

Recent Climate Change

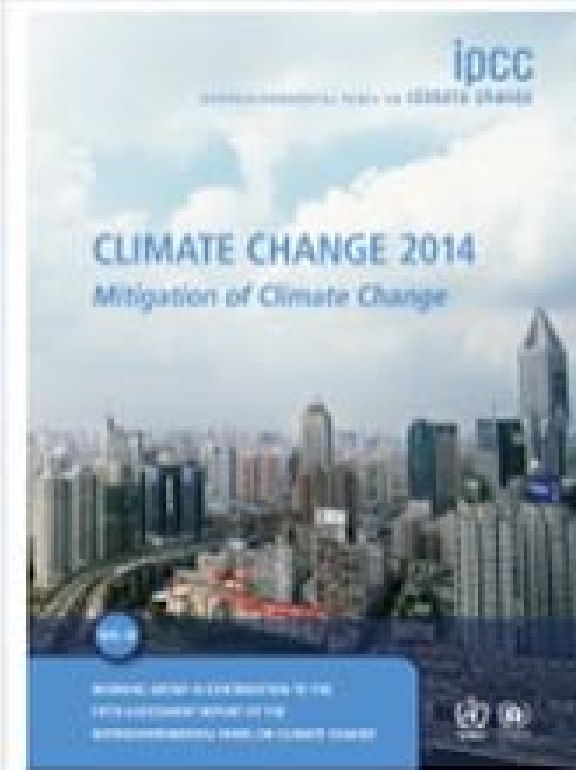
Module 6

Intergovernmental Panel on Climate Change (IPCC)

- Established 1988 under UN Environment Programme and the World Meteorological Organization
- Reviews (“assesses”) scientific research and periodically reports to national governments
- Fifth Assessment Report (AR5) 2013
- Sixth Assessment Report (AR6) coming out now
- Authoritative
- Conservative!
- Written in “Officialese” (therefore hard to read & understand!)

IPCC: Three Working Groups

- **WG 1: Physical Science Basis** (“**Simple**”)
- **WG2: Impacts, Adaptation, Vulnerability** (“**Serious**”)
- **WG3: Mitigation** (“**Solvable**”)





BY THE NUMBERS

Author Team

234 authors from **65** countries

28% women, **72%** men

30% new to the **IPCC**

Review Process

14,000 scientific publications
assessed

78,000+ review comments

46 countries commented on Final
Government Distribution



[Credit: NASA]

“Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.”



[Credit: Peter John Maridable | Unsplash]

“ Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.

ipcc

INTERGOVERNMENTAL PANEL ON climate change





[Credit: Yoda Adaman | Unsplash]

“ It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.



[Credit: Hong Nguyen | Unsplash]

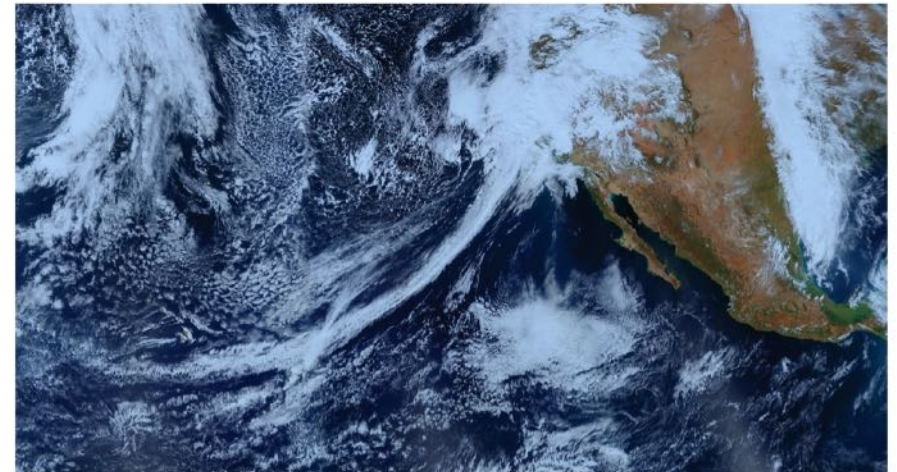
“ Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

US 4th National Climate Assessment

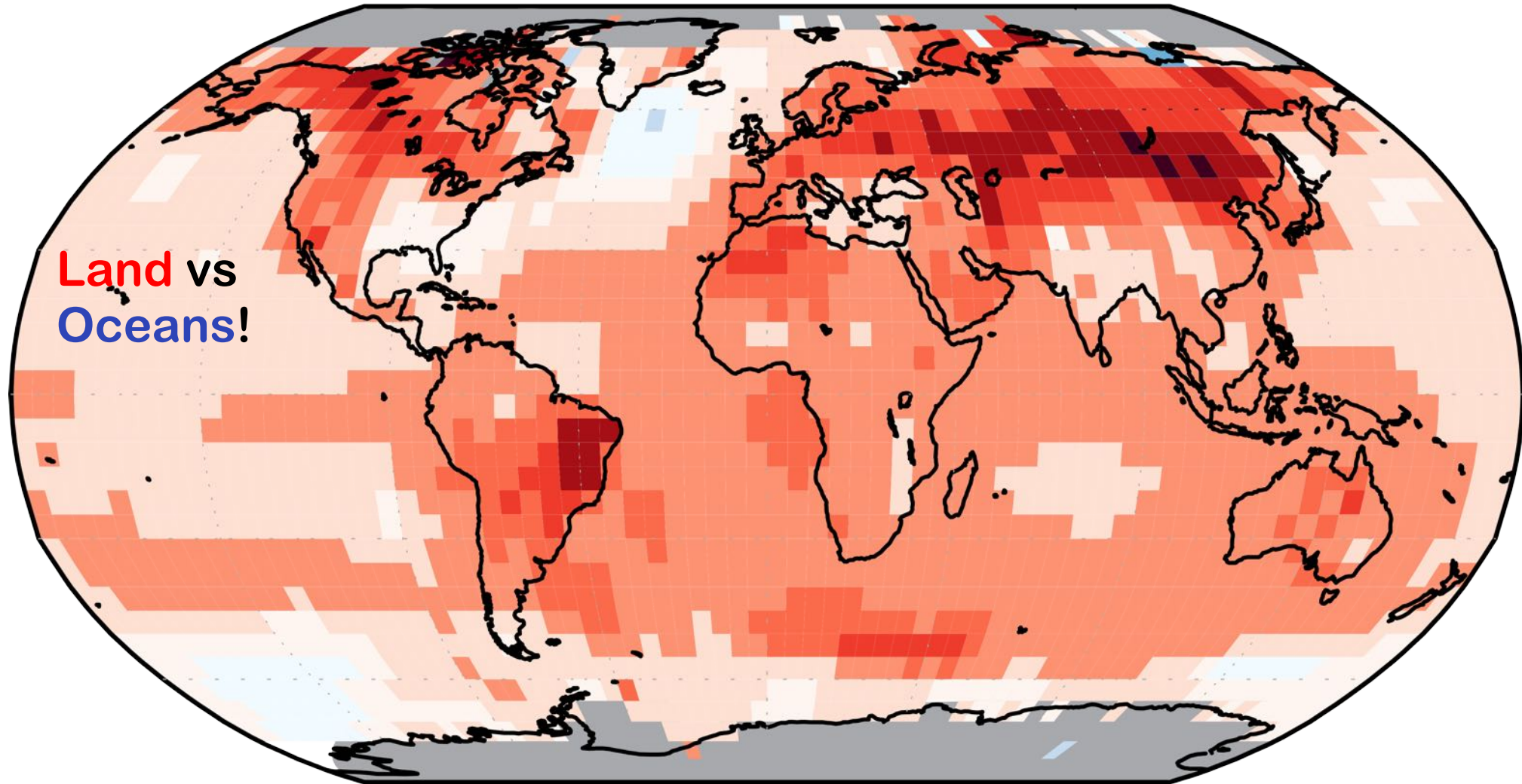
- **Similar concept to IPCC ARs (periodic review of published science)**
- **US agencies, US focus**
- **More attention to public audience than IPCC (clearer language)**
- **NCA4 published 2017**

CLIMATE SCIENCE SPECIAL REPORT



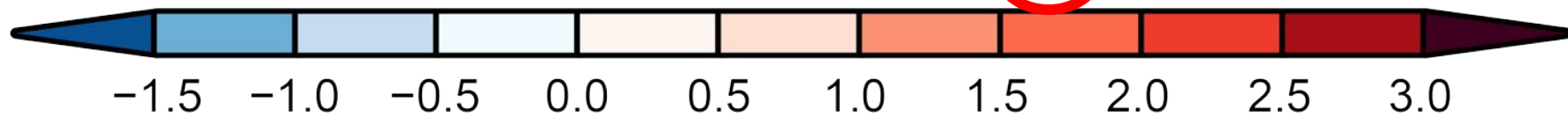
Fourth National Climate Assessment | Volume I

Surface Temperature Change



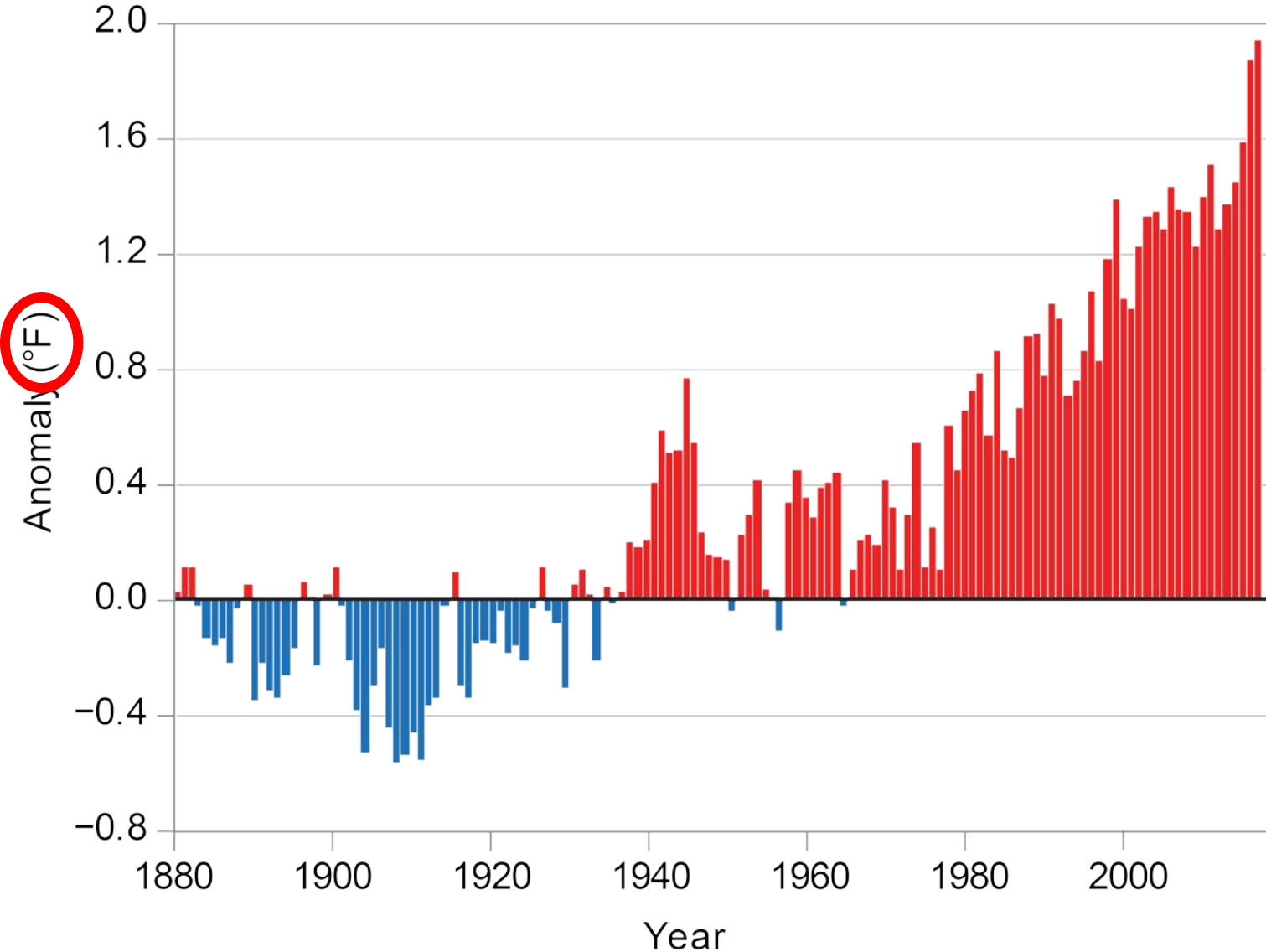
Land vs
Oceans!

Change in Temperature (°F)

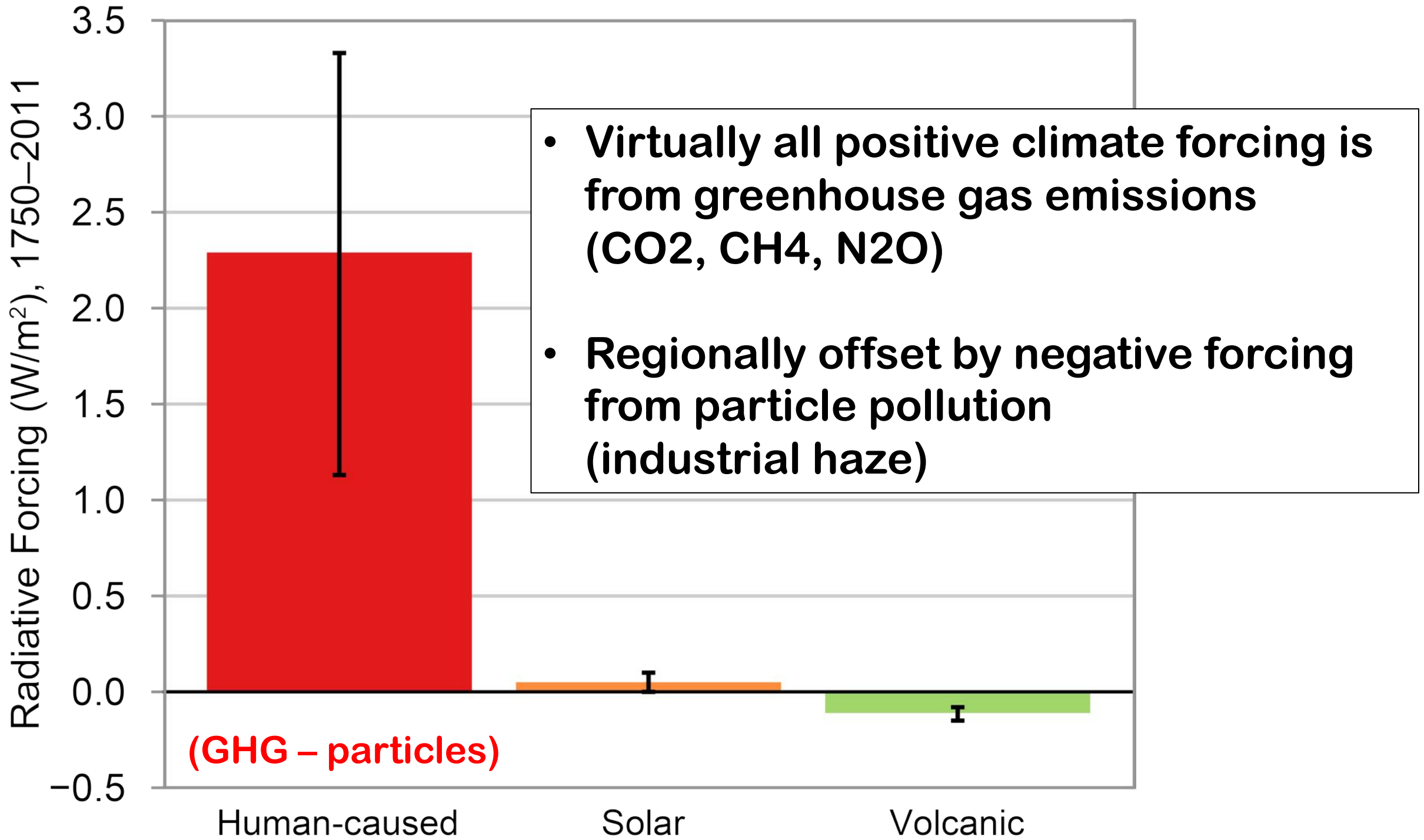


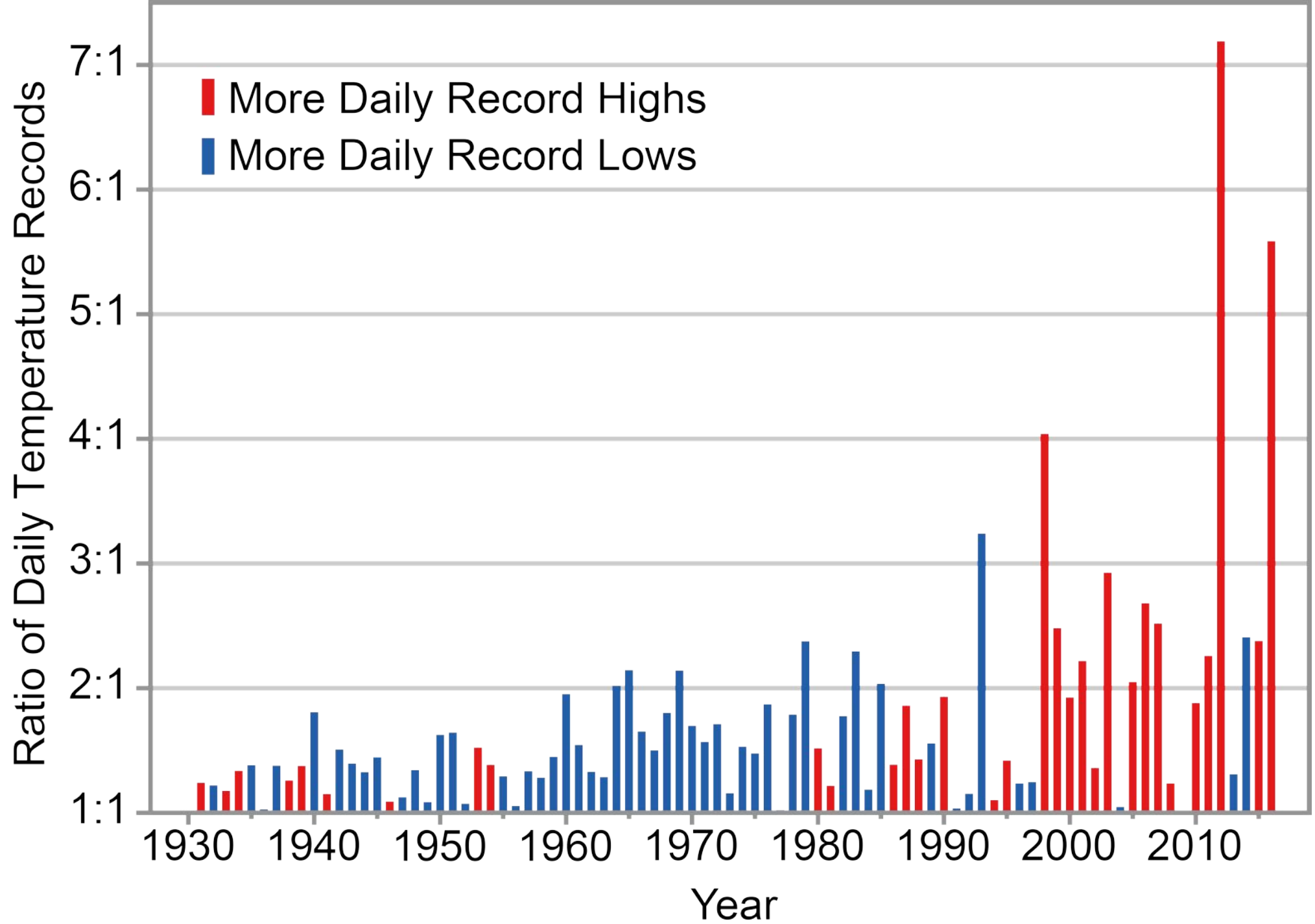
Global Land and Ocean Temperature Anomalies

Annual

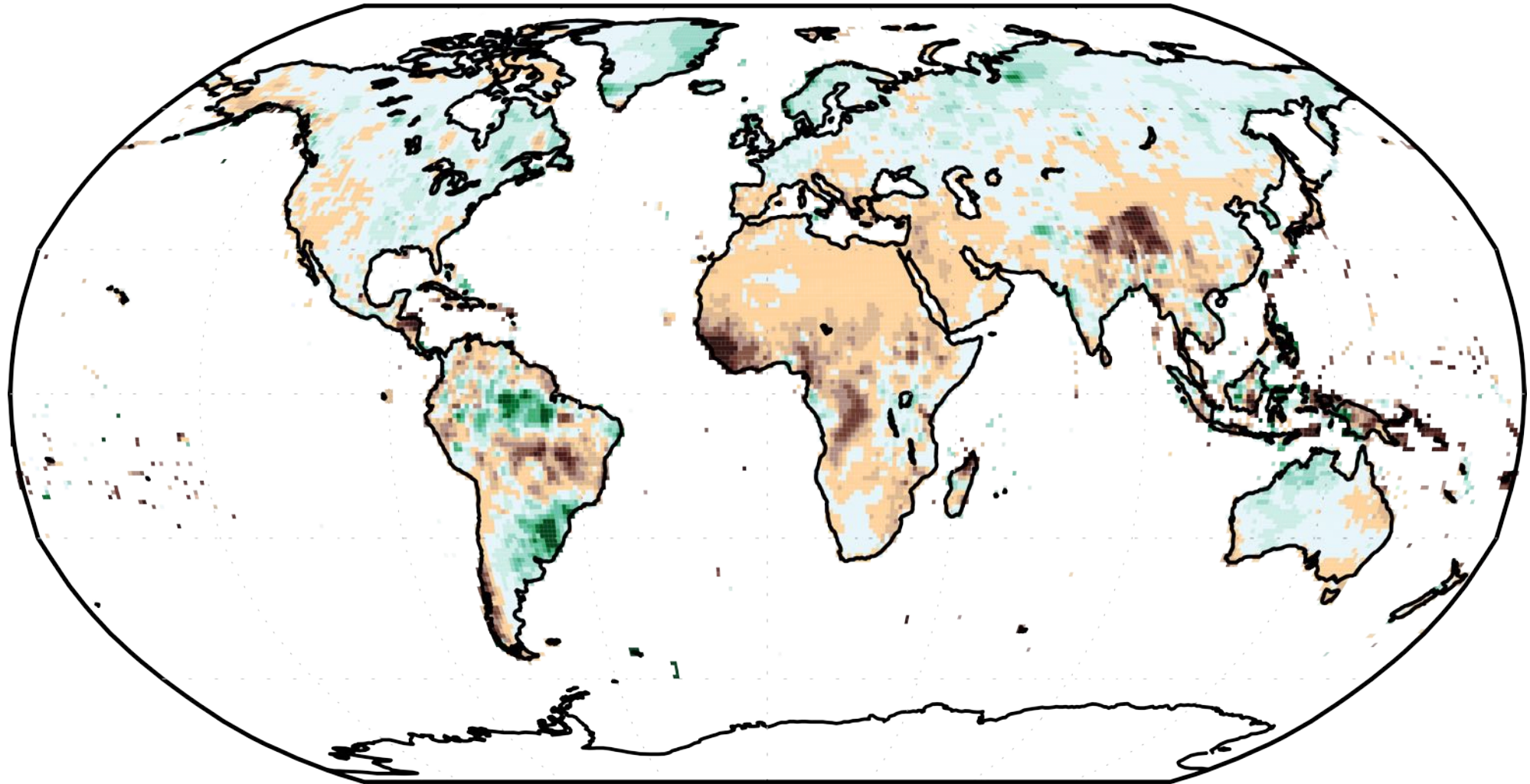


- **US NCA4 uses Fahrenheit rather than Celsius!**
- “Anomalies” are changes in temperature **relative to 1900-1960**
- **Not much warming until ~ 1975**
- **Steady warming of ~ 0.35 F (0.19 C) per decade since then**

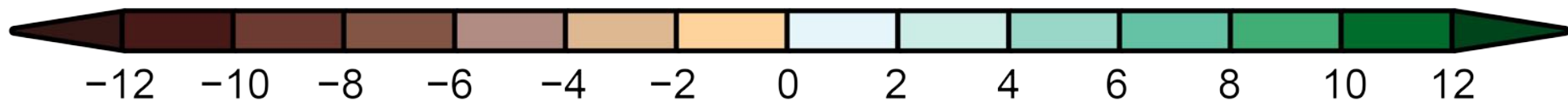




Annually-averaged Precipitation Trends



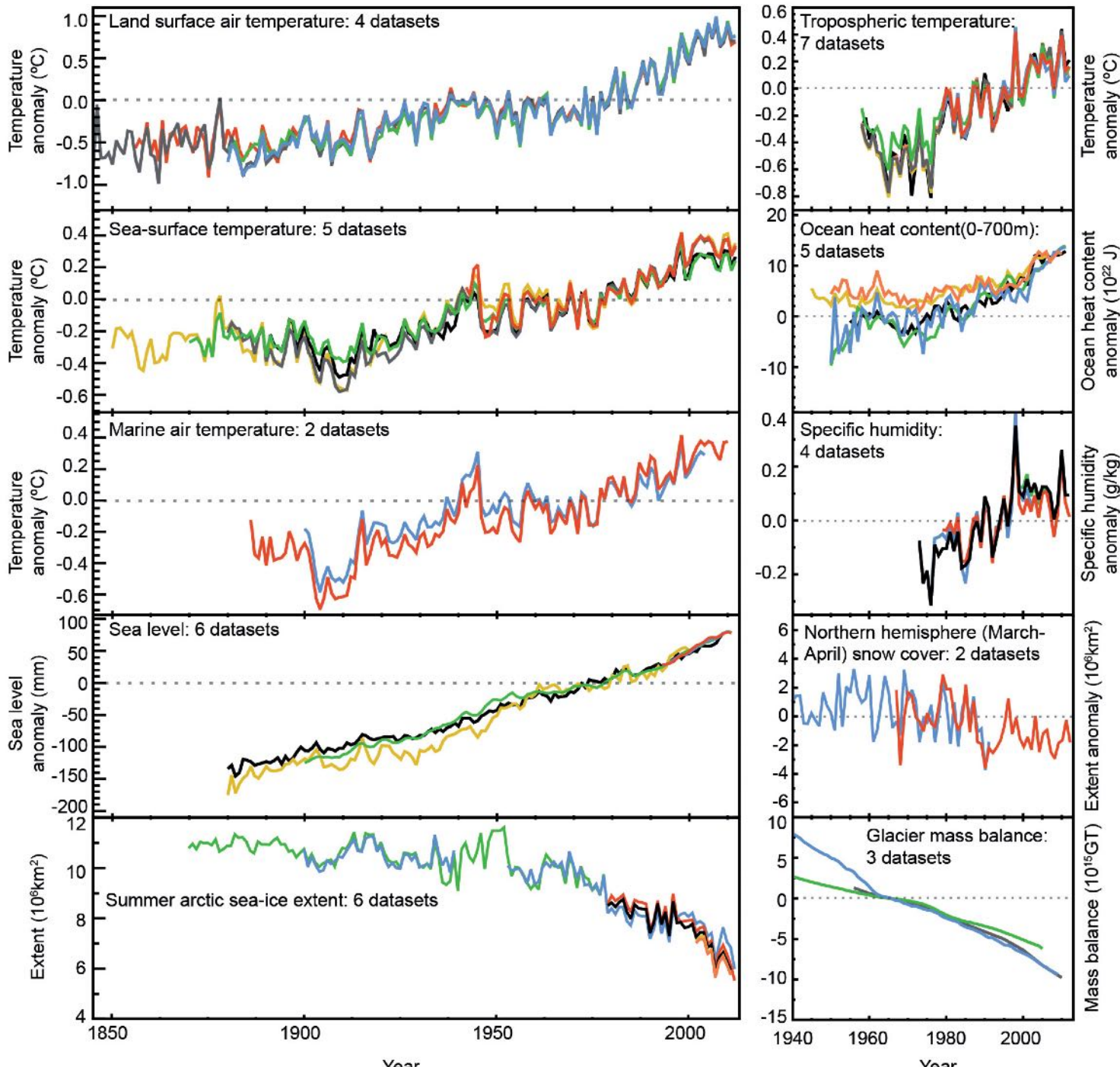
Change in Precipitation (inches)



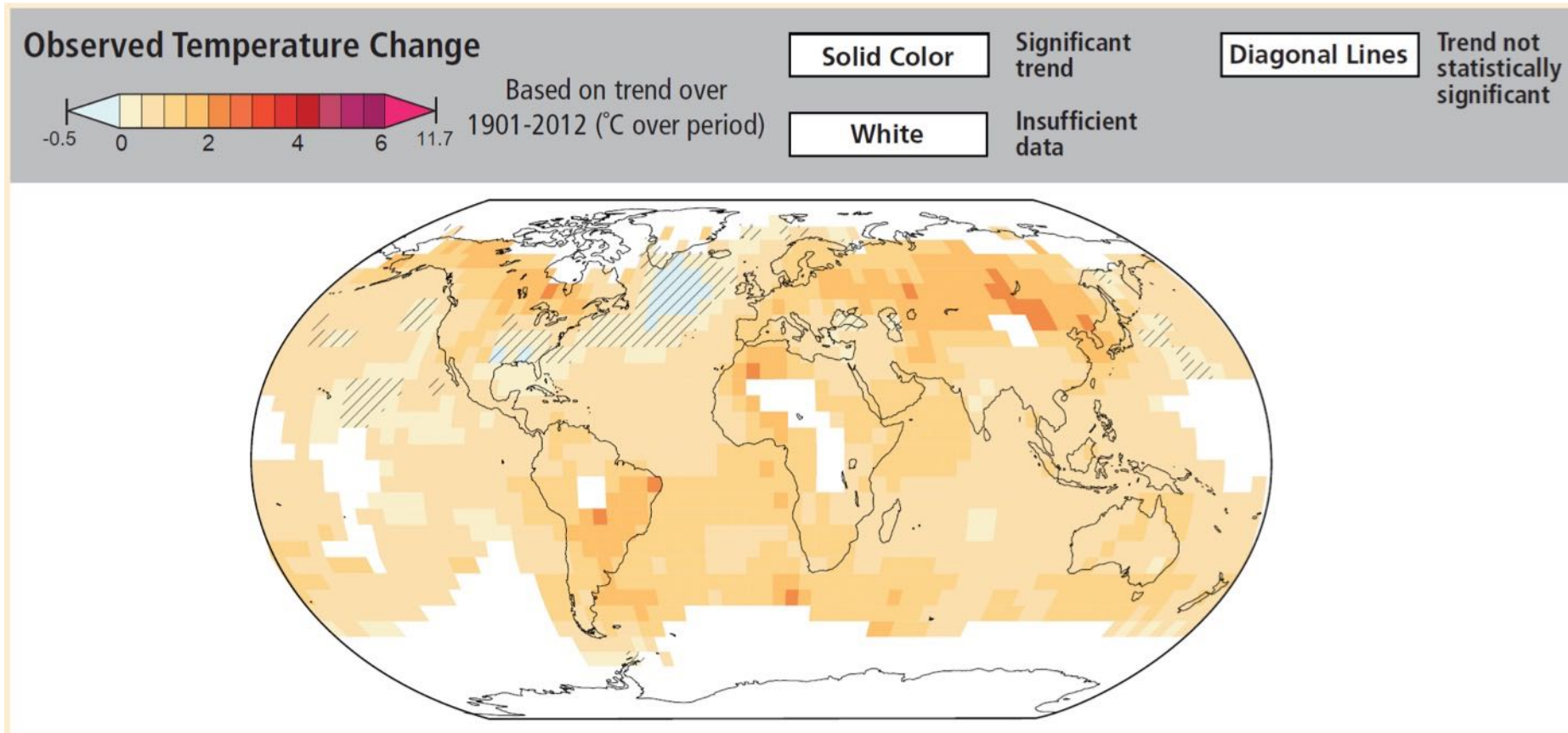
Observed Climate Change

Observations

- Observed changes are large & observed in many different ways
- Warmer in air, on surface, & in ocean
- Less ice both on land & floating on sea
- Rising seas
- Moister air

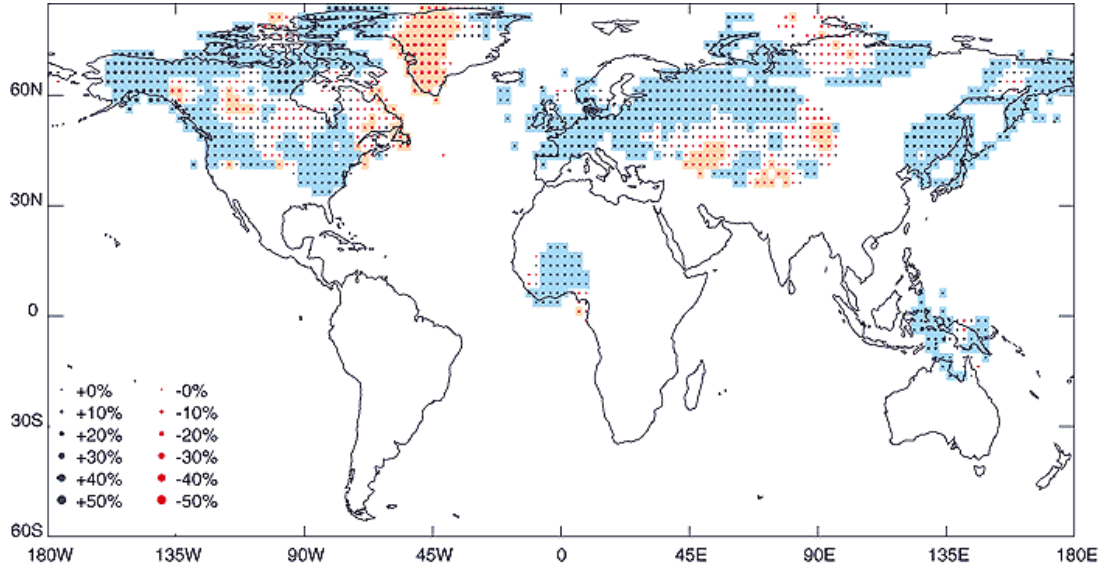


Observed Warming Since 1900



- **More warming on land than ocean**
- **Warming since 1900 less than 1 C over ocean**
- **Warming since 1900 around 1 C over land**

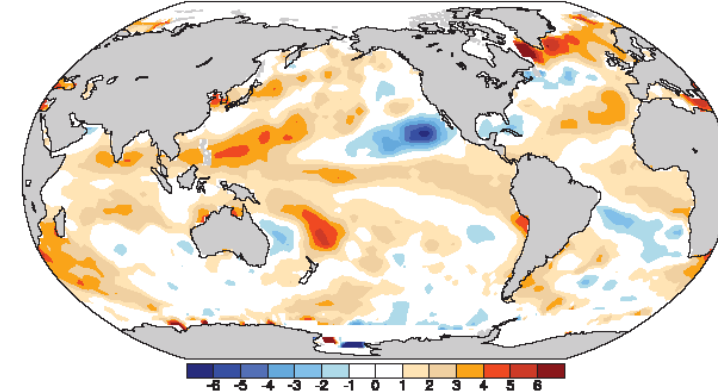
Water Vapor Trends



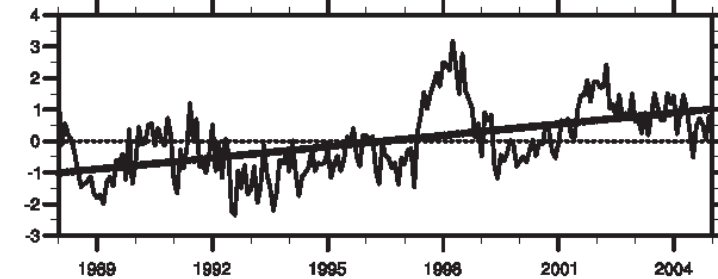
Trends in annual mean surface water vapour pressure, 1975 to 1995, expressed as a percentage of the 1975 to 1995 mean. Areas without dots have no data. Blue shaded areas have nominally significant increasing trends and brown shaded areas have significant decreasing trends, both at the 5% significance level. Biases in these data have been little studied so the level of significance may be overstated. From New et al. (2000).

ATMOSPHERIC WATER VAPOUR

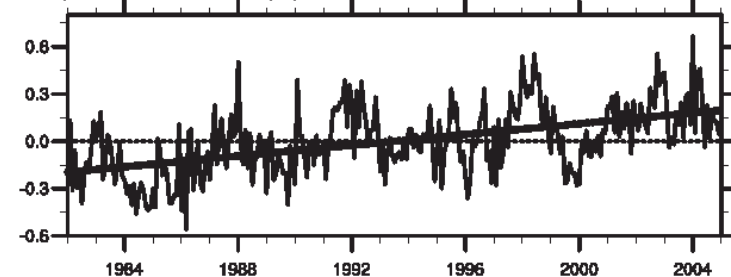
a) Column Water Vapour, Ocean only: Trend, 1988-2004



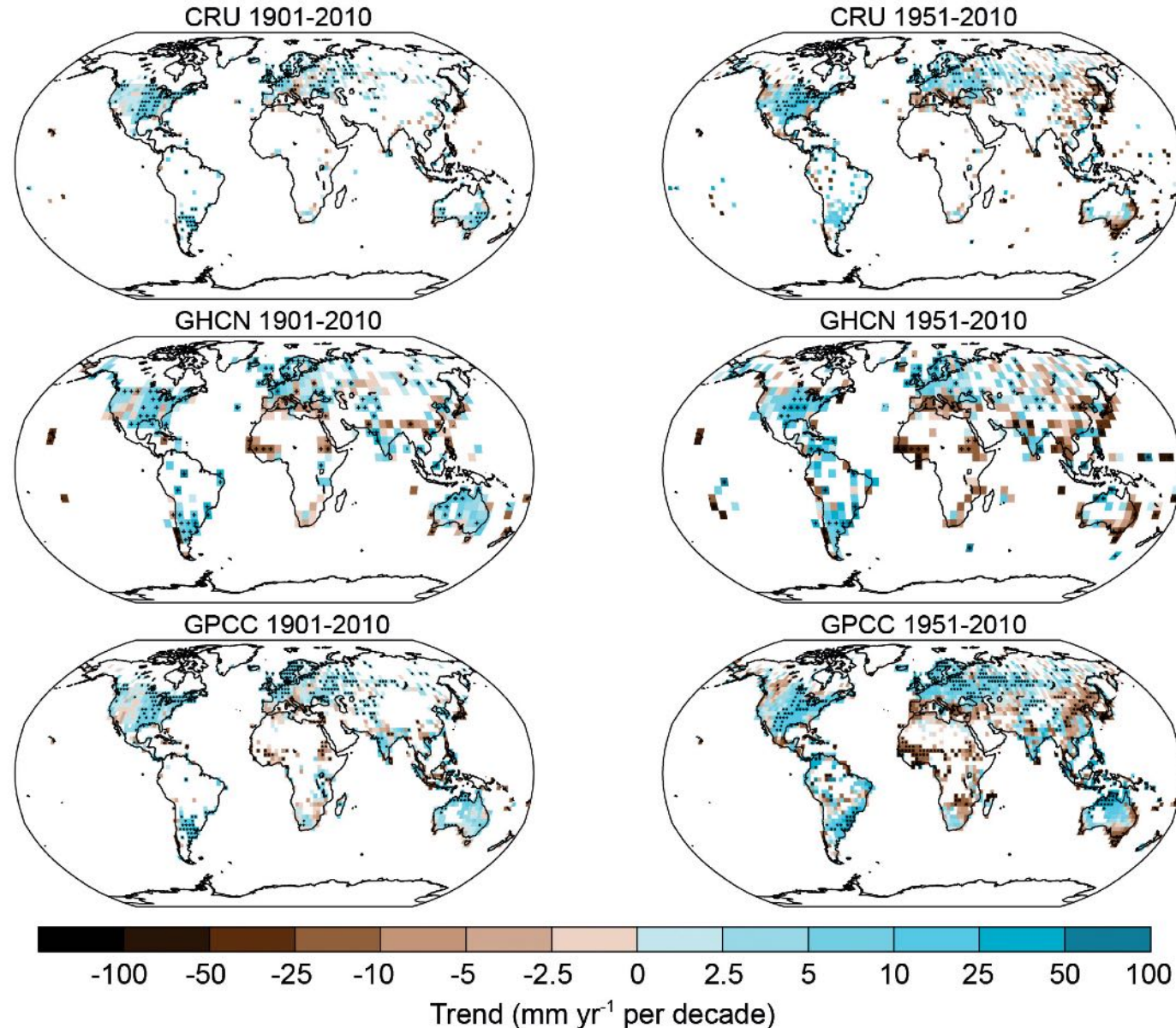
b) Global ocean mean (%) 1.2% per decade



c) Global mean T2-T12 (°C) 0.17 °C per decade

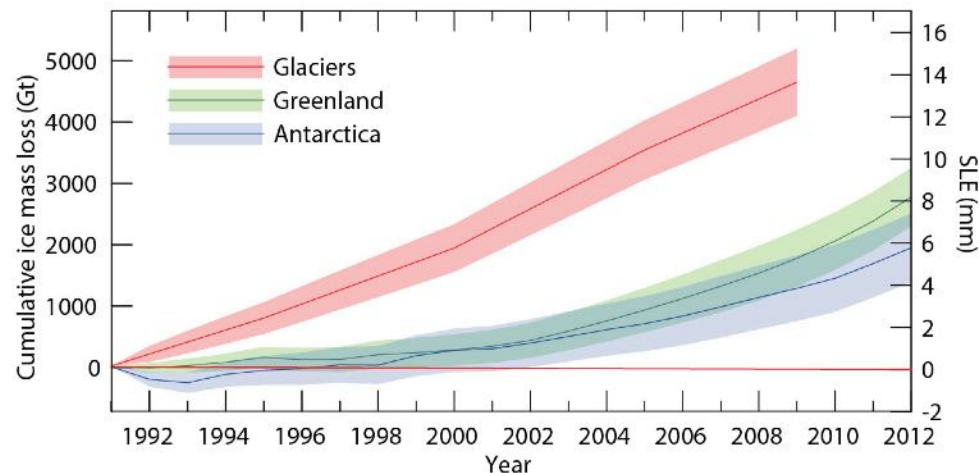
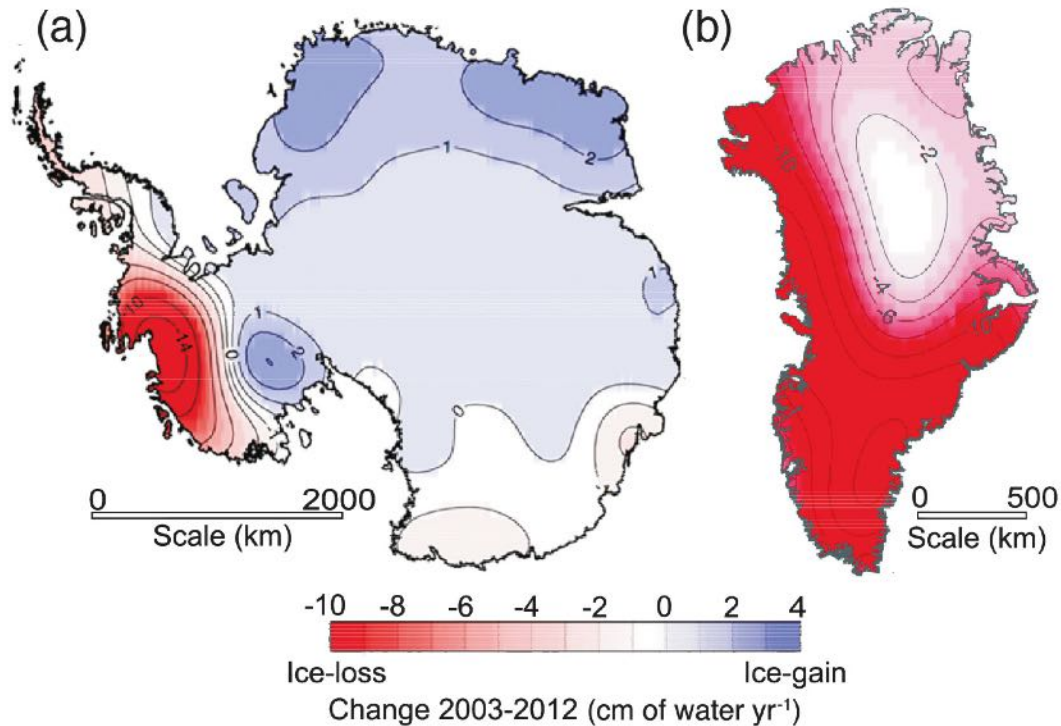


Precipitation Trends



- Warmer air evaporates more water
- Overall precipitation must therefore also increase
- Wet places get wetter, and dry places get drier

Ice Mass Loss

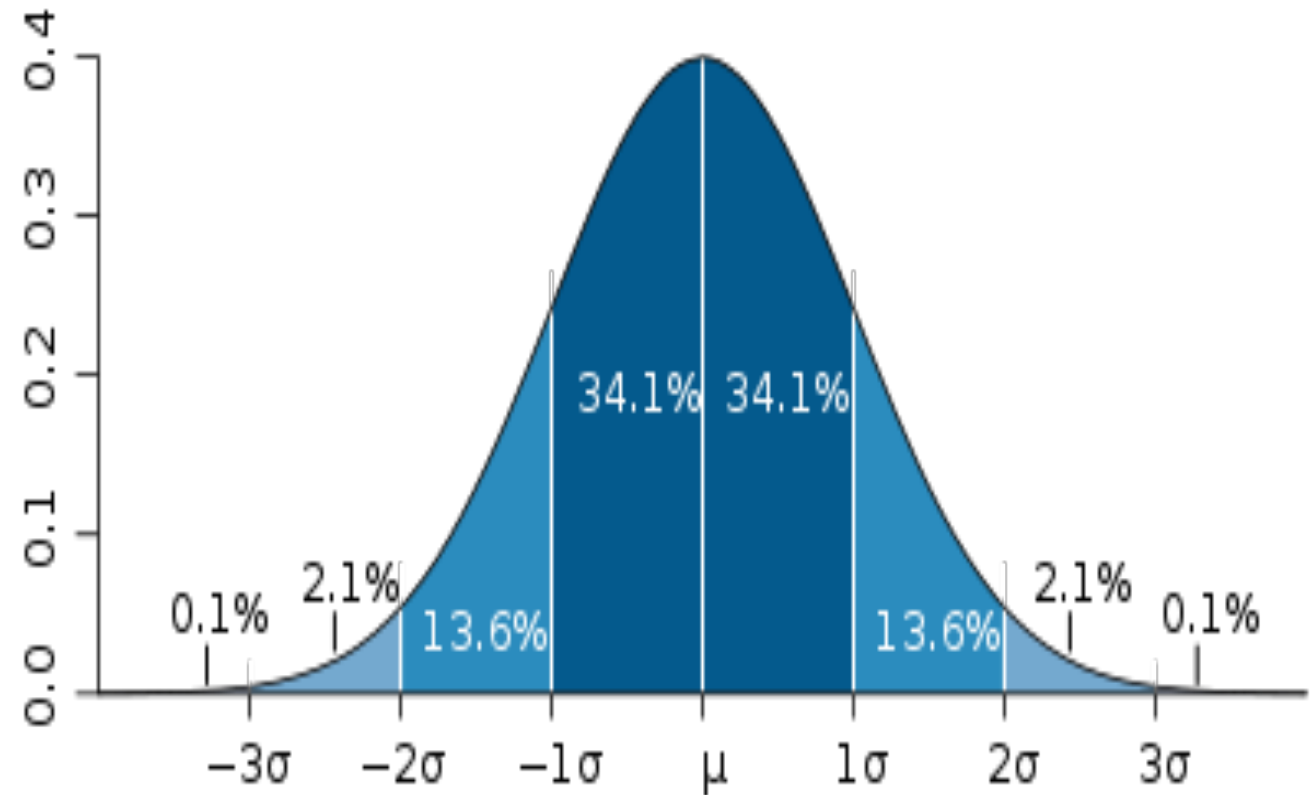


- Good data only since the 1990s (sat)
- Smaller glaciers are losing mass faster than ice sheets
- Greenland and West Antarctic Ice Sheets are losing mass
- East Antarctic Ice Sheet (much bigger) is gaining mass

Means and Extremes

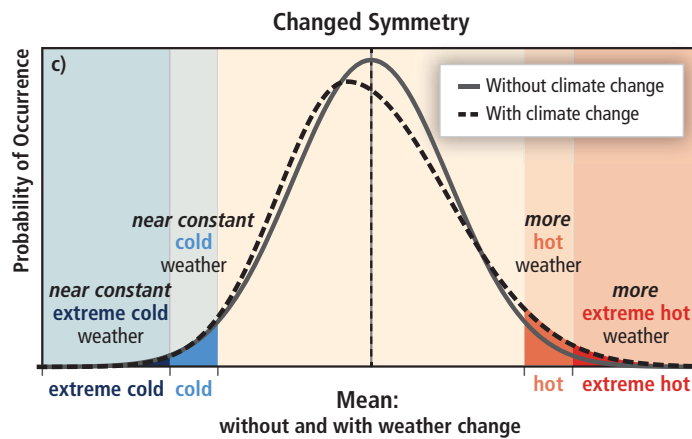
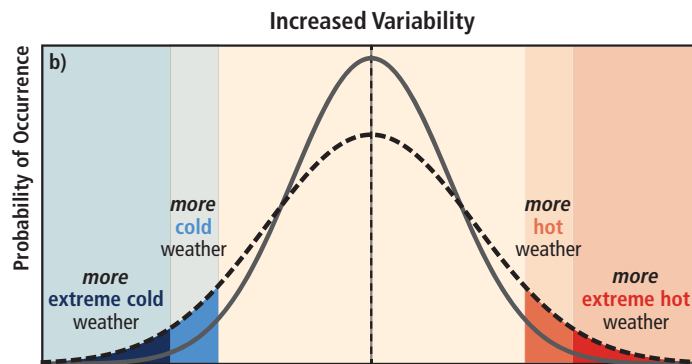
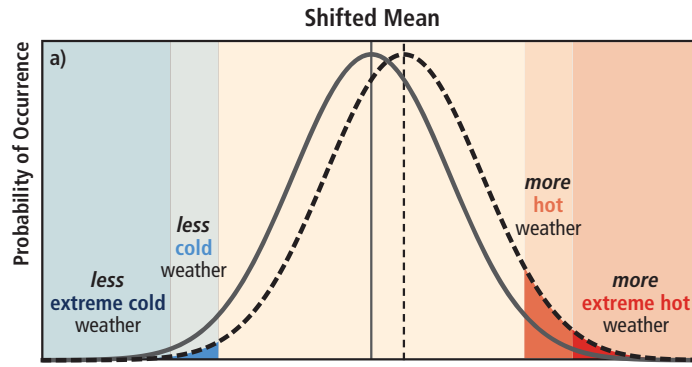
Bell Curves

- “**Normal distribution**” or “**Gaussian**”
- **Average = Mean = Median = Mode**



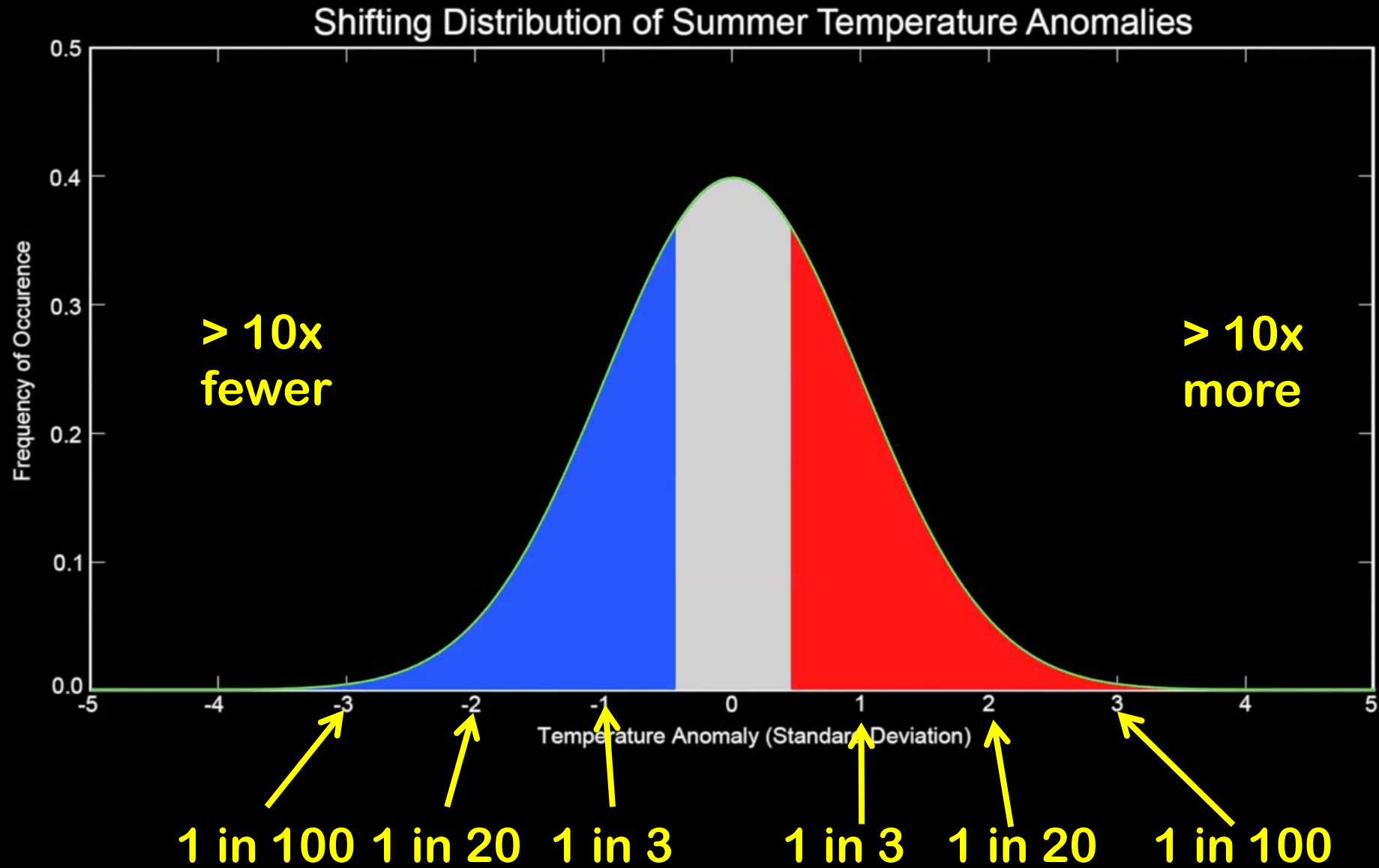
- “Standard deviation” σ measures “width”
 - 68% of values fall within 1σ of mean
 - 95% within 2σ of mean, 99.6% within 3σ

Means & Extremes

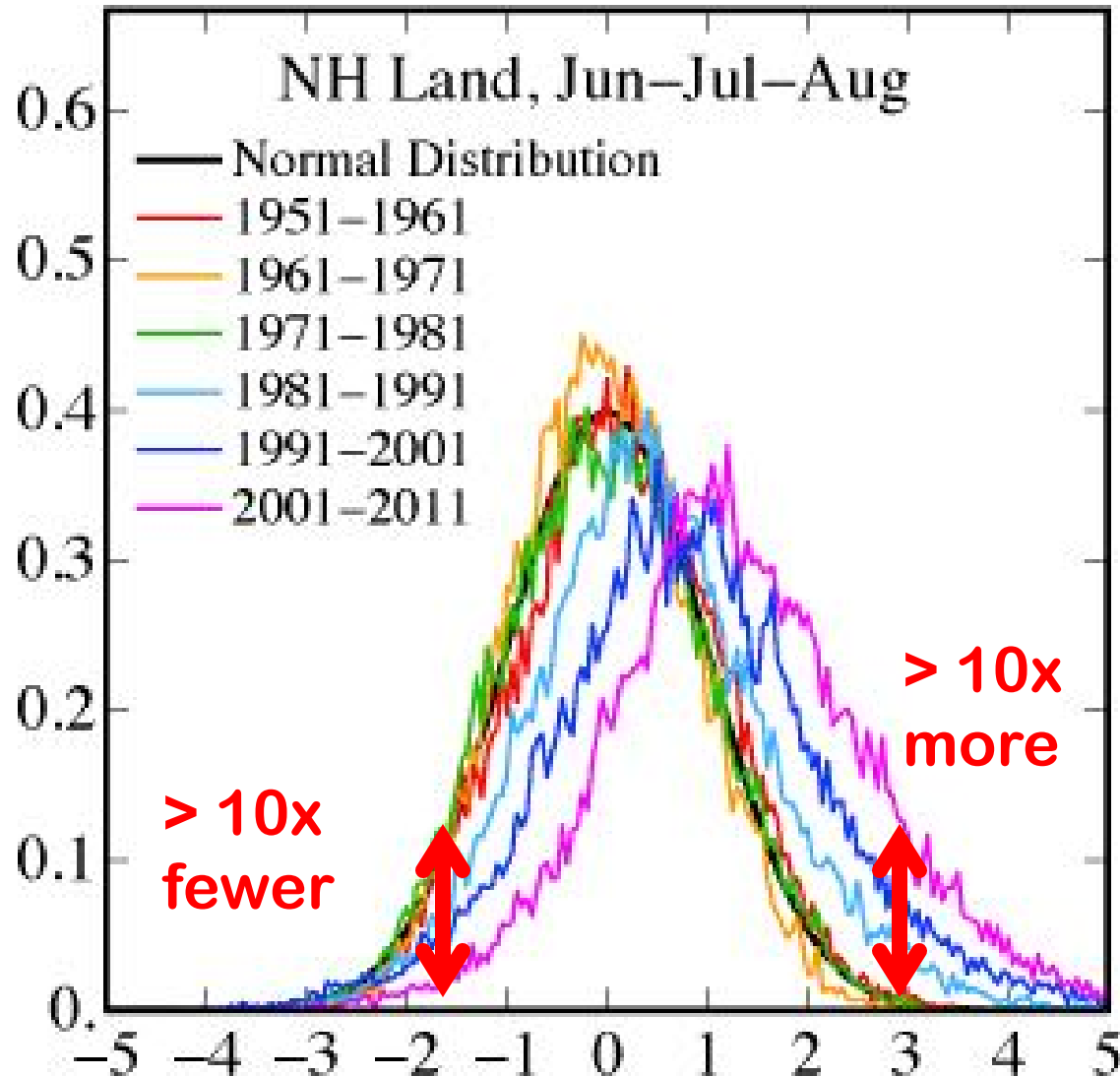


- “Bell curves” also known as “Normal distributions”
- People, crops, animals, economies, ecosystems tend to be more sensitive to extremes than averages
- Small changes in averages produce large changes in extremes
- Changes in the shape of the distribution also produce changes in extremes

60 Years of Summer Temps



Summer Temperatures



- Shift of mean by about 1σ
- Increase in variability (σ) as well

Heat Wave Statistics

Figure 7.19 Characteristics of the summer 2003 heatwave in Europe. (a) June, July, August (JJA) temperature anomaly with respect to 1961–90; (b) to (d) JJA temperatures for Switzerland; (b) observed during 1864–2003; (c) simulated with a regional model for the period 1961–90; (d) simulated for 2071–2100 under the SRES A2 scenario. The vertical bars in (b) to (d) represent mean summer surface temperature for each year of the time period considered; the fitted Gaussian distribution is indicated in black.

