Our Changing Climate

CLIMATE CENTRAL

Climate change is…

Simple

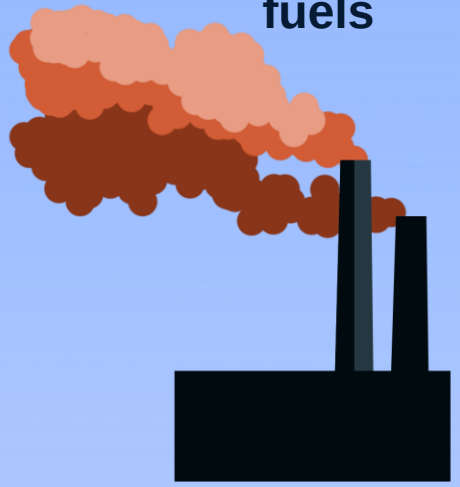
Serious

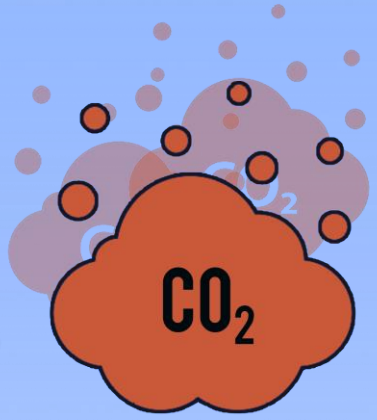
Solvable

Simple

Simple

Burning fossil fuels





More CO_2 in the atmosphere

Temperature rises

Our Atmosphere

99% nitrogen and oxygen, with important trace amounts of greenhouse gases:

- Water vapor
- Carbon dioxide
- Methane
- Nitrous oxide

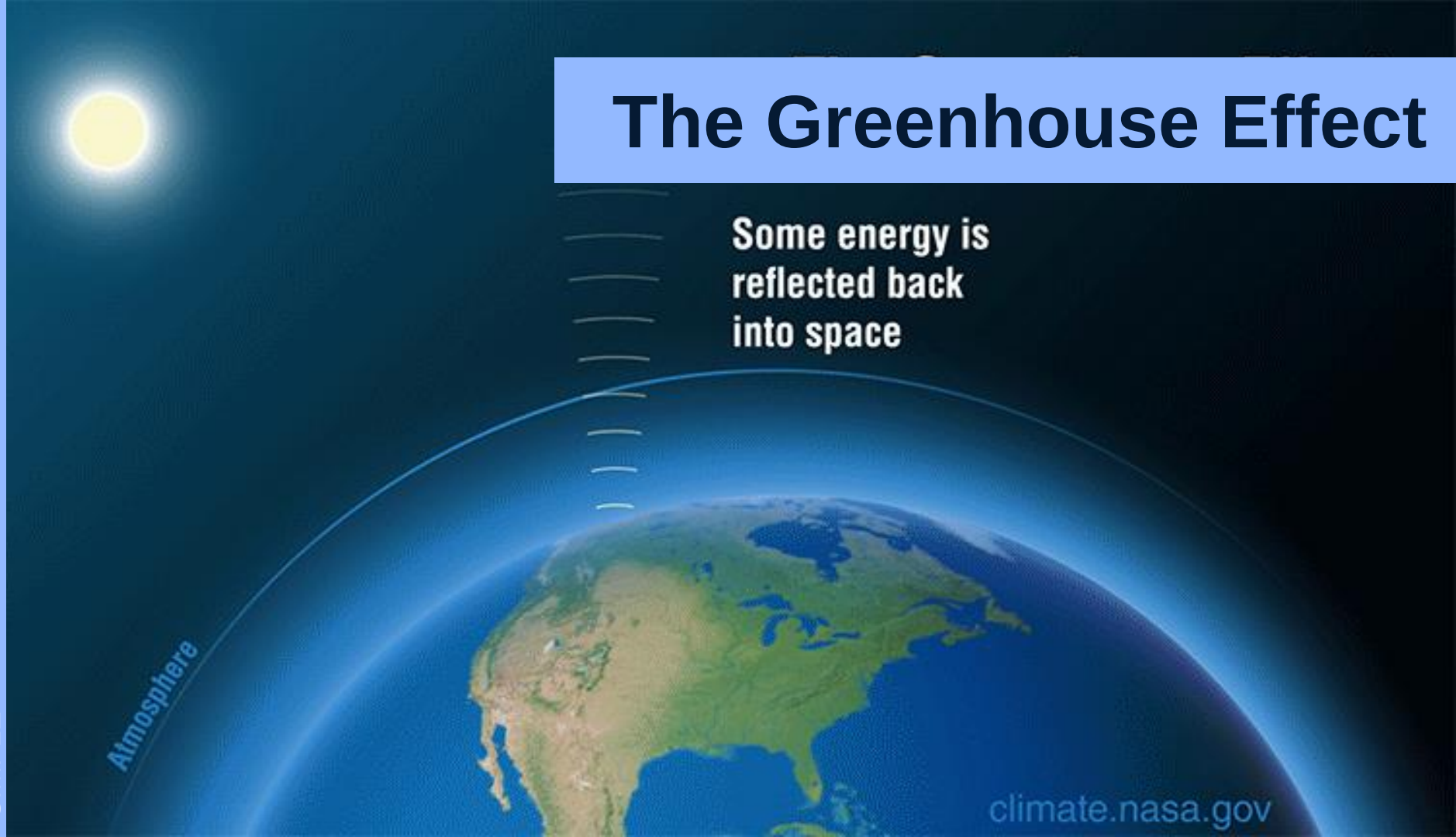
The Greenhouse Effect

SIMPLE

The Greenhouse Effect

SIMPLE

The Greenhouse Effect



SIMPLE

The Greenhouse Effect

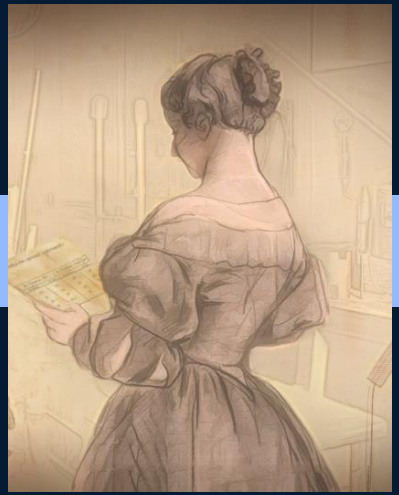
SIMPLE

The Greenhouse Effect

SIMPLE

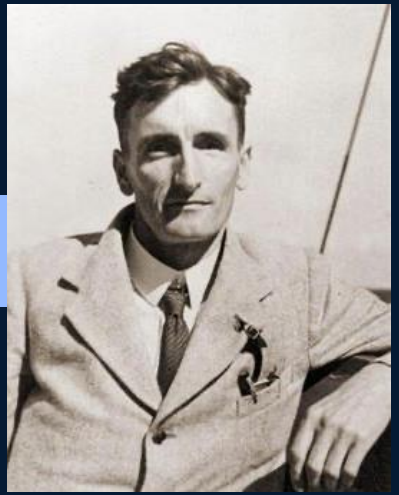
Evidence That CO2 Is A Greenhouse Gas

Joseph Fourier
(1820s)



Eunice Foote
(1850s)

Svante Arrhenius
(1890s)

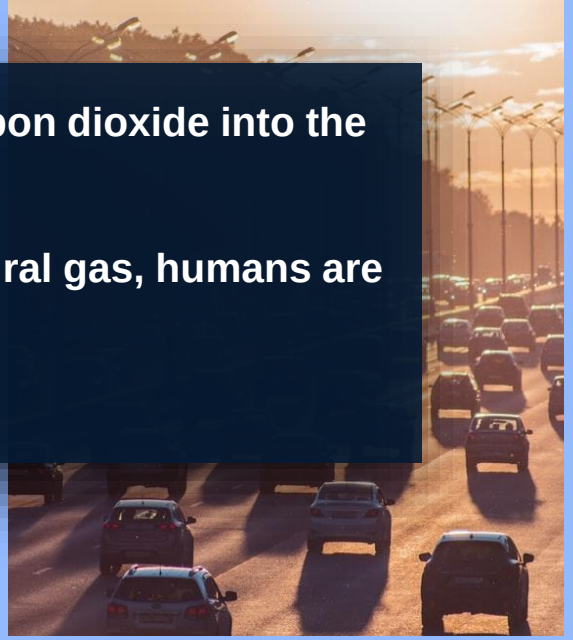


Guy Stewart Callendar
(1930s)

SIMPLE

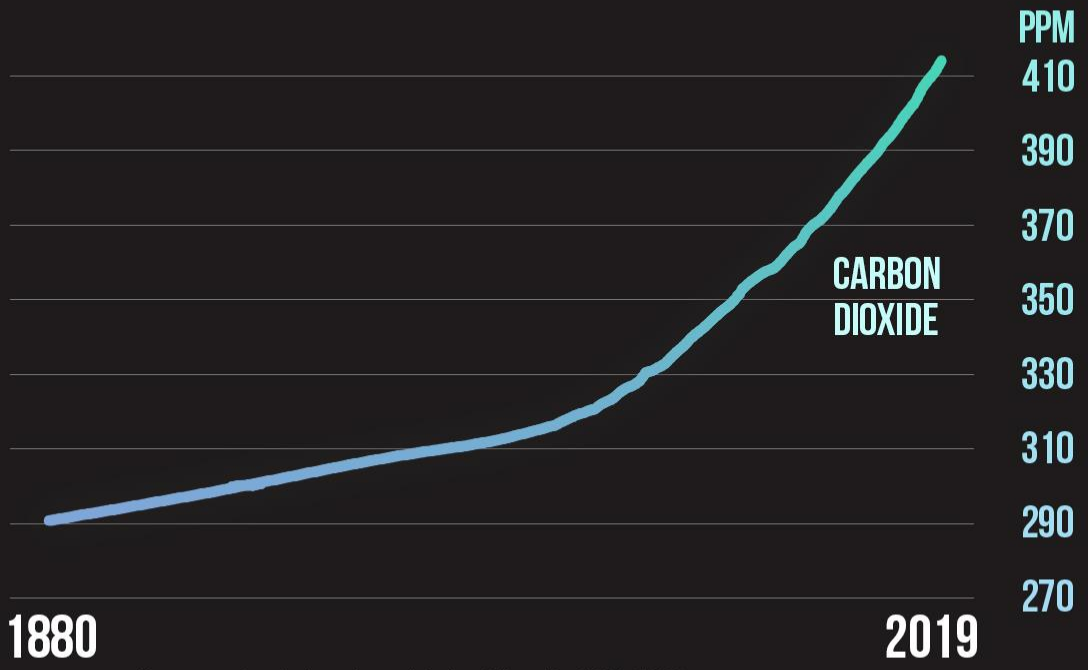
Burning fossil fuels puts carbon dioxide into the atmosphere

By burning coal, oil, and natural gas, humans are warming the planet



SIMPLE

GLOBAL TEMPERATURE & CARBON DIOXIDE



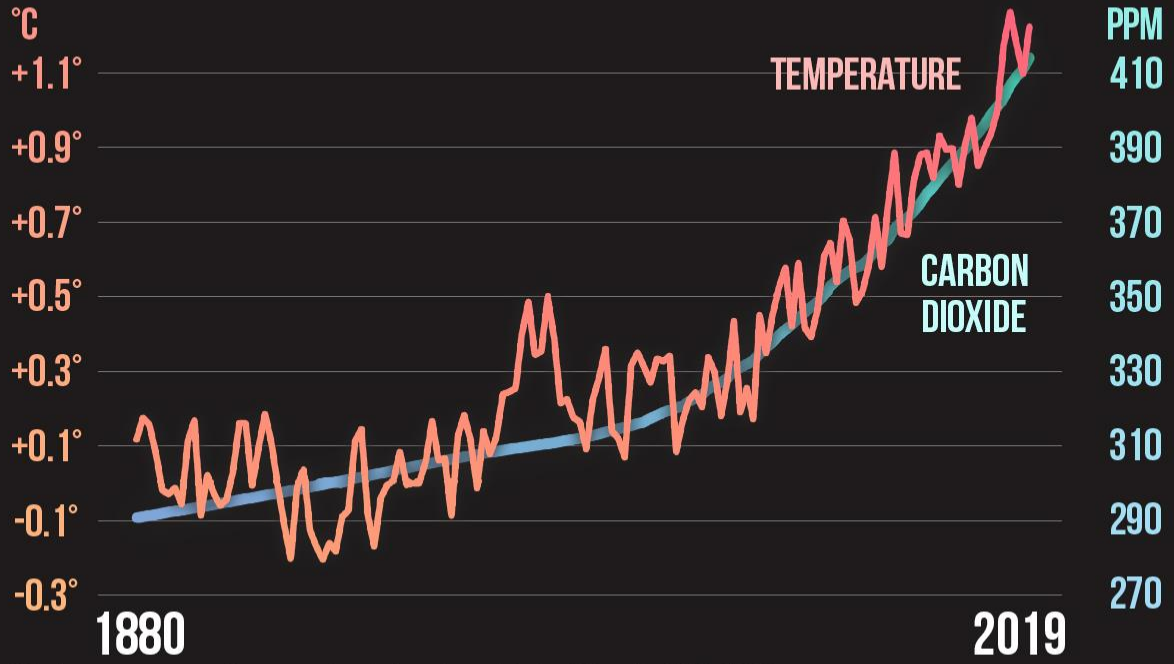
Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)
Global annual average carbon dioxide
Source: NASA GISS, NOAA NCEI, ESRL

CLIMATE CENTRAL

SIMPLE

SIMPLE

GLOBAL TEMPERATURE & CARBON DIOXIDE

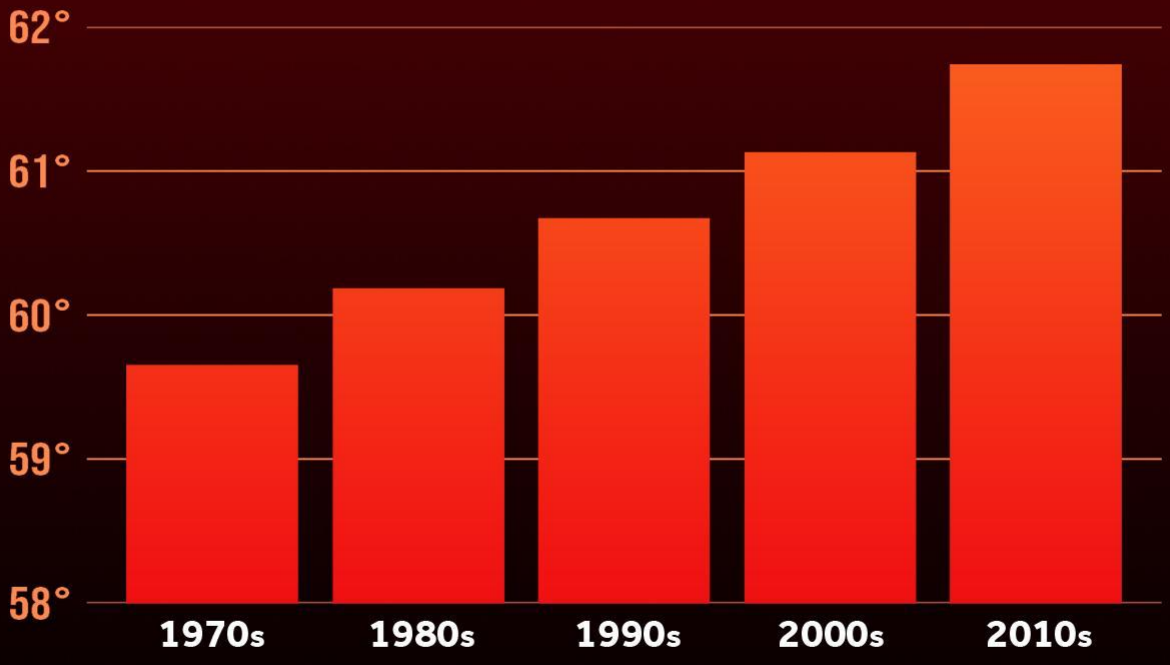


Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)
Global annual average carbon dioxide
Source: NASA GISS, NOAA NCEI, ESRL

CLIMATE CENTRAL

Local Graphic Available

OKLAHOMA CITY
DECADES OF WARMING



Average decadal temperature (°F). Data through 12/1/2019.
Source: RCC-ACIS.org

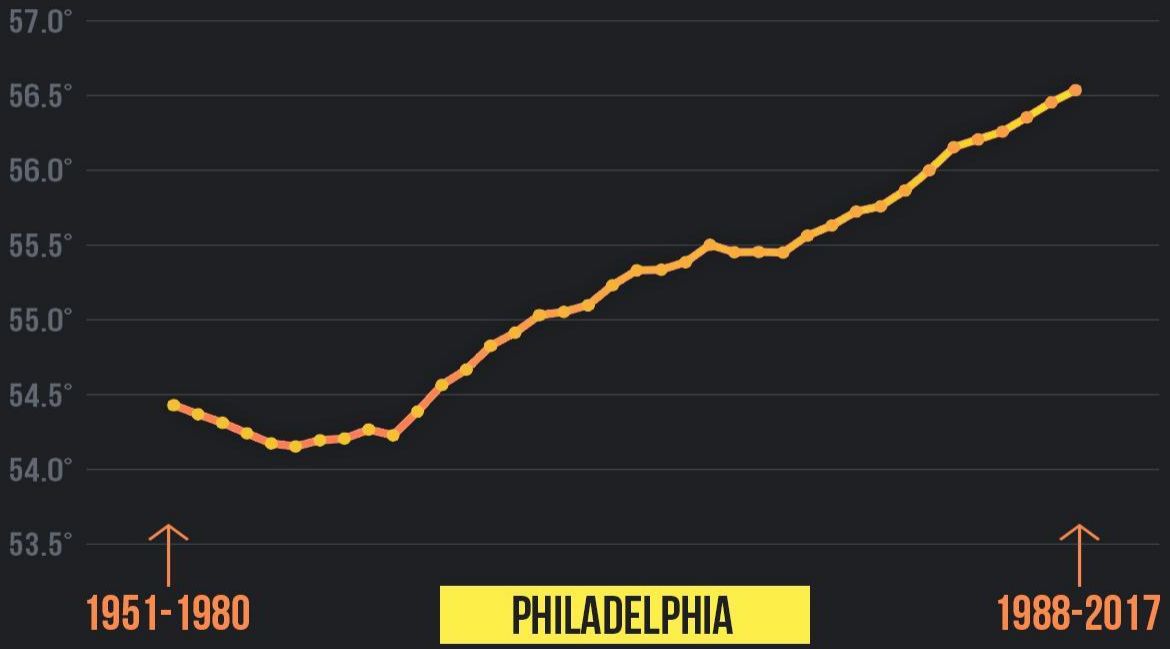
CLIMATE CENTRAL

SIMPLE

Local Graphic Available

THE NEW NORMAL

30-Year Temperature Averages Are Rising



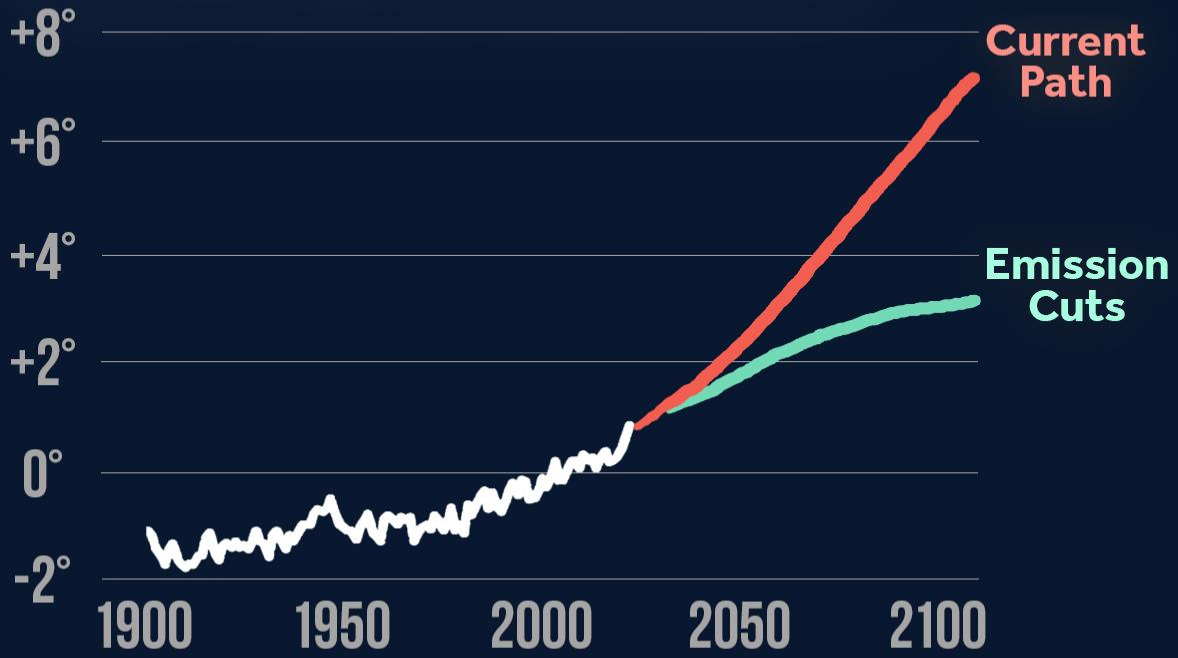
Normal is based on 30-year average temperature, adapted from NOAA
Source: RCC/ACIS.org

CLIMATE CENTRAL

SIMPLE

FUTURE WARMING

Projections (°F) Based on Emissions Decisions



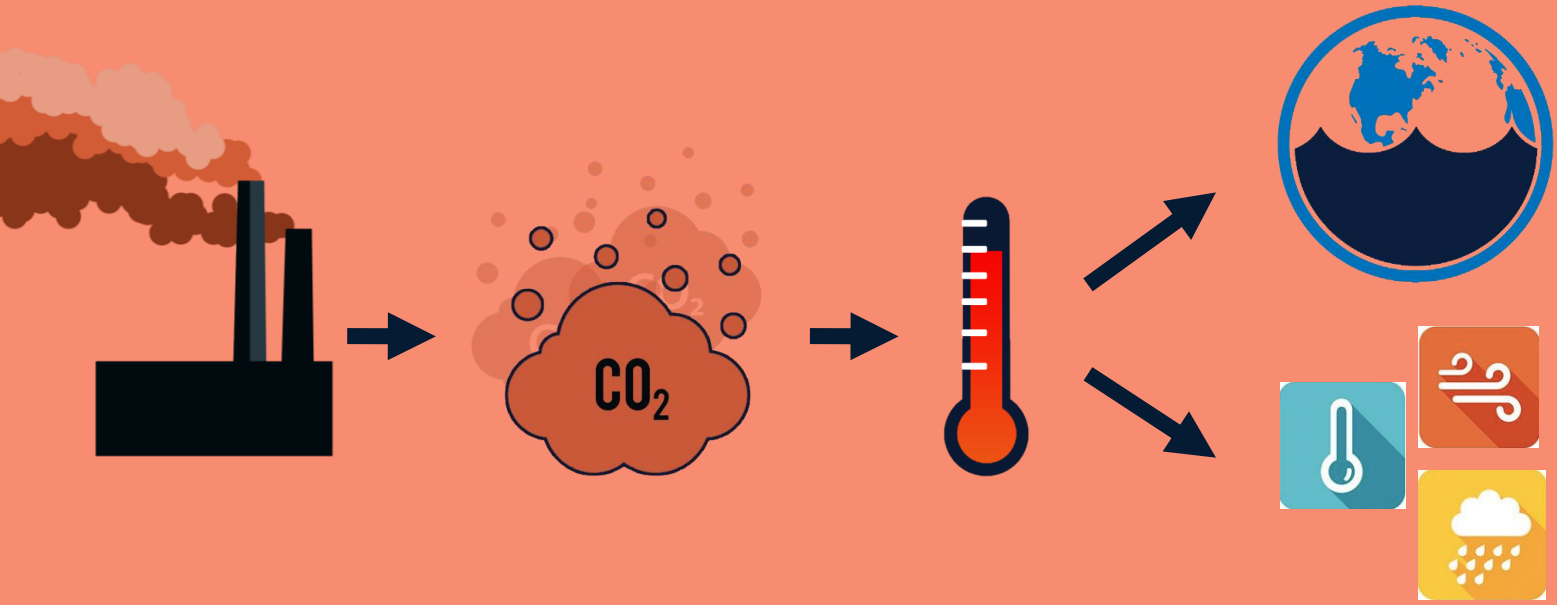
Current path represents RCP8.5, Emission cuts represents RCP4.5
Source: 4th National Climate Assessment 2018

CLIMATE CENTRAL

SIMPLE

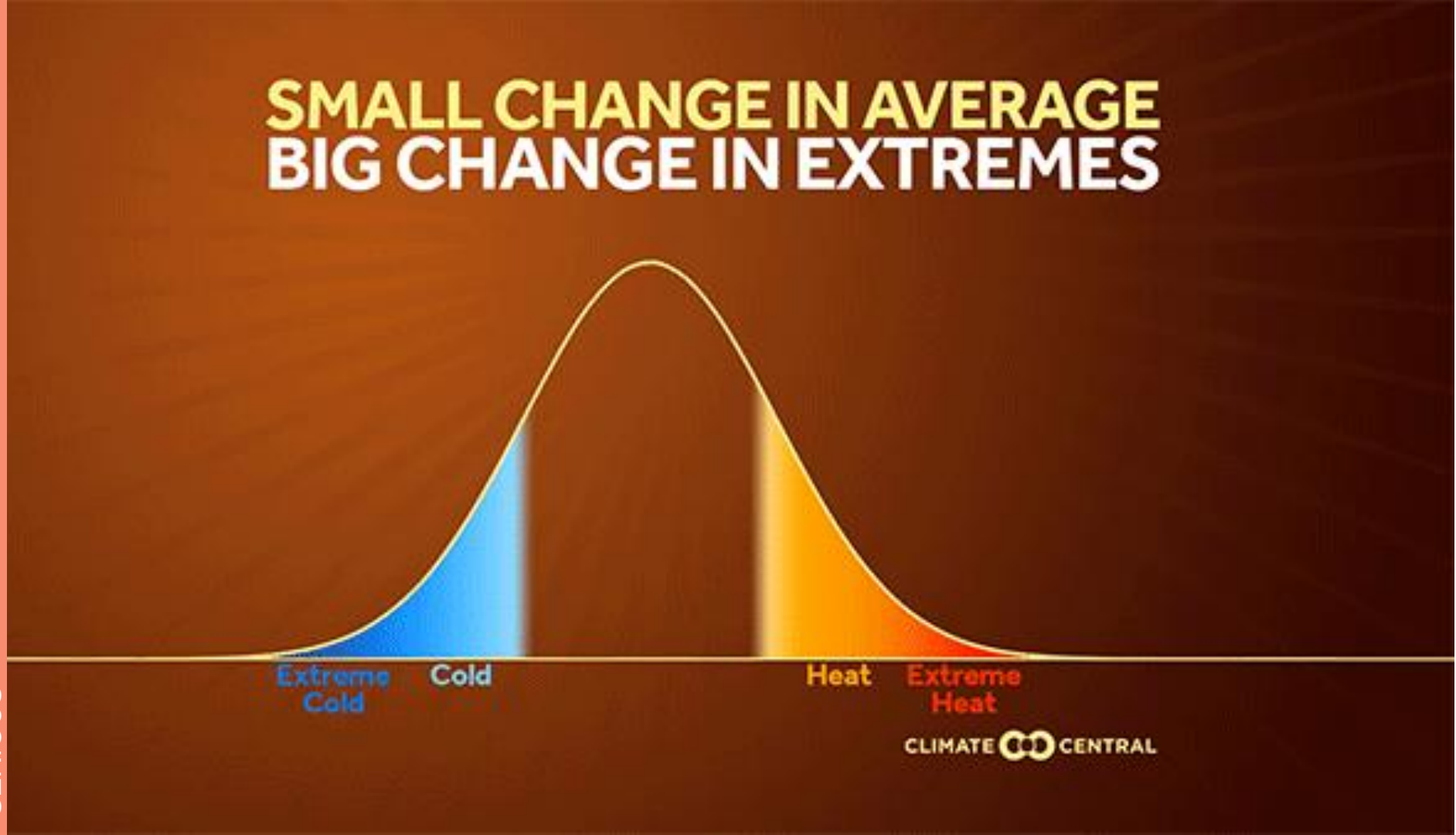
Serious

Serious



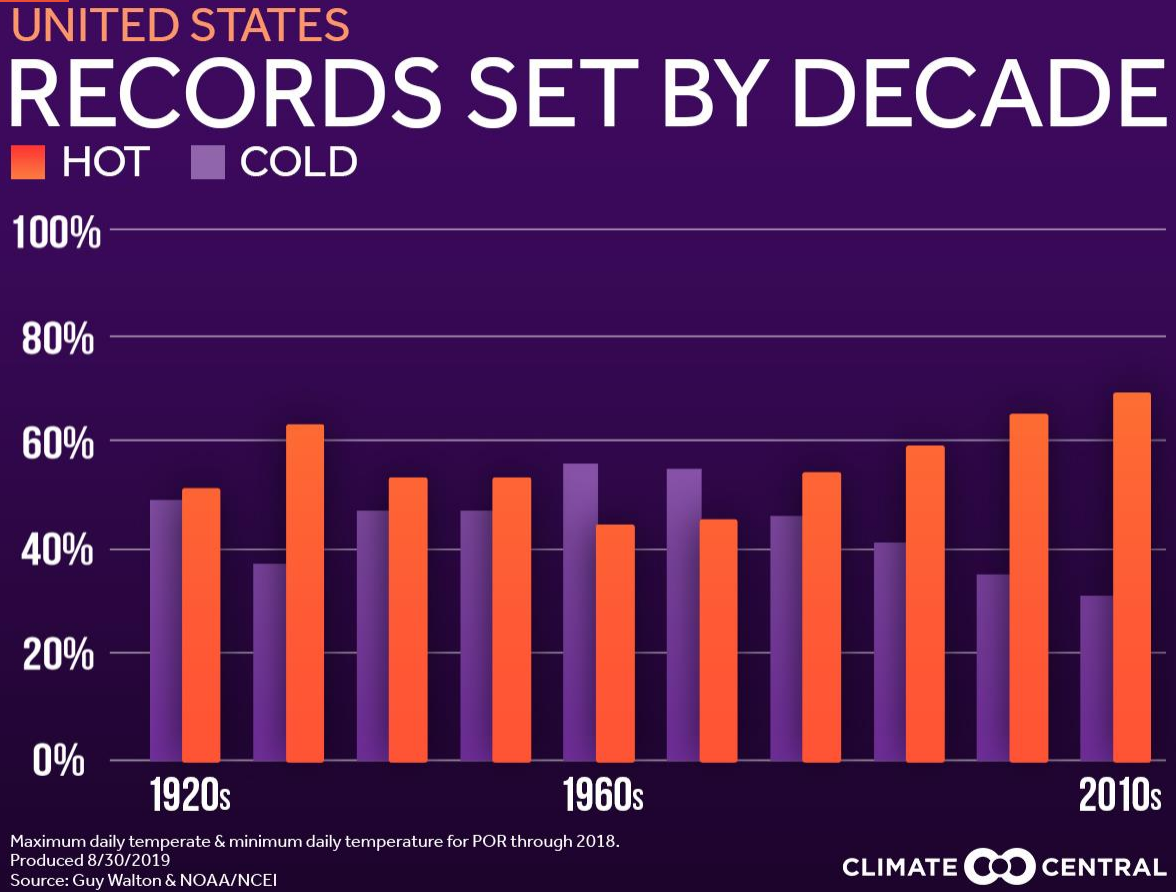
Rising seas

Wild weather


SMALL CHANGE IN AVERAGE
BIG CHANGE IN EXTREMES
Extreme Cold
Cold
Heat
Extreme Heat
CLIMATE CENTRAL

SERIOUS

Local Graphic Available



SERIOUS

Snowfall Patterns Changing Regionally And Seasonally

- Globally—less snow and shorter snow seasons
- Locally—potential for bigger snow events in snowy areas

SERIOUS

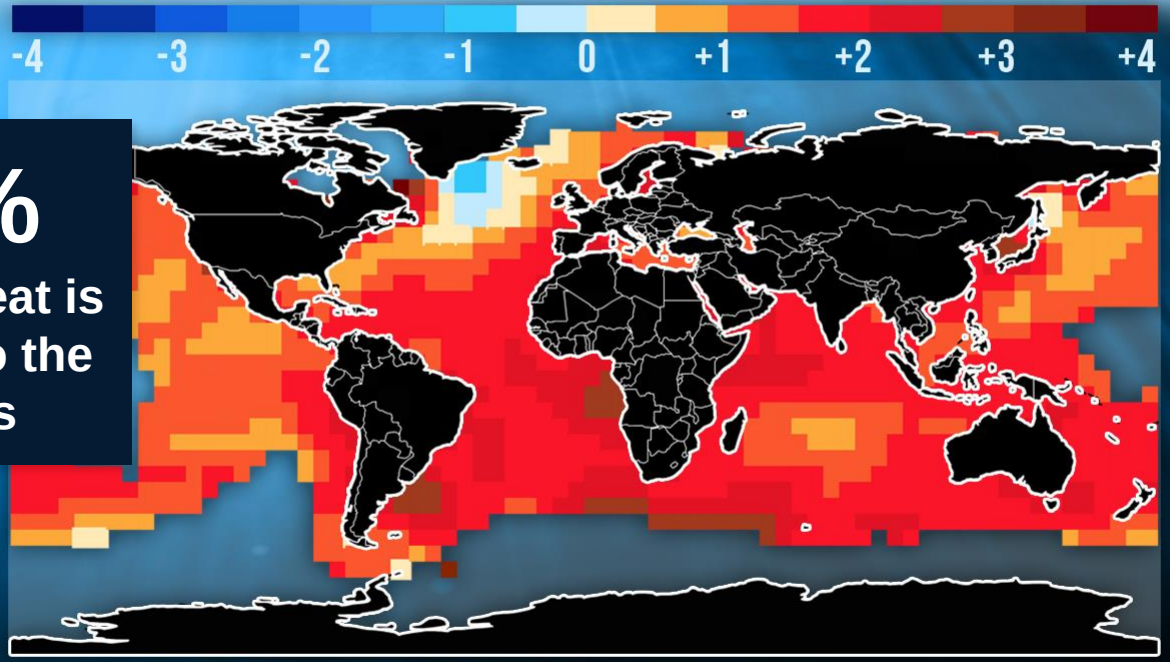
Bear Glacier

SERIOUS

SERIOUS

OCEANS HEATING UP

Change in sea surface temperature (°F) since 1901:



93%

of extra heat is going into the oceans

Data through 2015. Gray indicates insufficient data
Source: IPCC, NOAA: Merged Land-Ocean Surface Temp Analysis

CLIMATE CENTRAL

SERIOUS

SEA LEVEL RISE

BY CENTURY

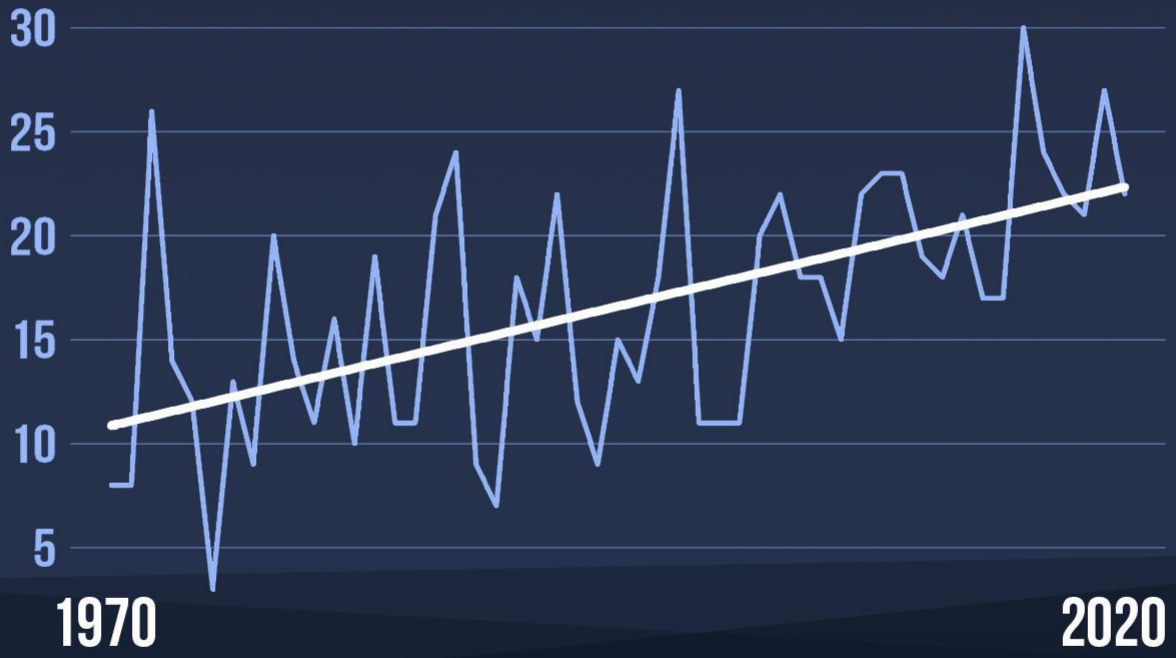
Central reconstruction shown
Source: Kopp et al. 2016 (PNAS)

CLIMATE CENTRAL

SERIOUS

HIGHER TIDES, MORE FLOODING

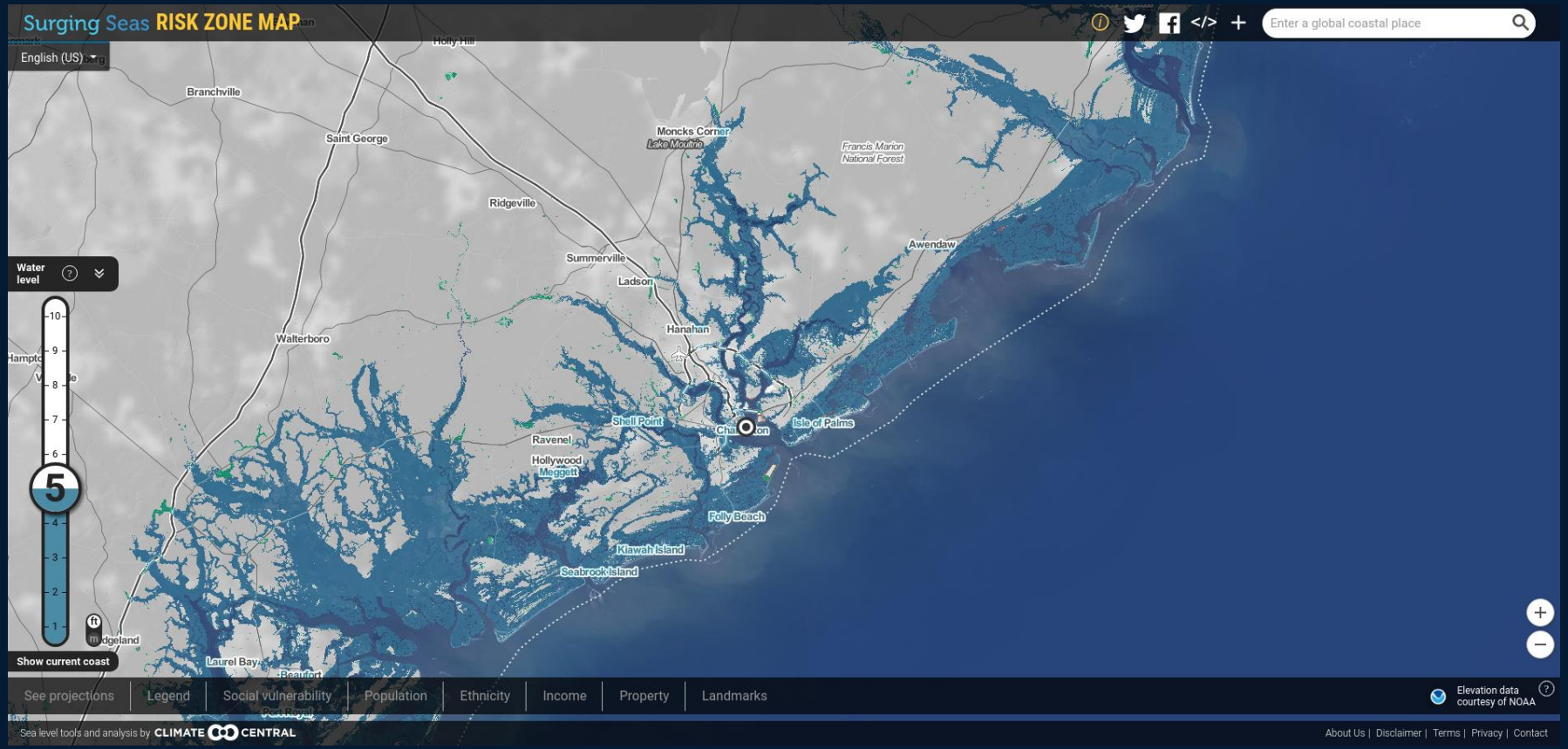
PEAK # OF CONCURRENT U.S. COASTAL FLOODS YEARLY



Annual maximum number of NOAA tide gauges exceeding a minor flood threshold in a single day, 1970 to September 2020

CLIMATE CENTRAL

Charleston, SC Sea Level Rise Projection



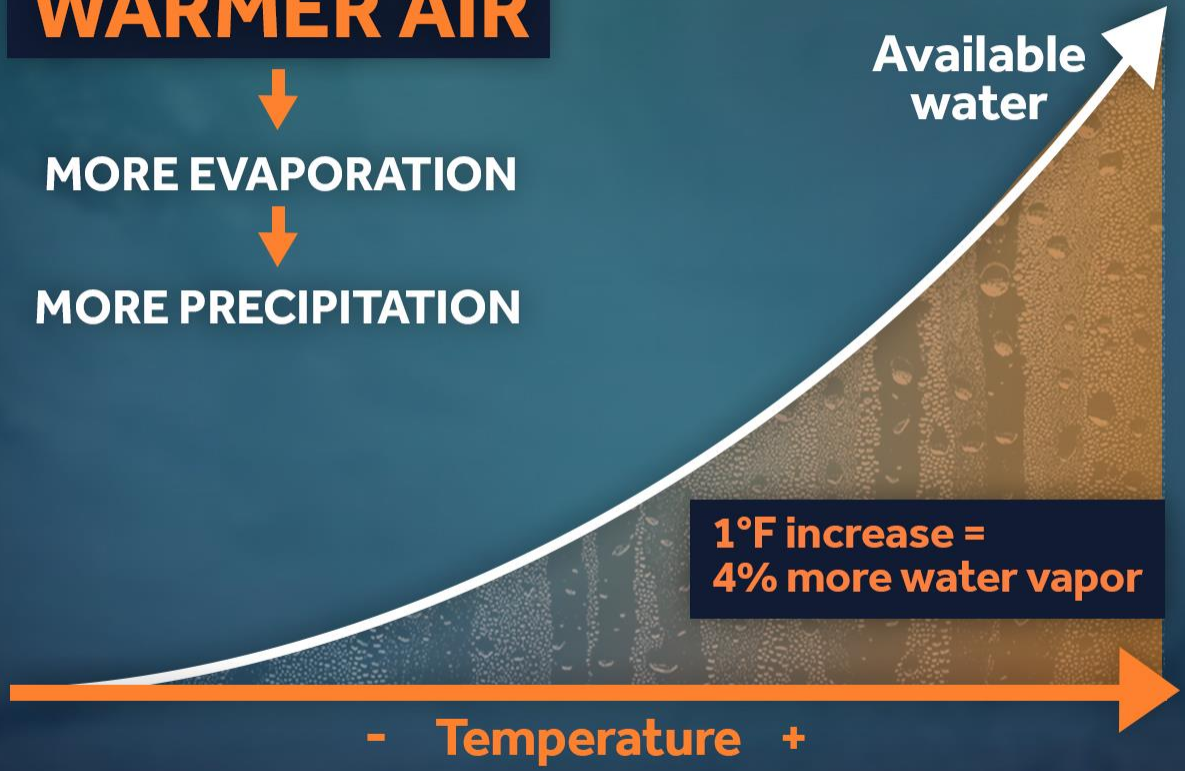
SERIOUS

SERIOUS

WARMER AIR

MORE EVAPORATION

MORE PRECIPITATION

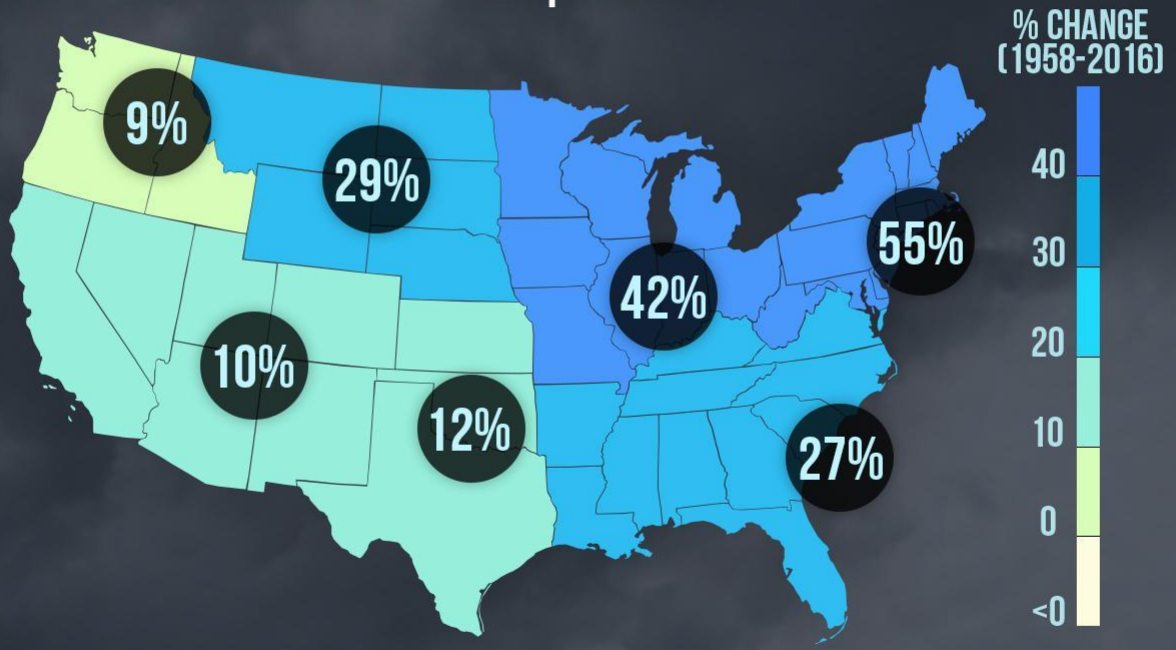


CLIMATE CENTRAL

SERIOUS

MORE DOWNPOURS

Increase in Heaviest Precipitation Events



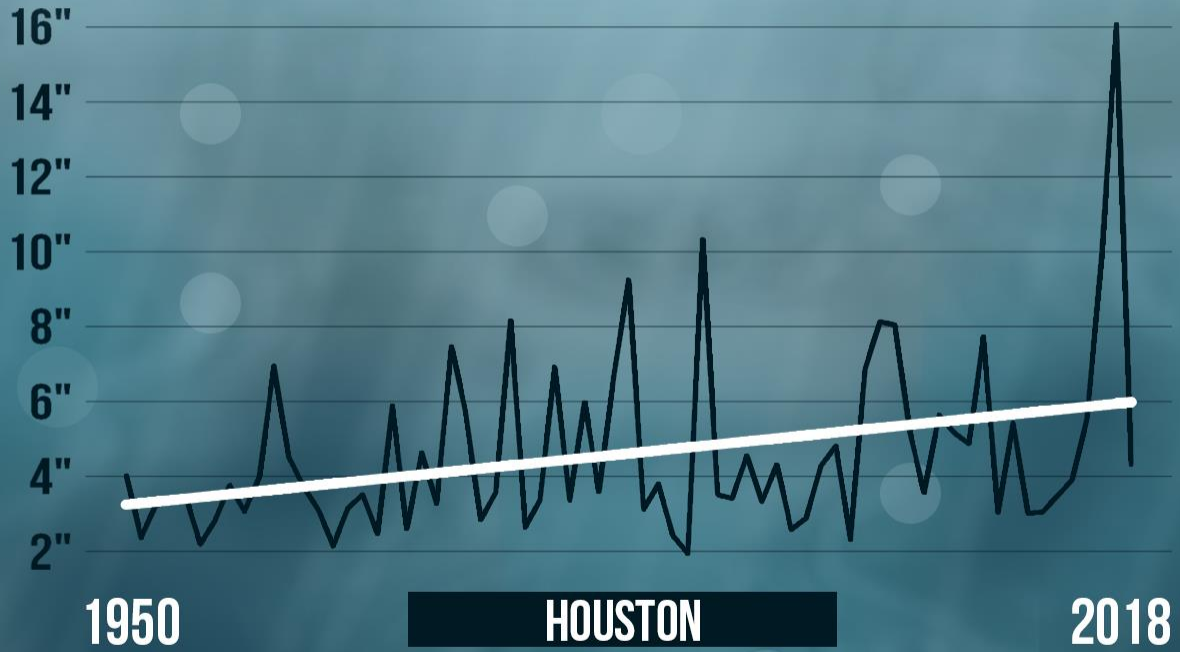
Heaviest events defined as top 1% of events
Source: USGCRP Climate Science Special Report 2017

CLIMATE CENTRAL

Local Graphic Available

DAILY DELUGE

RAIN ON THE WETTEST DAY EACH YEAR

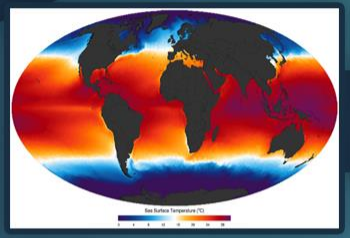


Amount of precipitation on the wettest calendar day observed each year
Source: RCC-ACIS.org

CLIMATE CENTRAL

SERIOUS

HURRICANES & CLIMATE CHANGE
What we know



Warmer water = more fuel

Heavier rain

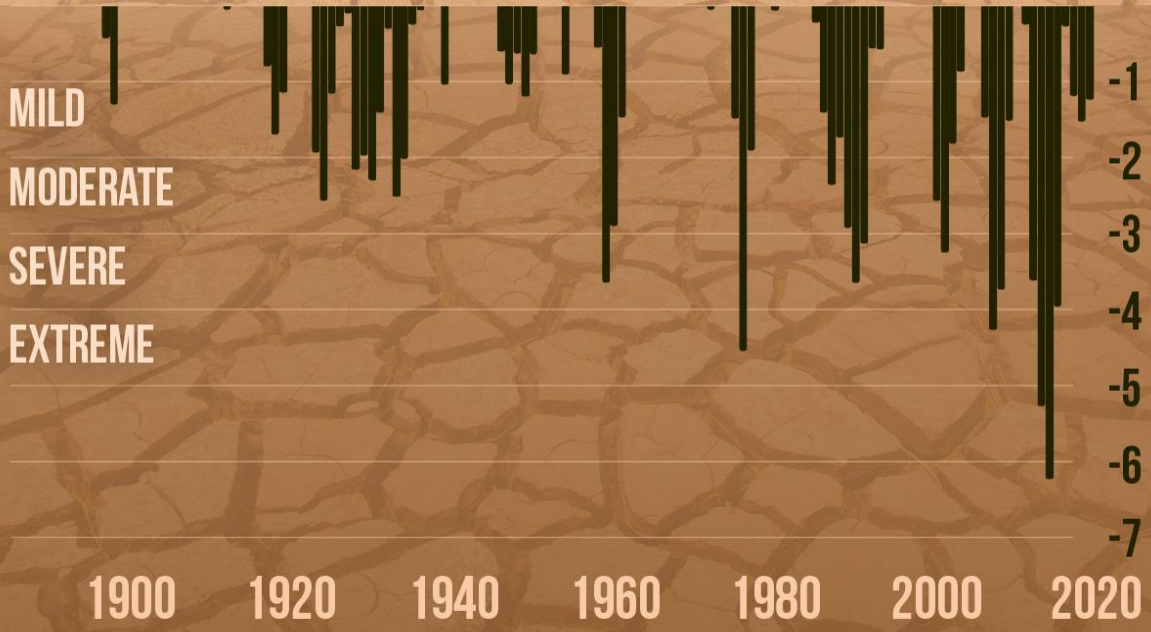
Higher storm surge

CLIMATE CENTRAL

SERIOUS

SERIOUS

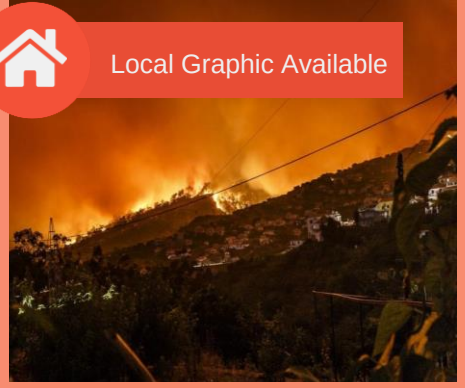
WESTERN U.S. DROUGHT INDEX



Palmer Hydrological Drought Index 24 month average. NCEI West U.S. climate region (CA and NV).
Source: NCEI

CLIMATE CENTRAL

Local Graphic Available

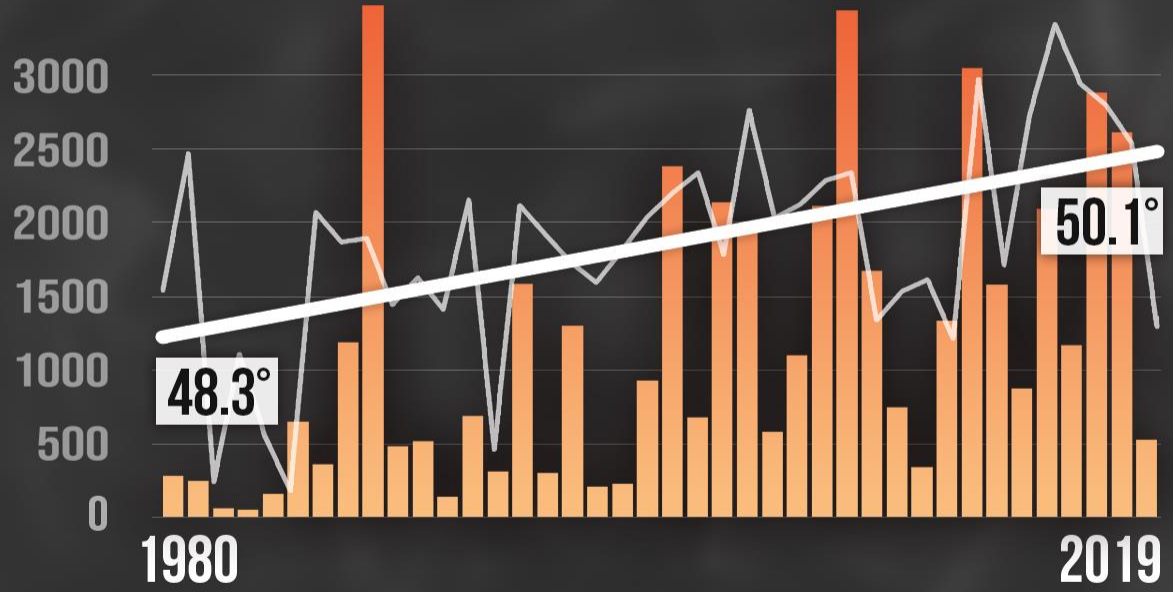


SERIOUS

HOTTER YEARS, HIGHER FIRE RISK

ACRES BURNED ACROSS WESTERN STATES

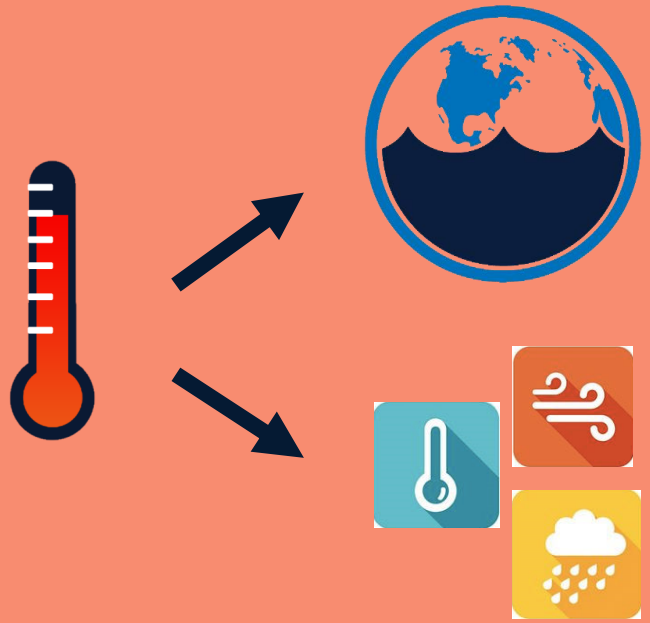
(THOUSANDS OF ACRES)



Total acres burned in the west calculated by summing acres burned across 11 states: AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, & WY. Avg annual temps (1980-2019) calculated by averaging temps across same states. Source: National Fire & Aviation Management FAMWEB Data Warehouse & NOAA/NCEI's Climate at a Glance

CLIMATE CENTRAL

Serious



Rising seas

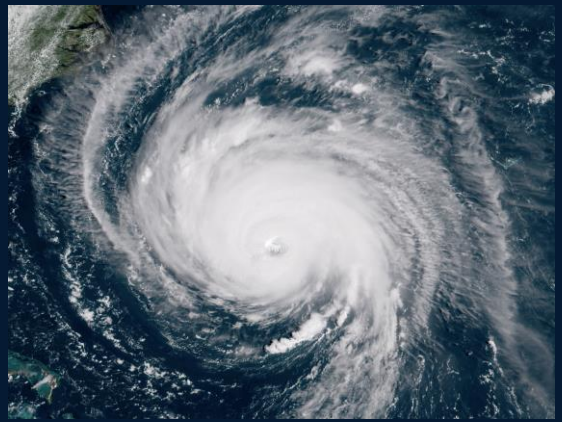
Wild weather

Nature

Health

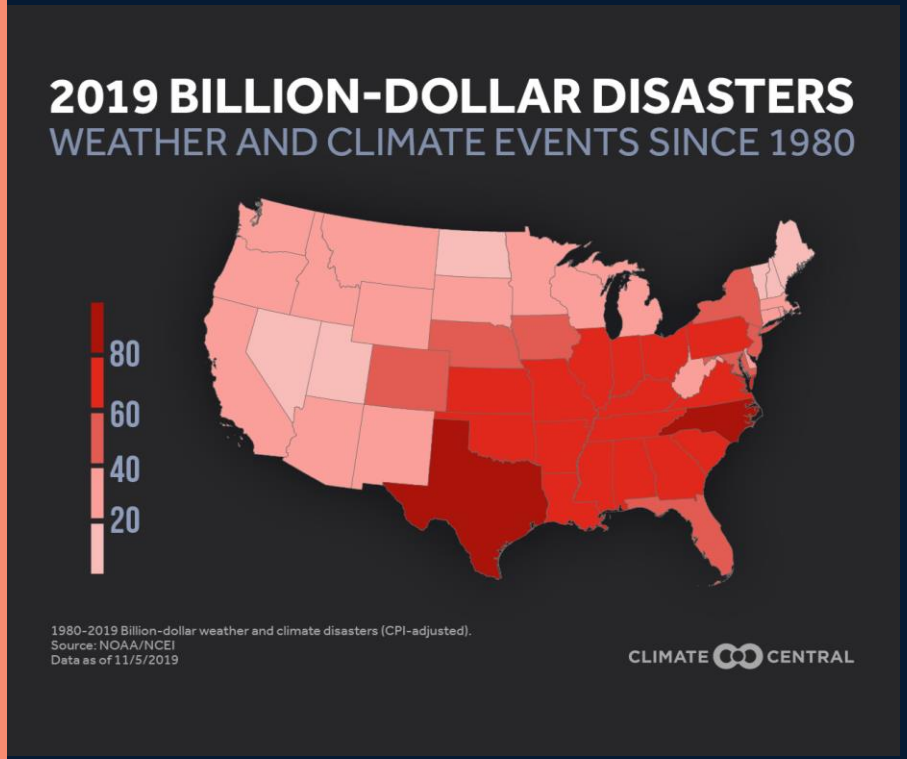
Economy

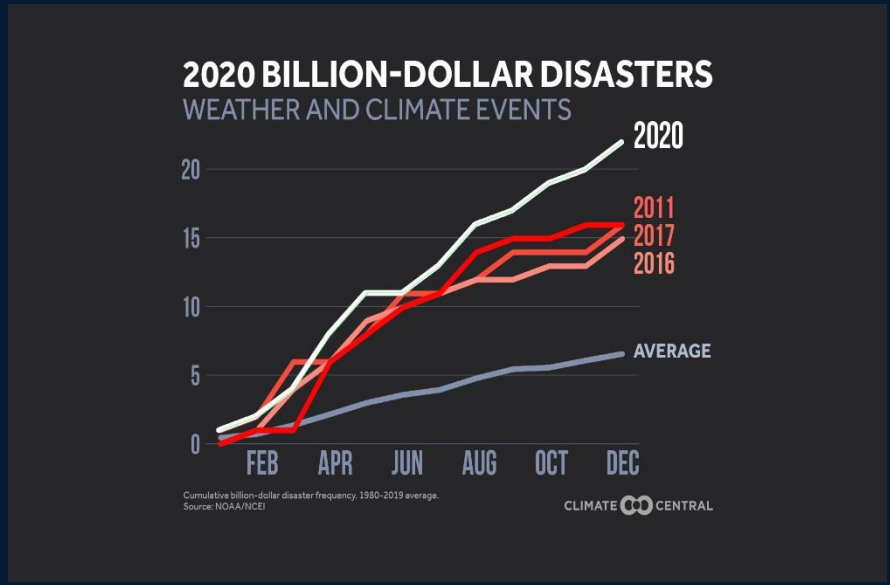
Impacts from extreme weather



SERIOUS

SERIOUS


2019 BILLION-DOLLAR DISASTERS
WEATHER AND CLIMATE EVENTS SINCE 1980
80
60
40
20
1980-2019 Billion-dollar weather and climate disasters (CPI-adjusted).
Source: NOAA/NCEI
Data as of 11/5/2019
CLIMATE CENTRAL


2020 BILLION-DOLLAR DISASTERS
WEATHER AND CLIMATE EVENTS
2020
2011
2017
2016
AVERAGE
20
15
10
5
0
FEB
APR
JUN
AUG
OCT
DEC
Cumulative billion-dollar disaster frequency. 1980-2019 average.
Source: NOAA/NCEI
CLIMATE CENTRAL

Animals & Ecosystems

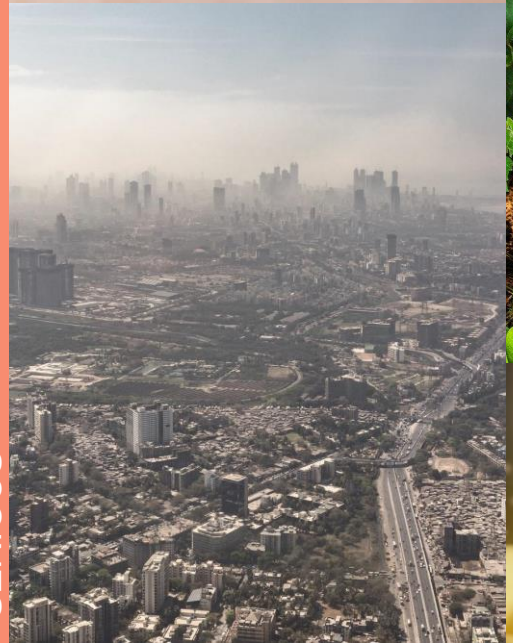
Moving northward and to higher elevation

Mismatched timing between animals and food sources

Increasing vulnerability to invasive species & extinction

Global decline in coral reefs

SERIOUS



Health

Worsening air quality

More heat-related illnesses

Longer, stronger allergy seasons

Increasing risk of insect and food-borne diseases

SERIOUS

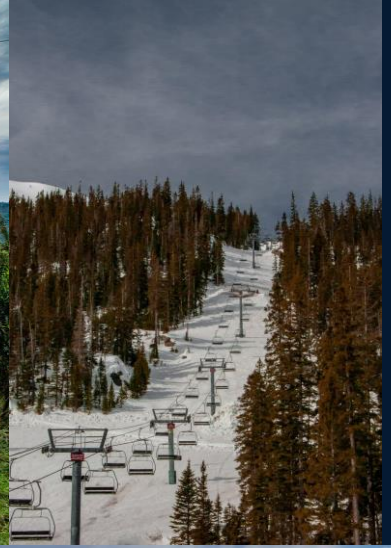
Food & Farming

Stress from increased weather extremes (droughts & floods)

Shifting planting zones

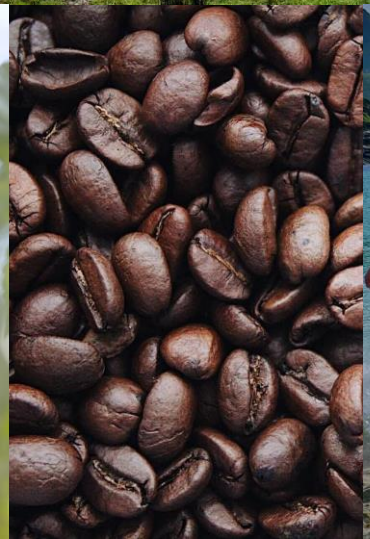
Increased crop diseases and pests

SERIOUS



Ways Of Life

- Sports
- Outdoor activities and recreation
- Coffee and Beer



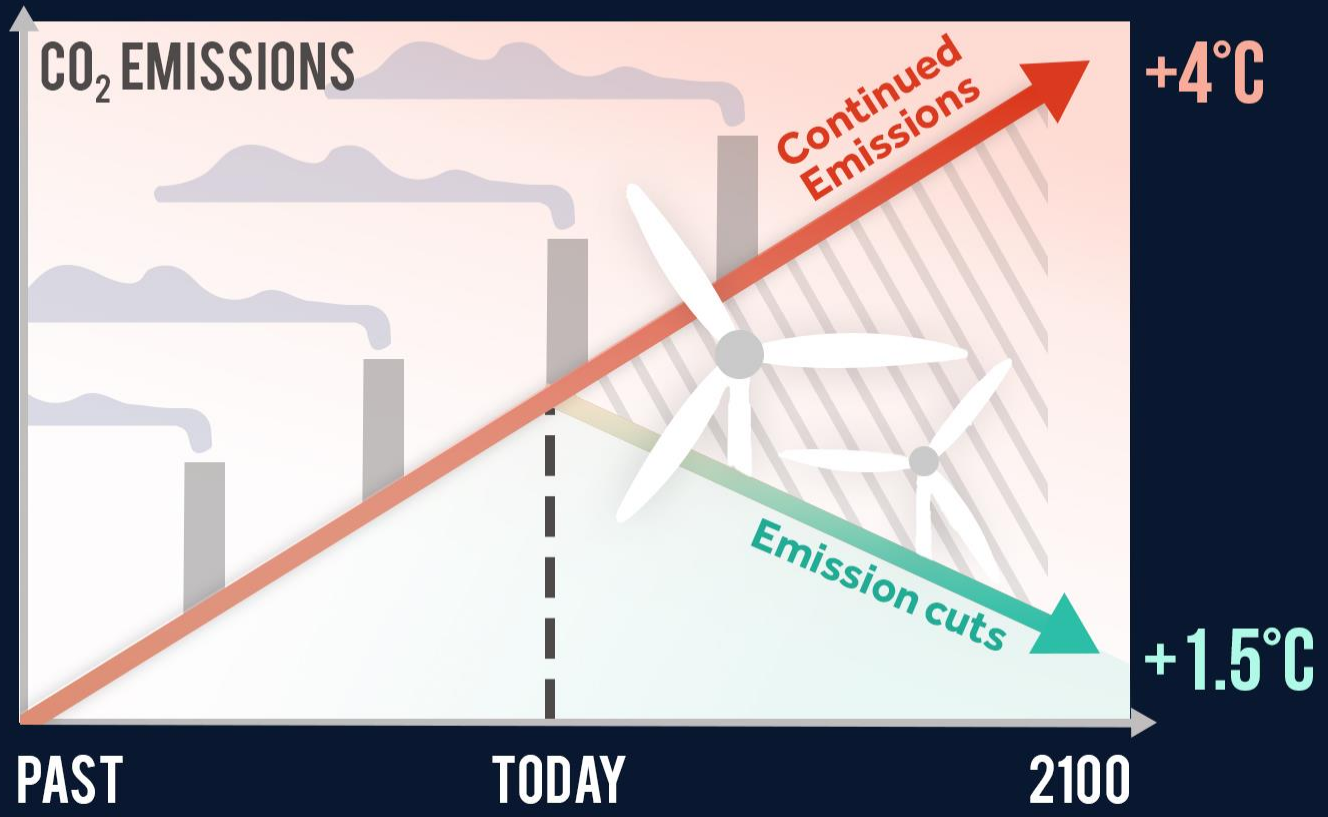
SERIOUS

1.5°C (2.7°F)	VS	2°C (3.6°F)
8.5-30 inches of sea level rise by 2100	**Sea Level Rise**	Additional 4 inches of sea level rise and 10.4 million more people exposed
Loss of **70-90%** of coral reefs	**Ecosystems**	Loss of **99%** of coral reefs
350 million people in urban areas exposed to severe drought	**Extreme Weather**	**410 million people** in urban areas exposed to severe drought
At least one sea-ice-free Arctic summer **after 100 yrs**	**Arctic Ice**	At least one sea-ice-free Arctic summer **after 10 yrs**

SERIOUS

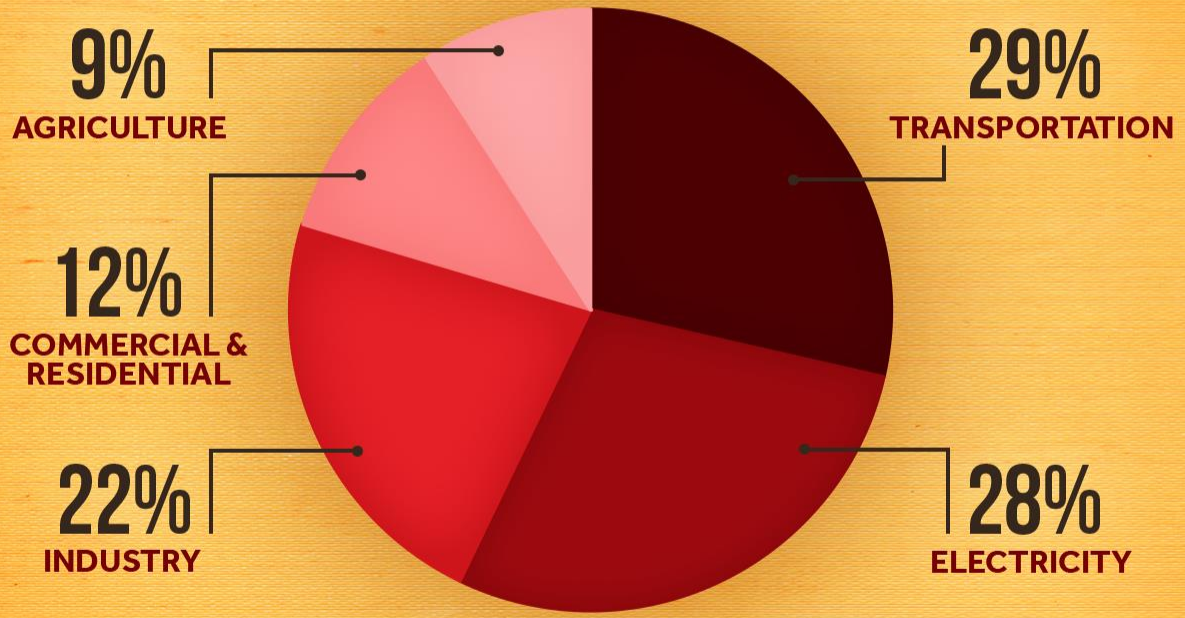
Solvable

We Need to Make Big Cuts, Fast



SOLVABLE

GREENHOUSE GAS SOURCES
UNITED STATES EMISSIONS BY SECTOR

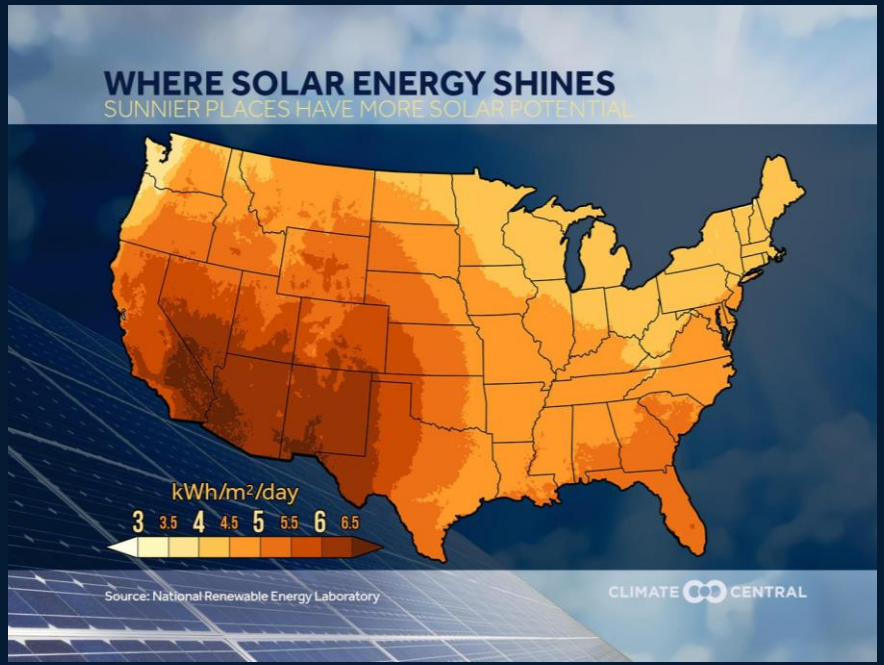


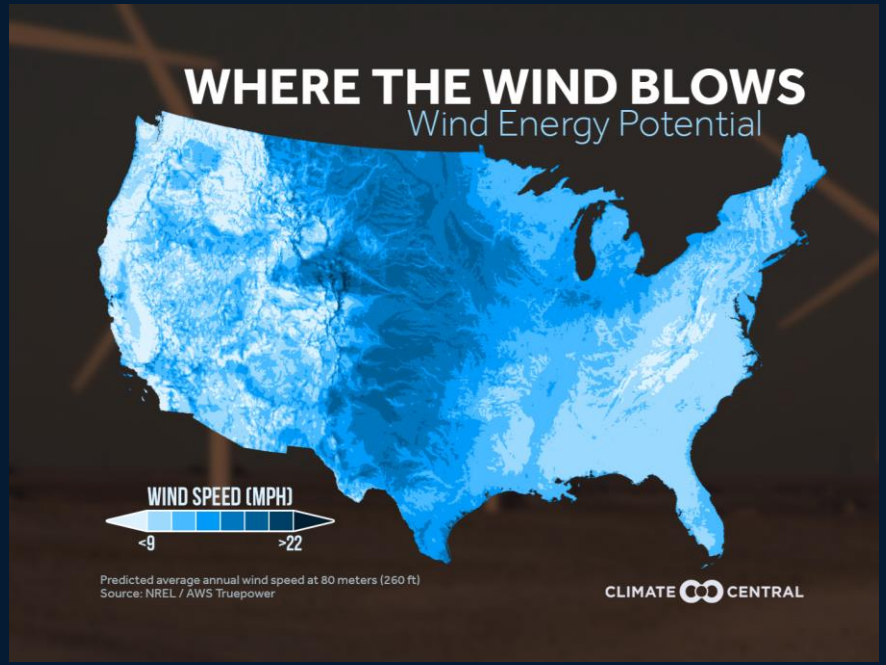
Source: U.S. EPA 2017 (released 2019)

CLIMATE CENTRAL

SOLVABLE

Renewable Energy





SOLVABLE

Local Graphic Available

SOLVABLE

CALIFORNIA
SOLAR ELECTRICITY GENERATION

	YESTERDAY	TODAY	TOMORROW
ELECTRICITY GENERATED (MWH)	84,000	69,000	78,000
EQUIVALENT HOMES POWERED	34%	28%	31%
HOME ENERGY SAVINGS	110%	95%	104%

Electricity Generated (mwh): Approximate electricity generated in megawatt-hours.
Equivalent Homes Powered (locally): Electricity generated divided by the number of homes in the area, assuming average daily electricity usage.
Home Energy Savings: Percentage of daily electricity cost saved by an average household with an average-sized solar array on its roof versus using power only from the grid.
Source: Climate Central WeatherPower tool

CLIMATE CENTRAL

CALIFORNIA
WIND ELECTRICITY GENERATION

	YESTERDAY	TODAY	TOMORROW
ELECTRICITY GENERATED (MWH)	54,000	3,300	2,800
EQUIVALENT HOMES POWERED	22%	1%	1%
SMARTPHONES CHARGED	4.9 billion	298.6 million	258.8 million

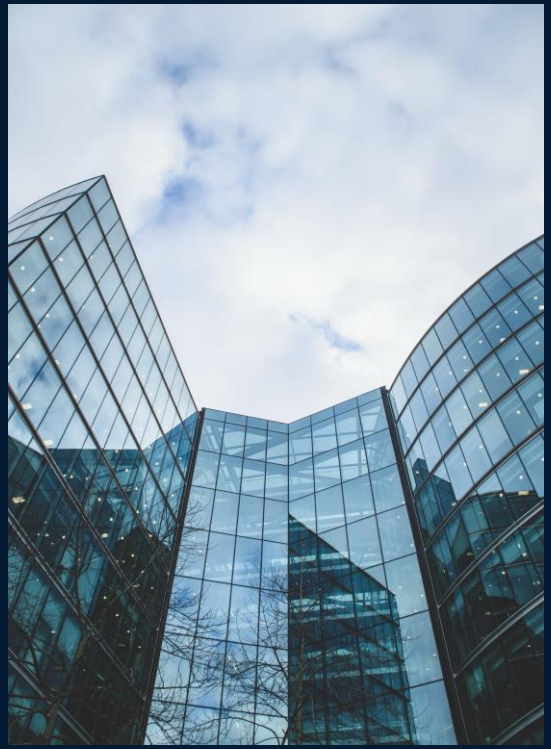
Electricity Generated (mwh): Approximate electricity generated in megawatt-hours.
Equivalent Homes Powered (locally): Electricity generated divided by the number of homes in the area, assuming average daily electricity usage.
Smartphones Charged (equivalent): The number of typical smartphones that could be charged using the amount of electricity generated .
Source: Climate Central WeatherPower tool

CLIMATE CENTRAL

Electrifying Transport

SOLVABLE

Better Buildings



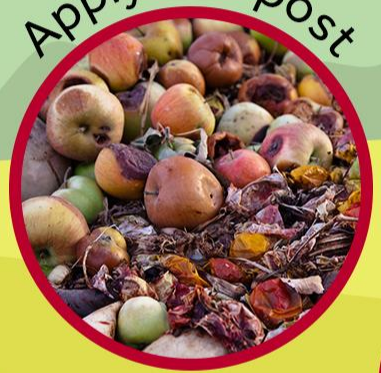
- Dynamic Glass
- Insulation
- Electric heating & cooling

SOLVABLE

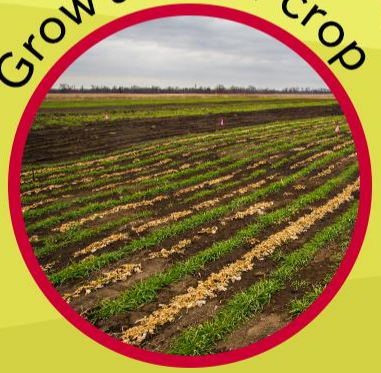
BUILDING BETTER SOILS

Farming practices that increase soil carbon

Apply compost



Grow a cover crop



Reduce tilling

Source: Paustian et al. 2017

CLIMATE CENTRAL

SOLVABLE

Maintain Natural Carbon Sinks & Flood Buffers

Grasslands

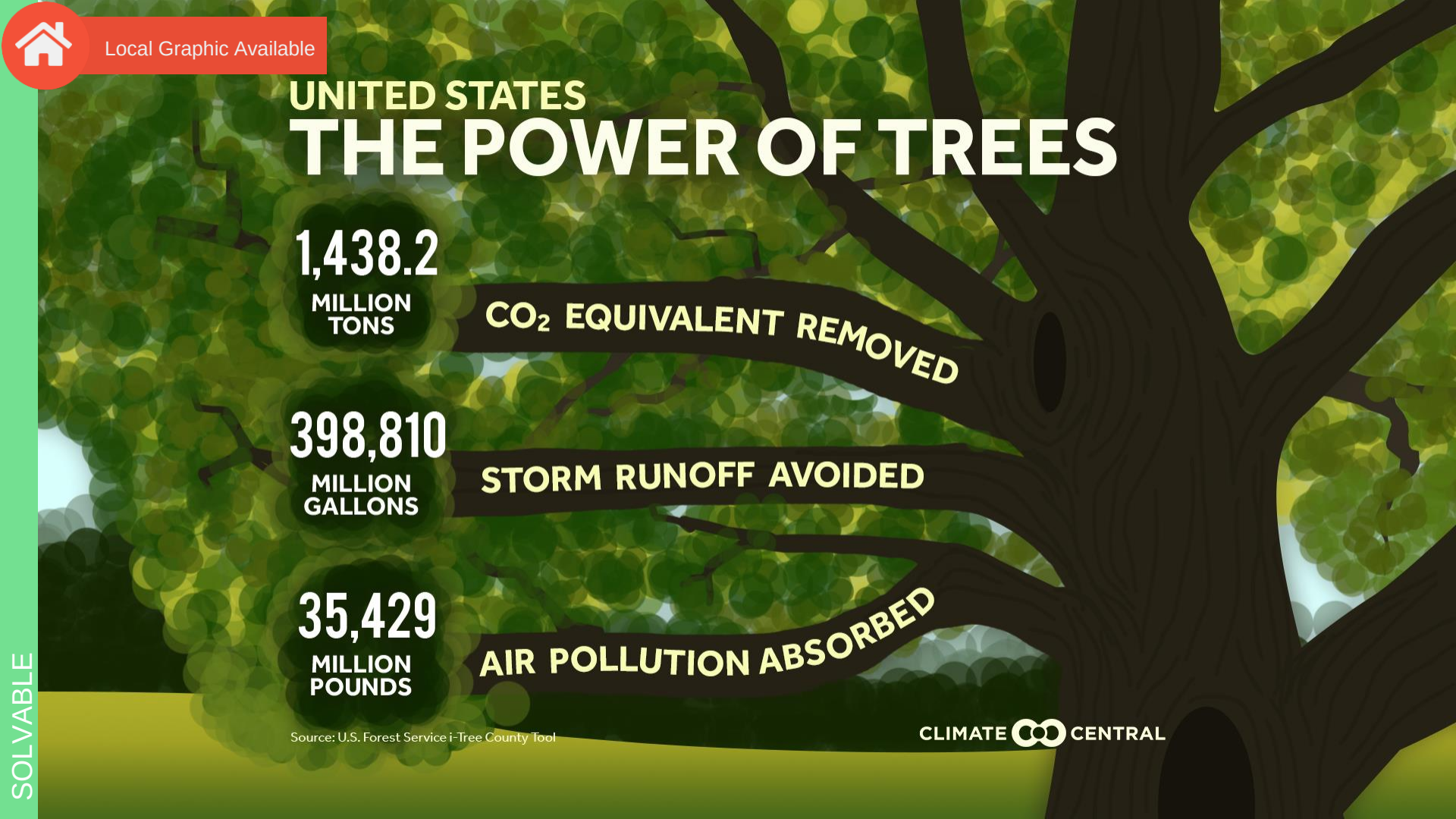
Coastal Wetlands

Peatlands

Forests

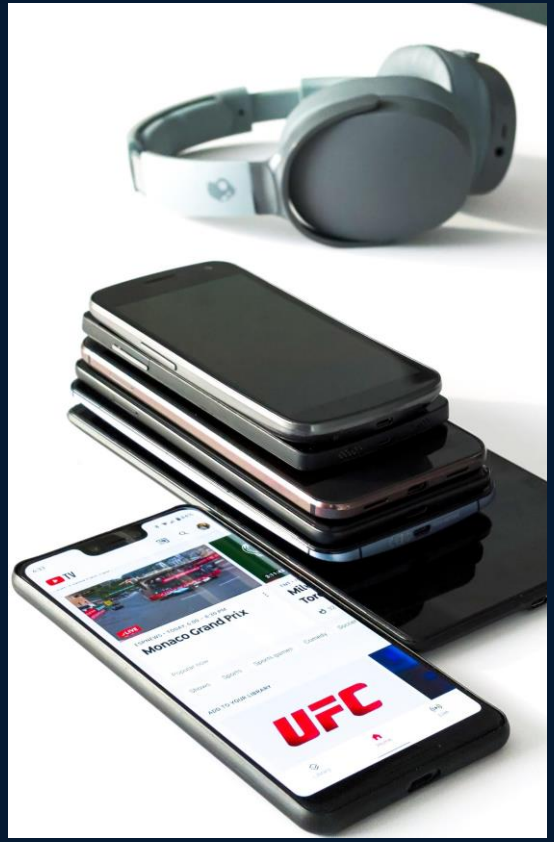
SOLVABLE

Local Graphic Available

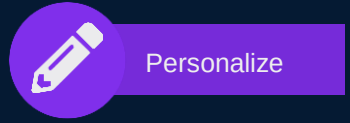


SOLVABLE

We Have Done Big Things Before

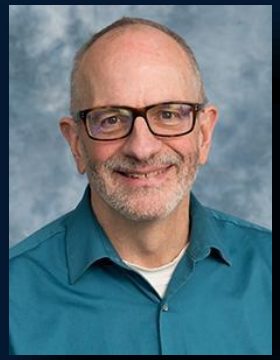


SOLVABLE



[Insert who/what inspires you to combat climate change here]

- **Simple**
  - Well-understood science that goes back to 1800s
- **Serious**
  - Impacts are already being felt & will only accelerate
- **Solvable**
  - We have what we need to make changes



Special thanks to Scott Denning at Colorado State for the Simple, Serious, Solvable framing

ADDITIONAL SLIDES

For those wanting to go deeper into some topics

- **Supplementary Slides**: *premade slides with main points provided*
  - Greenhouse effect – animation (58)
  - Longer term glacial retreat – Muir Glacier (59)
  - Paleoclimate reconstruction and long term carbon dioxide time series data (60-62)
  - Length of greenhouse gases in the atmosphere (63)
  - Rising Temperatures, US and global (64-66)
  - Astronomical influences (67-68)
  - Ocean temperatures – Time series with ENSO flucutations (69)
  - Consensus science (70)
  - Projections and pathways (71-73)

- **Local + Extra Slides:** *collection of local and extra graphics organized by topic*
  - Extreme Weather
  - Rising Temperatures
  - Ice & Snow
  - Sea Level Rise & Ocean Warming
  - Health Impacts

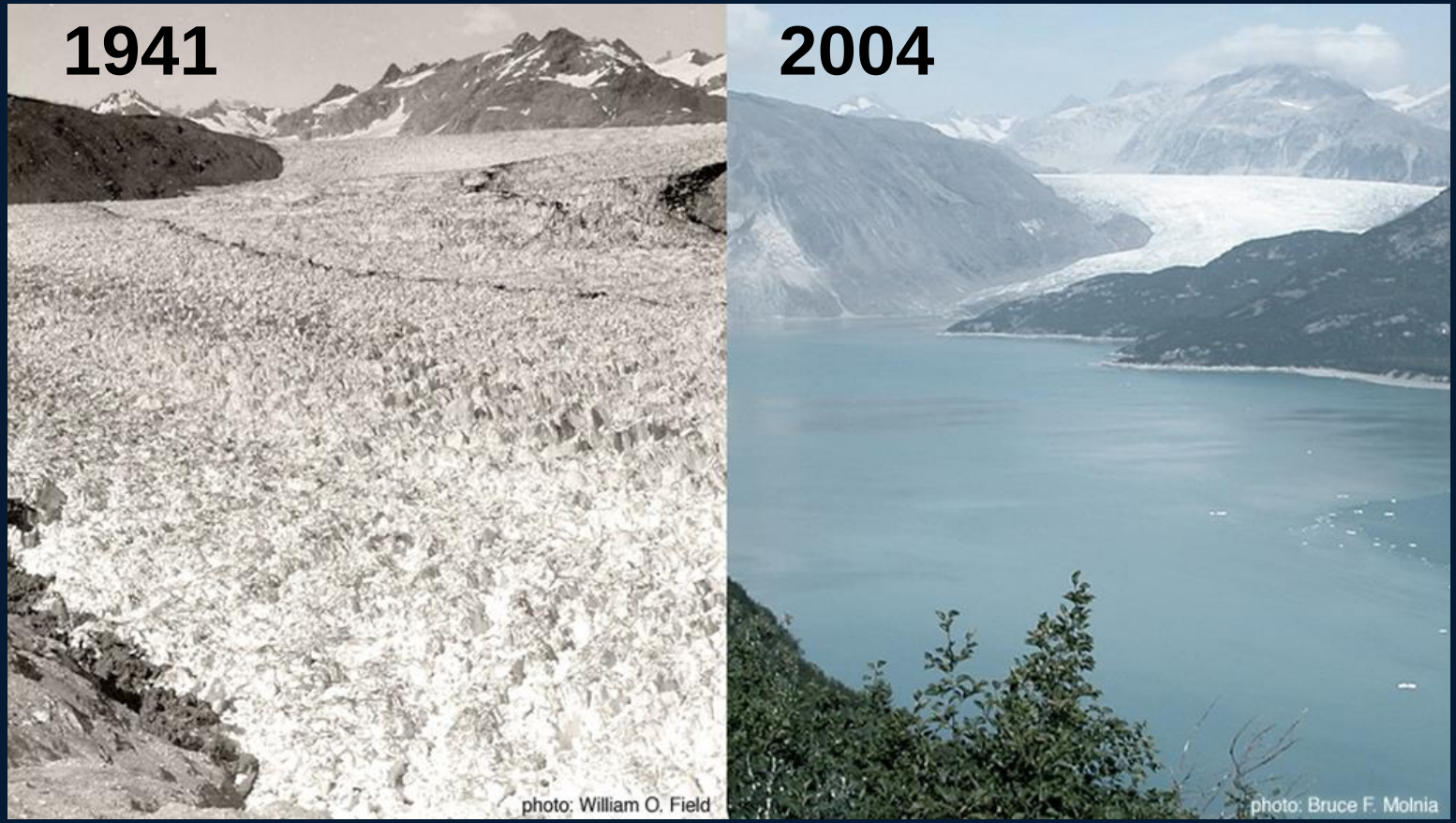
Supplementary Graphics

These additional slides can help you further explore a specific topic, if desired

The Greenhouse Effect

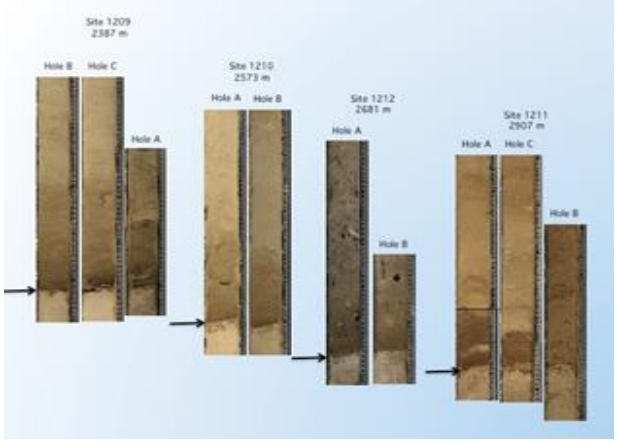
SIMPLE

SERIOUS



Alaska's Muir Glacier

Reconstructing Past Climates

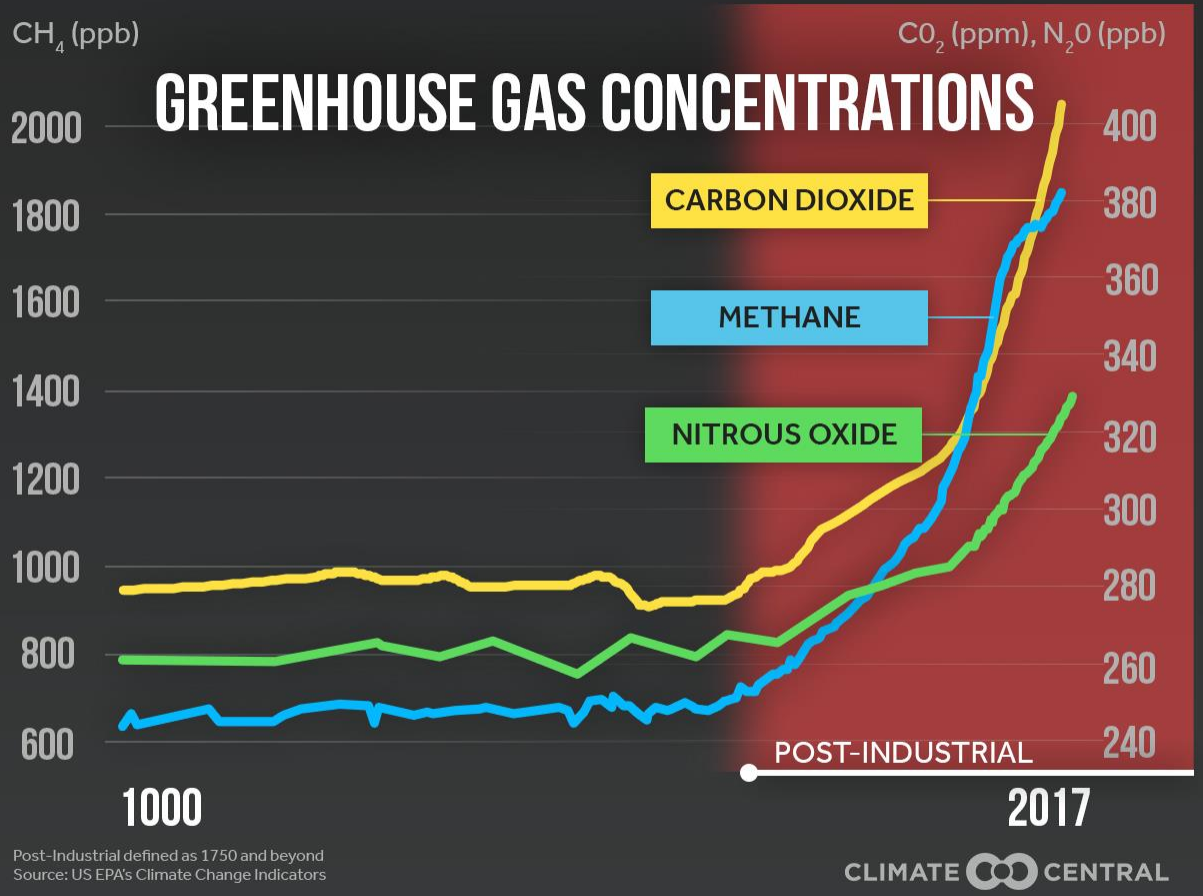


CARBON DIOXIDE CLIMB

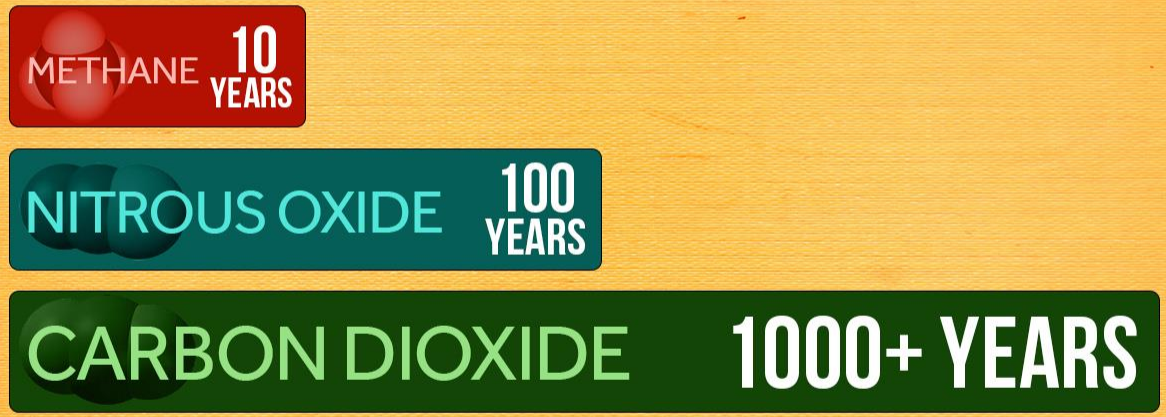
Daily Update

Source: Luthi et al (2008) (cdiac.ornl.gov) & NOAA ESRL (esrl.noaa.gov)

CLIMATE CENTRAL


CH_4 (ppb)
$C0_2$ (ppm), N_20 (ppb)
GREENHOUSE GAS CONCENTRATIONS
2000
1800
1600
1400
1200
1000
800
600
400
380
360
340
320
300
280
260
240
CARBON DIOXIDE
METHANE
NITROUS OXIDE
POST-INDUSTRIAL
1000
2017
Post-Industrial defined as 1750 and beyond
Source: US EPA's Climate Change Indicators
CLIMATE CENTRAL

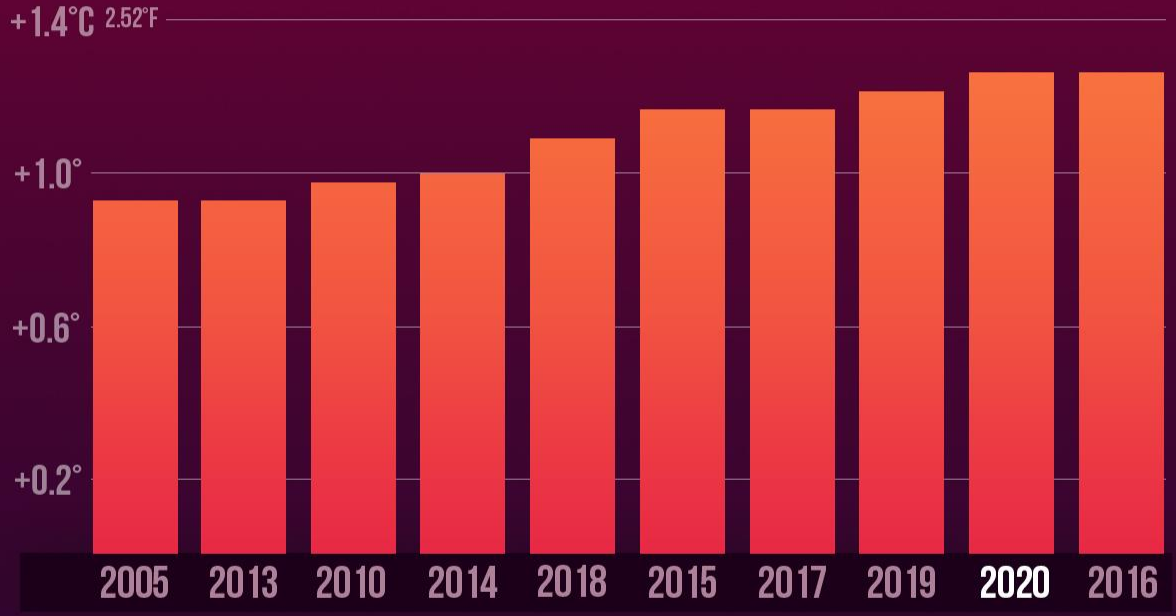
GREENHOUSE GASES LAST A LONG TIME



Numbers based on lifetime in atmosphere, not their warming potential

CLIMATE CENTRAL

10 HOTTEST GLOBAL YEARS ON RECORD

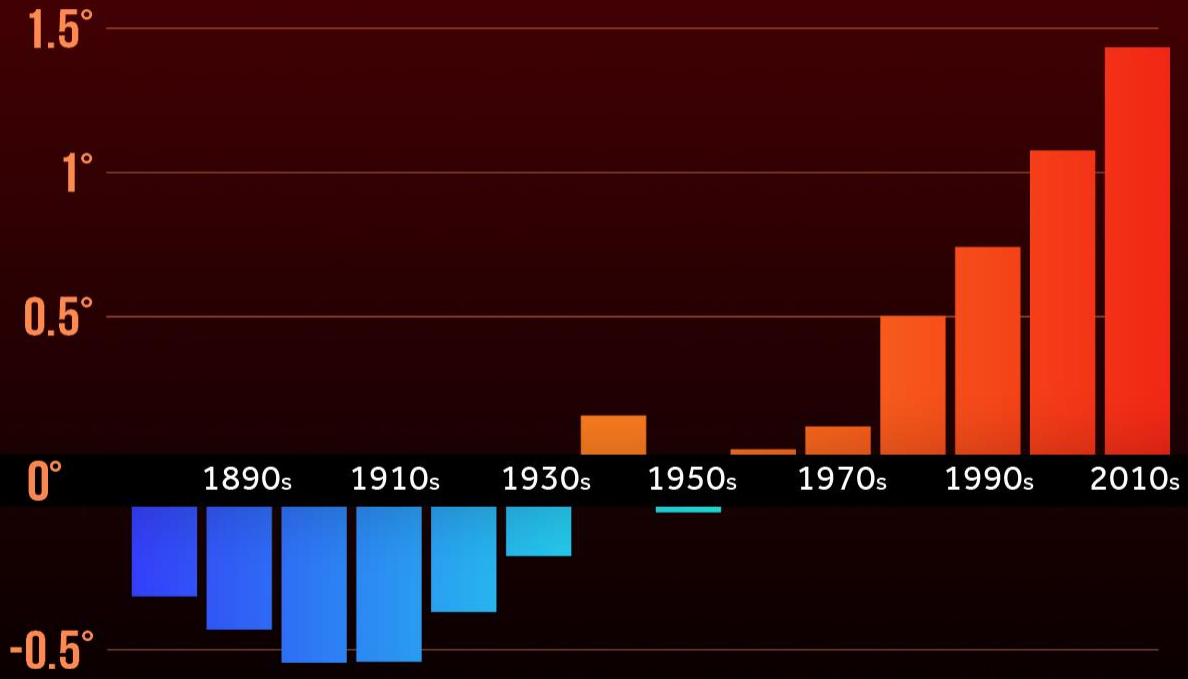


Source: NASA GISS & NOAA NCEI global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910). Data as of 1/14/2021.

CLIMATE CENTRAL

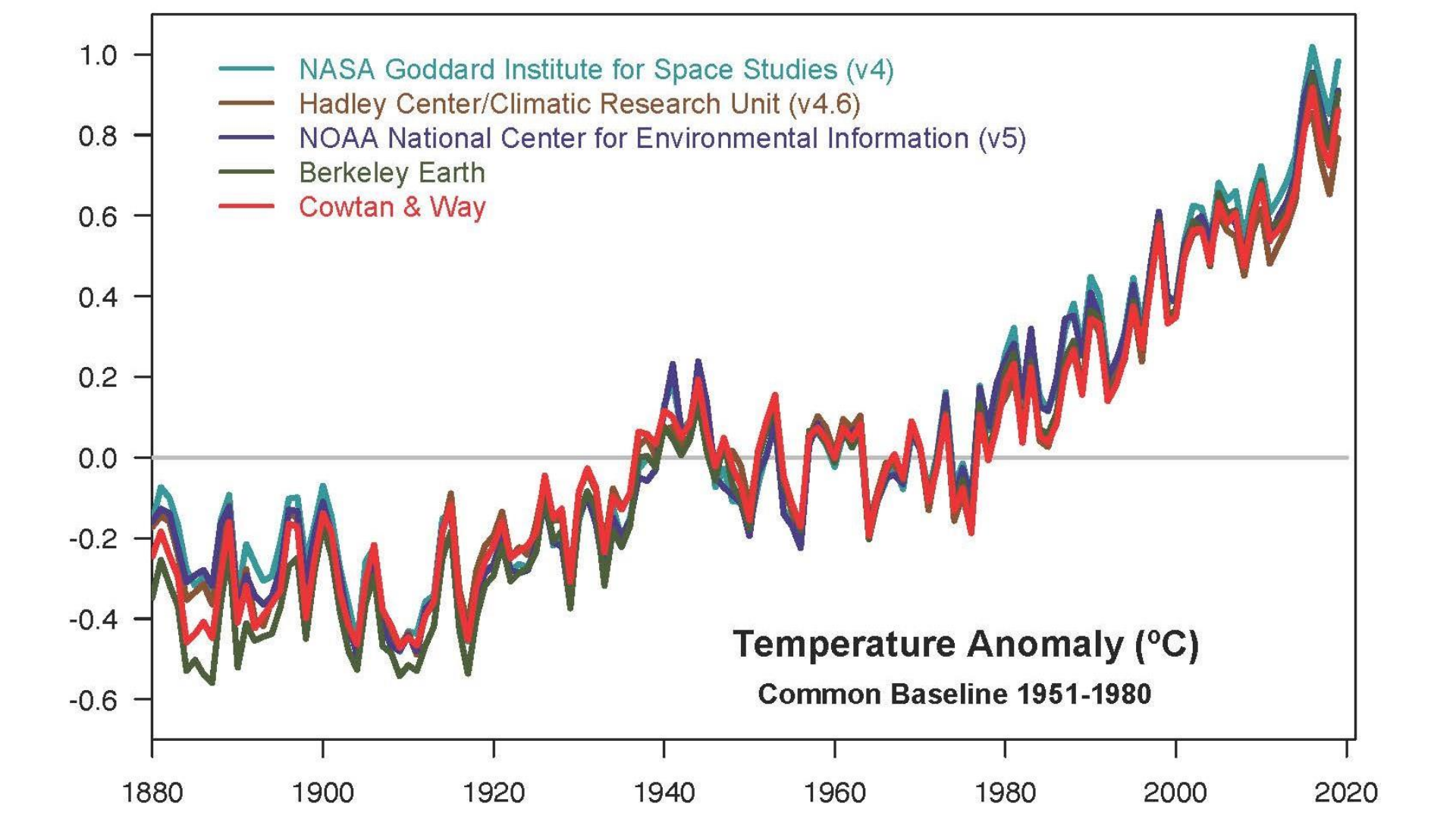
Local Graphic Available

GLOBAL
DECADES OF WARMING

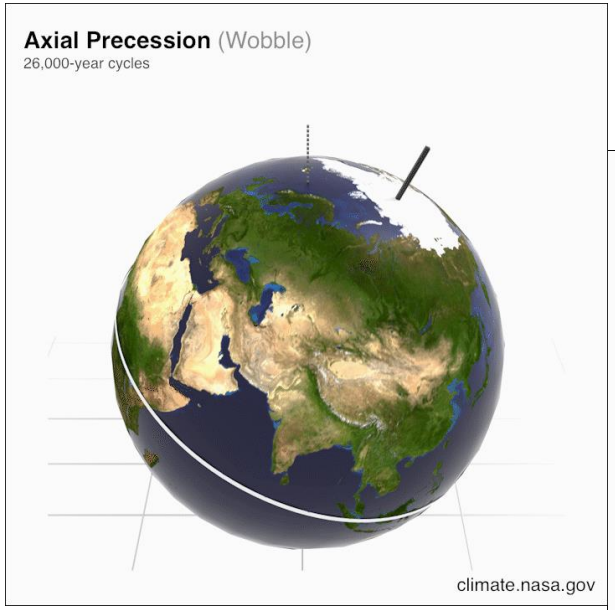


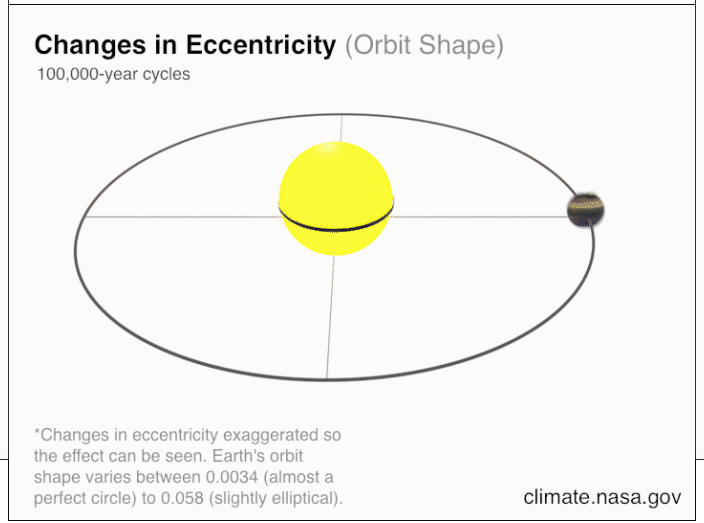
Average decadal temperature anomalies from 20th century average (°F). Data through October 2019.
Source: NOAA

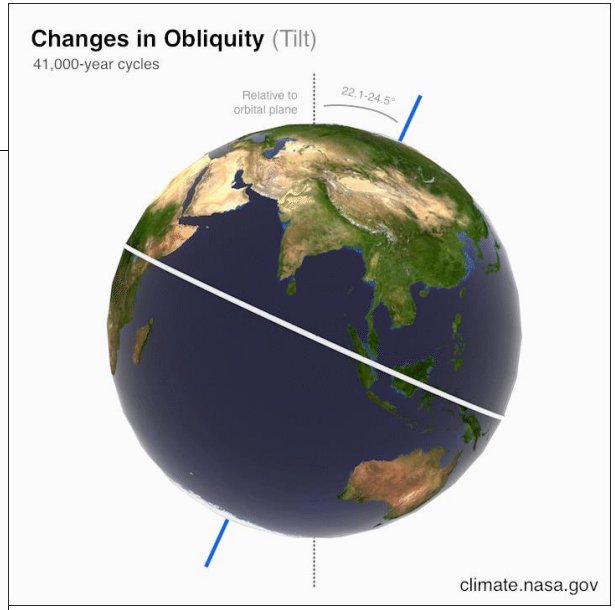
CLIMATE CENTRAL

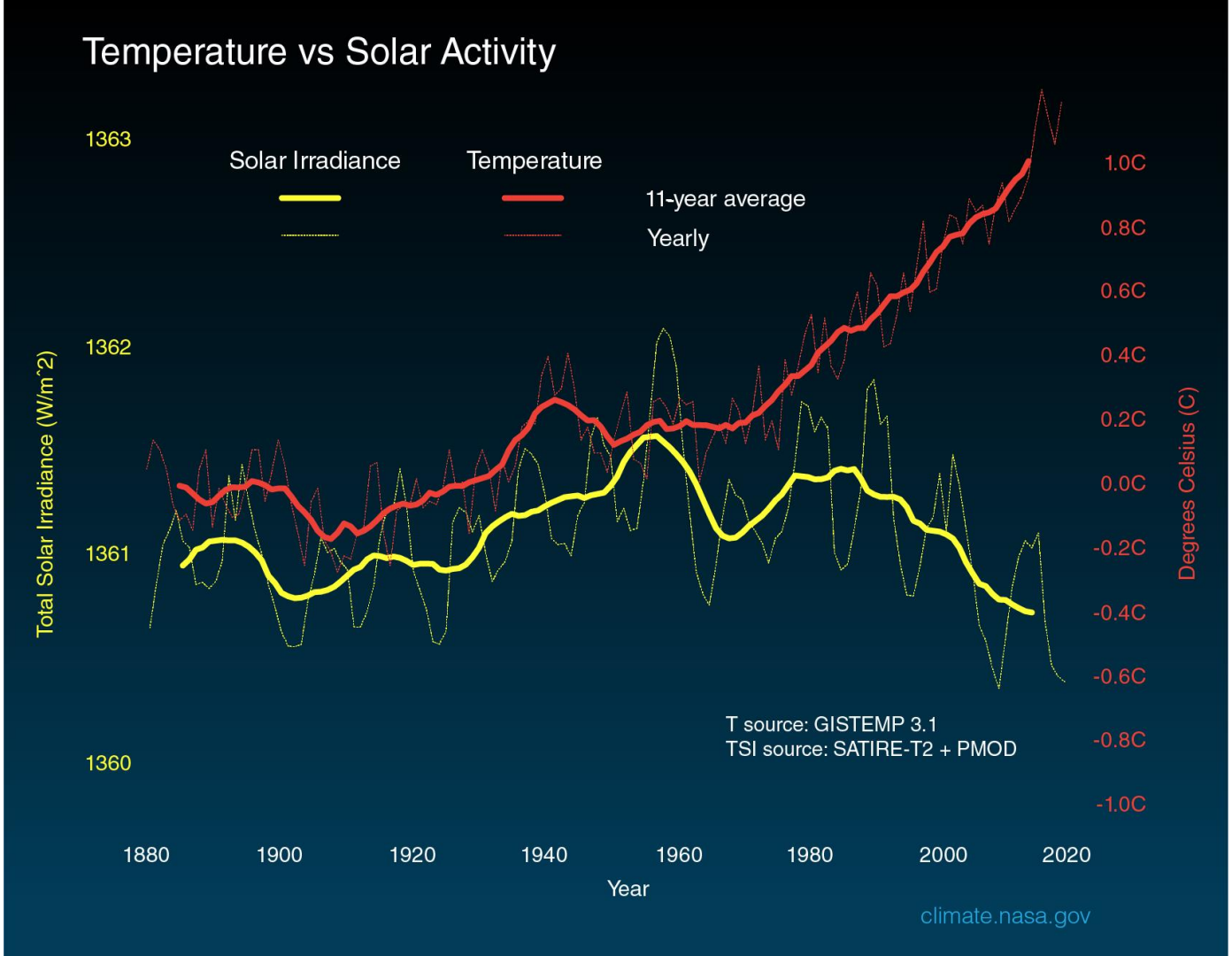

NASA Goddard Institute for Space Studies (v4)
Hadley Center/Climatic Research Unit (v4.6)
NOAA National Center for Environmental Information (v5)
Berkeley Earth
Cowtan & Way
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
1880
1900
1920
1940
1960
1980
2000
2020
Temperature Anomaly (°C)
Common Baseline 1951-1980

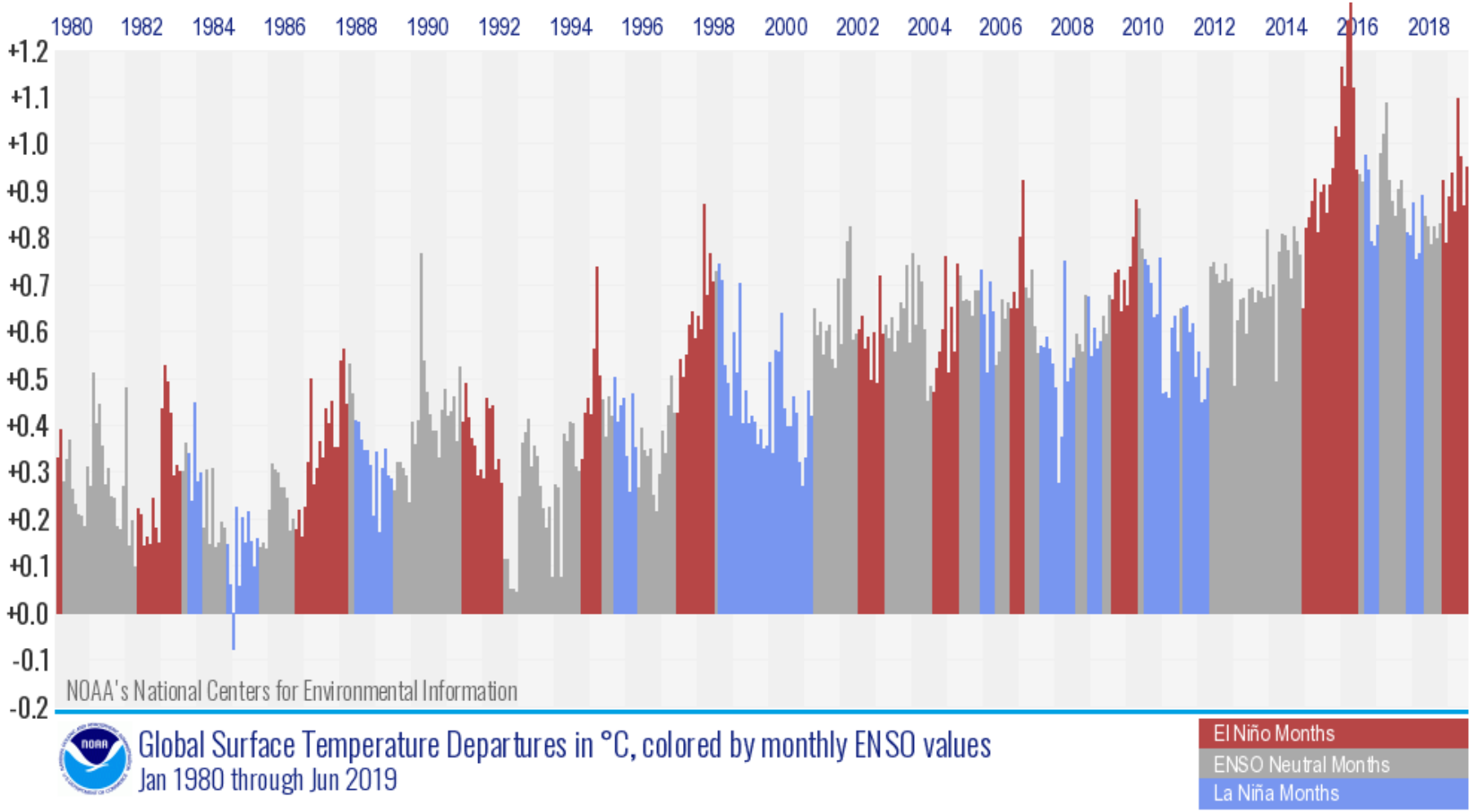
Natural Climate Change - Takes Much Longer



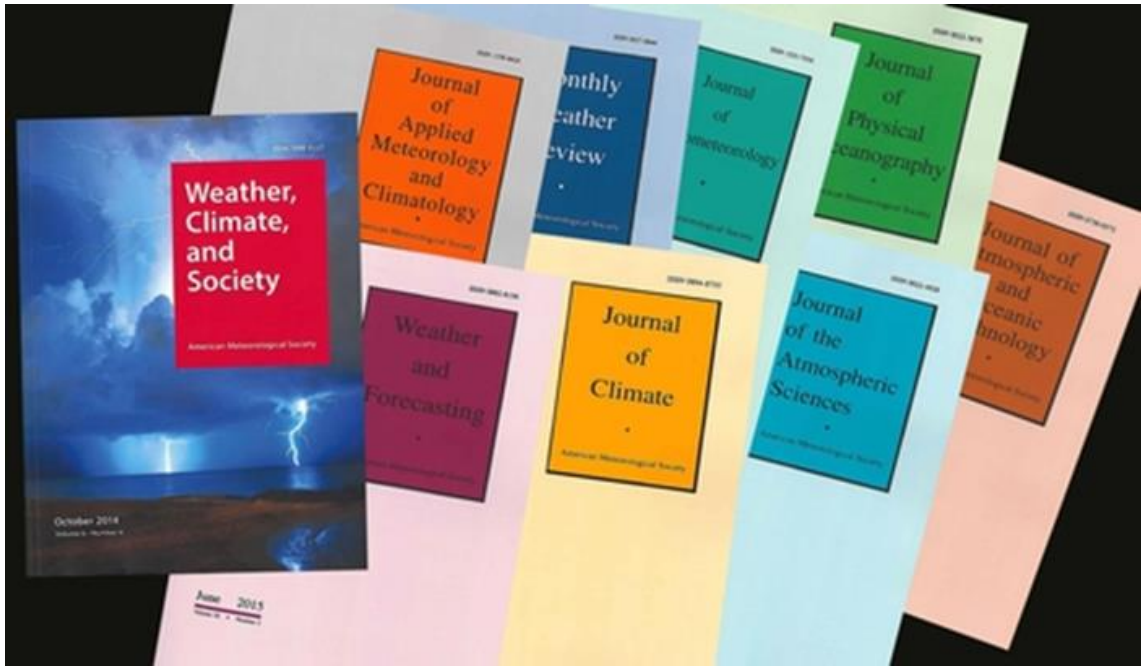





Temperature vs Solar Activity
Solar Irradiance
Temperature
11-year average
Yearly
1363
1362
1361
1360
Total Solar Irradiance (W/m^2)
1.0C
0.8C
0.6C
0.4C
0.2C
0.0C
-0.2C
-0.4C
-0.6C
-0.8C
-1.0C
Degrees Celsius (C)
T source: GISTEMP 3.1
TSI source: SATIRE-T2 + PMOD
1880
1900
1920
1940
1960
1980
2000
2020
Year
climate.nasa.gov


1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
+1.2
+1.1
+1.0
+0.9
+0.8
+0.7
+0.6
+0.5
+0.4
+0.3
+0.2
+0.1
+0.0
-0.1
-0.2
NOAA's National Centers for Environmental Information
Global Surface Temperature Departures in °C, colored by monthly ENSO values
Jan 1980 through Jun 2019
El Niño Months
ENSO Neutral Months
La Niña Months

Human-caused Climate Change is widely agreed upon...



97%

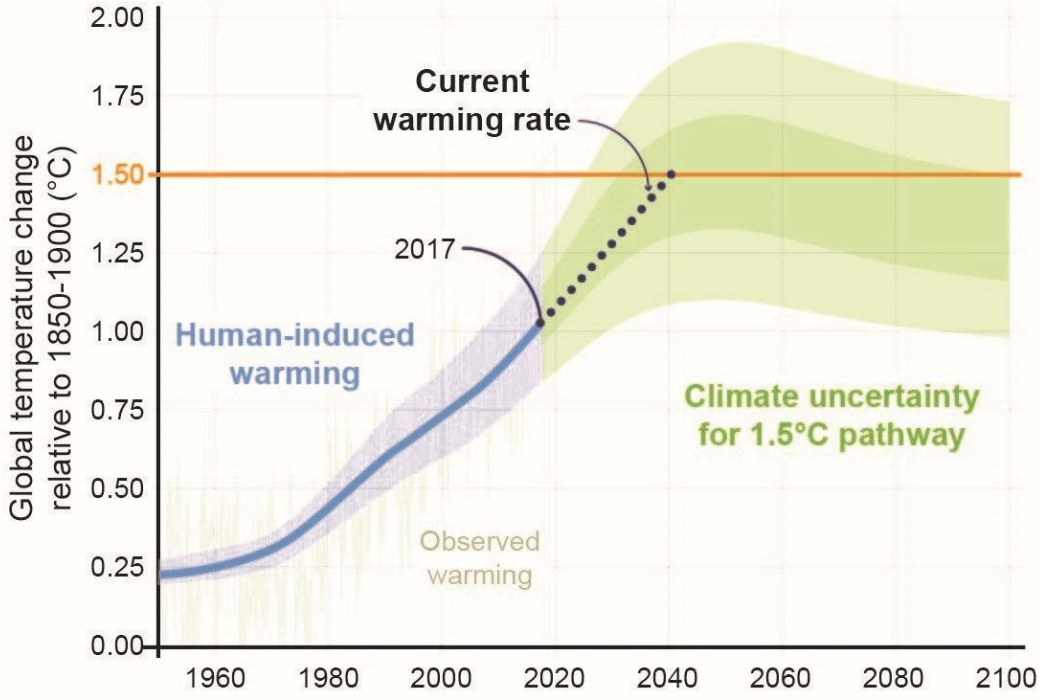
of actively publishing climate scientists agree that human-caused climate change is happening.

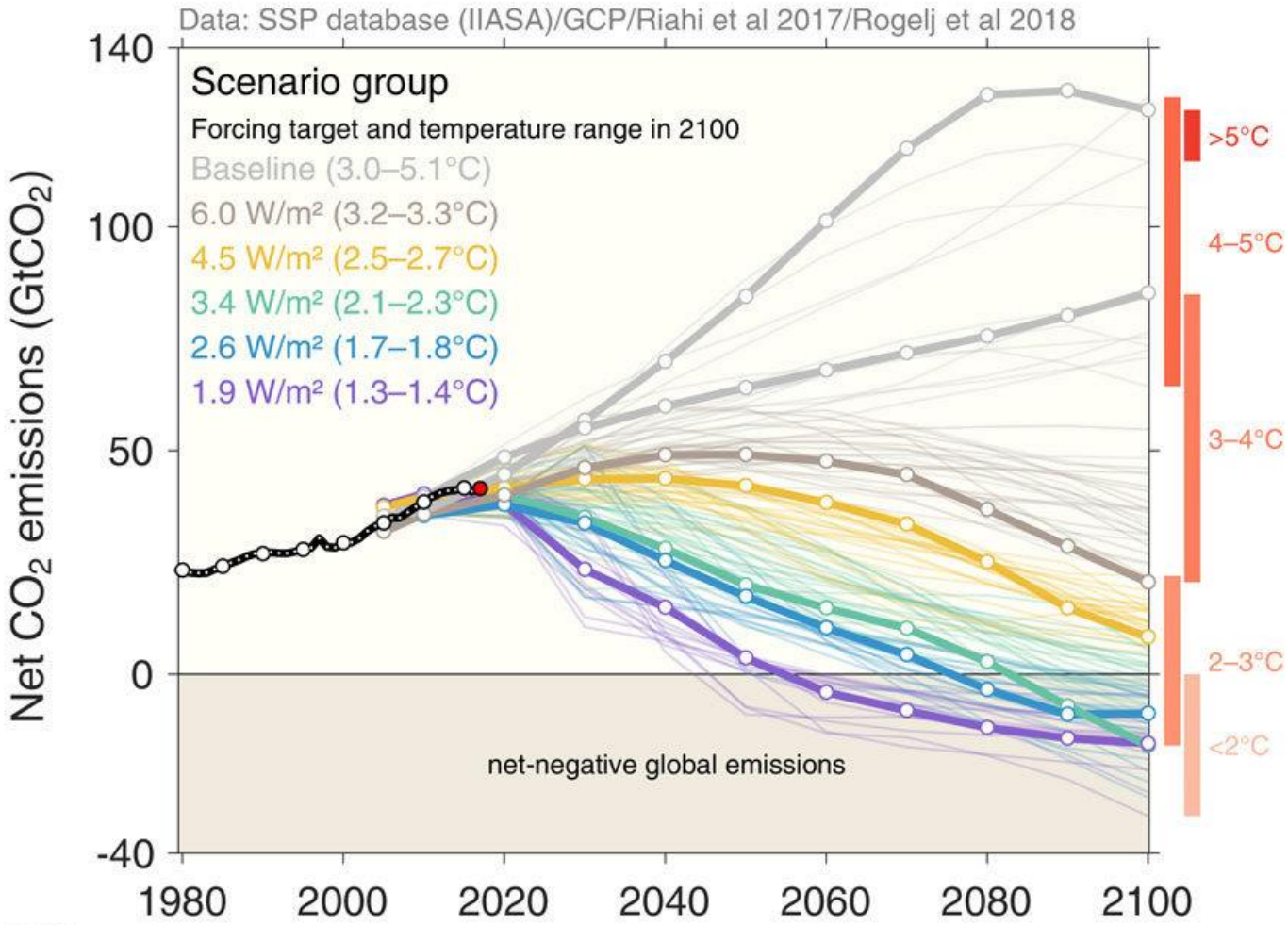
99.9%

of scientific research studies published in peer-reviewed scientific journals find that human-caused climate change is happening.

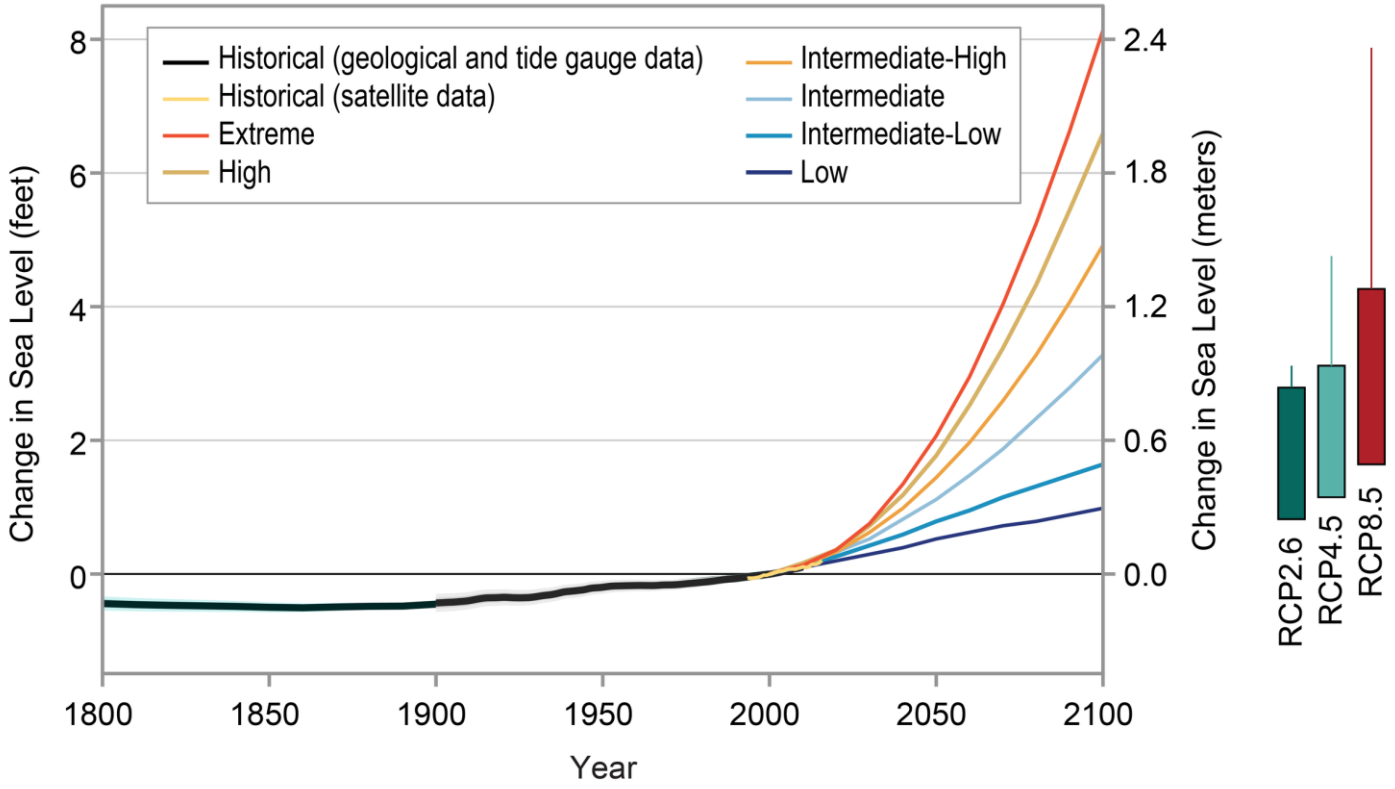
FAQ1.2: **How close are we to 1.5°C?**

Human-induced warming reached approximately 1°C above pre-industrial levels in 2017





Sea Level Rise Projections over a century

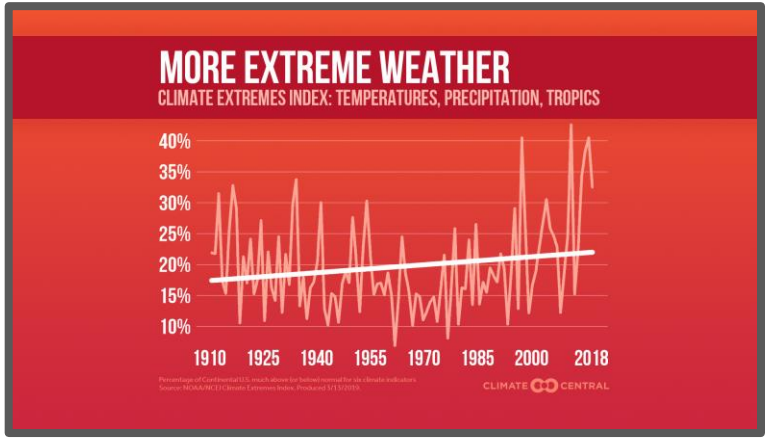


Local + Extra Graphics

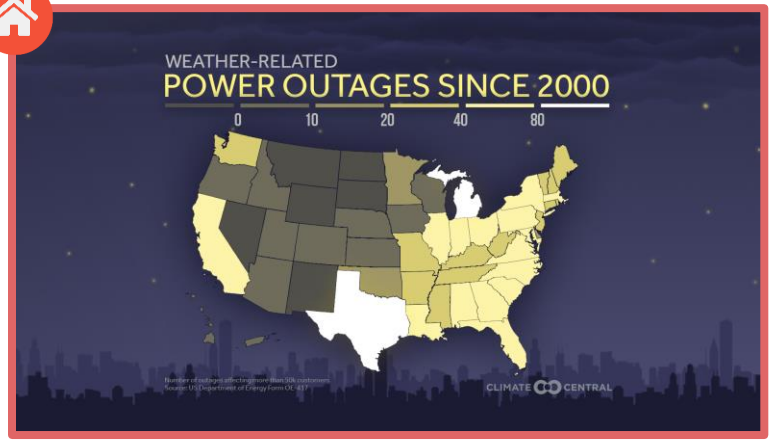
Directly copy or click on the URL in the slide notes to use the desired graphic

look for the  in the upper left of slides to indicate images with local data - URL in slide notes

Extreme Weather

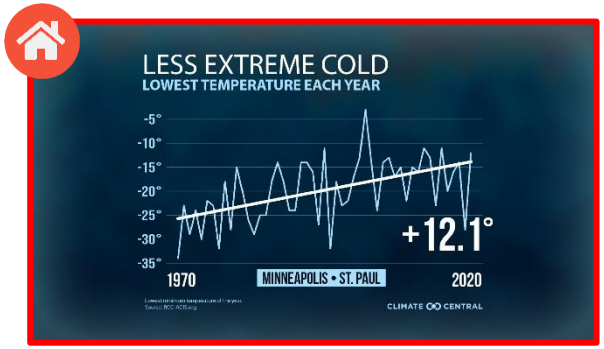


More Extreme Weather

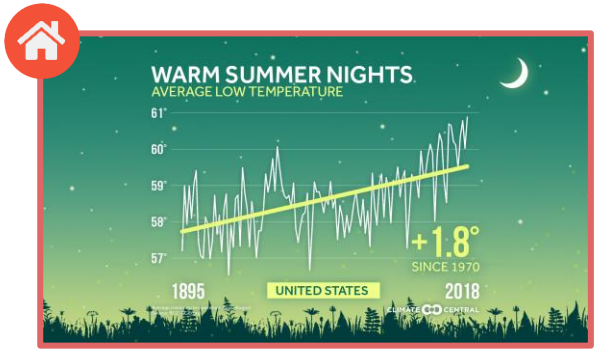


Power Outages

Rising Temperatures



Not-So-Extreme Cold

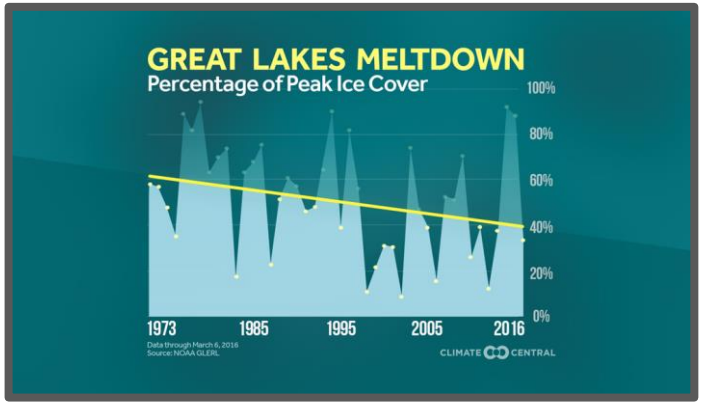


Warm Summer Nights

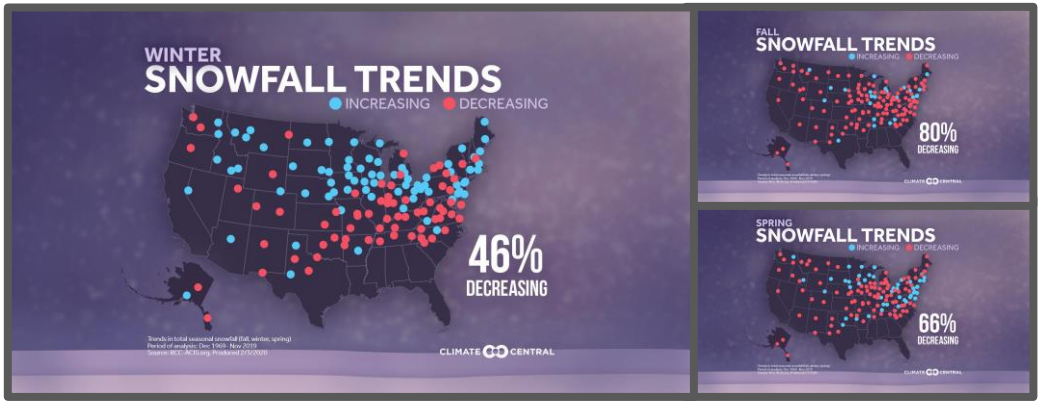
Days Above X

Seasonal Warming

Ice & Snow

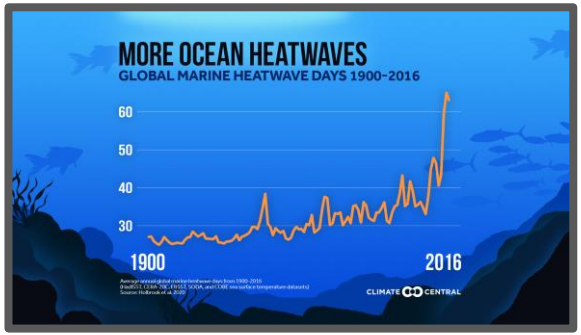


Great Lakes Meltdown



Snowfall Trends (Winter, Fall, Spring, Summer)

Sea Level Rise & Ocean Warming



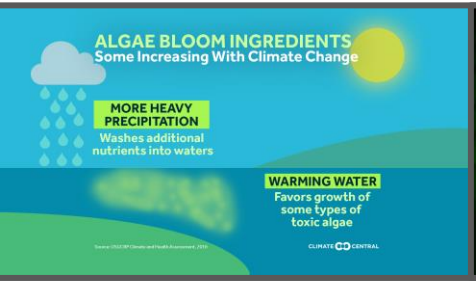
Ocean Heat Waves

Where’s the Heat?

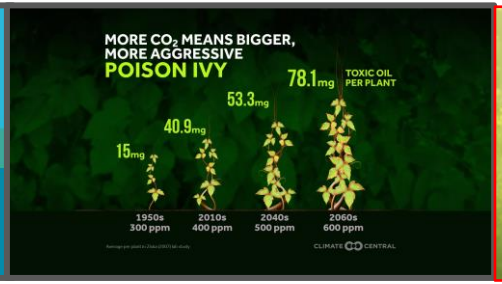
Coastal Flood Days

What’s At Risk?

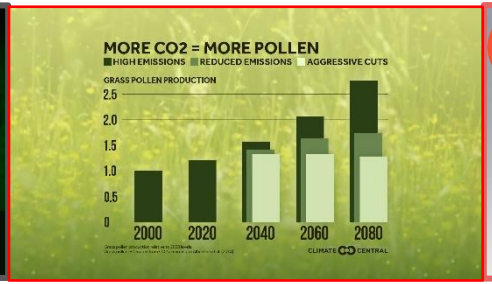
Health Impacts



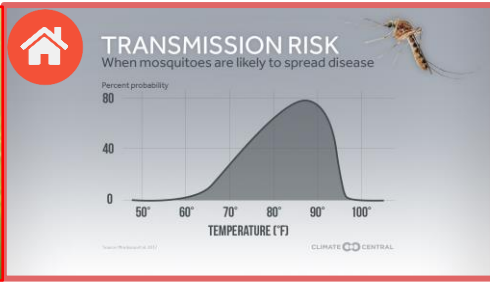
Algal Blooms



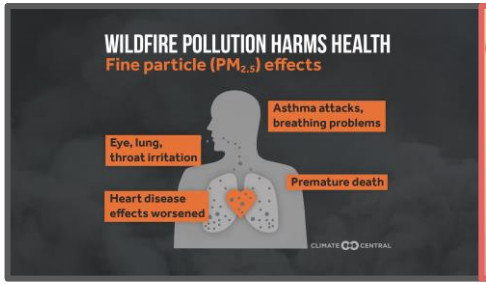
Poison Ivy



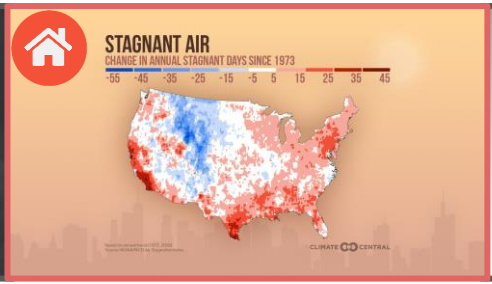
Pollen



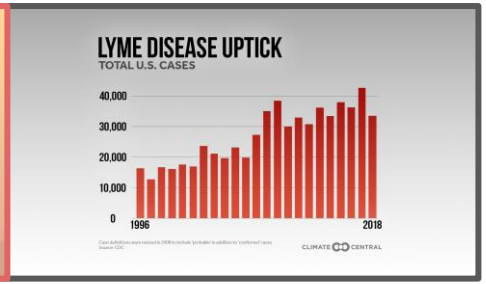
Mosquitoes



PM 2.5



Air Pollution



Ticks