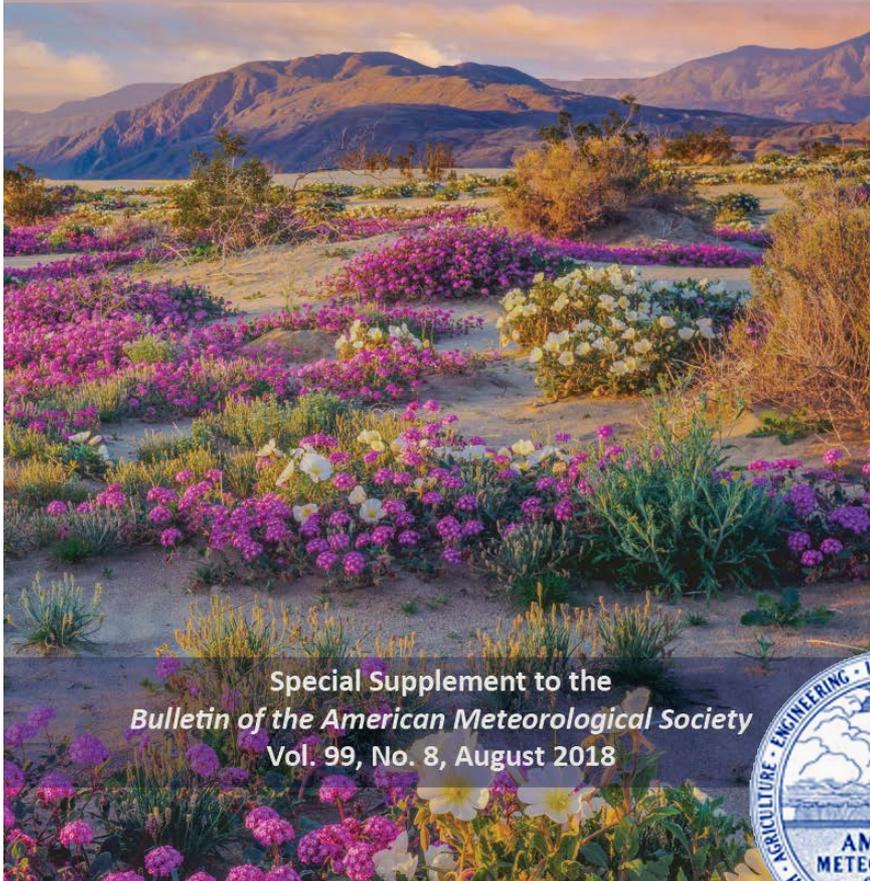
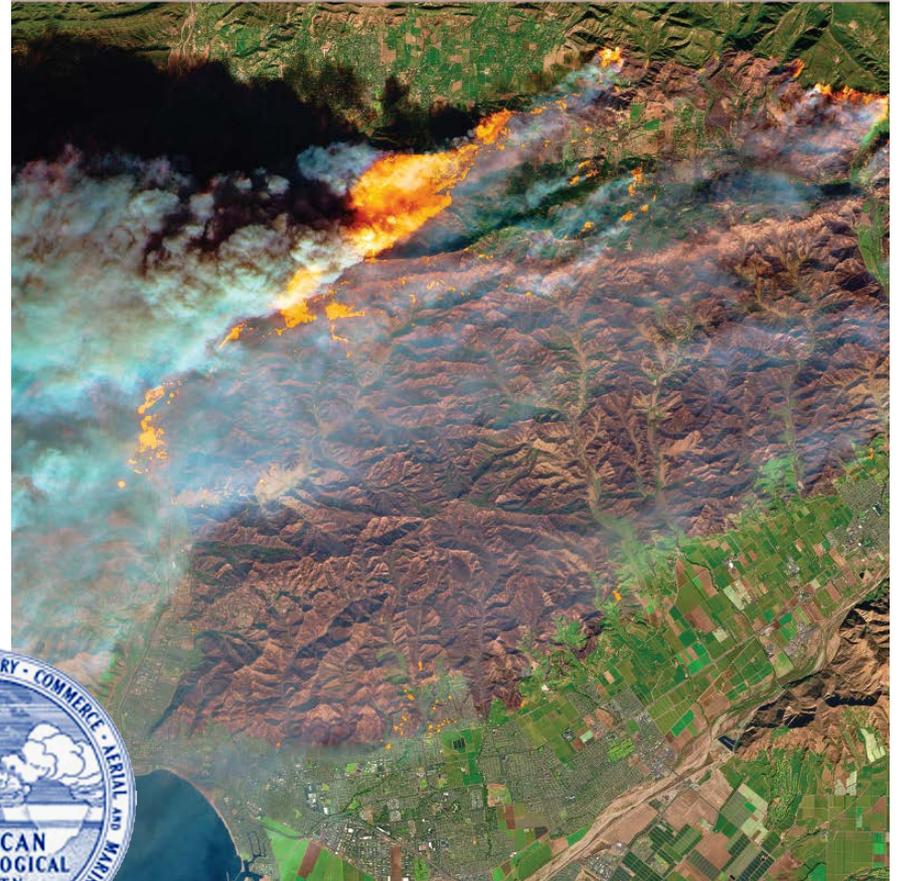


# STATE OF THE CLIMATE IN 2017

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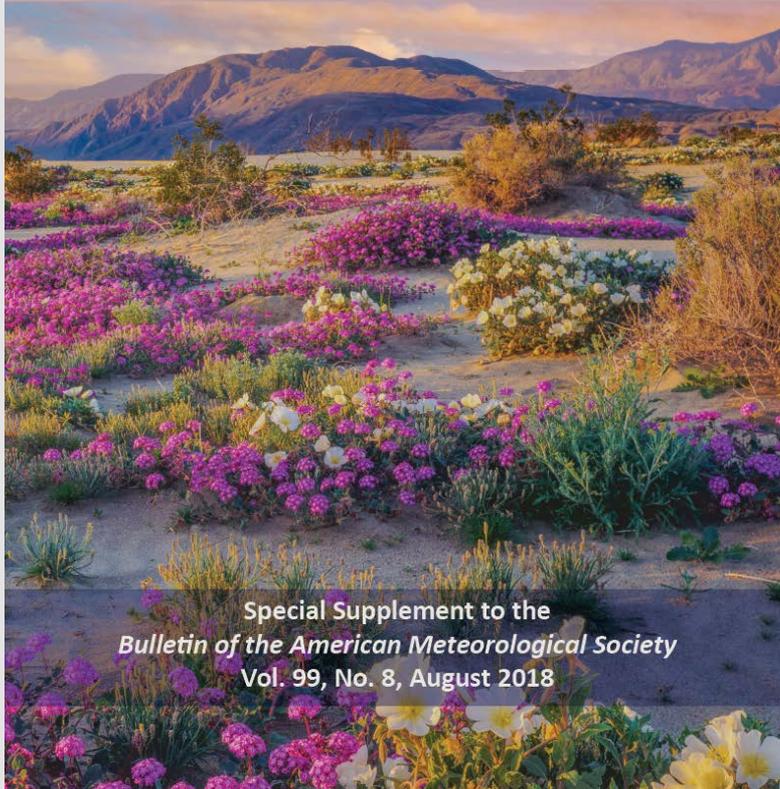


Special Supplement to the  
*Bulletin of the American Meteorological Society*  
Vol. 99, No. 8, August 2018



# Today's Presenters

## STATE OF THE CLIMATE IN 2017



### Jeff Rosenfeld

Editor-In-Chief, *Bulletin of the American Meteorological Society* | Boston, MA

### Deke Arndt

Chief, Monitoring Branch, NOAA's National Centers for Environmental Information | Asheville, NC

### Gregory C. Johnson, Ph.D.

Oceanographer, NOAA's Pacific Marine Environmental Laboratory | Seattle, WA

### Emily Osborne, Ph.D.

Program Manager, NOAA's Arctic Research Program | Silver Spring, MD



# Report is in its 28th Year of Publication

- Many scientists from many disciplines from around the world fit the pieces of Earth's climate system and its changes together to connect the dots
  - Dozens of essential climate indicators, extreme weather and climate events, historical context
- This report does not pursue “attribution” or contain forecasts, scenarios, or projections



524 authors from 65 countries; 19 editors on 3 continents



Atmosphere



Land



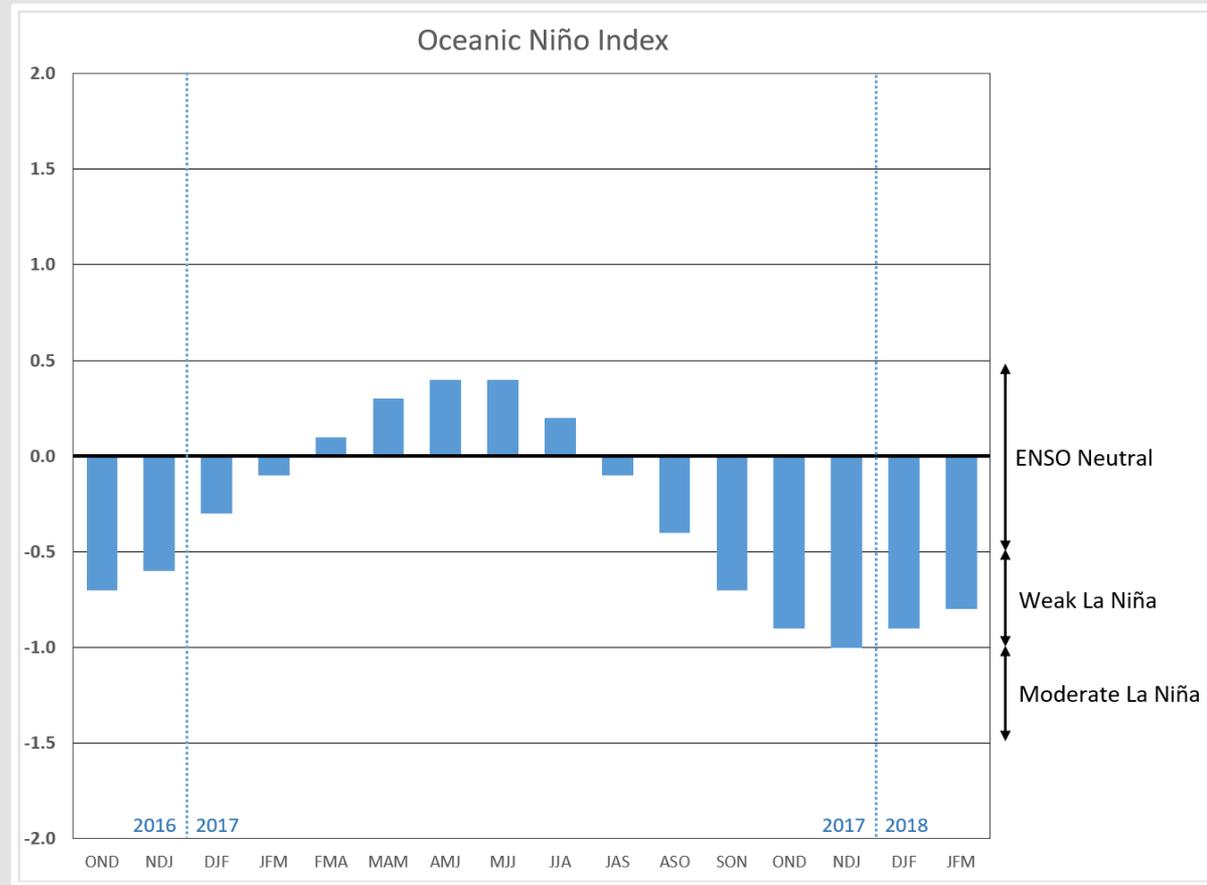
Oceans



Snow and Ice

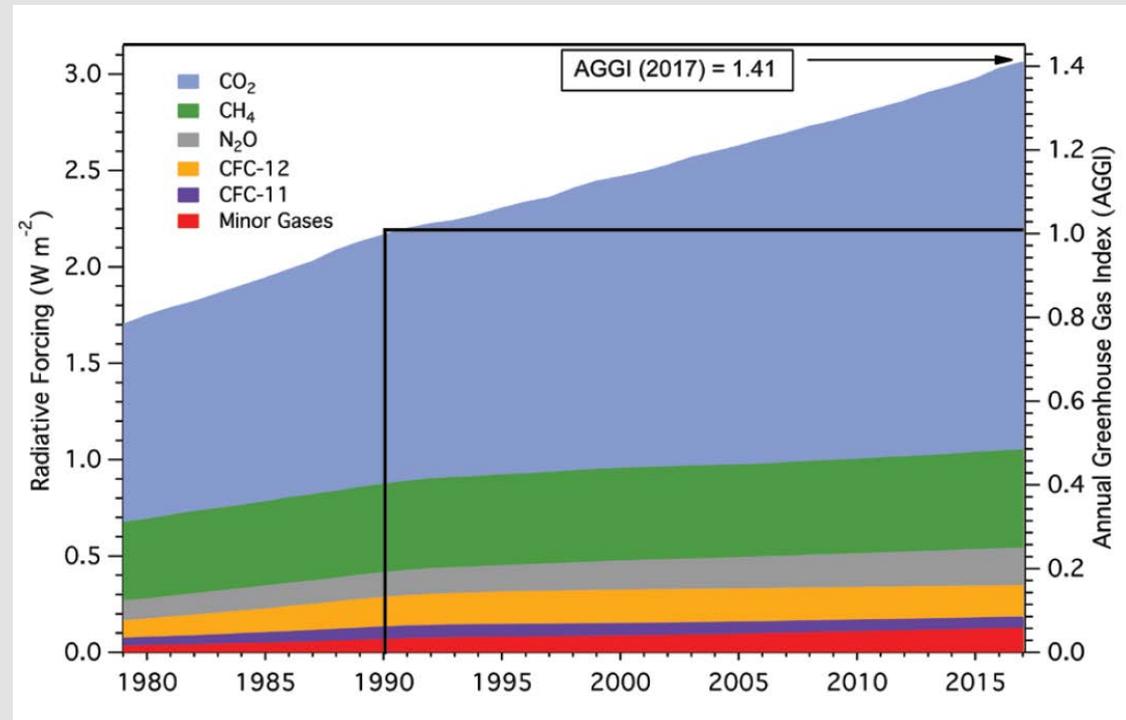
# La Niña

- The state of ENSO provides important context throughout the report at several scales
- 2017 ended in weak La Niña conditions



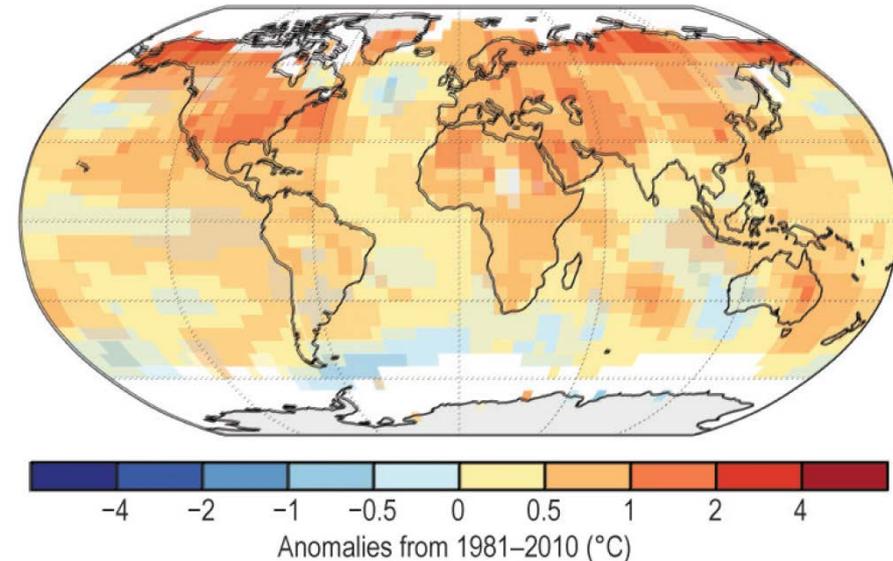
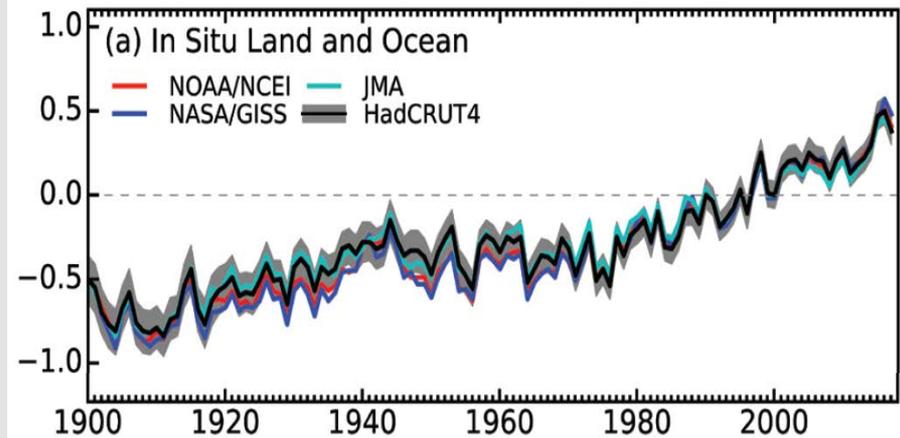
# Greenhouse Gases

- Global averages of long-lived greenhouse gases (GHGs) in 2017
  - **Carbon dioxide (CO<sub>2</sub>):** 405.0 ppm, an increase of 2.2 ppm from 2016
  - **Methane (CH<sub>4</sub>):** 1849.7 ppb, a 6.9 ppb increase since 2016
  - **Nitrous oxide (N<sub>2</sub>O):** 329.8 ppb, a 0.9 ppb increase since 2016
- Total GHG “forcing” has increased 41% since 1990



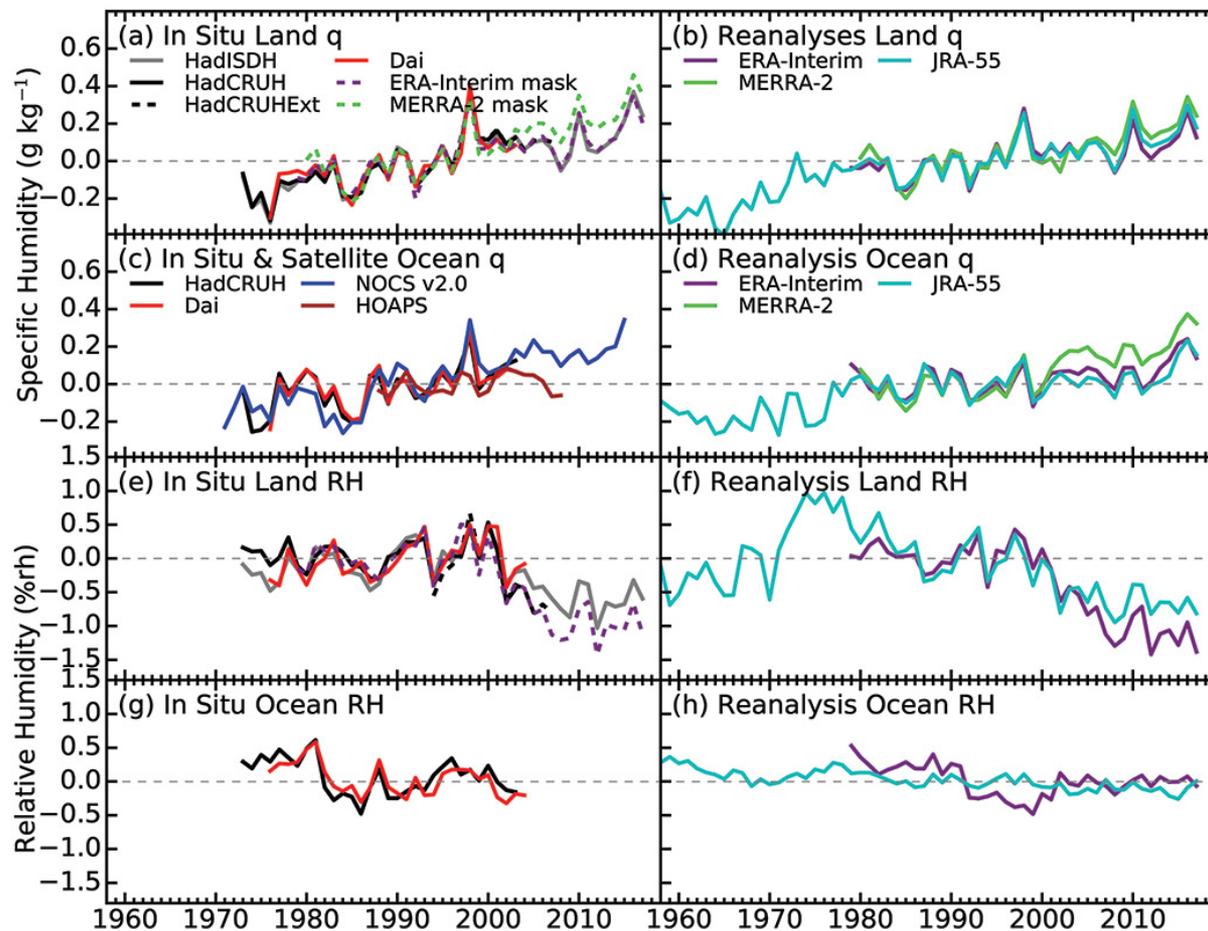
# Globally Averaged Surface Temperature

- 2<sup>nd</sup> warmest (one dataset) or 3<sup>rd</sup> warmest (three datasets) on record
  - Largely supported by reanalyses (2<sup>nd</sup> warmest)
- Approx. 0.38 to 0.48°C warmer than the 1981–2010 average
- Warmest non-El Niño year on record
- 2014, 2015, 2016, 2017 are the four warmest years on record



# Humidity

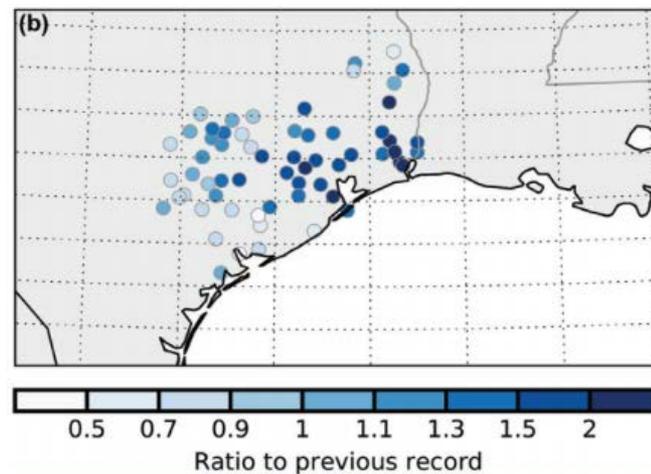
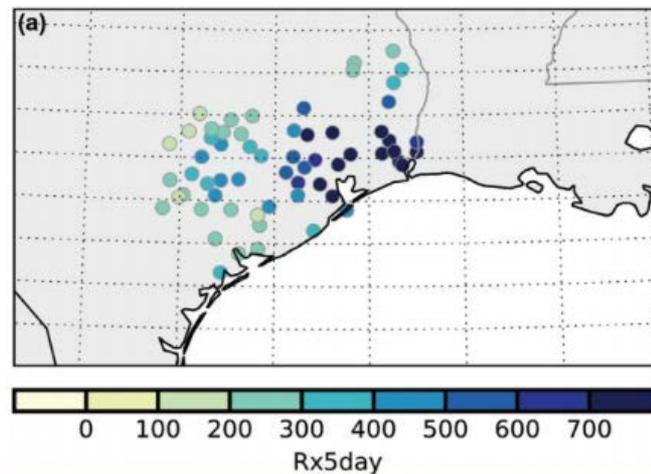
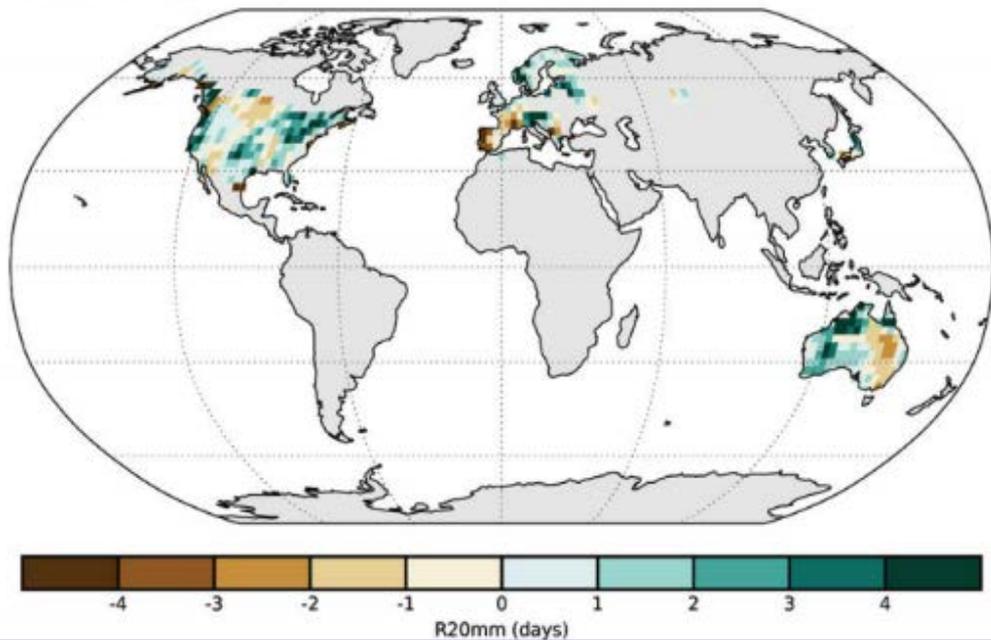
General trends indicate increasing water vapor and slightly decreasing relative humidity



# One recurring theme: extreme precipitation

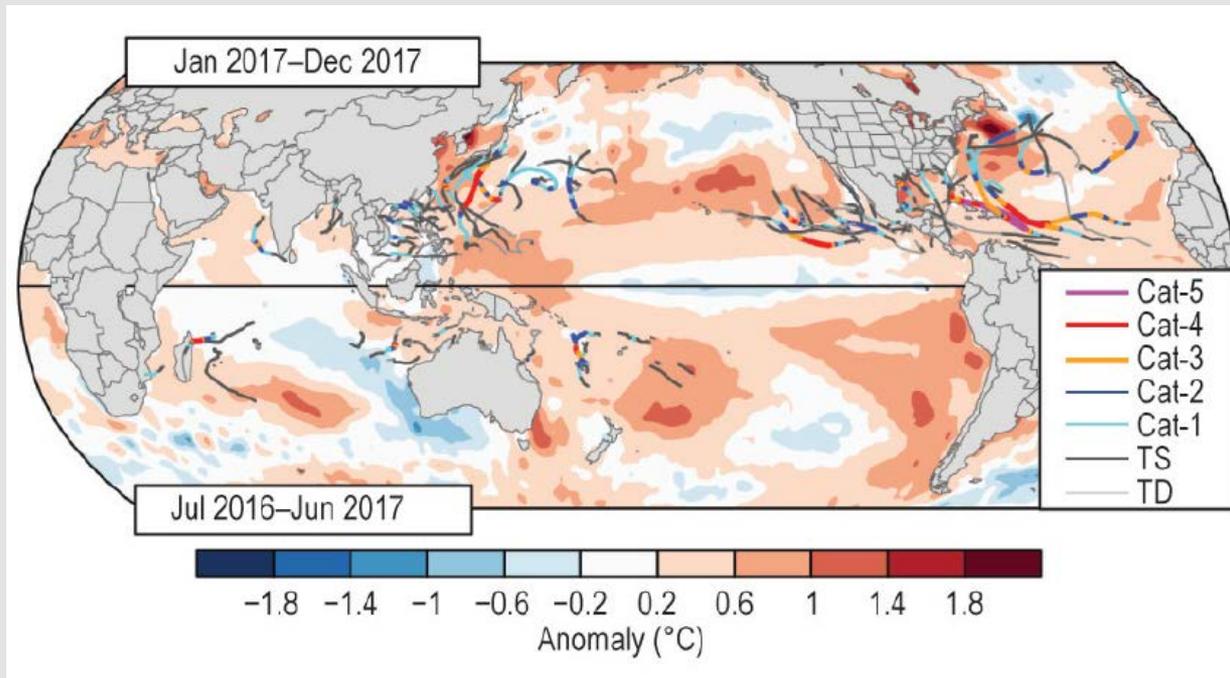
- In addition to documenting extreme events on every inhabited continent, sidebars focused on methods to characterize extreme precipitation.

Number of Very Heavy Precipitation Days vs. average



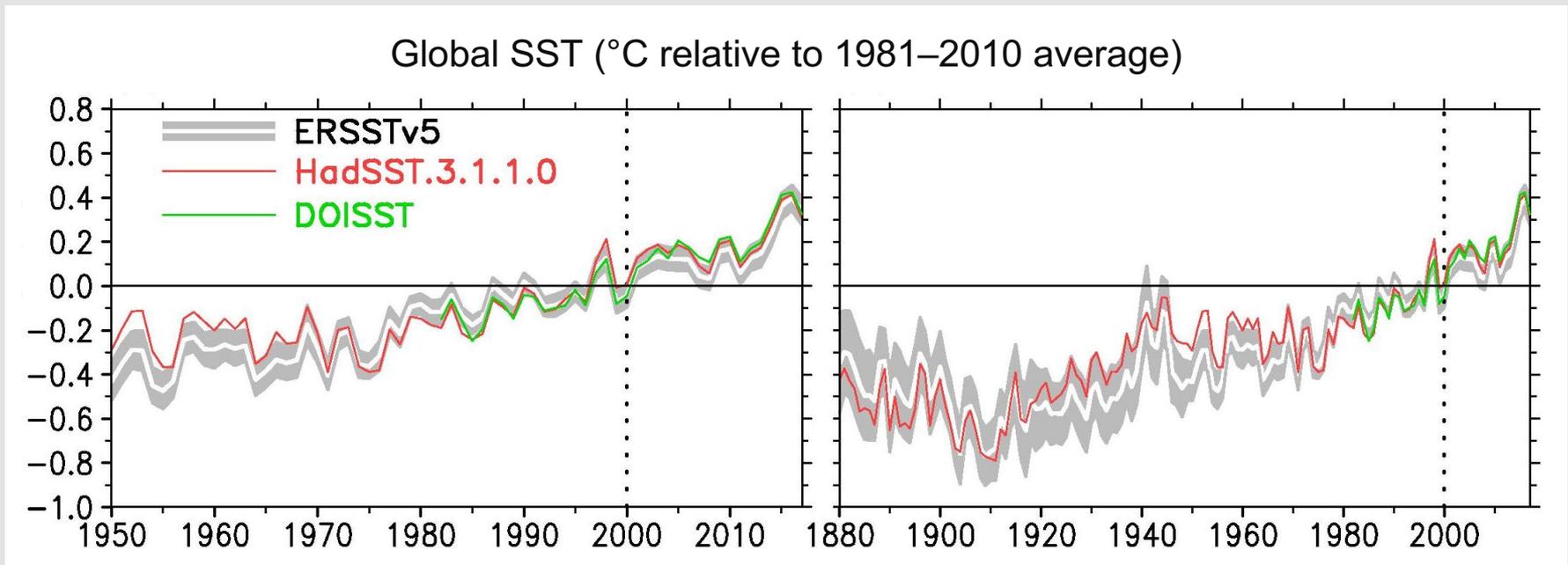
# Tropical Cyclones

- 85 named storms globally
  - Slightly above average of 82
- North Atlantic Basin Accumulated Cyclone Energy index roughly 2.4 times its median value
  - Three catastrophic major hurricanes: Harvey, Irma, Maria
- Other basins near or below normal



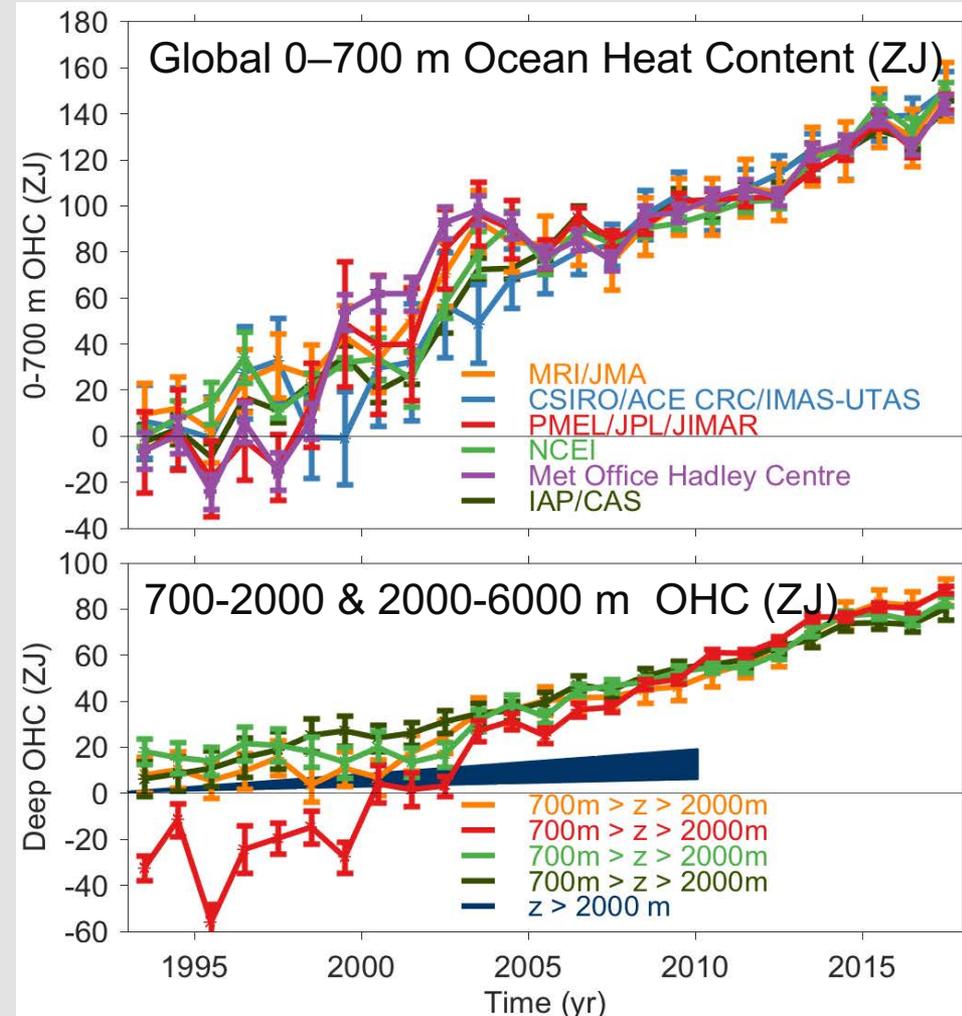
# Global Sea Surface Temperature Warm in 2017

- Global SST in 2017 cooled by  $0.04^{\circ}\text{C}$  relative to 2016 record high
- Difference between 2017 and 2016 is within yearly confidence limits of  $\pm 0.06^{\circ}\text{C}$
- Small drop probably related to tropical Pacific cooling after 2015/16 El Niño
- Warming trend 2000–17 for ERSSTv5  $0.17^{\circ}\text{C}$  per decade



# Record High Global Ocean Heat Content in 2017

- Global Ocean Heat Content from 0-700 m record in 2017 in all six analyses (top panel)
- Close agreement among estimates since Argo array of robotic floats achieved global coverage circa 2005
- 700–2000 m ocean also steadily warming (bottom panel)
- 2000–6000 m ocean also shows warming trend (bottom panel)
- Full depth warming trend 1993–2017 350 ( $\pm 50$ ) TW (around 18 times global primary energy supply consumption rate for 2015)

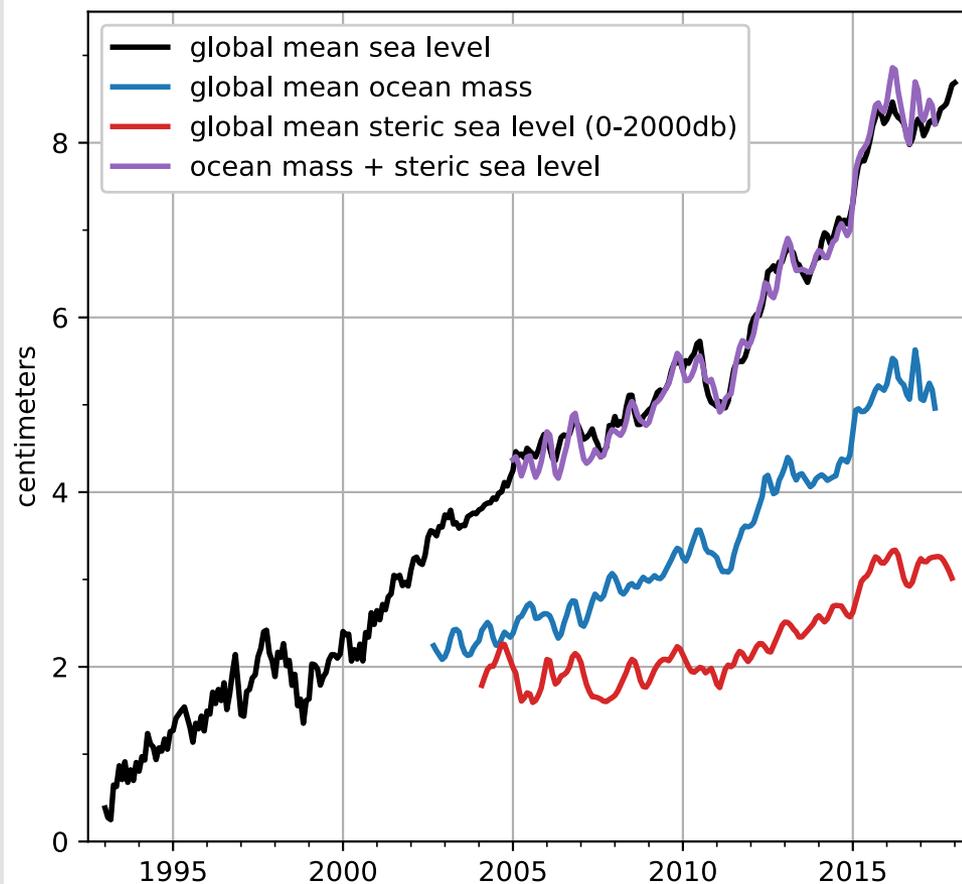


# Record High Global Sea Level in 2017

- Global sea level record high in 2017, the sixth consecutive year
- Global sea level 7.7 cm (3 inches) higher in 2017 than in 1993
- Global sea level trend since 1993 3.1 cm (1.2 inches) per decade
- Since 2005 2/3 of trend from increasing ocean mass & 1/3 from ocean warming

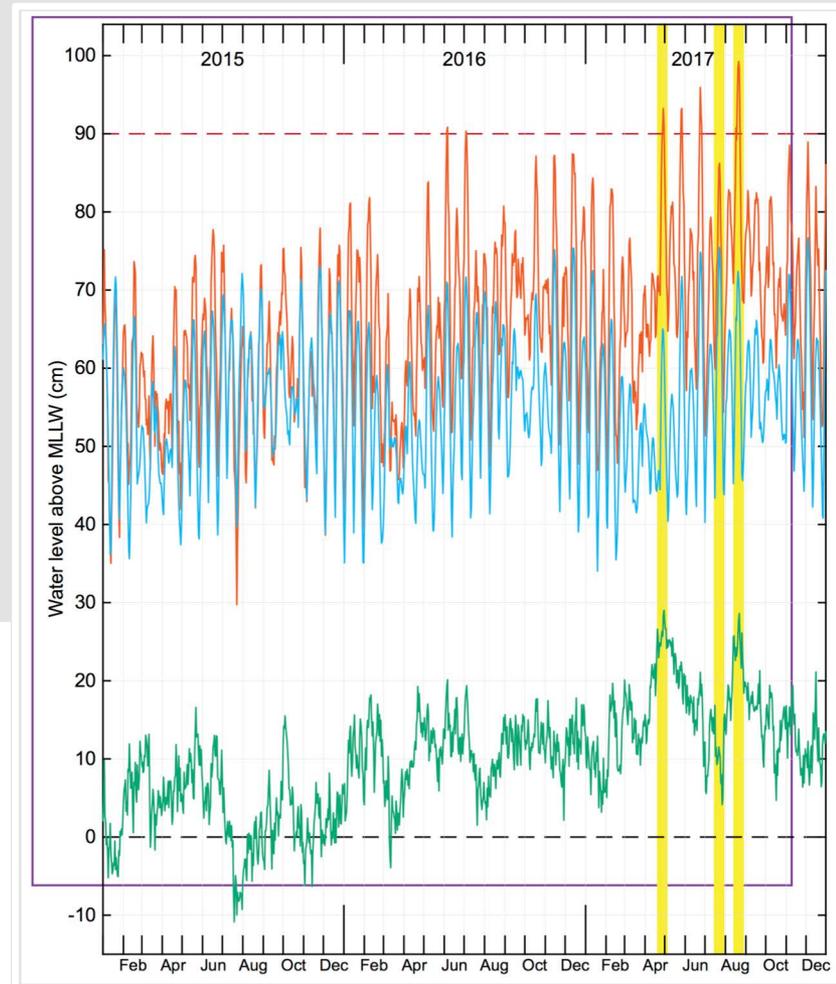
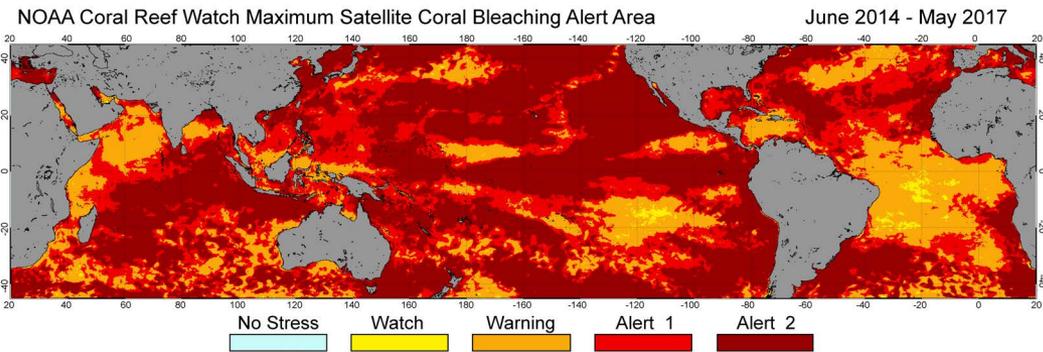
*Surface fluctuates,  
ocean warms more steadily,  
seas continue rise.*

Global Sea Level Anomaly (cm)

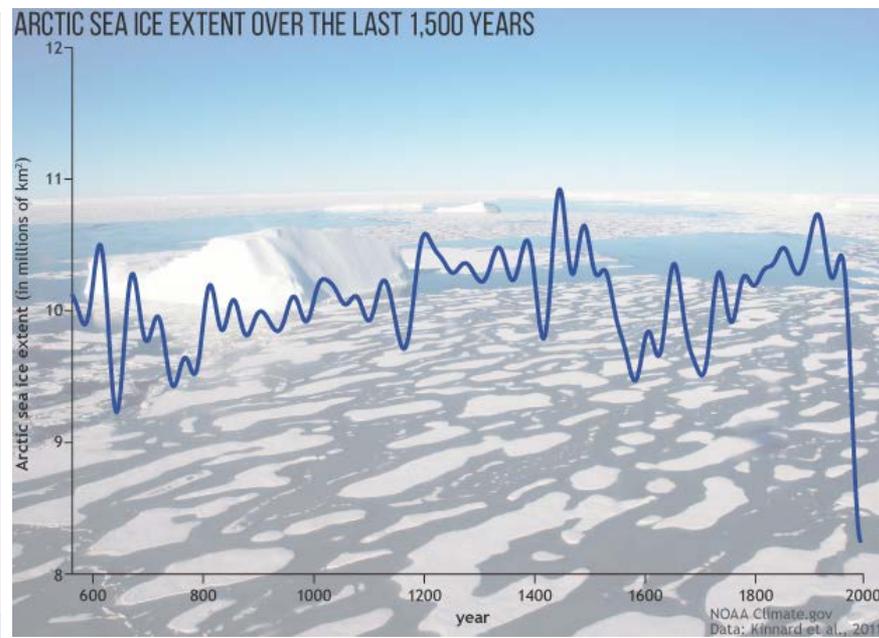
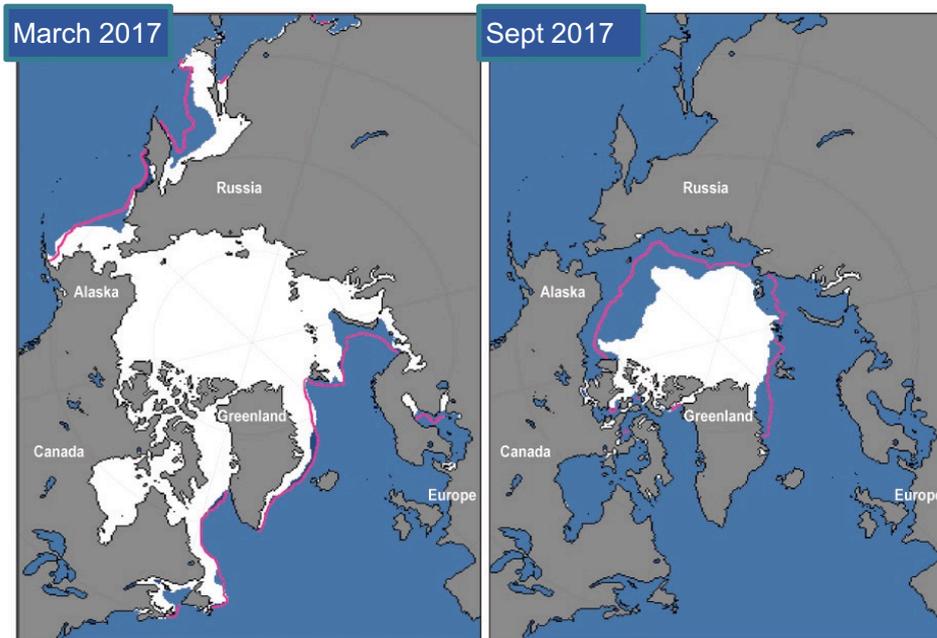


# Impacts: Global Oceans Chapter Sidebars

- Warm Sea Surface Temperatures: **Unprecedented Three Years of Global Coral Reef Bleaching 2014–17** (pp. S74–S75)
- Sea Level Rise: **Nu`a Kai: Flooding in Hawaii Caused by a “Stack” of Oceanographic Processes** (pp. S88–S89)



# Arctic Sea Ice Extent: Record Lows



The **March 2017** sea ice maximum was **the lowest on record (1981–2017)**.

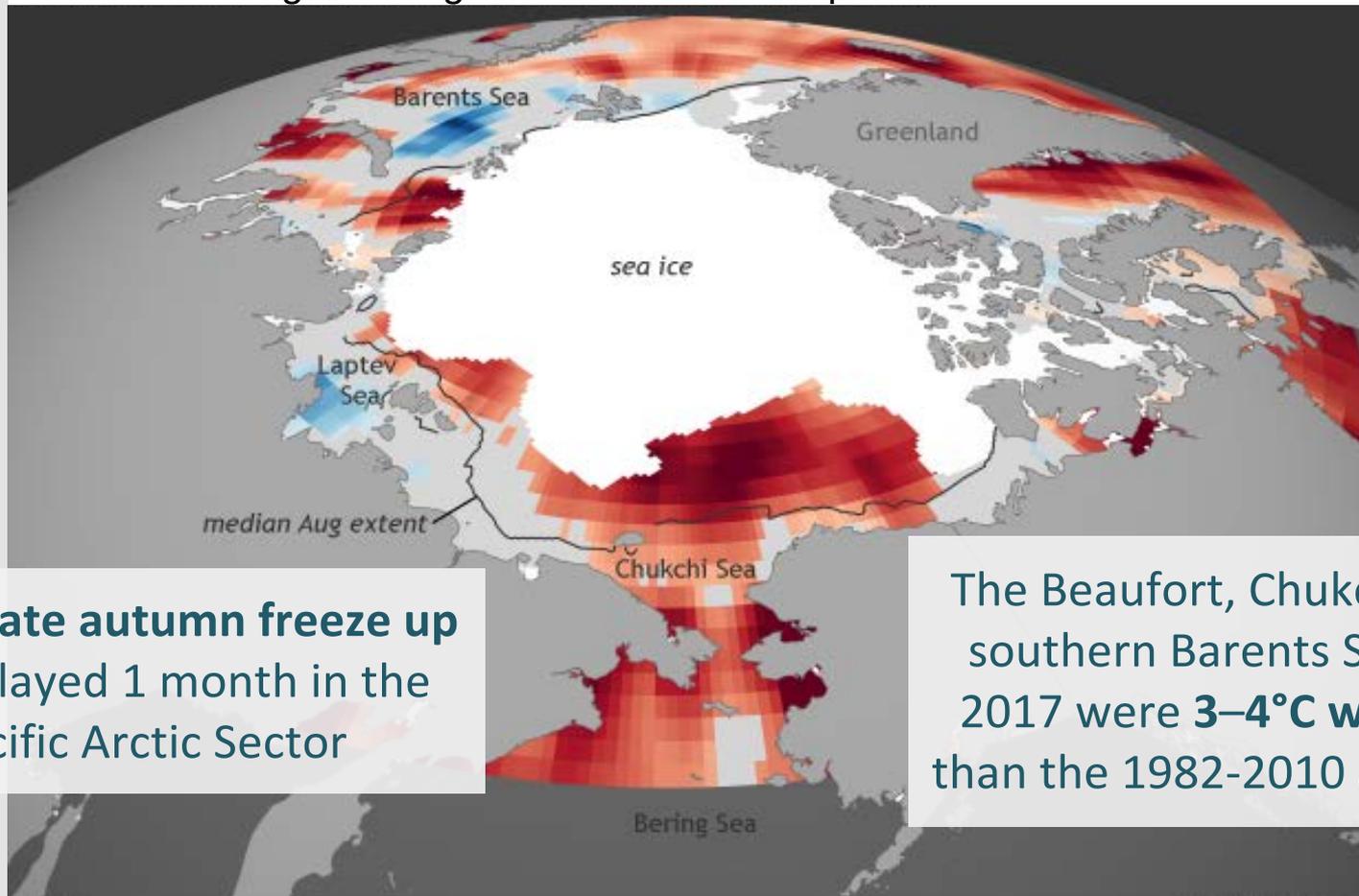
Ten of the lowest  
September minimum extents have  
occurred in the last 11 years.

Paleoclimate records indicate that  
the magnitude and sustained rate  
of sea ice loss is  
**unprecedented in the last 1,450 years.**

# Arctic Ocean

## Warming Seas and Delayed Freeze Up

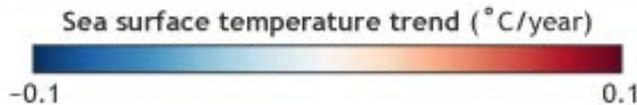
Changes in August Sea Surface Temperatures Over Time



Record late autumn freeze up was delayed 1 month in the Pacific Arctic Sector

The Beaufort, Chukchi and southern Barents Seas in 2017 were 3–4°C warmer than the 1982-2010 average

August  
1982–2017



NOAA Climate.gov  
Data: ARC 2017

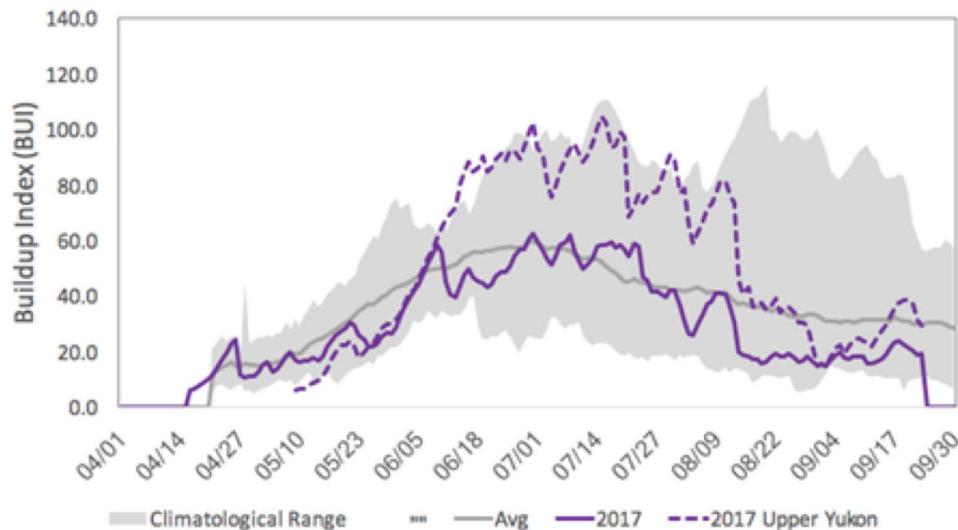
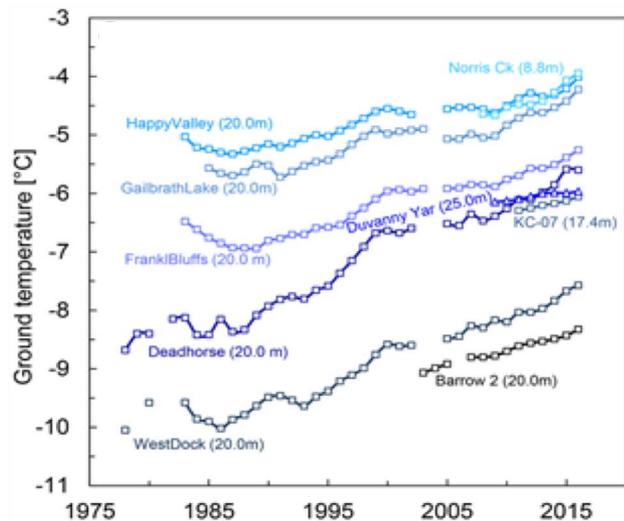


# Arctic Land

## Permafrost Thaw and Wildland Fires

Record high air temperatures in the North slope of Alaska correlate with many 22-year record breaking permafrost temperatures

More than **410,000 acres** were burned (63% of 2017 Alaska) in the Upper Yukon Zone in North East Alaska



Ben Jones, USGS



Alaska Native Science Commission



Beth Ipsen/BLM



Ed Stuzik, Yale

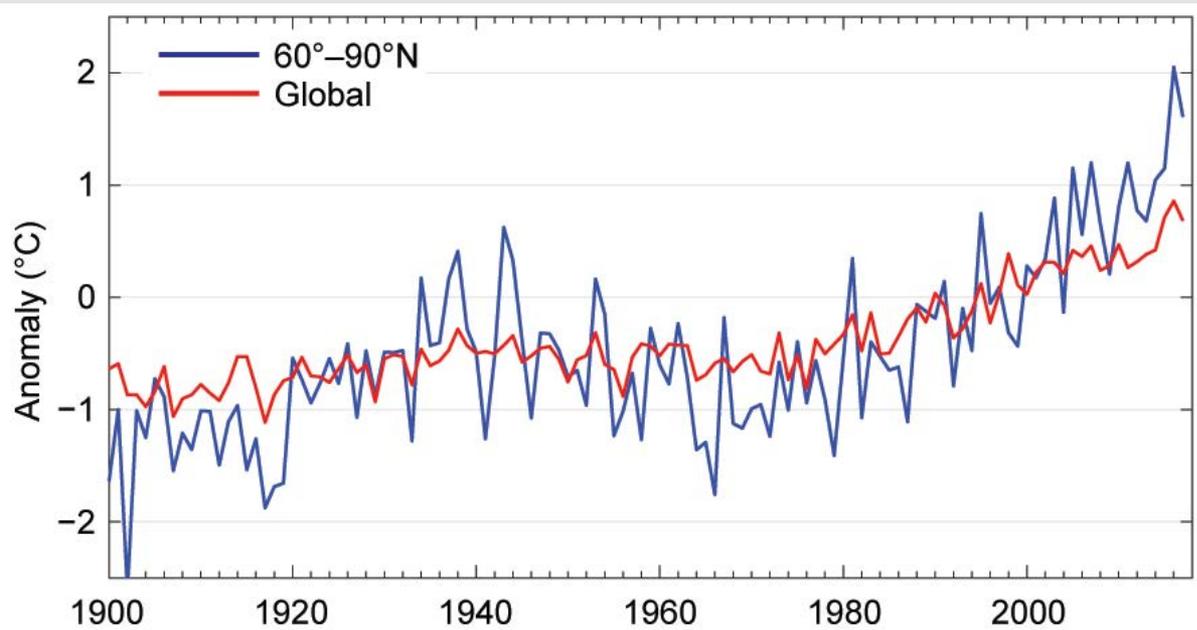


NOAA



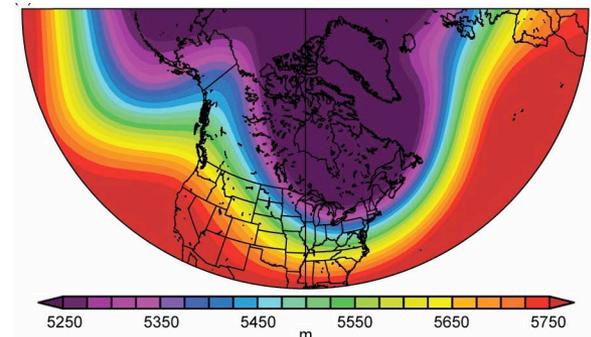
# Arctic Amplification and Midlatitude Weather Events

The Arctic continues to warm at twice the rate of lower latitudes, **2017 was the 2<sup>nd</sup> warmest year on record**



Record of Arctic (north of 60°) and Global mean Surface Air Temperatures 1900–2017

A warmer Arctic influences **midlatitudes**



Strong wave jet stream pattern in December 2017 resulted in a warm Alaska and cool central US

# For More Information

Link to Full Report and Today's Presentation:

<https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/>

