FAQ's –Ozone Pollution

Or Ozone Pollution?

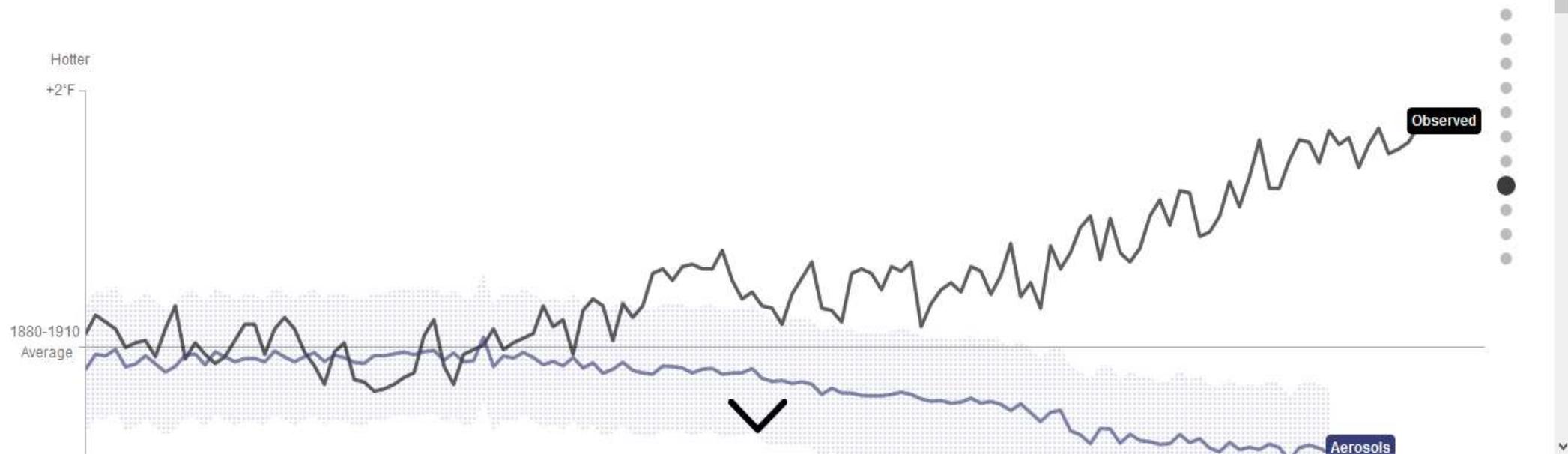
Natural ozone high in the atmosphere blocks harmful sunlight and cools things slightly. Closer to Earth, ozone is created by pollution and traps heat, making the climate a little bit hotter. What's the overall effect? Not much.



FAQ's – Aerosol Pollution

Or Aerosol Pollution?

Some pollutants cool the atmosphere, like sulfate aerosols from coal-burning. These aerosols offset some of the warming. (Unfortunately, they also cause acid rain.)



FAQ's – Greenhouse Gases

No, It Really Is Greenhouse Gases.

Atmospheric CO₂ levels are 40 percent higher than they were in 1750. The green line shows the influence of greenhouse gas emissions. It's no contest.

