



The Latest Projections: Extreme Events

Radley Horton
Columbia University

Weathering the Storm: ACCL/ACOEL Program
Columbia Law School
April 27, 2018

Climate Science Special Report

Fourth National Climate Assessment (NCA4), Volume I

This report is an authoritative assessment of the science of climate change, with a focus on the United States. It represents the first of two volumes of the Fourth National Climate Assessment, mandated by the Global Change Research Act of 1990.

📖 Recommended Citation

science2017.globalchange.gov

This report is the most comprehensive and up-to-date assessment of the state of climate science today.

- 477 pages
- 51 authors
- 12 federal agencies
- 5 reviews*

* Including a 131-page National Academy of Sciences review

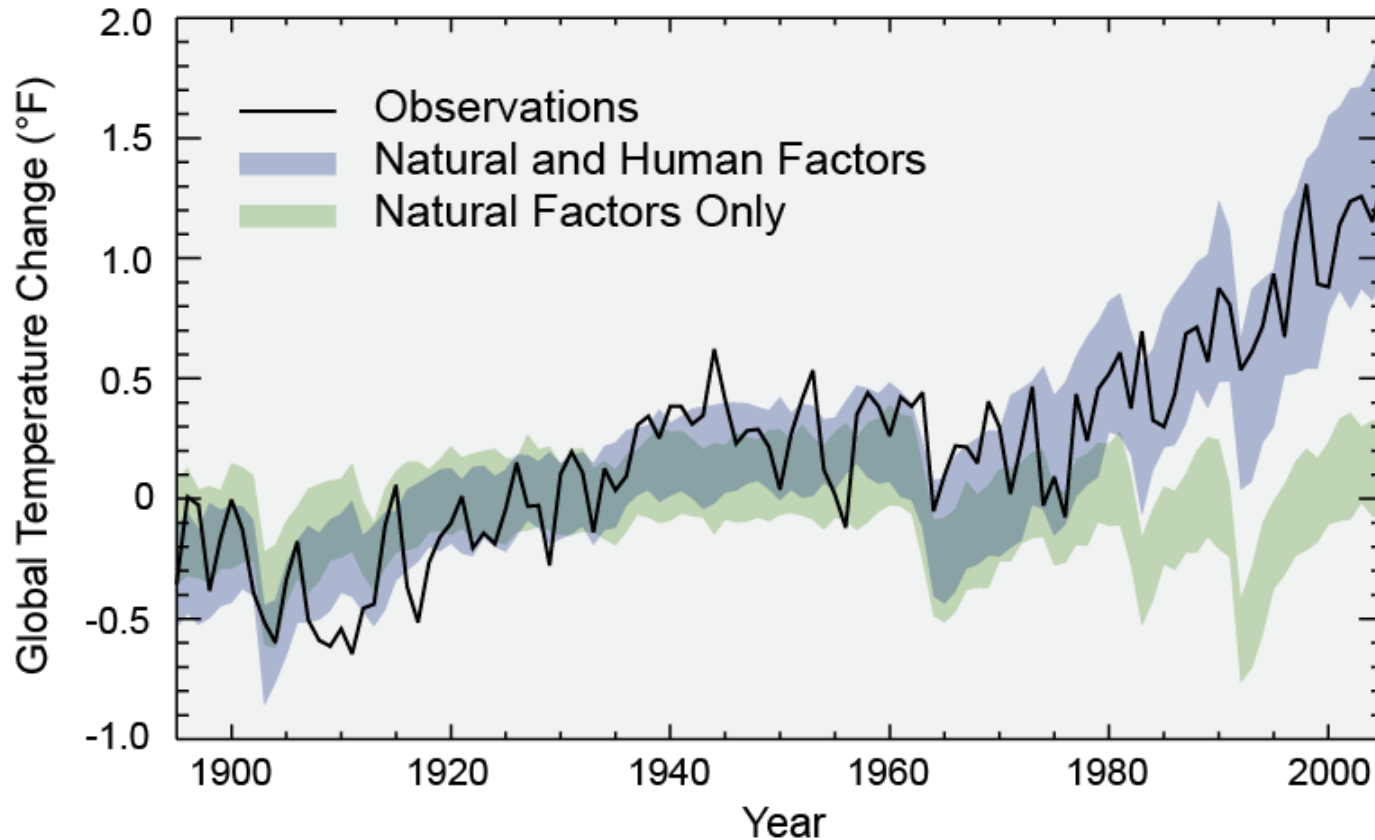


Latest Findings and Projections

- **Small shifts in average conditions can lead to large changes in extreme event frequency, duration, and intensity**
- Some systems appear to be changing even faster than anticipated
 - Sea level rise and coastal flooding
 - Arctic sea ice
 - Heavy precipitation
 - Fire and drought
 - More extreme heat and humidity
 - Ocean acidification and deoxygenation

Human or Natural Causes of Climate Change?

Separating Human and Natural Influences on Climate

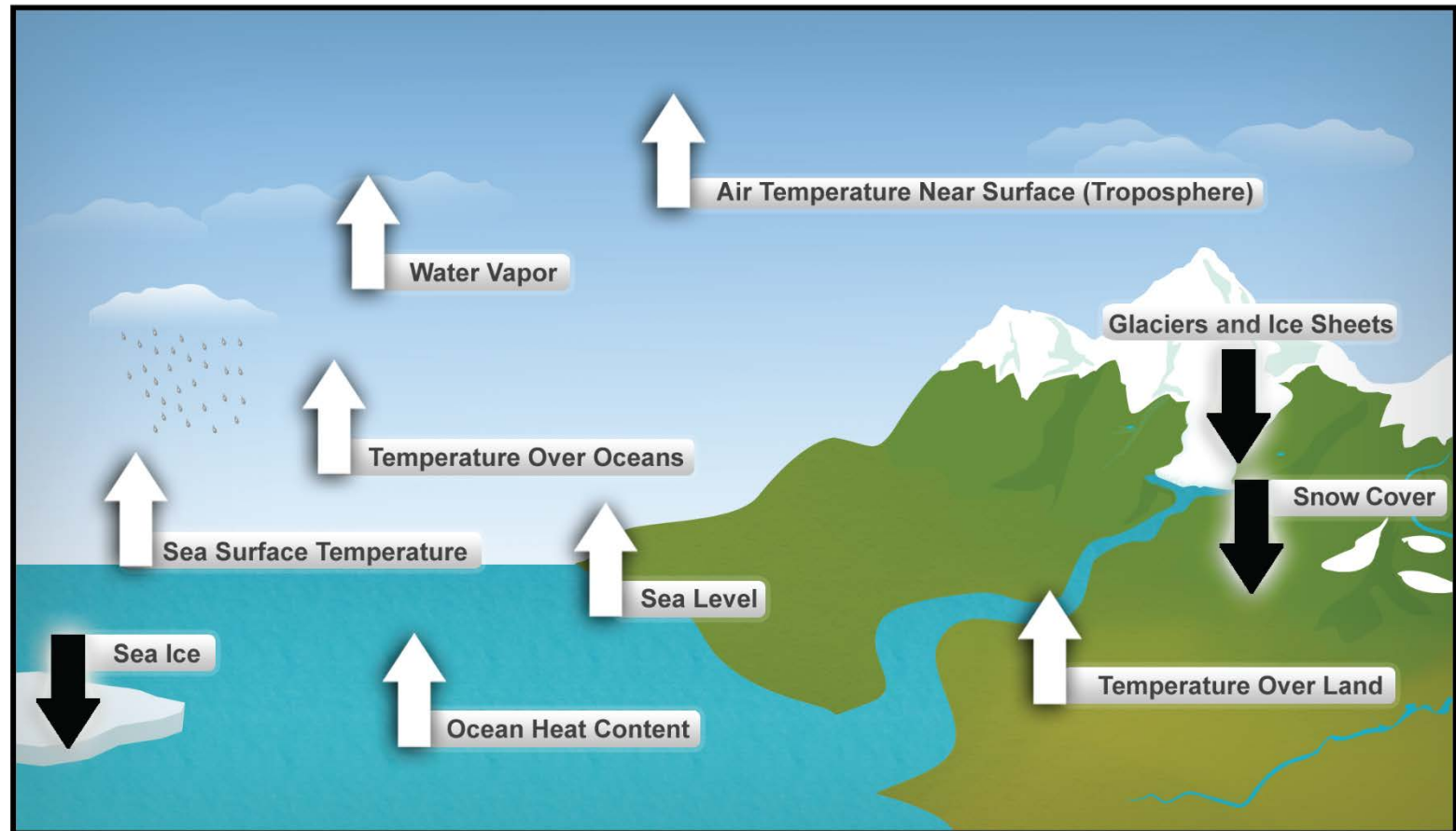


National Climate Assessment, 2014

Models can reproduce the climate with and without added CO2

How Do We Measure Climate Change?

Ten Indicators of a Warming World

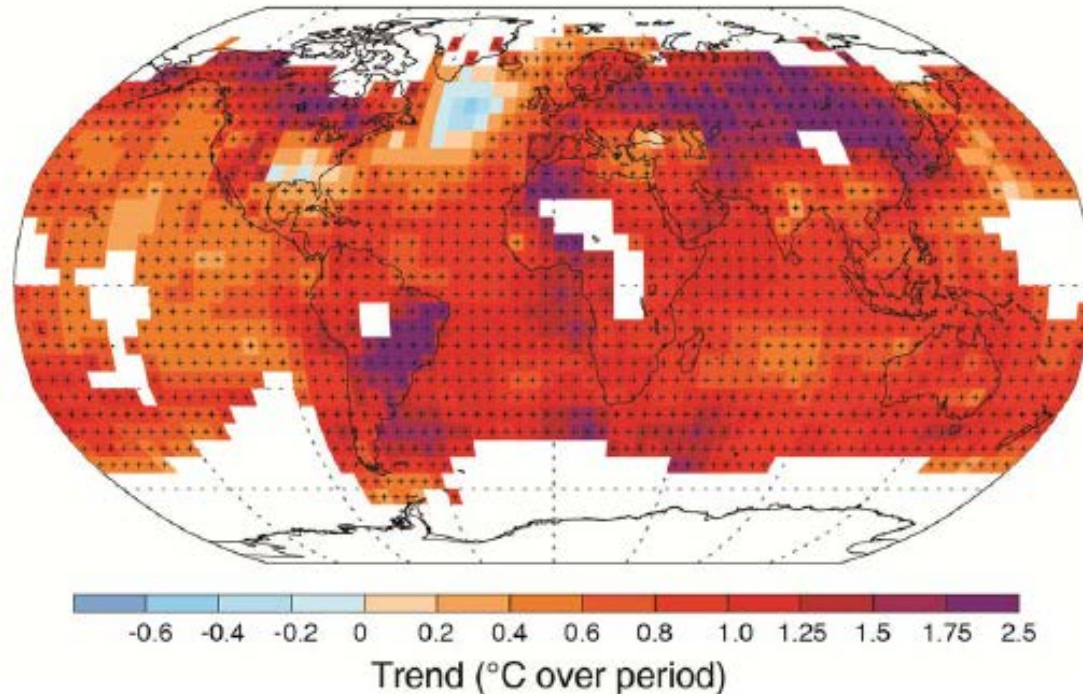


National Climate Assessment, 2014

These indicators are embedded into global climate models

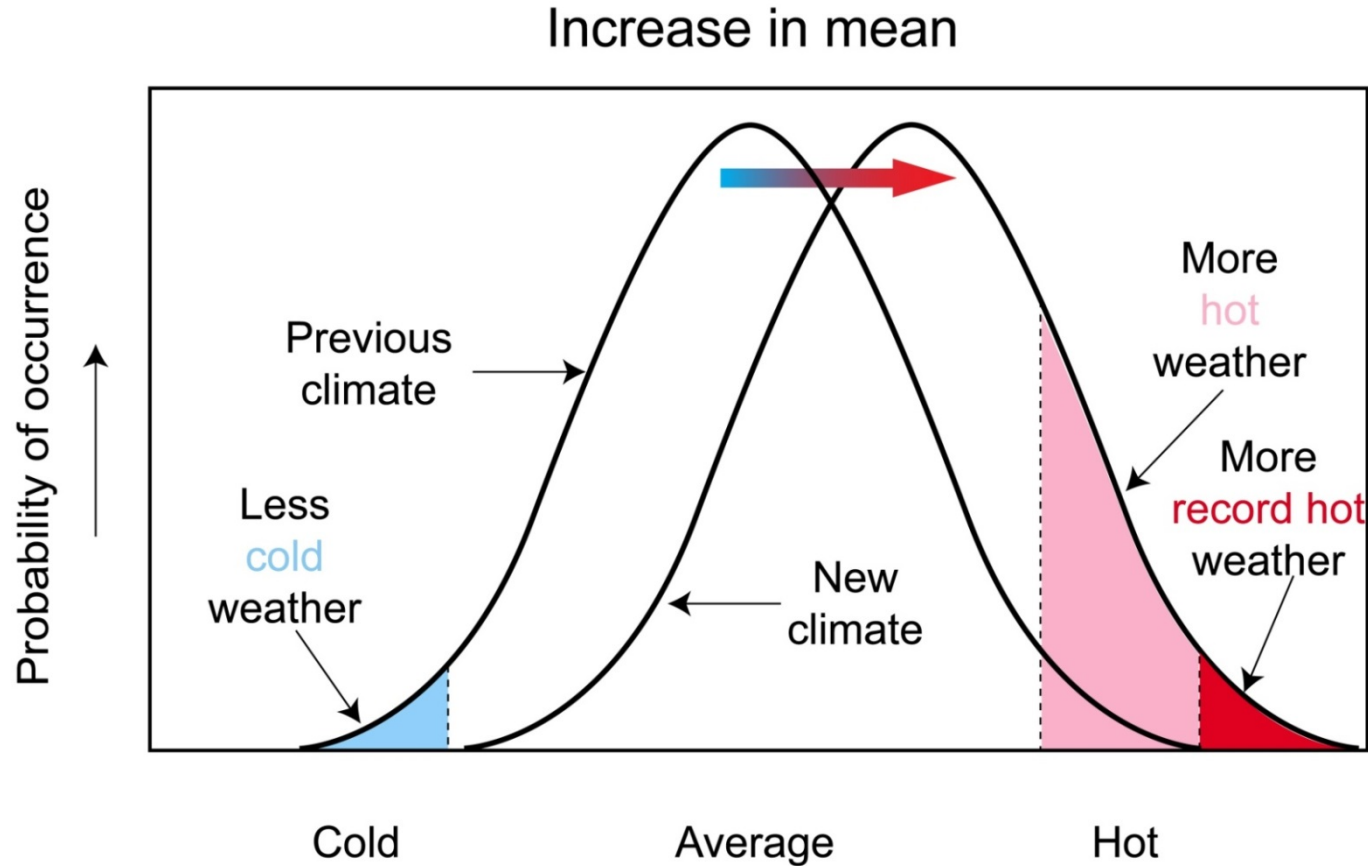
Observed Trends

(b) Observed change in average surface temperature 1901–2012



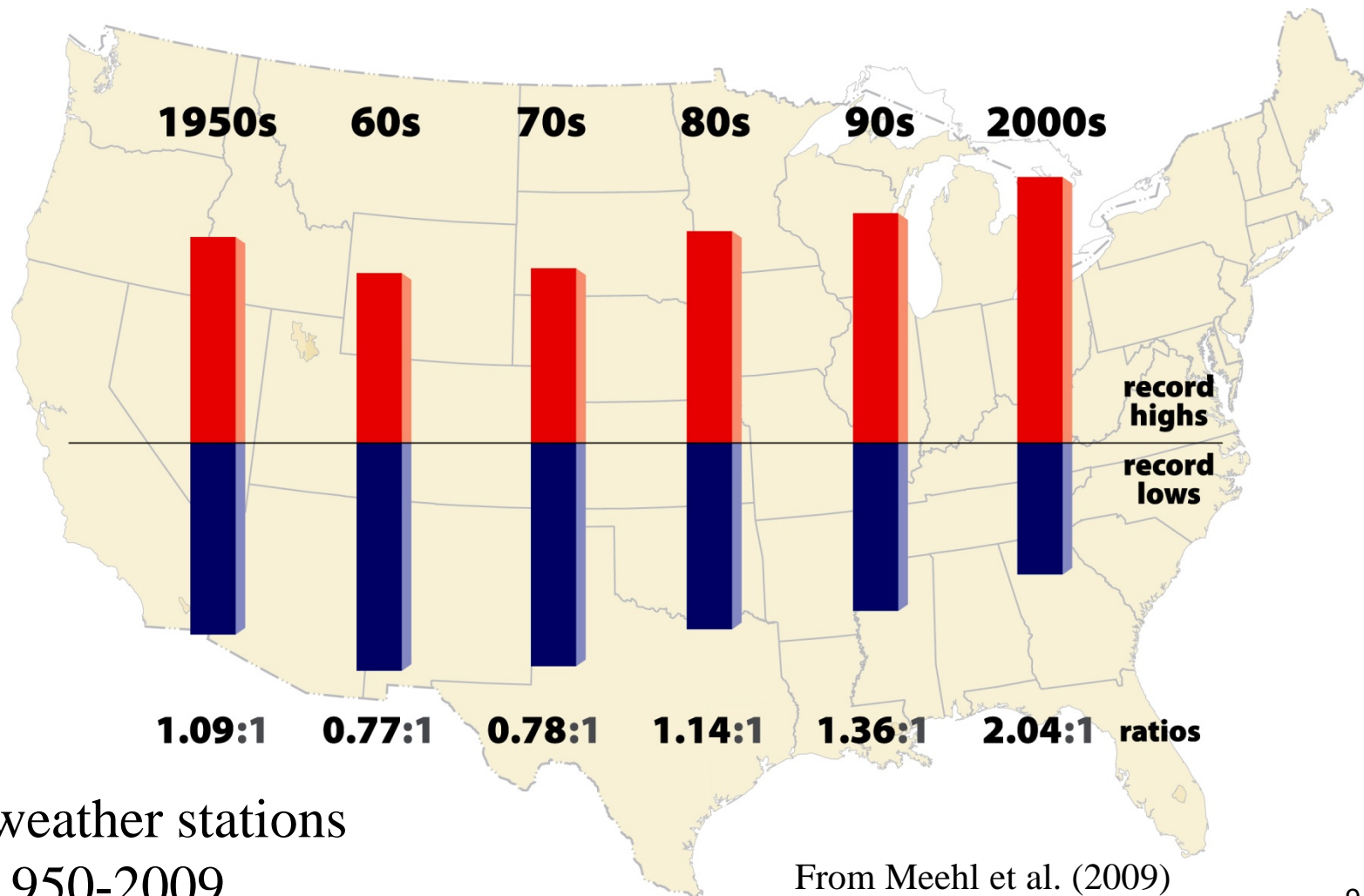
“Each of the last three decades has been successively warmer at the Earth’s surface than any preceding decade since 1850). In the Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1400 years (medium confidence).”

Potential Changes – Climate Extremes

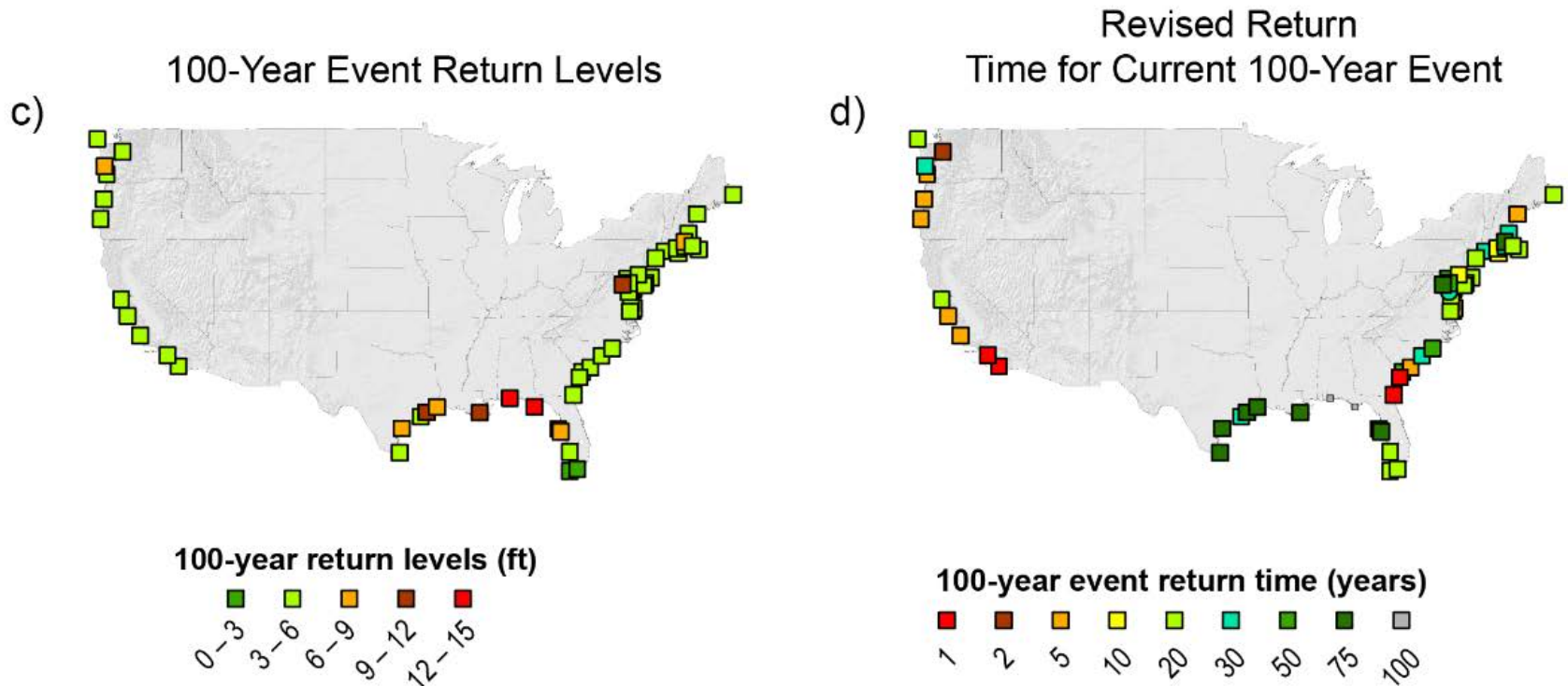


- Natural variability will continue
- Small shifts in mean values can lead to large changes in the frequency of extremes

Increasing trend: U.S. breaking many more heat records than cold records

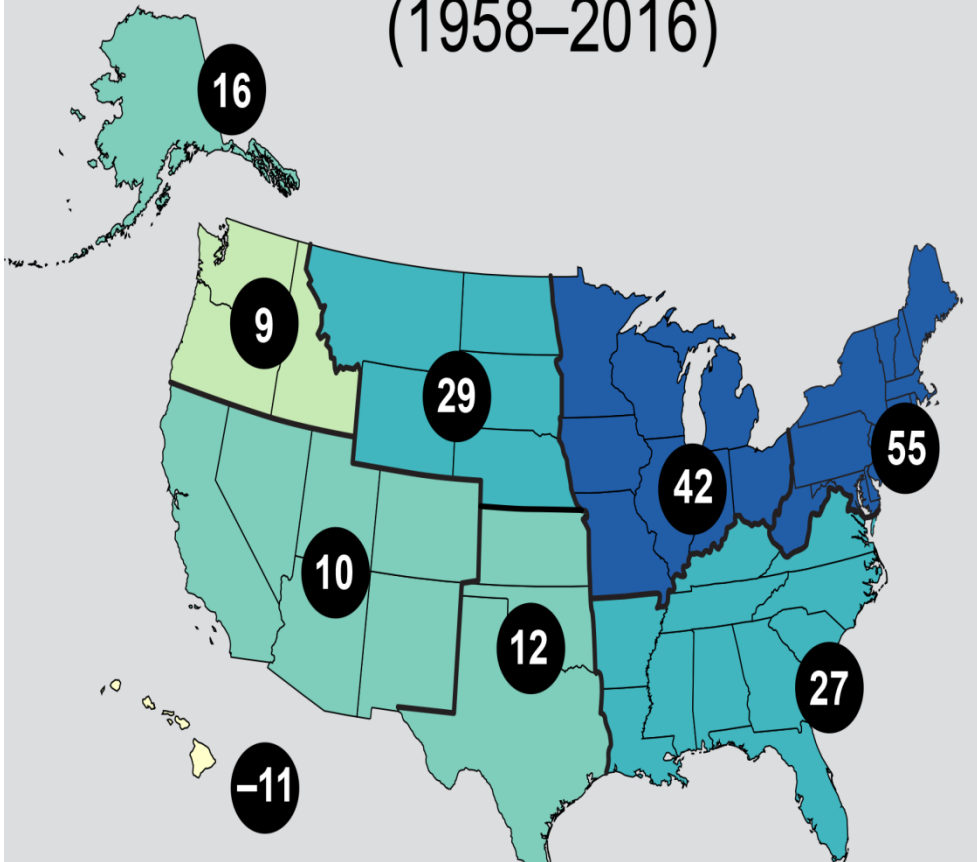


Sea Level Rise = More Frequent Flooding



*Sea level rise of just 2 feet, without any changes in storms, **would more than triple the frequency of dangerous coastal flooding along much of the U.S. coast***

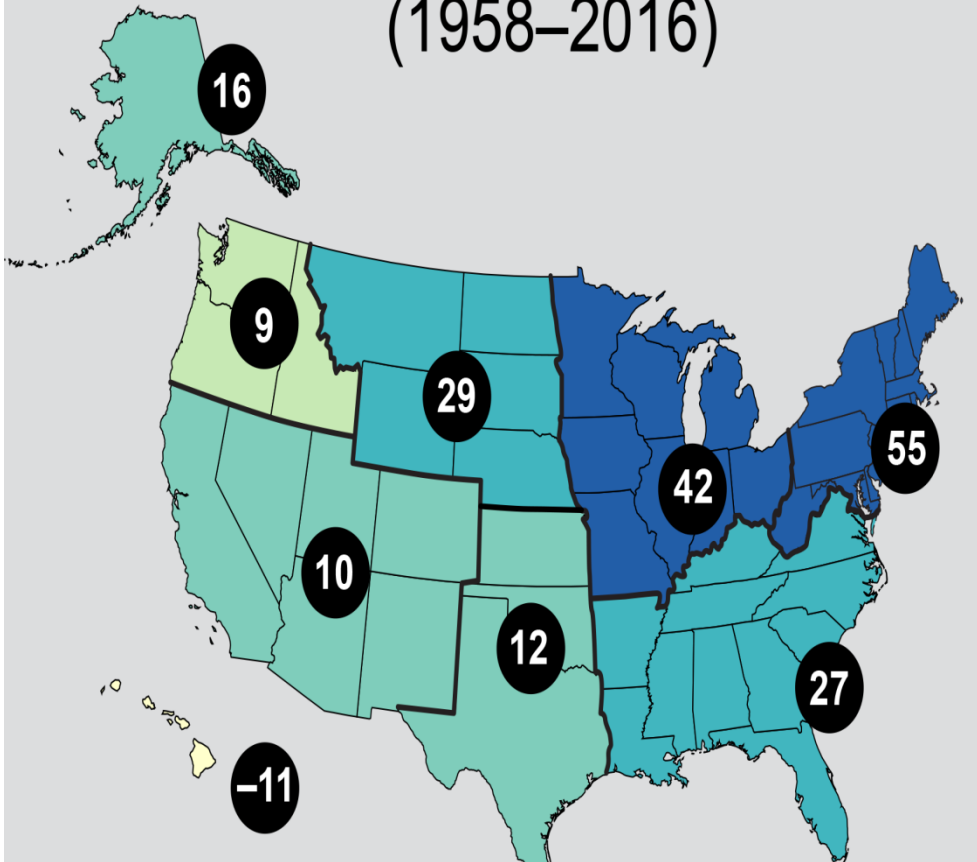
99th Percentile Precipitation (1958–2016)



The frequency + intensity of

- Extreme high temperature events are *virtually certain* to increase
- Extreme precipitation events are *very likely* to continue to increase

99th Percentile Precipitation (1958–2016)



The frequency + intensity of

- Extreme high temperature events are *virtually certain* to increase
- Extreme precipitation events are *very likely* to continue to increase

Climate models tend to underestimate the observed trends, especially for the increase in extreme precipitation events



An increase in precipitation rates, tropical cyclone intensity, and the number of very intense tropical cyclones – but not the *overall* number of storms.



An increase in precipitation rates, tropical cyclone intensity, and the number of very intense tropical cyclones – but not the *overall* number of storms.

Sea level rise will increase the frequency and extent of extreme flooding associated with coastal storms.

Global mean sea level has risen by about 7–8 inches (about 16–21 cm) since 1900, about 3 of those inches since 1993.



Emerging science on **Antarctic ice sheet stability** suggests that, for high scenarios, global mean sea level rise exceeding 8 feet by 2100 is physically possible, *although the probability of such an extreme outcome cannot currently be assessed.*



- The world's **oceans** are:
- absorbing more than 90% of the heat trapped & 25% of the CO₂ emitted to the atmosphere

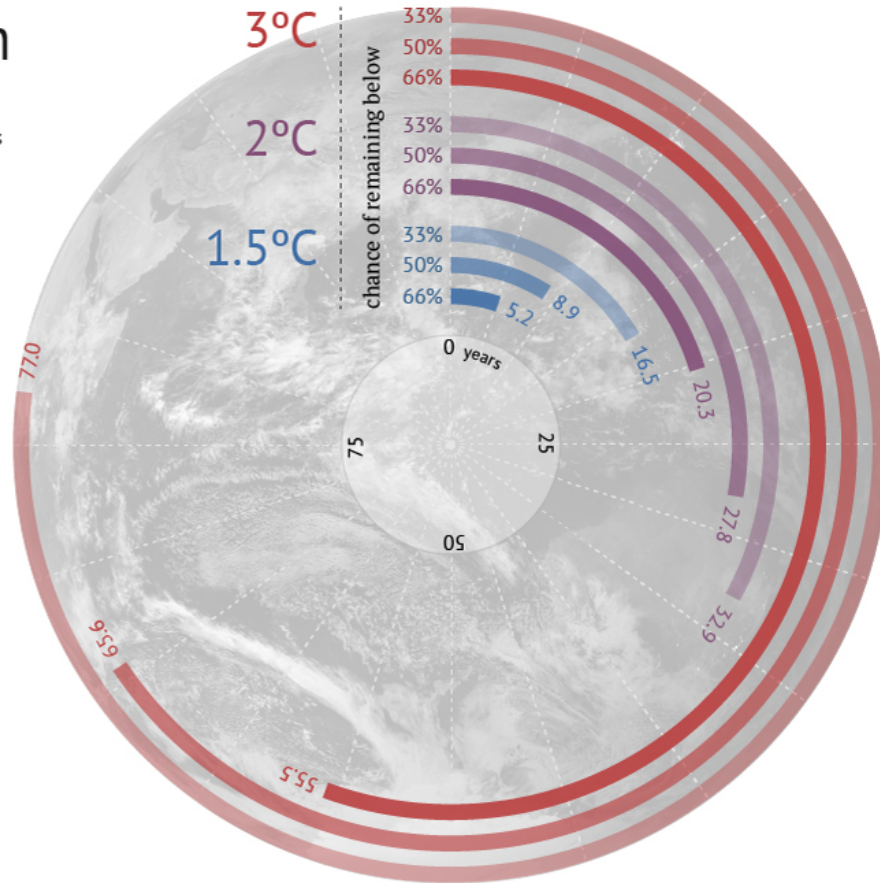


- The world's **oceans** are:
- absorbing more than 90% of the heat trapped & 25% of the CO₂ emitted to the atmosphere
 - experiencing declining oxygen concentrations at intermediate depths in many coastal areas



Carbon Countdown

How many years of current emissions would use up the IPCC's carbon budgets for different levels of warming?



While climate models incorporate important climate processes that can be well quantified, they **do not include all of the processes** that can contribute to feedbacks, compound extreme events, and abrupt and/or irreversible changes.

Future changes outside the range projected by climate models cannot be ruled out.

Moreover, the systematic tendency of climate models to underestimate temperature change during warm paleoclimates suggests that climate models are **more likely to underestimate than overestimate** the amount of long-term future change.

Looking Forward

- Small changes in average conditions can be associated with large changes in the frequency, intensity, and duration of climate extremes
- Climate tipping points cannot be ruled out, nor can non-linear impacts and networked system failures
- However....

There are also opportunities and reasons for optimism

- Societal tipping points could support climate solutions
- Climate solutions are already advancing rapidly
 - Greenhouse gas mitigation
 - Adaptation