Recent Weather Extremes: Outliers or a New Normal?

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Presentation Outline

- Overview of the 2017/18 Seasons
- Extreme Event Attribution
- Expected Impacts of Climate Change on Extreme Weather
- Importance of the Historical Record
- Putting Recent Extremes into Perspective

Recent US Weather and Climate Disasters
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Number of Events Increasing Mainly from Severe Storm

Recent Losses Dominated by US Hurricane
Extreme Event Attribution

The Analogy with Baseball and Steroids

The weather on steroids

An analogy... Climate warming is changing the weather like steroids change a baseball player.

Changes in the Mean and/or Variability Greatly Increase Probability of Extreme Events

Assuming a normal distribution of some weather variable (temperature),...
A shift of 1/3 σ in the mean will double the likelihood of an extreme event.
An increase in the variance by 20% does the same.
Climate change can shift the mean and (skew) the variance.
This is actually happening and likely to continue.
Extreme Event Attribution Typically Involves Analyzing Data and Running Climate Models

**OBSERVATIONS**
Seasonal cyclone energy in the western North Pacific (1970-2015)

**MODELS**
Odds of a North Pacific cyclone below the 90th percentile

**CHANGING RISK**
of a western North Pacific cyclone season like 2015’s

A Dynamics Explanation for Weather Extremes

Arctic ice melt has reduced the pole-to-equator temperature difference, large planetary waves that normally move slowly around the earth may move more slowly or become trapped, and amplify.

Which Types of Events Have Been Most Likely Influenced by Climate Change?

Overall confidence in event attribution is strongest for extreme event types that are:
- adequately simulated in climate models
- have a long-term historical record of observations
- are linked to human-caused climate change through an understood and robustly simulated physical mechanism
Expected Impacts of Climate Change on Extreme Weather

Expected Climate Change Impacts on Precipitation

Expected Climate Change Impacts on Tropical Cyclones

- GCMs do show increase in Cat 4s and 5s by latter this century
- Overall decrease in TC numbers
- Precipitation will increase
- Storm surge threat will increase
Expected Climate Change Impacts on Severe Storms

Expected Climate Change Impacts on Wildfire

Climate Change Impacts on Extreme Weather
Examining the Historical Record for Climate Trends

Looking at Historical Trends – Precipitation

Observed change in annual precipitation over land 1951–2010

US Landfalling Hurricanes Do Not Show a Trend
Some US Tornado Features are Showing Trends

- Number of Outbreaks (n ≥ 4)
- Maximum Outbreak Size

Potential For Severe Weather Has Been Increasing


One Ingredient For Wildfires Shows Some Trend

- Camp Fire 2018
- Autumn Diablo counts Butte CA
Some Noteworthy Records Were Set in 2017

• 2 Cat 4 landfalls in 15 days
• 2 Cat 4s at the same time
• 3 hurricanes at same time
• 3 Cat 4 landfalls in US/Territories
• 4 hurricanes in August
• 10 hurricanes in a row

How Unique was 10 Hurricanes in a Row?

Historical – 986 hPa
Stochastic – 986 hPa

Note: hurricane defined when central pressure is at or below 996 mb
How likely are 2 Cat 4 LFs in 15 Days?

- Multiple ATL Basin LFs in 2 weeks is quite common historically.
- More 2 week LFs since 1951.
- Stochastic probabilities similar to historical ones.
- For two Cat 4s in 2 weeks, historical probability is 2.54% vs. 1.82% for stochastic.

Colors correspond to categories involved.

Recent Hurricane Loss Activity Still within Historical Norm.
Cat Models Put Historical Losses in Proper Perspective

![Graph showing historical hurricane losses from 1900 to 2017 USD & Exposure.](image)

Events Like Harvey will Occur More Often

![Map showing hurricane track and model output.](image)

Historical record does show trend in forward speed, latitude of maximum intensity, and intensity.

Some Climate Change Impacts on TCs are Evident Now

**Impact on Hurricane Florence**

- Increased Intensity: 5%
- Decreased Forward Speed: -25%
- Increased Moisture: +7%

\[
1.05 \times 0.75 \times 1.07 = 1.50
\]

Historical record does show trend in forward speed, latitude of maximum intensity, and intensity.
Putting the 2017 & 2018 Wildfires into Perspective

2017 and 2018 Wildfires By the Numbers

5 of the top 10 most destructive California wildfires
2 largest wildfires in California history
USD 29 billion in insured cat losses

Northern California wildfires
October 8 – October 31
Burned area: 245,000 acres
Structures destroyed: 8,900
Costliest group of fires on record
Tubbs Fire costliest on record (until 2018 Camp)

Southern California wildfires
December 4, 2017 – January 12, 2018
Burned area: 308,000 acres
Structures destroyed: 1,355
Thomas Fire largest on record (until 2018 Ranch)
2018 Wildfires By the Numbers

- **Camp Fire**
  - Nov. 8 – Nov. 25
  - Burned area: 155,000 acres
  - Structures destroyed: 19,000
  - Deadliest and most destructive fire in CA history

- **Mendocino Complex Fire**
  - Jul. 27 – Sept. 18
  - Burned area: 460,000 acres
  - Structures destroyed: 280
  - Largest fire in CA history

- **Woolsey Fire**
  - Nov. 8 – Nov. 21
  - Burned area: 97,000 acres
  - Structures destroyed: 1,643
  - Ignited same day as Camp Fire and several other statewide fires

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California’s Top 20 Wildfires

From https://www.iii.org/fact-statistic/facts-statistics-wildfires

Area Burned Has Definitely Been Growing

From https://www.iii.org/fact-statistic/facts-statistics-wildfires
Wildfire Events of 2017 and 2018 are Not Tail Loss Events

Summary

- Weather catastrophes are getting more frequent and more costly with time
- Climate change may be playing a role b/c extremes for many weather phenomena expected to increase in intensity and frequency by 2100
- Extreme Event Attribution shows promise for understanding climate change influence on individual events
- Many aspects of 2017 and 2018 US hurricane activity are within current model expected probabilities
- 2017 and 2018 California wildfire events are not tail events
- Too early to tell if we are entering a new norm for many weather & climate phenomena