

Hurricanes and Extreme Precipitation

Q&A Notes and Resources

Links to resources:

- NC Climate Blog: <https://climate.ncsu.edu/ClimateBlog>
- NCICS Research highlights: <https://ncics.org/category/research-highlight/>
- CDC Infographics - What to do before and after a hurricane?
 - [English version](#)
 - [Spanish version](#)
- EPA Factsheets:
 - [Tropical Cyclone Activity factsheet](#)
 - [Heavy Precipitation Factsheet](#)
 - [US and Global Precipitation factsheet](#)
- USDA Hurricane Preparation and Recovery Commodity Guides ([link](#))
- NOAA Extreme Weather Information Sheets (NEWIS)
 - Emergency contact information and other resources for states across the Gulf, including three areas in North Carolina: <https://www.ngdc.noaa.gov/newis/>
- NC Sea Grant Coastal Rivers Flood Mitigation Page: <https://go.ncsu.edu/flooding>
- First Street Foundation - mapping flood risk in the US: <https://firststreet.org/>

Panel Questions:

1. What do you think are the biggest misconceptions about climate change as it relates to heavy precipitation and hurricanes?
 - Jared: He's gotten questions as to whether hurricane season is starting earlier
 - Ken: There is some anecdotal evidence, and certainly this season started early, but probably not enough data at this point to say there's a trend. However, as sea surface temperatures increase, they may be reaching thresholds conducive to hurricane formation earlier in the season.
2. What are the "big" questions related to hurricanes, extreme precipitation, and flooding you see us collectively tackling in the next 5-10 years?
 - Ken: One of the big challenges is that as well as we might understand the science, we have the big question about what society will do, how technology will evolve. That's a really big area of uncertainty about the future, e.g., will we find ways to transition energy from carbon-based to non-carbon-based fuels? From the science side, we need more computing power to better model the global climate, so hopefully that more computing capacity will improve resolution of these models to better understand how hurricane frequency/intensity will change.
 - Barbara: In the Netherlands, they do a lot of stress testing of systems under various scenarios and factor that into design. There's a lot of interest in that approach here in the US, but doing this takes multiple complex steps involving GIS, hydrologic models, and water flow models, so it's difficult to stress test using different scenarios. We need to collaborate to find ways to do repeated runs through this process.
 - Jared: More computational capacity in climate models is needed to better model heavy precipitation changes. On top of that, we need to figure out how to integrate

- the study of these problems and not be siloed on specific areas. Society needs to know what climate science and knowledge can tell us about specific sectors. What knowledge do we have that we can bring to different disciplines?
3. What can we do to get involved or stay informed about your work, or other related activities focused on these topics?
- Barbara: NC Coastal Rivers Flood Mitigation website: <http://go.ncsu.edu/flooding>
 - <https://ncseagrant.ncsu.edu/program-areas/coastal-hazards/n-c-coastal-rivers-flood-mitigation/>
 - Jared: Even the data currently being used is old. Citizen science can help provide updated data. Example: CoCoRaHS (Community Collaborative Rain, Hail, and Snow Network): <https://cocorahs.org/>.
 - For more information about CoCoRaHS in NC, you can also email Darrian Bertrand, and Applied Climatologist at the State Climate Office and the co-state coordinator for NC CoCoRaHS at cocorahs@climate.ncsu.edu

Questions submitted by attendees:

1. What is the definition of "torrential" rain - does that have a meteorological meaning more specific than the colloquial "a lot."
 - a. Ken: 'torrential' is probably a qualitative phrase, probably not a specific meteorological definition
 - b. There is a definition for "heavy" in reference to rain:
<https://www.weather.gov/cae/weatherterms.html>
2. Is precipitable water the same as humidity?
 - a. Ken: Precipitable water and humidity are very closely related. Humidity is a metric representing the amount of water vapor at a particular point or location. Precipitable water is a metric representing the amount of water vapor over the entire atmosphere. If you took a column of the atmosphere from the ground to the top of the atmosphere and condensed out all of the water leaving a pool at the bottom of the column, precipitable water is the depth of that pool.
 - b. NWS definition:
<https://forecast.weather.gov/glossary.php?word=precipitable%20water>
3. How much do infrastructure engineers and designers from various states collaborate? For instance, with all the major precipitation events in LA, TX, FL, are those states working together (and with NC) to design infrastructure solutions? Do the states doing these kinds of models share their data/models?
 - a. Jared: Good question - we are working with federal highways to have more collaboration across state DOTs.
 - b. Jared: This is the first project he's had with state DOT, so limited experience, but the Federal highway system is working on this a lot, so one question is how can that Federal-level information feed into state DOT planning. But DOTs vary from state to state and so do precipitation patterns and types of storm events. So infrastructure design has to be specific to the type of storms in an area.

- c. Barbara: The Transportation Research Board has annual meetings, and some focus on resilience, and include researchers presenting results.
4. Do the models for pseudo global warming (PGW) assume that these storms will occur (e.g. Florence would happen at all)? Since there's not consensus on the number of storms. Do these models start from the assumption that a storm has formed, and then go from there?
 - a. Jared: The PGW simulates the historical event of concern and how this event may change in response to a warmer climate; So it doesn't assume changes in the number of storms; We simulate the storm as it develops across the Atlantic; The storm track may slightly change and could hit slightly different areas; however, not likely to have huge changes to represent other states; each state would have to identify the storms they were interested in simulating
5. Has anyone considered reducing flooding by paying farmers to keep their soil covered, especially during hurricane season? Reduced tillage and cover crops, rather than bare soil, let a lot more water sink into the ground and keep the soil intact rather than letting both soil and water wash into the creeks.
 - a. Barbara: Have seen some of this in Iowa, but driven more by water quality considerations. Problem is that the heaviest flooding tends to occur when ground is already very saturated (e.g., from multiple heavy events). What they are looking at is paying farmers to store water, e.g. using berms.
 - b. If you saturate/flood farmland, want that also possibly flood country roads?
 - i. Barbara: Would have to be very careful about this to avoid flooding other areas, so they factor that in Need limited slope, contiguous area without homes, roads, etc that would also be flooded.
 - c. What about using built sinks around parks or playfields?
 - i. Barbara: Haven't looked at that, but have looked at forested areas and existing wetlands--ways to increase temporary storage in those areas, possibly using berms.
6. FEMA flood maps: are they looking to the future, or still looking just at the current situation?
 - a. Barbara: Still based on historical data. The city of Charlotte has looked at growth/build-out to remap flood plains and develop new floodplain ordinances.
7. Related question: Has anyone considered looking at changes to FEMA flood areas compared to changes in rain events...and try to look to the future?
 - a. There's been some work done by the First Street Foundation to
8. Why do low pressure areas form over Africa and why do these systems move from west to east?
 - a. Ken: Over the northern subtropics of Africa (the Sahel), summer is the rainy season and this is manifested by clusters of thunderstorms which move generally from east to west following the prevailing wind flow (see below). Randomly, areas of weak low pressure form in this area and these are preferential locations for thunderstorm formation. When these move off the continent into the Atlantic, they now have a virtually limitless source of moisture. If the ocean surface is warm enough (greater than about 80F) and other weather conditions are favorable, these thunderstorm

clusters can become organized and develop their own self-amplifying low pressure field.

- b. In the subtropics, the prevailing wind flow is from east to west. The reason is the rotation of the earth, which produces a force known as the Coriolis force which in the Northern Hemisphere deflects winds to the right. The maximum amount of energy from the sun is received at the equator. This triggers widespread thunderstorms along the equator. As air rises in the thunderstorms along the equator, this air has to be replaced and this air is drawn from the subtropics. As the air is drawn in, it is deflected to the west by the rotation of the earth (Coriolis force).
- c. To learn more about how hurricanes form, visit NOAA's SciJinks page on "How do Hurricanes Form?" ([here](#)).

Pre-Poll question: Have you personally been affected by a hurricane or other heavy precipitation in the recent years?

- Yes! Flooding in our backyard from heavy April rains 2 years
- Yes; Hurricane Floyd
- Heavy abundant rain through the spring then the dry spells followed by rain rain and more rain in the mountains is a challenge
- No not since Fran
- Hi. We have never been affected by a hurricane.
- Yes! In Asheville recently
- Heavy rain Savannah tornado
- Flooding from Florence
- Yes, in TX, and a few years ago meadow had 10 feet briefly
- Yes, blew out windows at mountain house during Hurricane Florence. Never thought I would have to worry about a hurricane in the mountains!
- Meadow in floodplain along Green River
- Yes. Started with Bertha & Fran in 1996.
- No direct experience with hurricanes, but we get a lot of residual heavy rainfall almost every year with creek flooding on the lower portion of our property as a result of hurricanes passing nearby.
- Isabel was the worst for me and my son we were in Bertie County then and no electricity for 3 weeks
- Yes, definitely, all of them. I grew up in Wilmington and still live in southeast
- Yep. I'm in Onslow.
- Yes was on the coast for Isabell and we were without water and electricity for 10 days..
- My begonias met their match with the 6" of rain in downtown Raleigh at the end of August
- Yes. I lived in Tampa and had to deal with quite a few hurricanes including the 2005 season which saw Katrina, Rita, and Wilma. We lost electricity for two days.
- lost a bridge on the greenway due to flooding, the greenway has been shut down several times over the past 3 years
- Yes, research sites were under water for 10 days!
- ***In addition to these, we received 6 additional "yesses" and 3 additional "nos".***