EXPLAINING EXTREME EVENTS OF 2017

From A Climate Perspective

Special Supplement to the Bulletin of the American Meteorological Society Vol. 99, No. 12, December 2018

Explaining Extreme Events of 2017 from a Climate Perspective

PANELISTS

Jeff Rosenfeld, Bulletin of the American Meteorological Society Martin Hoerling, NOAA Earth System Research Laboratory Julie Vano, NCAR Hydrometeorological Applications Project Lindene Patton, Earth & Water Law Group





Explaining Extreme Events in a Warming World



Explaining Extreme Events in a Warming World



US Northern Plains Drought: Summer 2017



Two Studies in BAMS EEE: Hoell et al., Wang et al.



"The 2017 Northern High Plains precipitation deficits were largely the result of internal atmospheric variability."

"Anthropogenic forcing made the occurrence of observed 2017 drought intensity up to 1.5 times [50%] more likely through aridification due to long-term increases in evapotranspiration"



Australian Wildfires in February 2017



Study in BAMS EEE: Hope et al.



Study in BAMS EEE: Hope et al.

"Increasing atmospheric CO_2 led to higher sfcT and reduced RH. Those factors would lead to enhanced fire danger. The differences between the two estimates [of FFDI using forecasts with and without CO_2 increases] are small "



Study in BAMS EEE: Hope et al.

Current (Fall 2018) US Drought Conditions



Current (Fall 2018) US Drought Conditions



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HYDROCLIMATIC EXTREMES AS CHALLENGES FOR THE WATER MANAGEMENT COMMUNITY: LESSONS FROM OROVILLE DAM AND HURRICANE HARVEY

JULIE A. VANO, MICHAEL D. DETTINGER, ROB CIFELLI, DAVID CURTIS, ALEXIS DUFOUR, KATHLEEN MILLER, J. ROLF OLSEN, AND ANNA M. WILSON



Services of the San Francisco Public Utilities Commission













A perspective from members of the American Meteorological Society Water Resources Committee Attribution studies, when focused on water management concerns, can help water managers navigate record-breaking extreme events.

Temperature can significantly change the magnitude of the water management impact.

Damaged Spillway at Oroville Dam Photo: CĂ DWR Feb 27, 2017

Both meteorological and operational factors are important in most extreme events.

Damaged Spillway at Oroville Dam Photo: CA DWR March 3, 201

Both meteorological and operational factors are important in most extreme events.

New Don Pedro Dam, Photo: TID Water & Power

Duration often determines event severity.

Hurricane Harvey Flooding Houston, TX Photo: Reuters

Maximum 72-hour Average Recurrence Interval



Attribution studies can help management navigate an important paradigm shift IF designed to address questions of the water management community.

This requires improved understanding and engagement between scientists and decision makers.

Hurricane Harvey Flooding Houston, TX Photo: Reuters

"Water management projects, such as dams, are optimized for design events of specific likelihood estimated based on historical records. Are these designs still valid? If not, by how much are we wrong? What are the potential risks for public safety?"

> Alexis Dufour San Francisco Public Utilities Commission

Attribution studies can provide a more informed context for understanding forecasts of extremes that are increasingly beyond our historical experience.

Contact: Julie Vano (jvano@ucar.edu) Michael Dettinger (mddettin@usgs.gov)





Liability Developments

Attribution Science & Foreseeability of Loss

Lindene E Patton, Esq. Earth and Water Law, LLC 10 December 2018



Why would 'attribution science' matter to a non-scientist ?

- Facility design criteria are applied in the context of required performance and reliability standards
- Performance and reliability are affected by environmental conditions
 - Weather;
 - Extreme events; and
 - Changes over time
 - Climate change
- Impacts design criteria
- Impacts Professional and Operator Duties
- Impacts Government Duties
- Impacts Director & Officer Duites

FORESEEABILITY





Source: noaa.gov





















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Solutions for BUSINESS AND THE PLANET Demands ? Claims ?: Ye reactive

- Katrina: levees
- Sandy
- Harvey, Irma, Maria
- Wildfires: CA and CO; and
- Florence
- Mystic River
- Cities & Counties

- Against whom ? ٠
 - <u>Contractors</u>
 - **Facility Owners**
 - Utilities
- Allegations ? ٠
 - Negligence
 - Failure to Disclose
 - Failure to Warn ٠
- Success ?
 - Far more successful than emissions claims
 - Affected by settlements & legislation limiting liability (Examples – N.O. levees & CA legilslation for PG&E; Hailstorm Bill 542A TIC in Texas (Sept 2017); balanced by Manchaca – revives bad faith

The human influence on Hurricane Florence

Kevin A. Reed, Stony Brook University Alyssa M. Stansfield, Stony Brook University Michael F. Wehner, Lawrence Berkeley National Laboratory Colin M. Zarzycki, National Center for Atmospheric Research

- Rainfall: The forecasted Hurricane Florence rainfall amounts over the Carolinas are increased by over 50% due to climate change and are linked to warmer sea surface temperatures and available moisture in the atmosphere.
- Storm Size: The forecasted size of Hurricane Florence is about 80 km larger due the effect of climate change on the large-scale environment around the storm.



Left: Ensemble average accumulated rainfall Hurricane Florence forecasts.

Right: Evolution of the ensemble average outer storm size (radius at peak wind speed of approximately 18 mph). **Red:** Florence in the world that is. **Blue:** Florence in the world that might have been without climate change.



HOME



Ensemble average forecasts for accumulated rainfall from Hurricane Florence using standard meteorological initial conditions (left) and those same conditions with the signal of climate change removed (right).



Foreseeability

Study of the impact of climate change on civil engineering standards:

- See work of Prof. Costa Samaras at <u>https://www.cmu.edu/cee/adaptation/</u>
- <u>https://www.cmu.edu/cee/prospective/graduate-</u> degree/masters/ms-concentrations/climate-change-adaptationfor-infrastructure.html</u>

American Society for Civil Engineers (ASCE)

• See <u>https://www.asce.org/climate-change/committee-on-adaptation-to-a-changing-climate/</u>

American Institute for Chemical Engineers (AIChE) -

see https://www.aiche.org/chenected/2017/11/paic-climate-task-force-attribution-observed-climate-change

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