Recent Weather Extremes: Outliers or the New Norm?

Peter Sousounis, Ph.D.
AIR Worldwide
Boston, MA
Presentation Outline

• Some Recent Extremes
• Extreme Event Attribution
• Expected Impacts of Climate Change
• Putting Recent Extremes into Perspective
Some Recent Extremes
US 2017 Billion Dollar Weather and Climate Disasters

This map denotes the approximate location for each of the 16 billion-dollar weather and climate disasters that impacted the United States during 2017.
US 2018 Billion Dollar Weather and Climate Disasters

January–September 2018

This map denotes the approximate location for each of the 11 separate billion-dollar weather and climate disasters that impacted the United States from January–September 2018.
Extreme Event Attribution
What is Extreme Event Attribution?

Extreme event attribution is a new branch of climate change science tasked with evaluating the degree to which anthropogenic global warming was responsible for a particular extreme event.
The Analogy with Baseball and Steroids

The weather on steroids

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

Credit Gerald Meehl, 2012)
Extreme Event Attribution Typically Involves Analyzing Data and Running Climate Models

Attribution analyses generally involve splitting historical record into two time periods and testing for statistically significant differences in extreme events. Models allow scientists to test whether there is a plausible physical link between global warming and behavior of a particular kind of extreme event.

From climate.gov
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

from climate.gov
Expected Impacts of Climate Change on Tropical Cyclones
TC Frequency Will Likely Decrease

- General Circulation Models do show increase in Cat 4s and 5s by later this century
- Overall decrease in Tropical Cyclone numbers - mainly from fewer weak ones
- Precipitation will increase for several reasons
- Storm surge threat will increase because of sea level rise and because of stronger storms
Several Factors are Clouding Our View

Data quality
Length of record
Climate change happening slowly
Climate change signal is small compared to the noise of climate variability
Not looking at the right features
Numerical climate models are not correctly guiding us
Some Climate Change Impacts on TCs are Evident Now

Historical record does not show any trend in US hurricane landfall frequency

Historical record does show trend in forward speed, latitude of maximum intensity, and intensity.
Most Weather Systems Will Become More Extreme

Climate Change Impacts on Extreme Weather

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Peter J. Sousounis, Ph.D.
AIR-Worldwide
Boston, MA

Christopher M. Little, Ph.D.
Atmospheric and Environmental Research
Lexington, MA
Putting the 2017 Hurricane Records into Perspective

Climate Change and Weather
What About Those Hurricane Records 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 – 996 hPa**

*Note: for other analyses hurricane defined when central pressure is at or below 996 mb*

**Stochastic – 996 hPa**
How about Three Cat 4s in a Row?

Probability of Consecutive Cat 4s or Higher

Historical – 945 hPa

Stochastic – 945 hPa
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
- More 2 week LFs during 1983-2017 than 1951-82
- Stochastic probabilities similar to historical ones
- For two Cat 4s in 2 weeks historical probability is 2.54% vs 1.82% for stochastic
Recent Hurricane Loss Activity Still within Historical Norm

Top Ten US Hurricane Events From Loss

<table>
<thead>
<tr>
<th>Event</th>
<th>Incls Loss (2017 BUSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galveston Hurricane 1900</td>
<td>30</td>
</tr>
<tr>
<td>Great Miami Hurricane 1915</td>
<td>20</td>
</tr>
<tr>
<td>Great Okeechobee Hurricane '26</td>
<td>120</td>
</tr>
<tr>
<td>Great New England Hurricane '28</td>
<td>140</td>
</tr>
<tr>
<td>Ft. Lauderdale Hurricane '38</td>
<td>60</td>
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<tr>
<td>Hurricane Donna '47</td>
<td>60</td>
</tr>
<tr>
<td>Hurricane Betsy '65</td>
<td>50</td>
</tr>
<tr>
<td>Hurricane Andrew '92</td>
<td>50</td>
</tr>
<tr>
<td>Hurricane Katrina '05</td>
<td>50</td>
</tr>
</tbody>
</table>
Summary

- Weather extremes seem to be happening more frequently
- Extreme event attribution shows promise to understand impact of global warming
- Extremes expected to increase in intensity and frequency by 2100
- Some climate change impacts are detectable now
- Most 2017 hurricane extremes are within current model expected probabilities