

**Better solutions.
Fewer disasters.
Safer world.**

A photograph of a flooded street in a town. The water is murky and reflects the overcast, grey sky. Buildings line the street, and several red fire hydrants are visible in the water. The scene is somber and illustrates the impact of flooding.

Shifting Hazards and Early Warning for a Changing Climate

Tim Manning, Senior Advisor, Washington DC

Pacific Disaster Center

www.pdc.org

First, some caveats:

Disasters are, like anything, a complex system, with many variables.

Climate change can not likely be linked to any one *specific* disaster.

A changing climate is likely only a part of the increase in disasters.

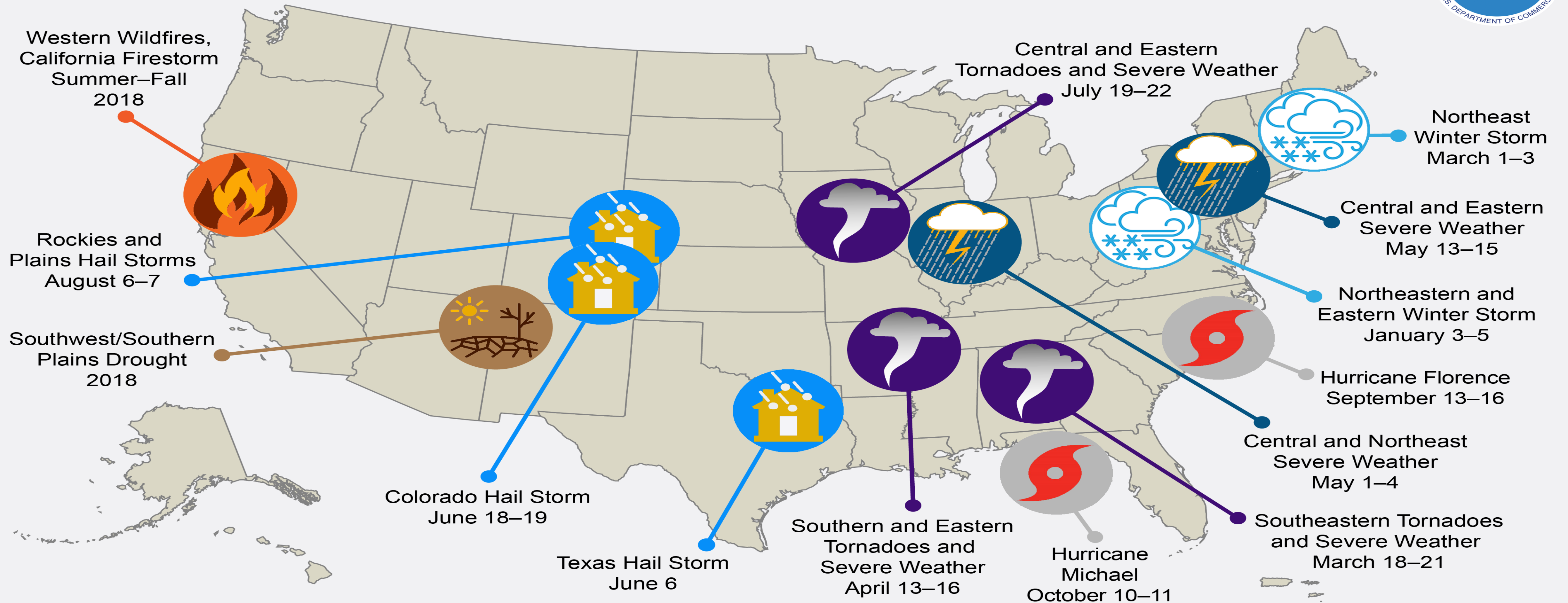
Other factors, such as population growth, urbanization, economics, and aging infrastructure, play a role.

Other DRR programs such as Sendai Framework compliance, the Sustainable Development Goals, and other practices are likely driving *down* losses.

Meteorological and climatological disasters are increasing with frequency, severity, and impact world wide.

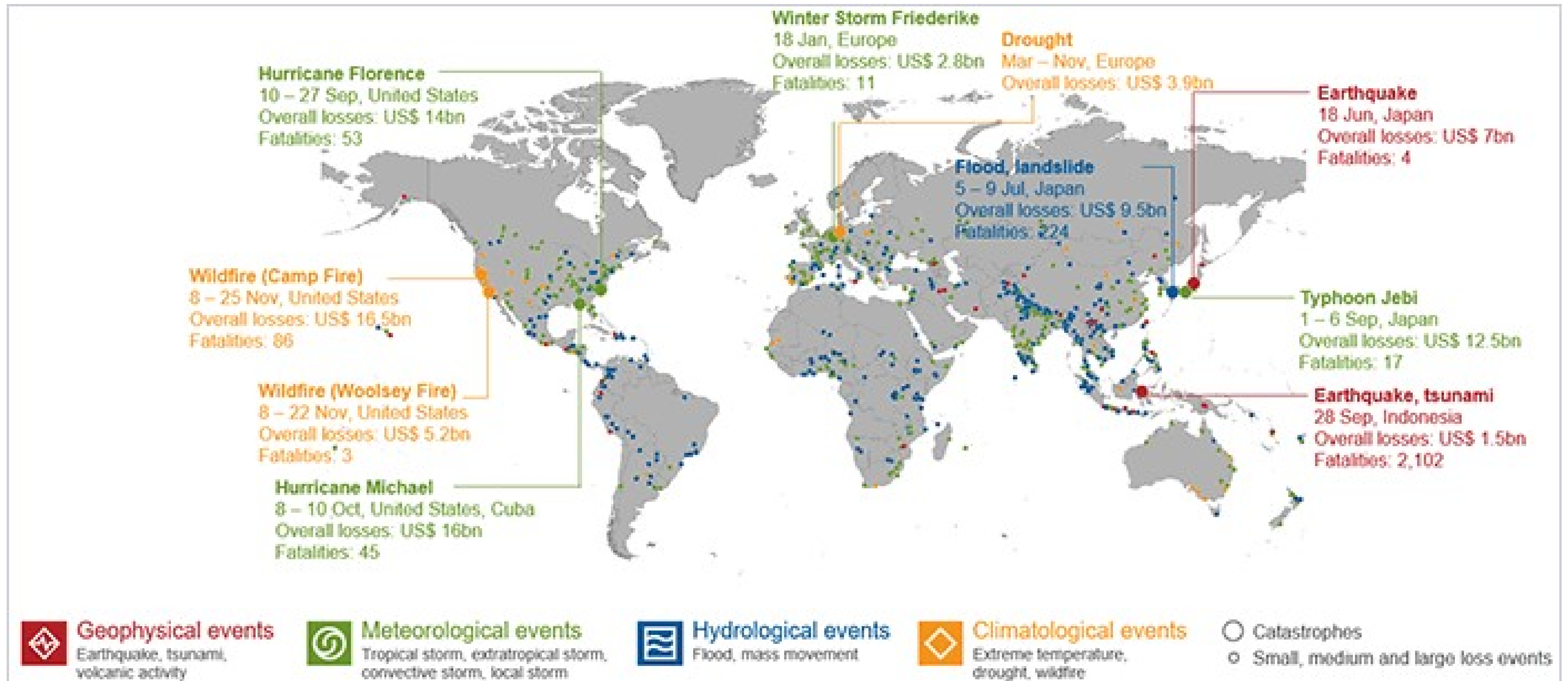


U.S. 2018 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2018.

2018 Disasters globally, the vast majority hydro-met-climate risk.



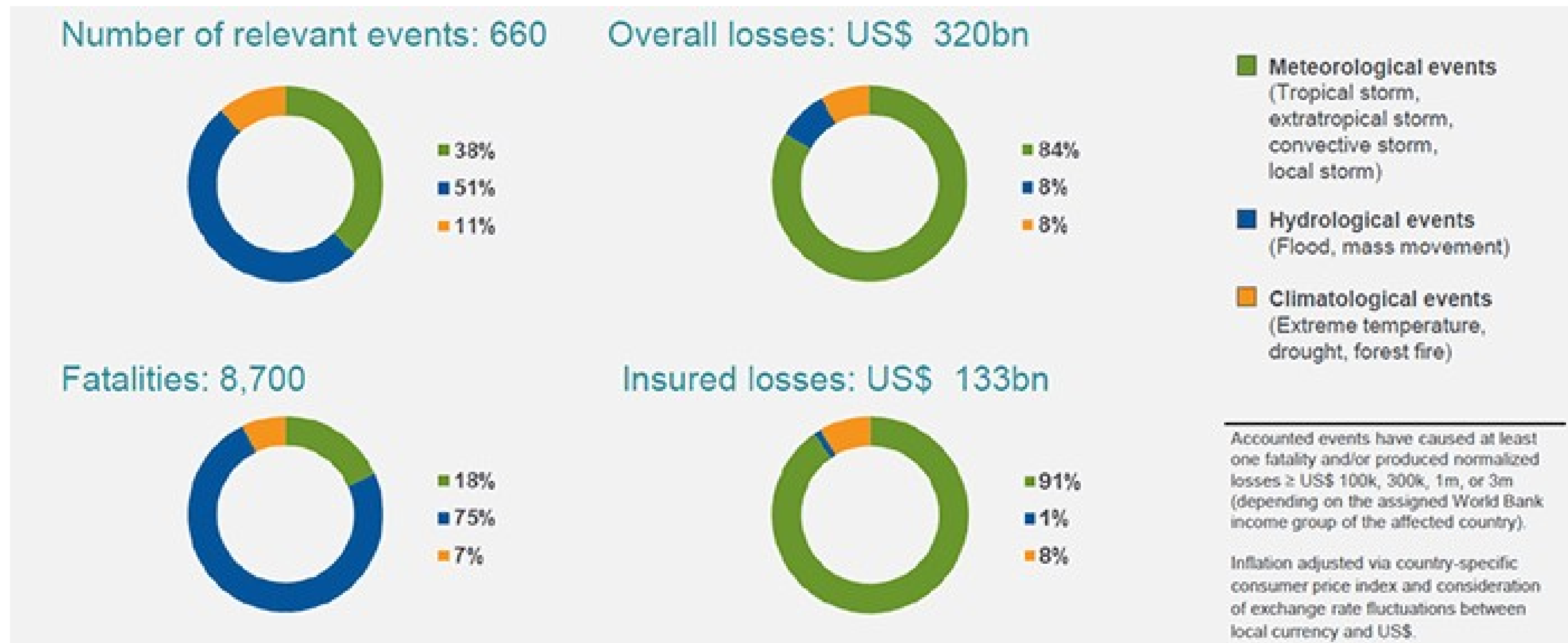
Source: © 2019 Munich Re, Geo Risks Research, NatCatSERVICE. As of March 2019.

Disaster frequency is growing

	The figures of the year 2018	The figures of the year 2017 <small>(Losses in original values)</small>	Average of the last 10 years 2008-2017 <small>(Losses adjusted to inflation based on local CPI)</small>	Average of the last 30 years 1988-2017 <small>(Losses adjusted to inflation based on local CPI)</small>
Number of events	850	740	630	500
Overall losses in US\$ m	160,000	350,000	190,000	140,000
Insured losses in US\$ m	80,000	140,000	61,000	41,000
Fatalities	10,400	13,000	60,000	53,000

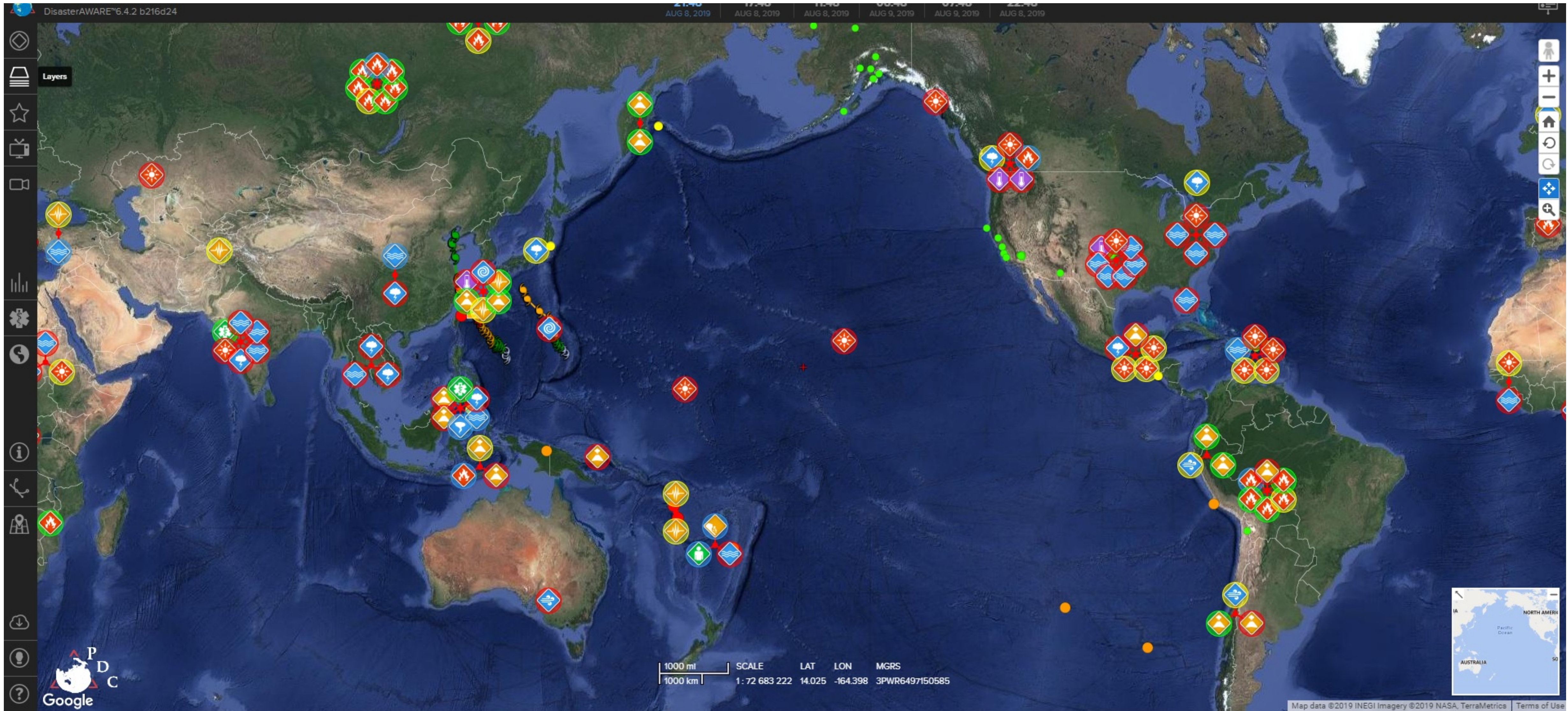
Source: © 2019 Munich Re, NatCatSERVICE. As of March 2019.

Percentage distribution - World weather-related catastrophes by type of event, 2017



Source: © 2018 Munich Re, Geo Risks Research, NatCatSERVICE. As of February 2017.

Active hazards on the afternoon (EDT) of Aug 8, 2019



Government and non-government organizations are facing more frequent and more intense events, and uncertain future.



Emergency Planning, staffing, resources, budgets, are all based on a future estimate rooted in the past.



Are we correct about what future disasters might look like? How many there might be?

Are our models correct?



Cyclone 'Storm Rachel' brings snow and gales to United Kingdom
via Telegraph, Picture: Nigel Bennett

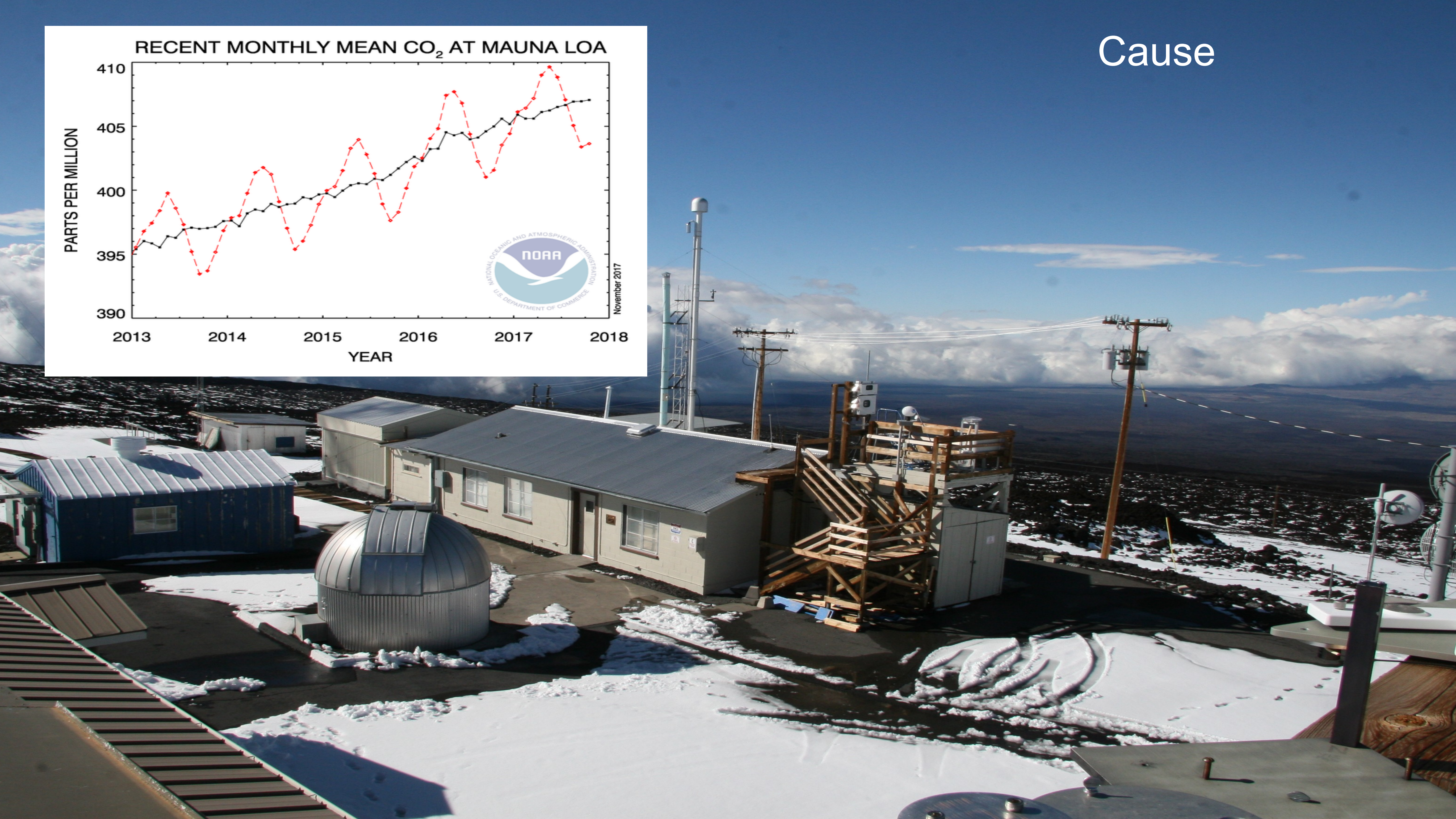
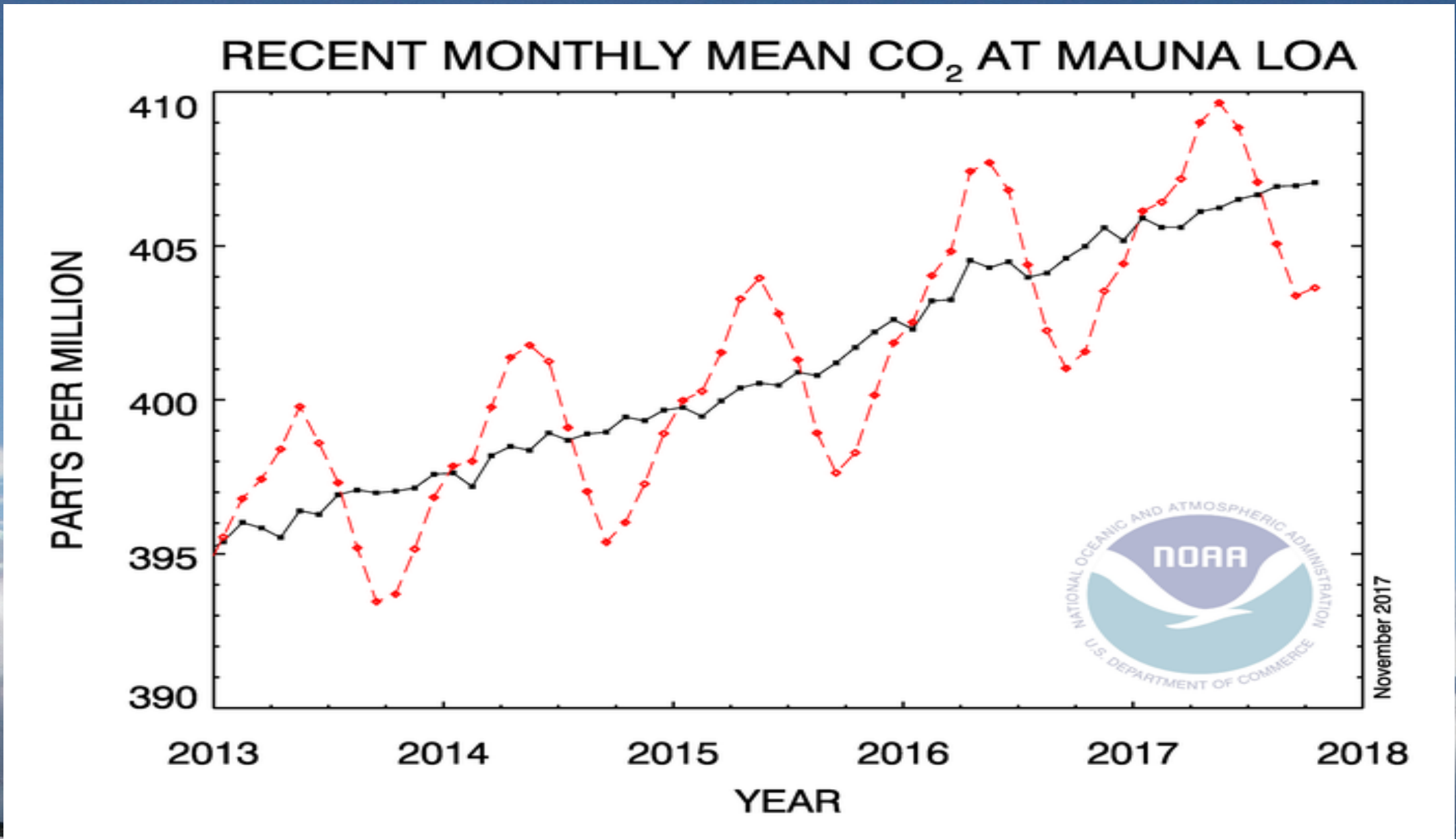


Climate vs Weather



“Climate is what you expect, weather is what you get.”

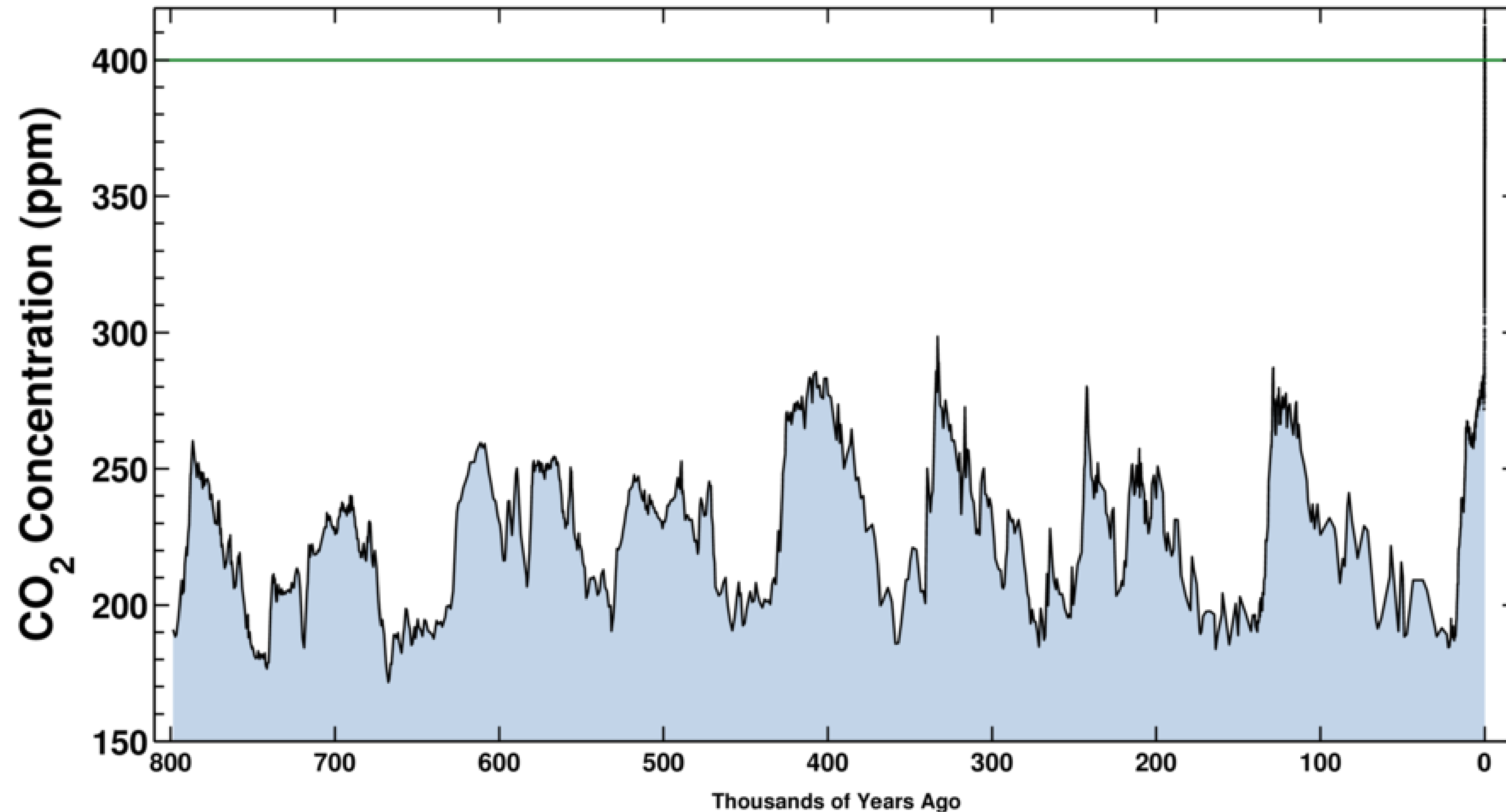
Cause



Latest CO₂ reading
August 06, 2019

409.97 ppm

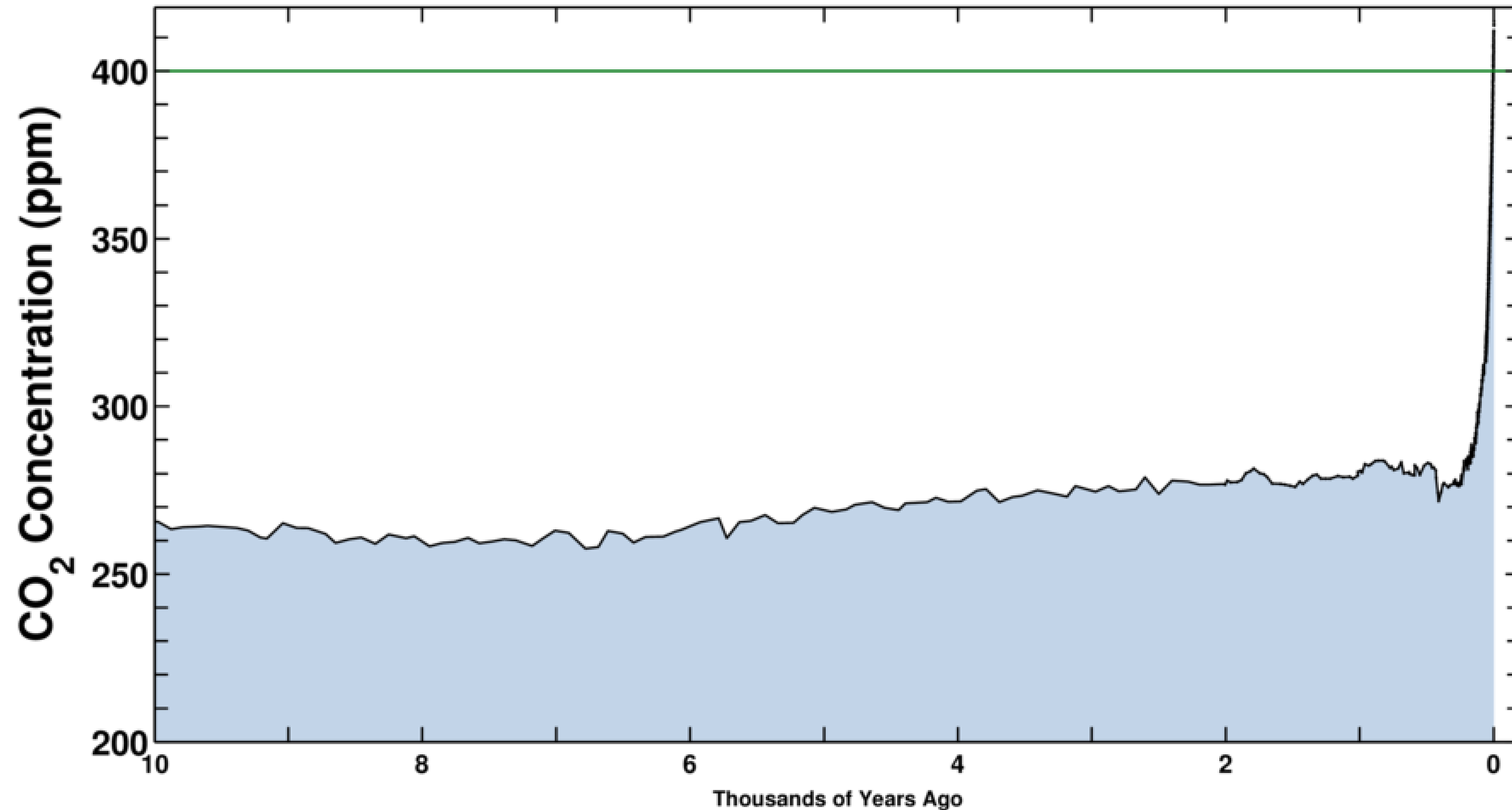
Ice-core data before 1958. Mauna Loa data after 1958.



Latest CO₂ reading
August 06, 2019

409.97 ppm

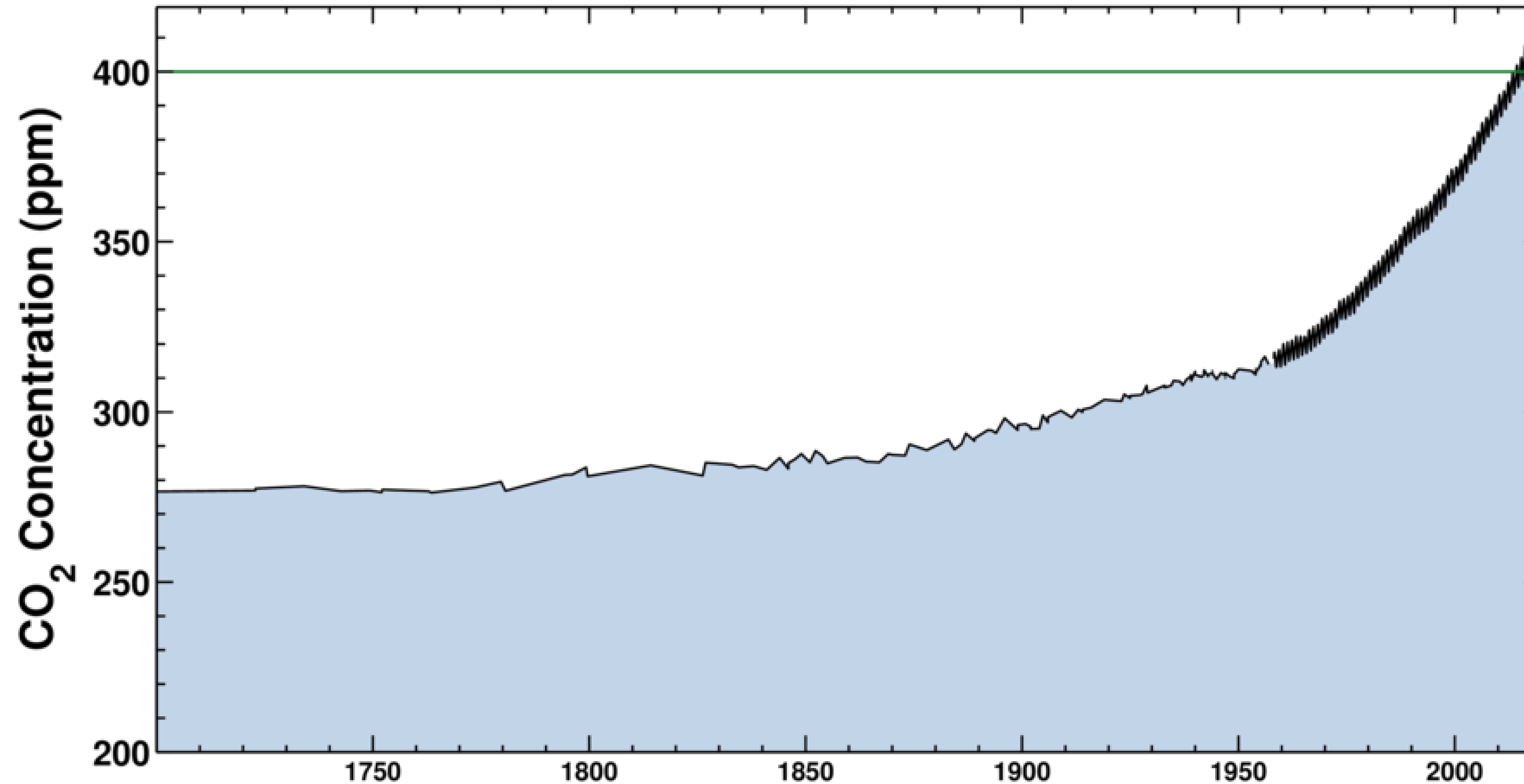
Ice-core data before 1958. Mauna Loa data after 1958.



Latest CO₂ reading
August 06, 2019

409.97 ppm

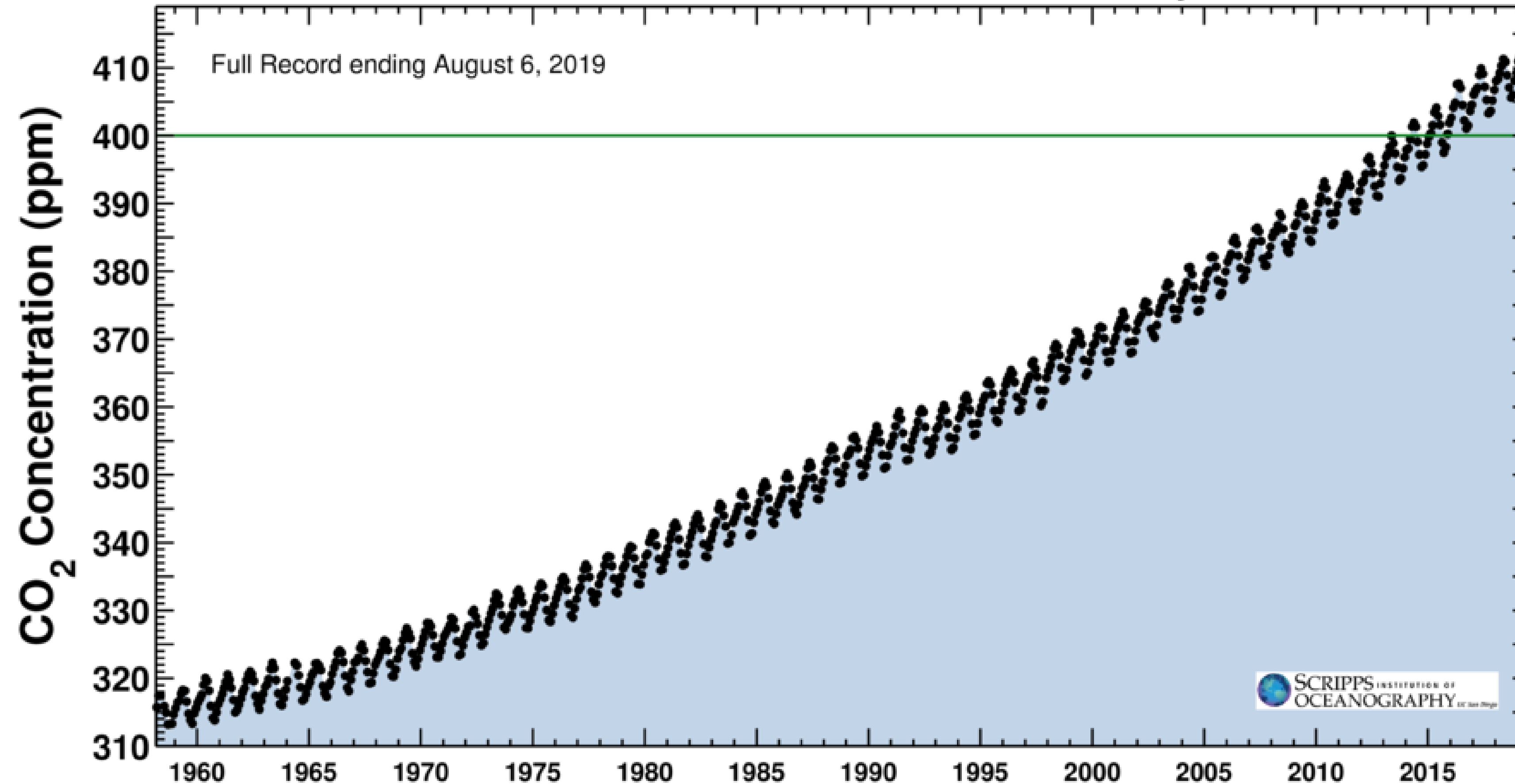
Ice-core data before 1958. Mauna Loa data after 1958.



Latest CO₂ reading
August 06, 2019

409.97 ppm

Carbon dioxide concentration at Mauna Loa Observatory

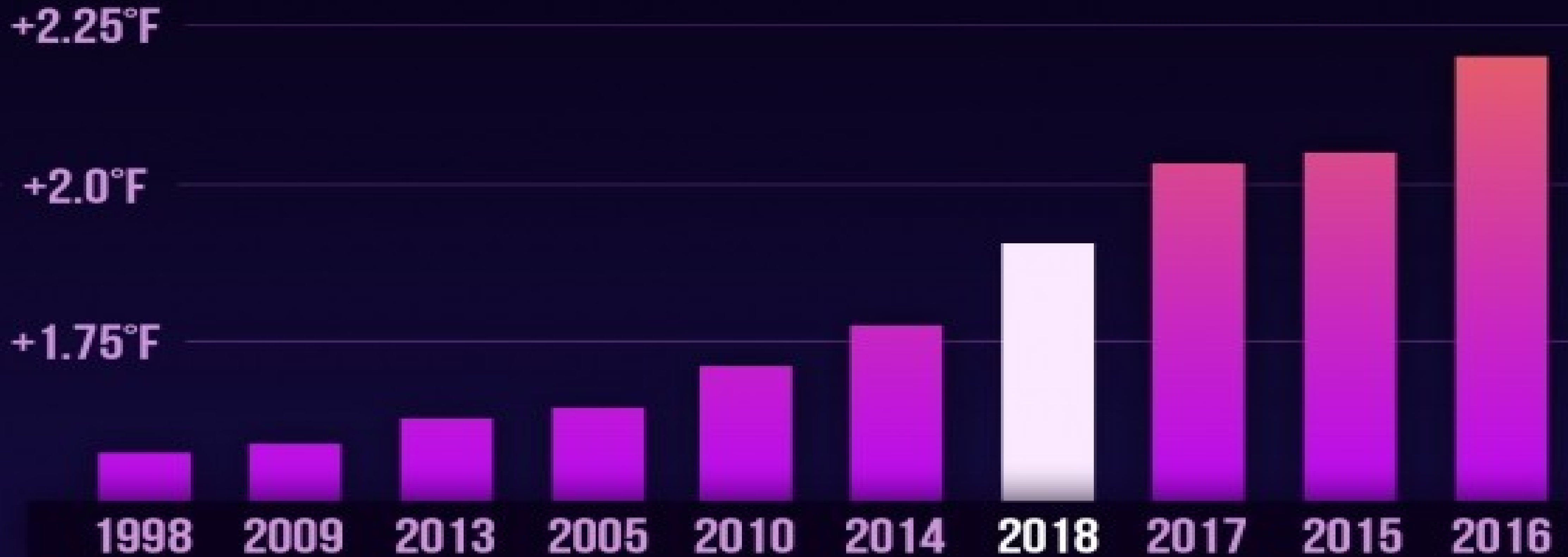


& effect



HOTTEST YEARS ON RECORD GLOBALLY

LAST 5 = HOTTEST 5

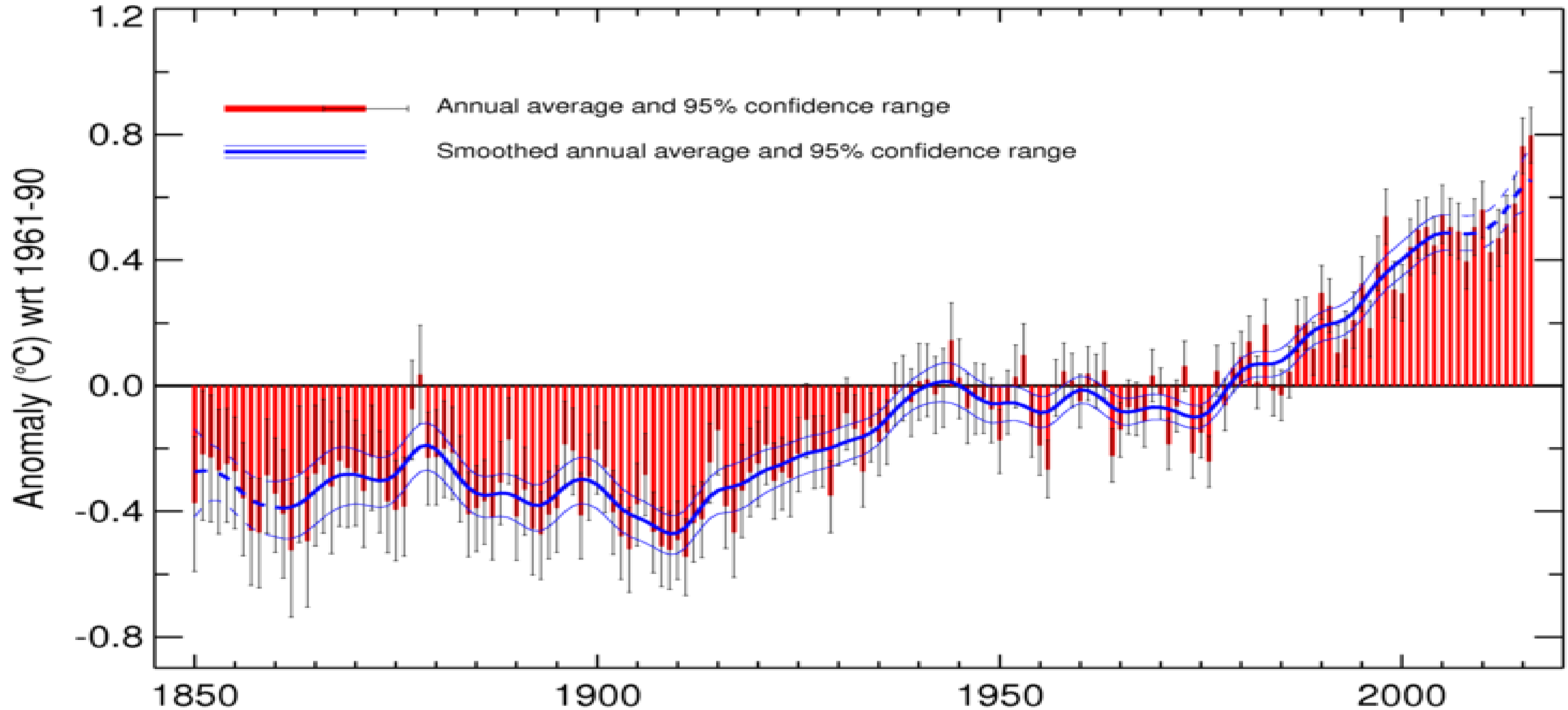


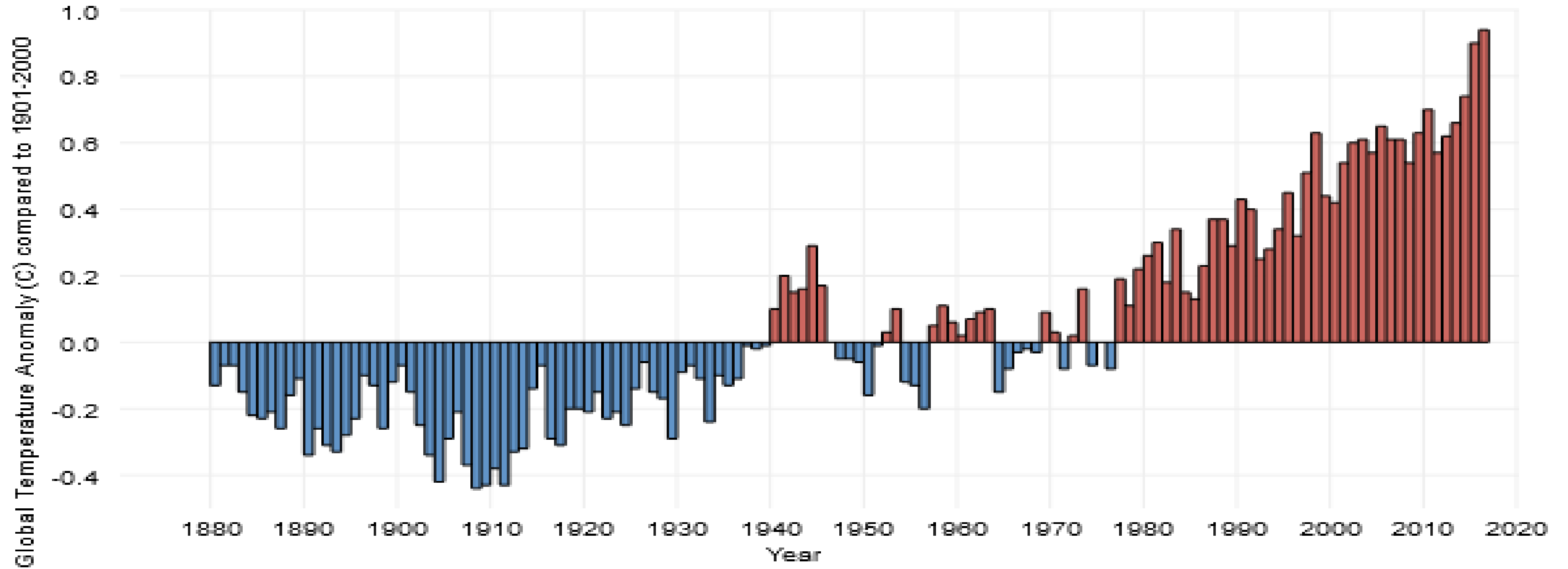
Source: NASA GISS & NOAA NCEI global temperature anomalies (°F) averaged and adjusted to early industrial baseline (1881-1910). Data as of 2/6/2019.

CLIMATE  CENTRAL

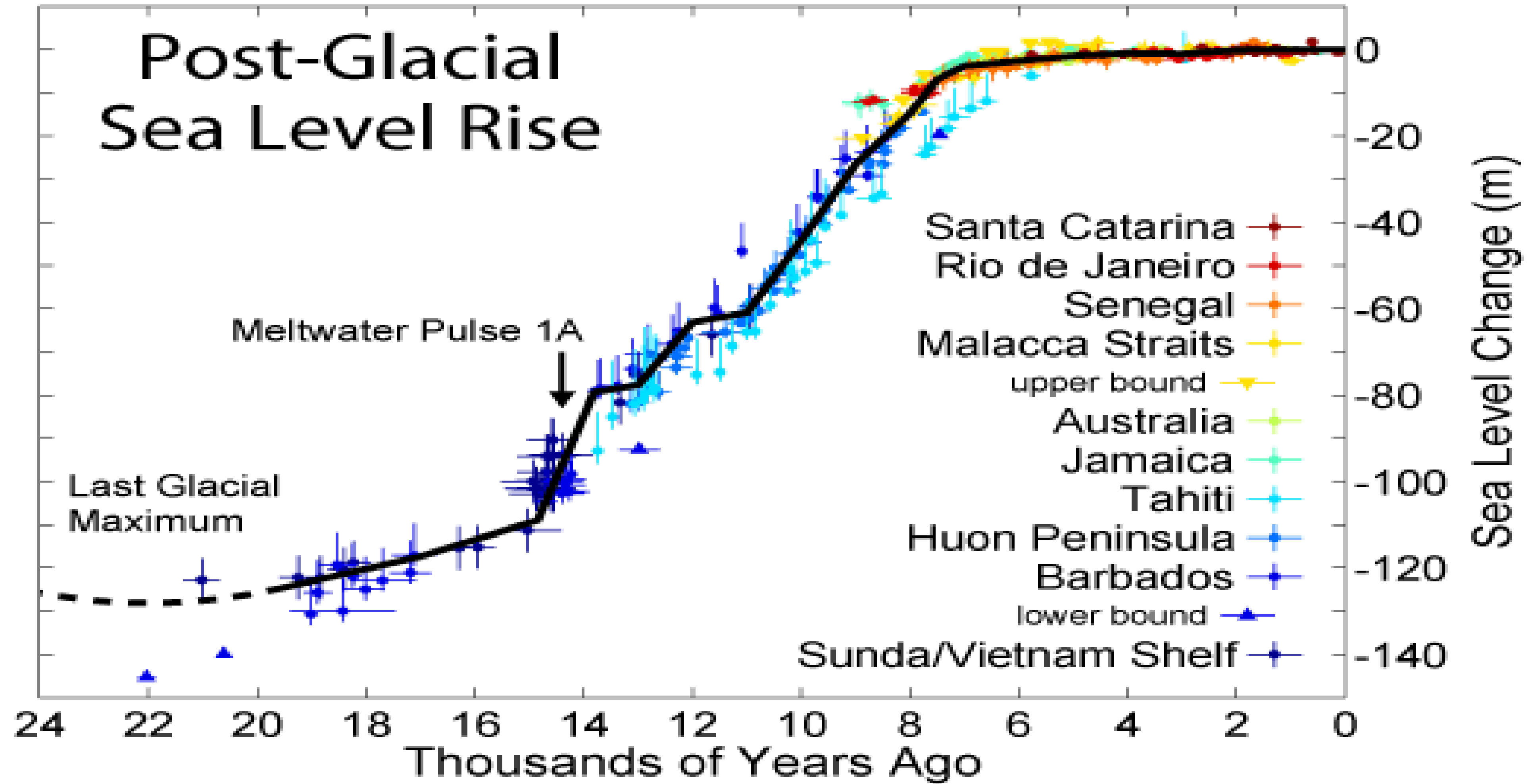
Global average temperature 1850-2016

Updated from Morice et al. 2012





NOAA's History of global surface temperature since 1880



The 12 lowest extent ice years on record have been in the last 12 years

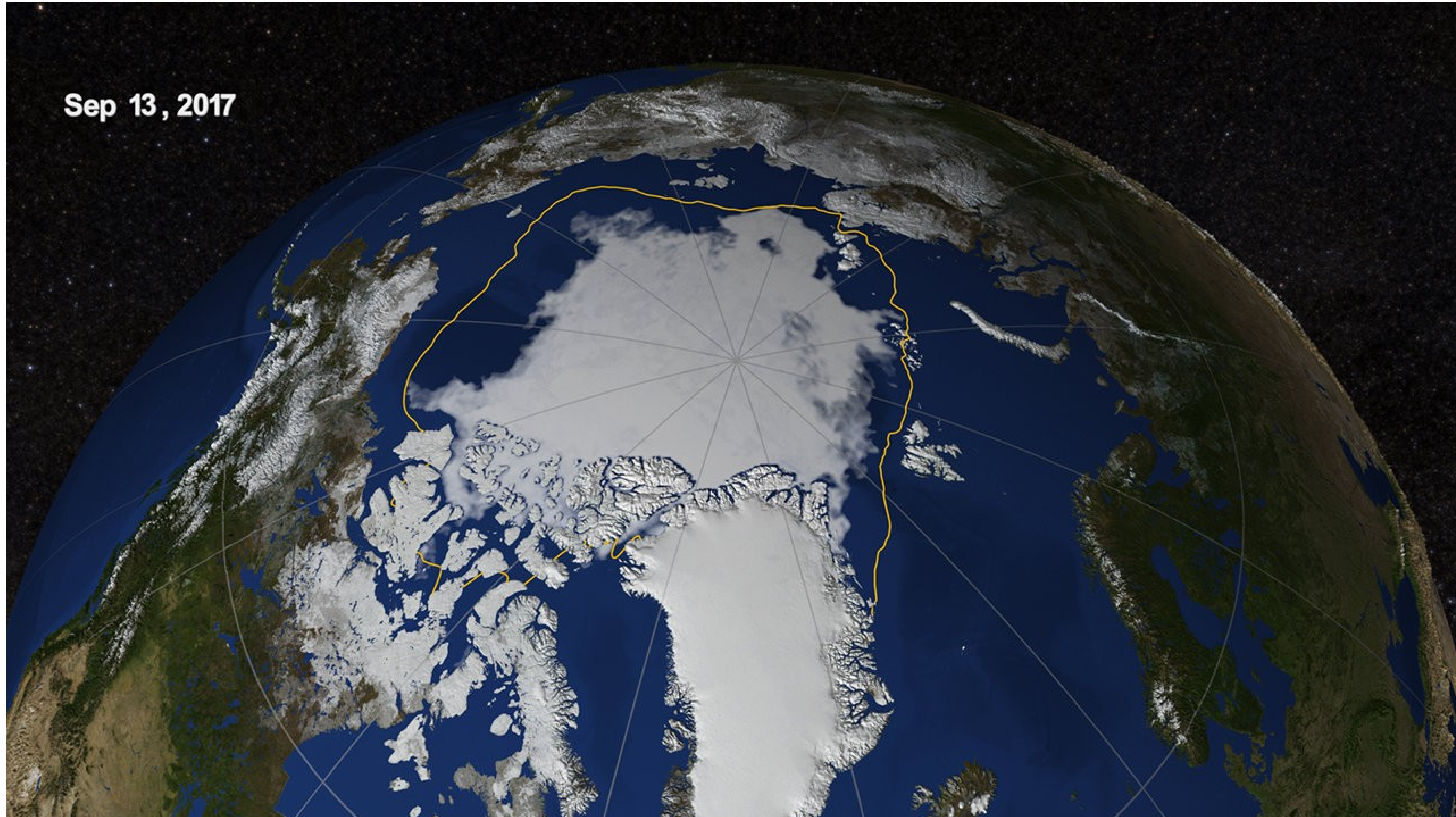
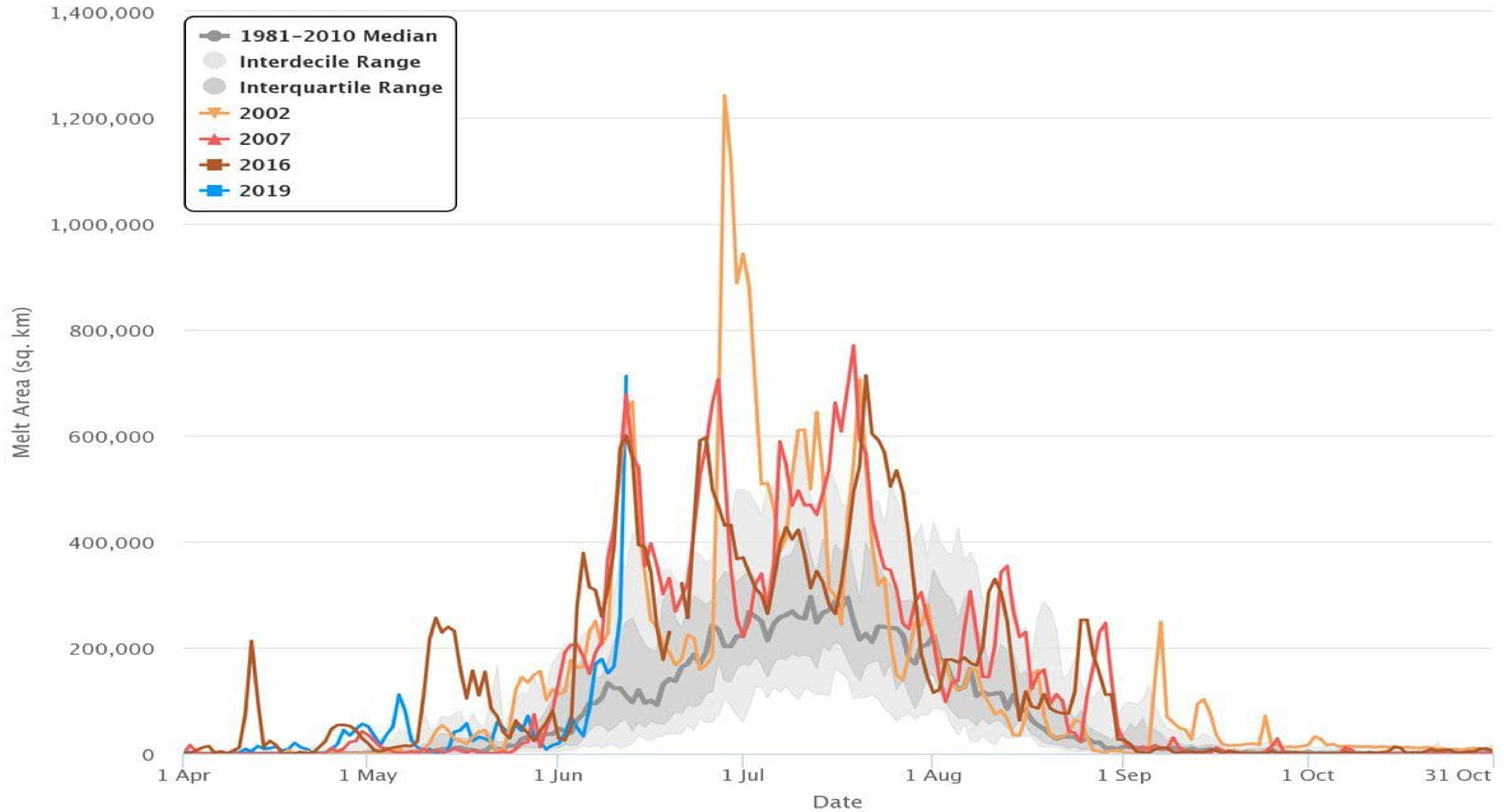
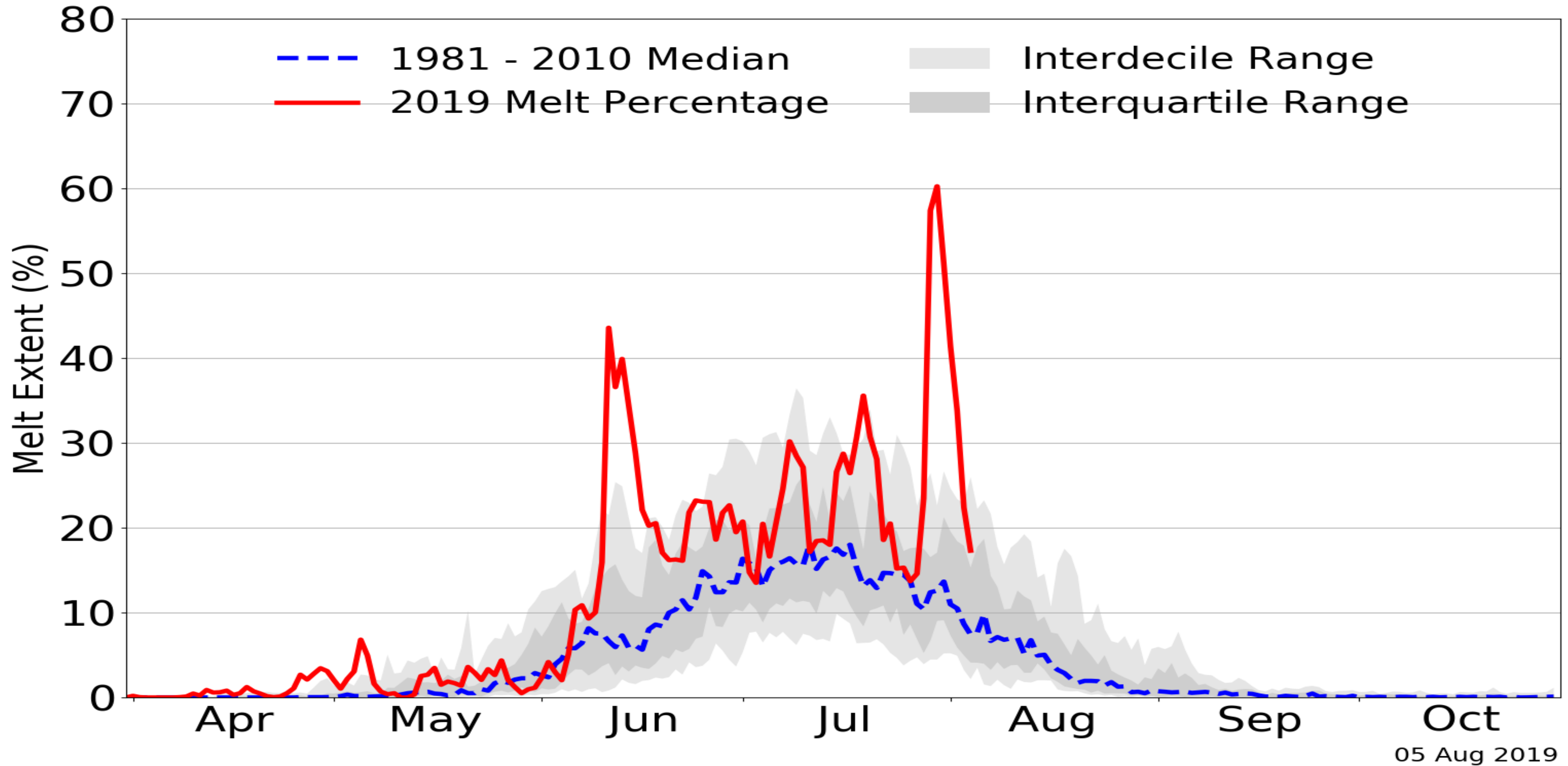


Image: NASA <https://climate.nasa.gov/news/2633/end-of-summer-arctic-sea-ice-extent-is-eighth-lowest-on-record/> Period of satellite record 1979 - present
Record data Source: National Snow and Ice Data Center

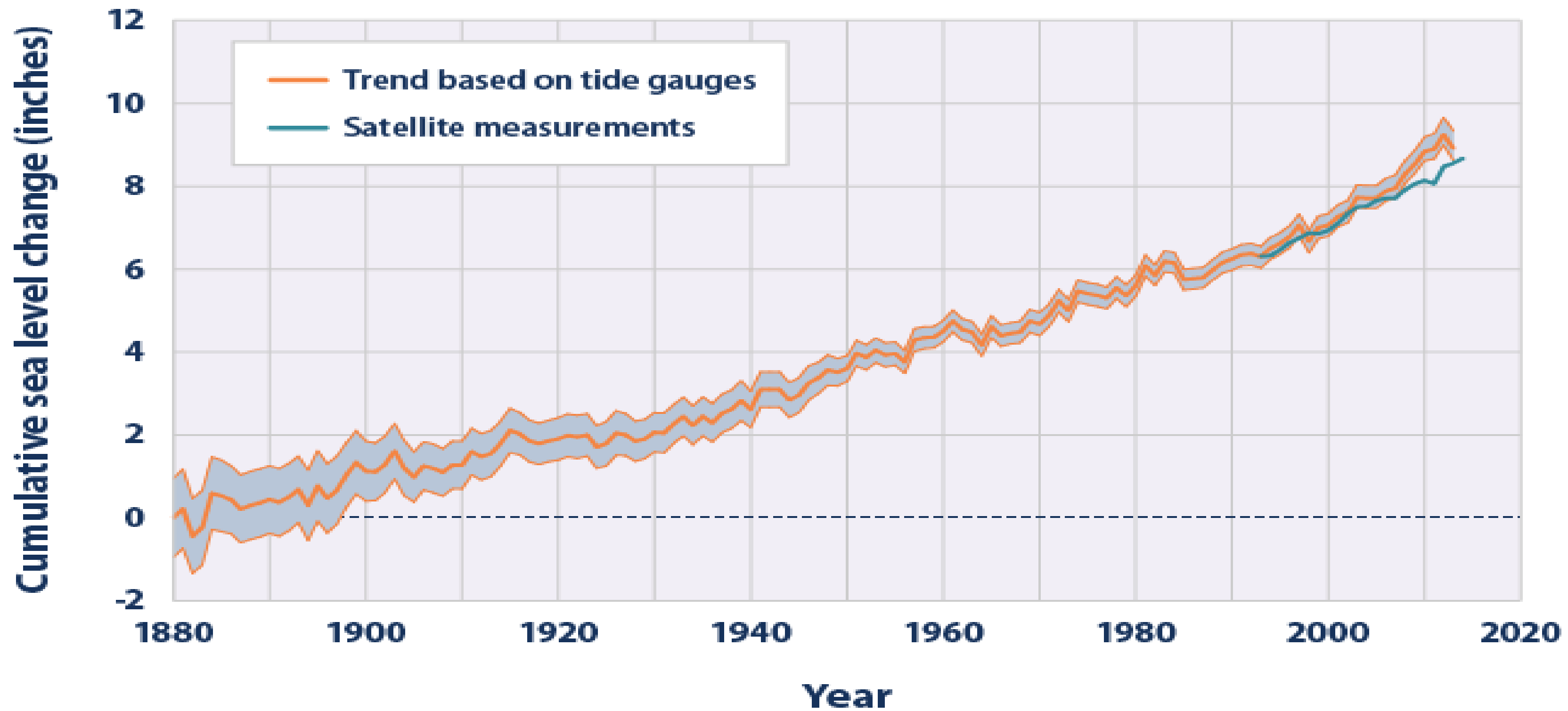
Greenland Surface Melt Extent



Greenland Melt Extent 2019



Global Average Absolute Sea Level Change, 1880–2014



Data sources:

- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2015 update to data originally published in: Church, J.A., and N.J. White. 2011. Sea-level rise from the late 19th to the early 21st century. *Surv. Geophys.* 32:585–602. www.cmar.csiro.au/sealevel/sl_data_cmar.html.
- NOAA (National Oceanic and Atmospheric Administration). 2015. Laboratory for Satellite Altimetry: Sea level rise. Accessed June 2015. http://ibis.grdl.noaa.gov/SAT/SeaLevelRise/LSA_SLR_timeseries_global.php.

For more information, visit U.S. EPA’s “Climate Change Indicators in the United States” at www.epa.gov/climatechange/indicators.

What does this mean for emergency preparedness and disaster risk reduction and response?

Models and model calibration for DRR is wrong, and we need to update our assumptions and base data

And the public needs updated hazard-specific warning

The New York Times

100-Year Flood, for the Second Straight Year

By [Francis X. Clines](#)

May 9, 2002



The business of undertaking was never more vital along storm-racked Main Street in this old Appalachian mining town as Jim Widener mucked out the casket display room of his funeral home today.

"We're managing to handle the wake of Shirley Faye Mitchem," Mr. Widener said as this remote coal hollow reeled under the devastation of its second deadly flood in 10 months.

"Mrs. Mitchem was killed when the storm took down a tree on Route 52 that smashed into her car," said Mr. Widener, who had just finished restoring his funeral home from the effects of the flash flood last July when the second one swept through Main Street last

Adaptation and planning factors: **Flooding**

Planning for the number of disasters and magnitude, based on historical record will fail. May have already failed.

Communication of risk to the public need change

Flood probability base rate is now wrong.

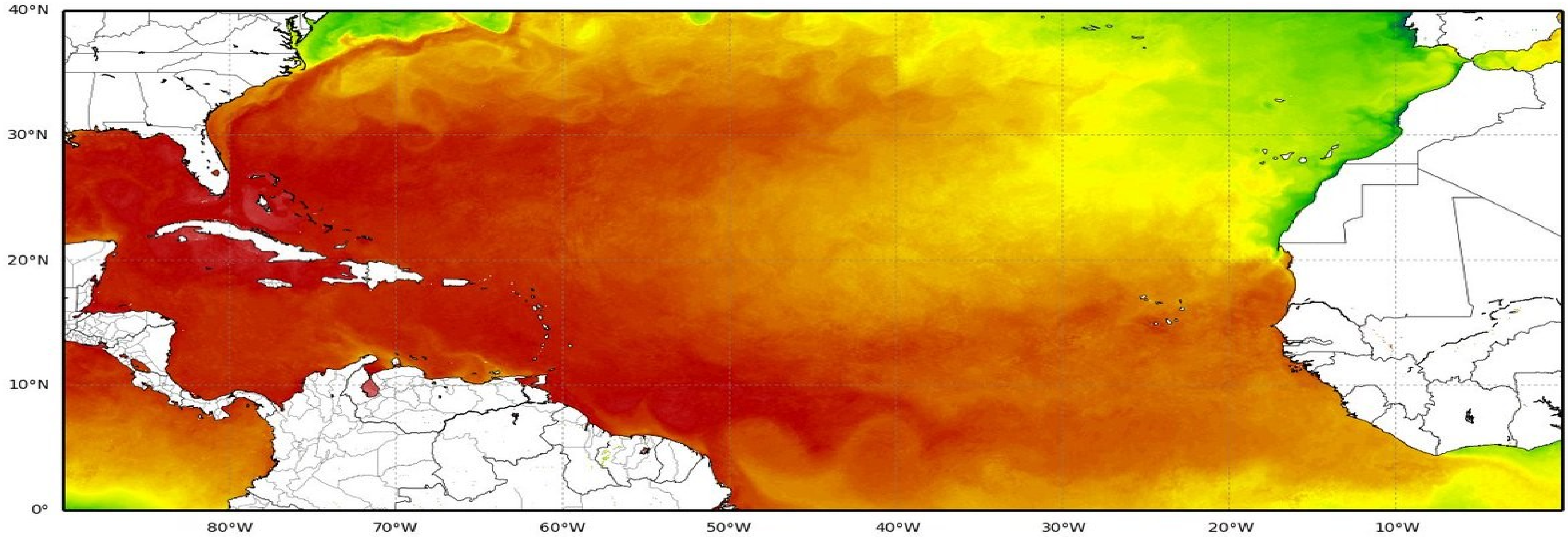
$$\textit{Recurrence interval} = (n + 1)/m$$

Where:

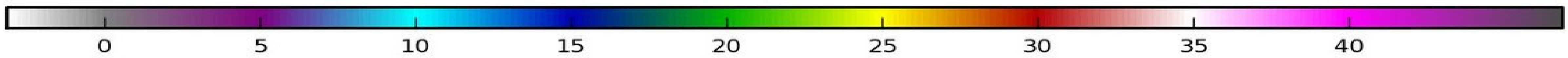
n number of years on record;

m is the *number of recorded occurrences* of the event being considered

Warmer atmosphere, warmer oceans, shifting currents = more rain and in new places.

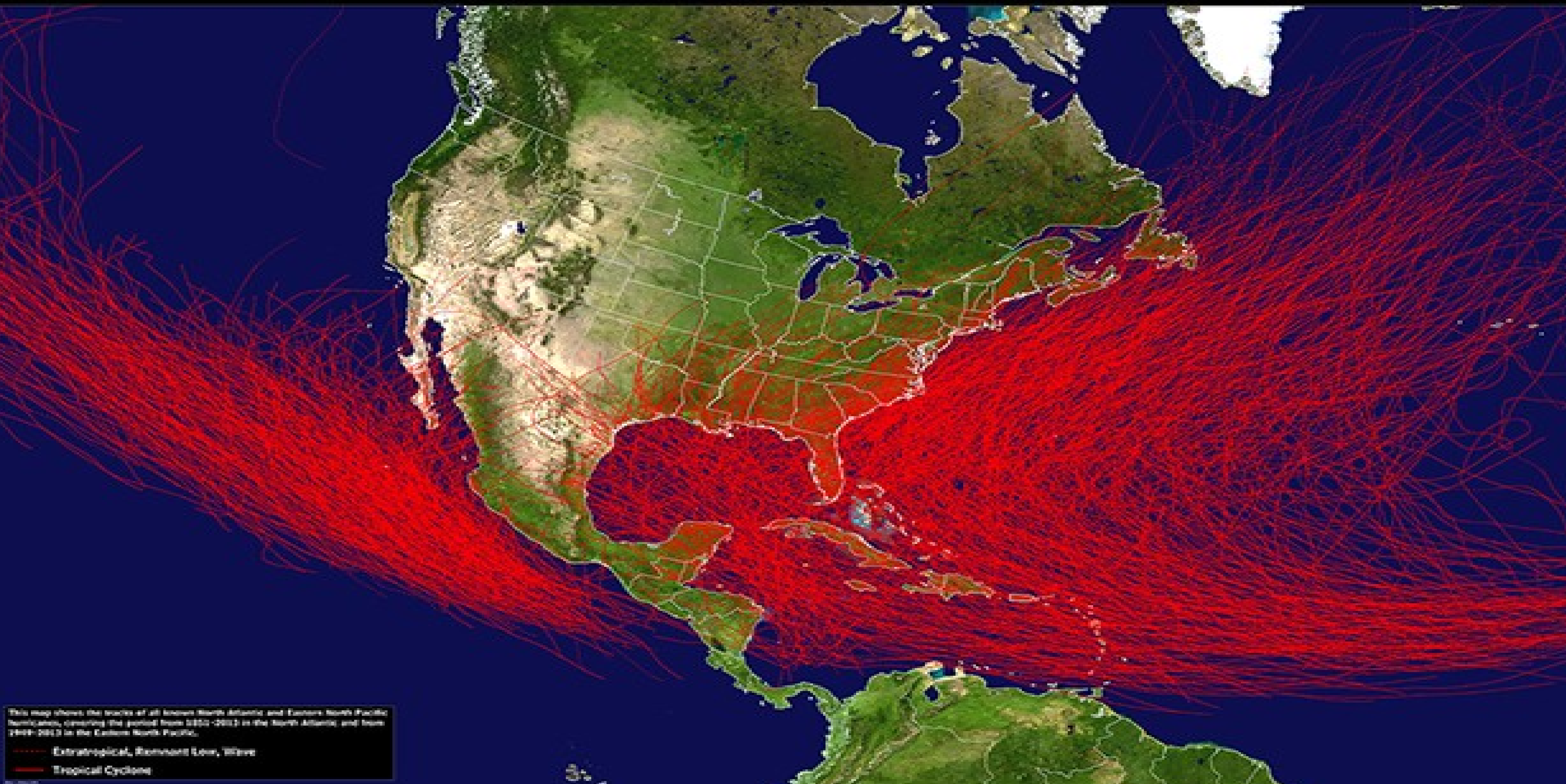


NASA SPoRT - Sea Surface Temperature (C) - 20170904 0600 UTC



Hurricane History

Data from 1949 in the Pacific, from 1851 in the Atlantic



This map shows the tracks of all known North Atlantic and Eastern North Pacific hurricanes, covering the period from 1850-2013 in the North Atlantic, and from 1949-2013 in the Eastern North Pacific.

- Extratropical, Remnant Low, Wave
- Tropical Cyclone



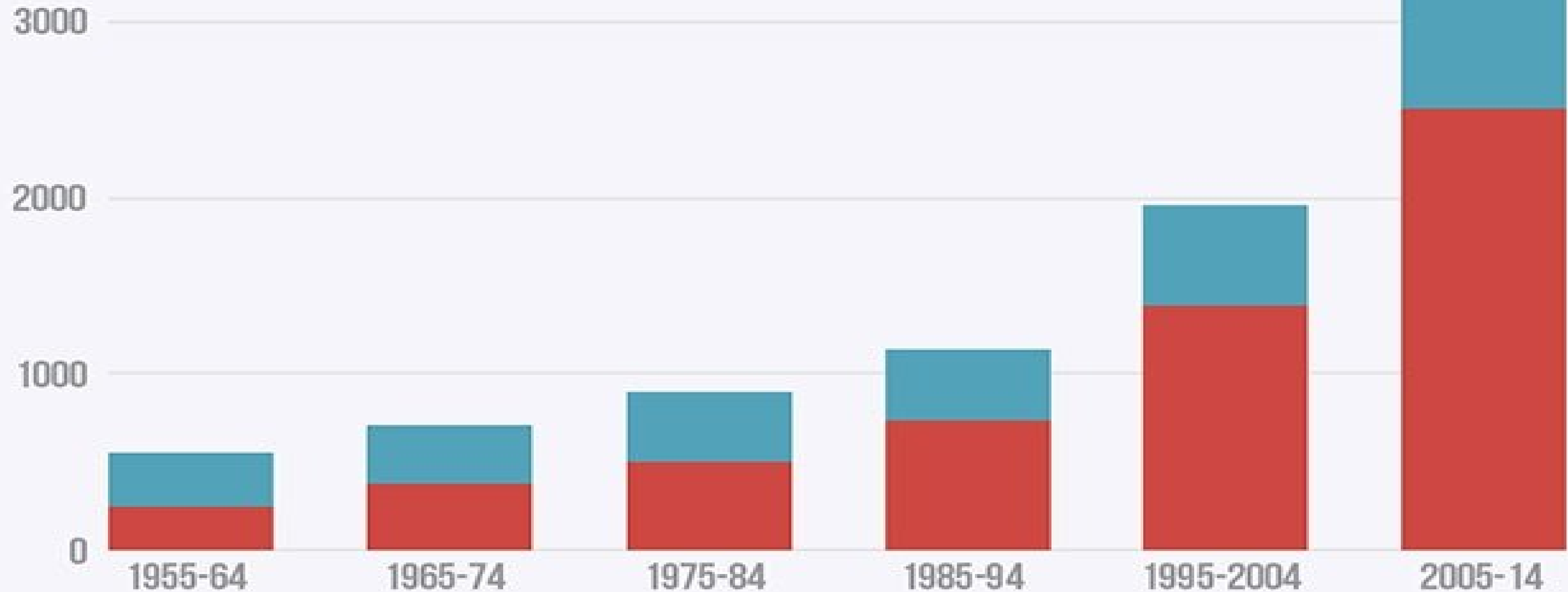
Tropical Cyclone damage in Vermont, 44N

Rising sea levels raise the base on which floods, and storm surge, ride, expanding the areas of risk



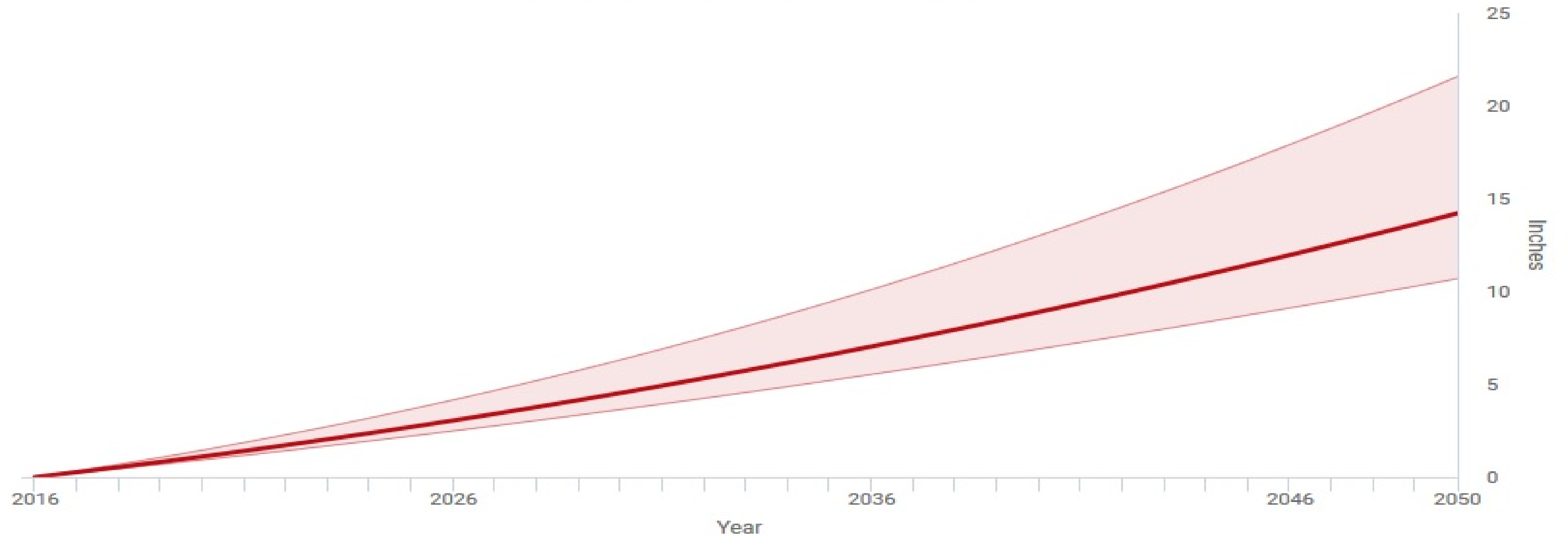
Coastal Flood Days in the U.S.

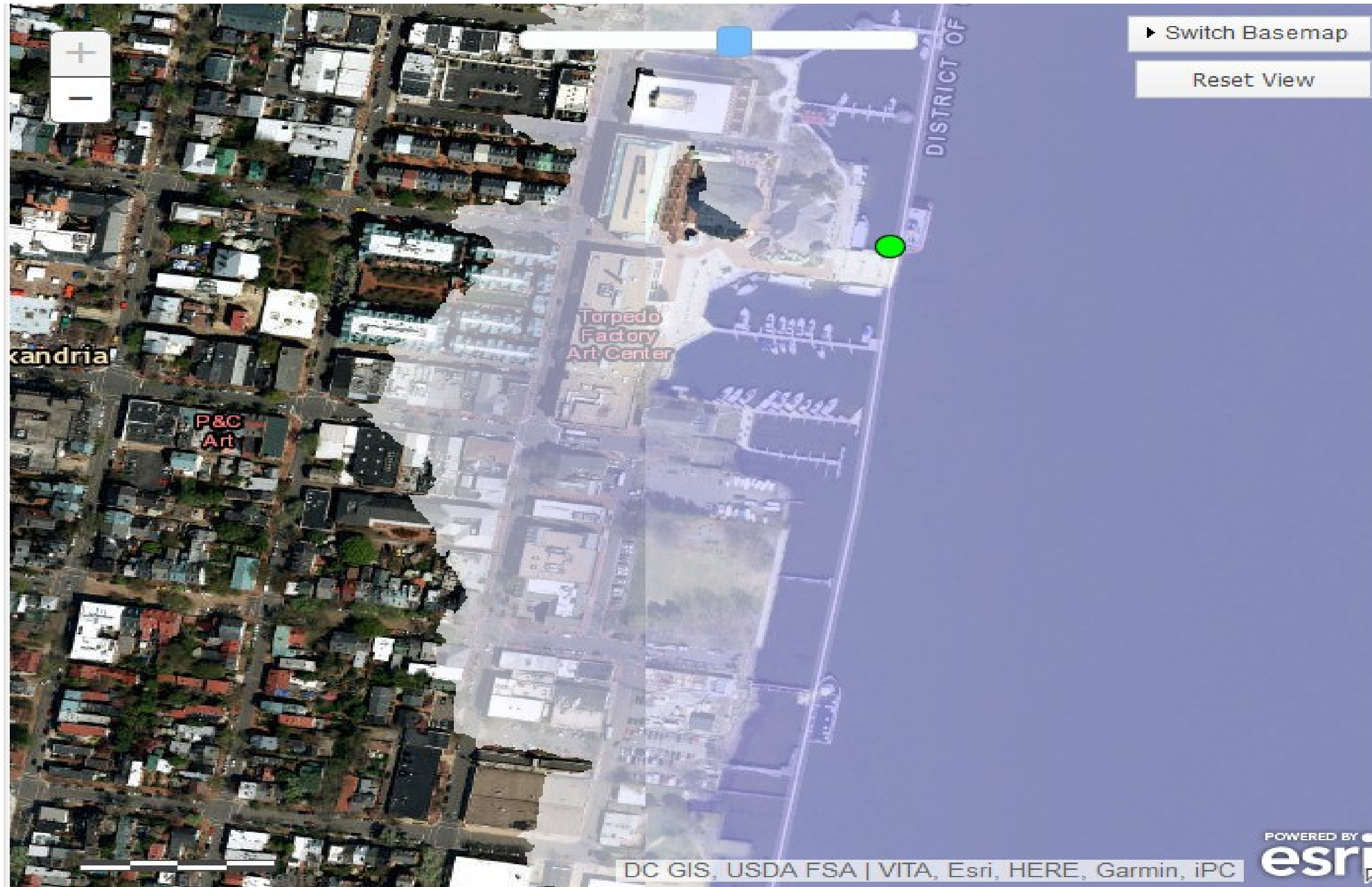
■ Natural ■ Driven by climate change



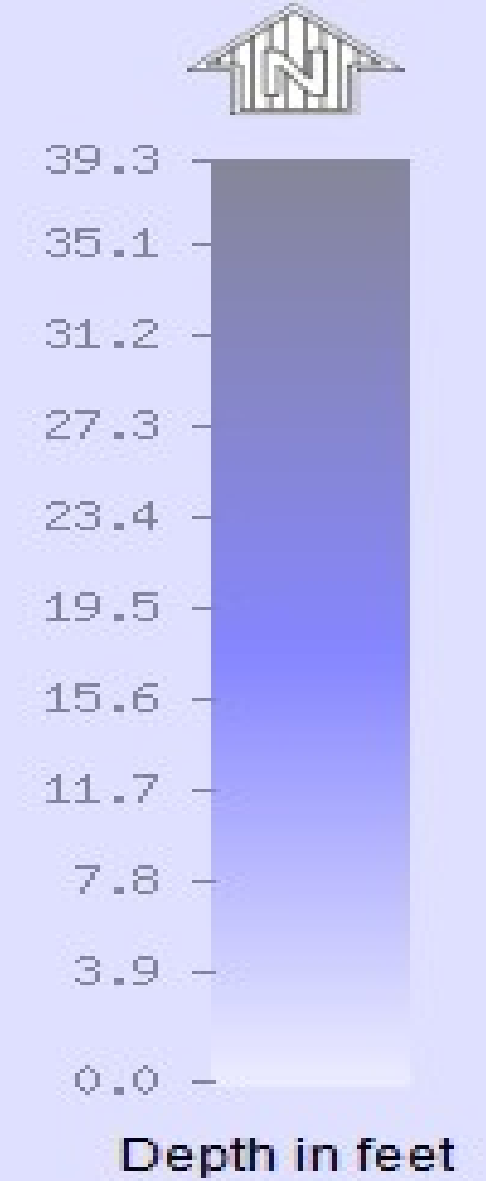
Orange shows human-driven global sea level rise effects
Floods totaled across 27 sites; must top NWS 'nuisance' thresholds
Source: Kopp et al. 2016 (PNAS)


National Sea Level Rise Forecasts





Switch Basemap
Reset View



 Gauge Location

- About Inundation
- Download Dataset(s)
- FAQ
- User Guide
- Inundation Sites
- Inundation Legend

User guide video on 

What is UTC time?
Map Help

Disclaimer



POWERED BY 

DC GIS, USDA FSA | VITA, Esri, HERE, Garmin, iPC

Click on mapped inundation to see water depth values for that location, or hold shift and drag to zoom to area.

Current Stage: 1.8 ft at 03/25/2019 15:06:00 UTC	Selected Inundation NAVD88: 1.1 ft stage: 1.1 ft	Mouse Location Depth: 0 - 1.71 ft	Lat: 38.804308 Lon: -77.036198
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8' Inundation extent

Adaptation and planning factors – Drought

Planning for the number of disasters and magnitude, based on historical record will fail. May have already failed.

Communication of risk to the public need change

Drinking water access, manufacturing, agricultural impacts

Resource conflicts



Photo: CBS news



**Pastoralist and Farmer-Herder Conflicts
in the Sahel** photo uncredited





ONE WAY

STOP

How Disaster Management Agencies assess risk, plan DRR strategies, and plan to respond

THIRA (US)



Public's assessment of risk more rooted in memory

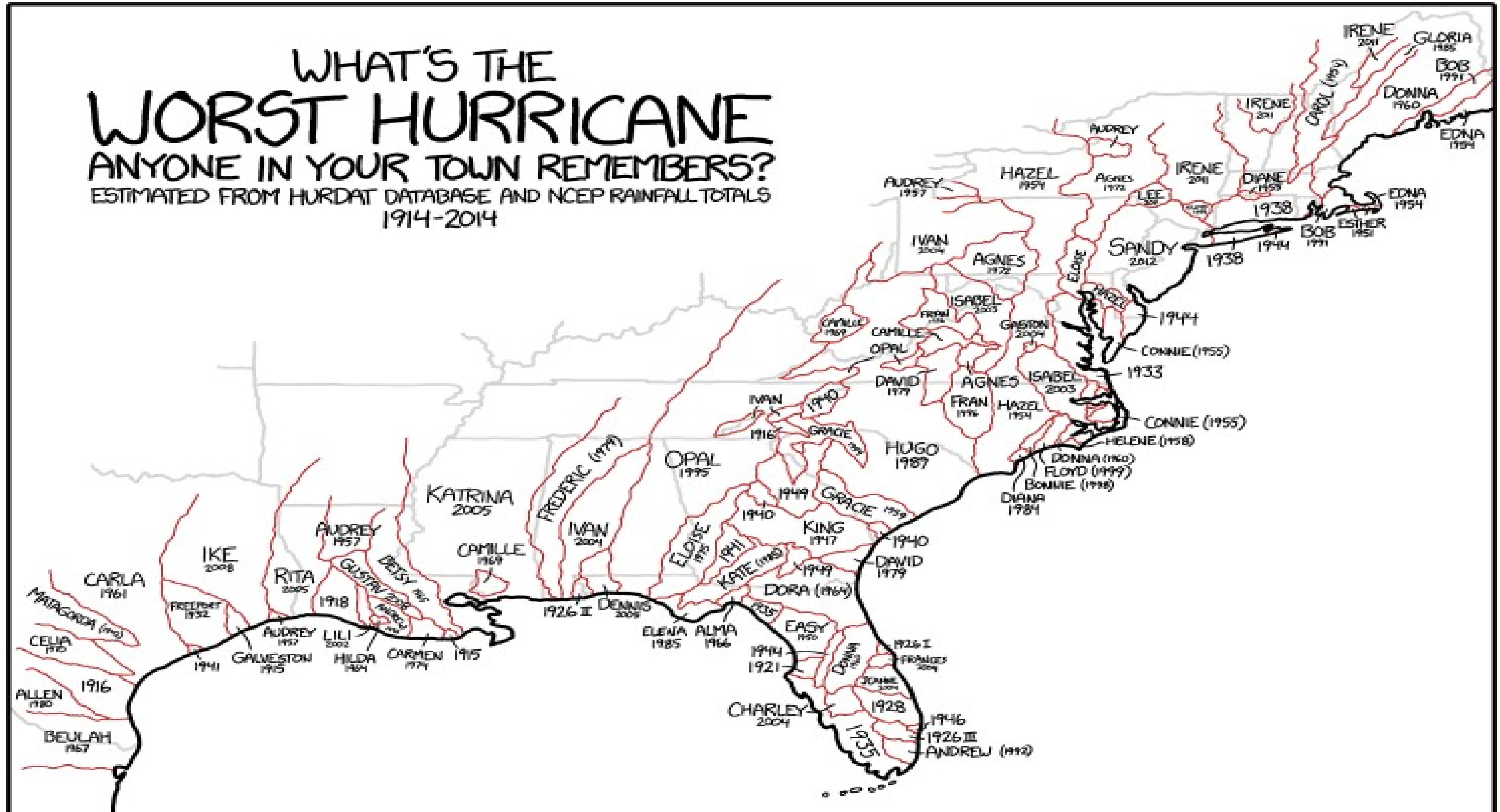
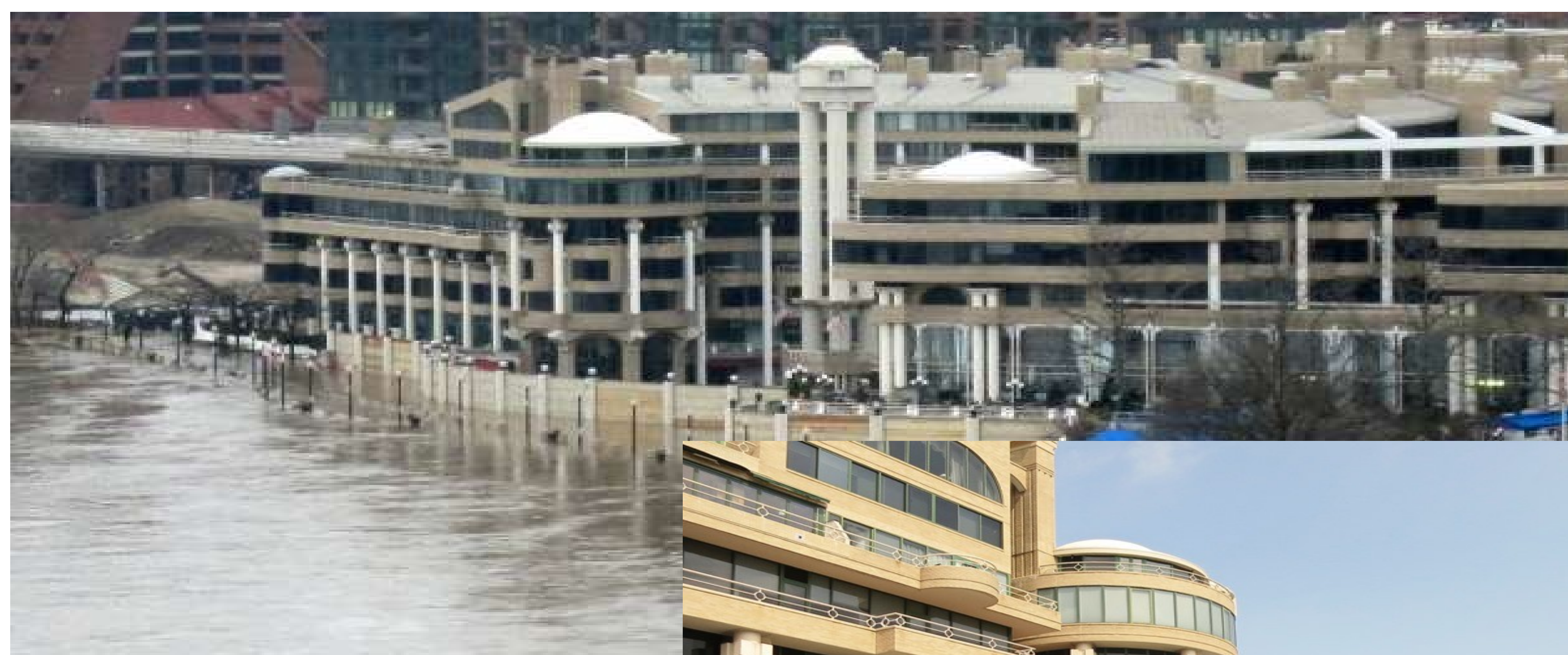


Image: Randall Munroe <https://xkcd.com/1407/>











“Early” is now. Warning for climate-change induced disaster risk needs to be included as part of the climate dialog with the governments and public.



**Better solutions.
Fewer disasters.**

Safer world.



[@disasteraware](https://twitter.com/disasteraware)



www.facebook.com/disasteraware