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In This Issue:

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Synthesis of Hurricane Barry Report

Vincent Brown, SCIPP Research Assistant/LSU Department of Geography

As of August 30th, 2019, Hurricane Barry remains the only tropical cyclone to make landfall in the United States in 2019. The 2019 hurricane season has been quiet thus far, but that is likely to change as we approach the climatological peak in tropical cyclone activity for the Atlantic. In fact, as of this morning, Hurricane Dorian had a forecasted track near the east coast of Florida, possibly as a major hurricane. Before we say hello to Dorian and goodbye to Barry, it is worthwhile to revisit the unique characteristics of Hurricane Barry to better understand the complex nature of these storms and why they're difficult to forecast.

Hurricane Barry was both a success and failure with regards to its forecast. The initialization and tracking of Barry, as well as its forecasted strength, were done quite well. The National Hurricane Center (NHC) detected and monitored a broad area of low pressure over the central United States, migrating south into the GOM, 5-days in advance of it becoming a tropical storm (Fig 1). This type of early forecasting — the detection of disturbed weather inland in the southeastern United States turning into a Hurricane and making landfall in Louisiana —might just be unprecedented. Models showed slight disagreement from July 10-11th regarding the landfall zone but agreed quickly thereafter. Almost all models released on July 11th forecasted Barry becoming a Hurricane and making landfall in Louisiana. Most issues regarding the diverging tracks were related to the disorganization of the system, making it difficult to accurately initialize the models without an accurate storm center. Forecasting is particularly challenging under these circumstances. Overall, the forecasted tracking and strength of the storm is considered a huge success, while the precipitation forecast was a completely different story.

Hurricane Barry was forecasted to be a rainmaker because of its slow movement, warm Gulf of Mexico sea surface temperatures, and ample tropical moisture. 7-day precipitation estimates released on July 11th were in the 10—15-in. range with localized areas forecasted to receive +20 in. across southeastern Louisiana. While a few locations across southern Louisiana did experience impressive rainfall totals (23.68 in. at Ragley, LA, and 18.16 in. at Oberlin, LA) (Fig 2), the widespread heavy rainfall that was

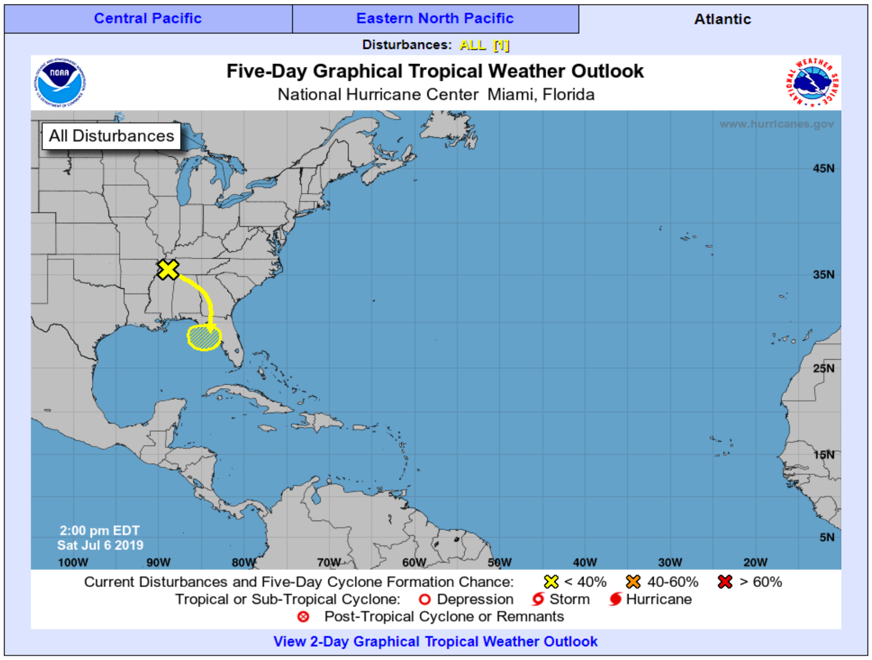

Figure 1. First Tropical Weather Outlook produced by the National Hurricane Center at 2:00 pm EDT, Saturday, July 6th 2019 concerning an elongated trough over Tennessee and northern Mississippi. This is the first sign of Hurricane Barry.

forecasted never arrived. Most precipitation totals in areas like New Orleans and Baton Rouge were less than 5 in., spurring criticize from the public. Precipitation forecasts for Hurricane Barry did not validate because of wind shear, dry air, and the difficulty in forecasting the location and timing of tropically induced rain bands.

Hurricane Barry is a great example of what wind shear can do to a tropical storm. Barry never formed the well-defined eye and circulation expected with most hurricanes. Once Barry started to form and tried to intensify, the shear in the environment was too much for the storm to overcome, causing a disorganized and vertically separated storm that was unable to effectively circulate heavy rain bands into southeastern Louisiana. Dry air also limited Hurricane Barry's ability to produce extreme rainfall. Dry air can induce evaporation of liquid water in tropical cyclones, thus removing a critical ingredient needed for strengthening. Tropical cyclones also contain a warm core and evaporation is a cooling process that can reduce vertical motions (convection) within the storm. Dry air is also denser than moist air (water vapor) at a constant temperature and will tend to sink (descend) and warm adiabatically producing layers of warm stable air that can also limit convection. Dry air surrounded Barry and the disorganized nature of the storm could not handle the excess dry air.

So why were the models so wrong with forecasting precipitation totals? For starters, all for the correct ingredients were present (warm moist air, warm SST, low initial wind shear, etc.). With low-shear and high precipitable water, it seemed Barry would have no problem organizing and making use of an energy-packed environment (initially) to produce extreme precipitation. What the models did not anticipate were increases in vertical wind shear and dry air that caused Barry to fall apart. As Barry deteriorated, the forecasted rainfall totals fell as well and eventually synced with what was observed. It is also important to note how difficult it is for both humans and models to forecast where tropically induced rain bands will occur. Some rain bands did arrive in parts of Louisiana, for example, isolated areas like Ragley received over 23 in., but overall, Barry's rainfall totals did not live up to the expectation. For the full report see

http://www.southernclimate.org/documents/Final_Barry.pdf

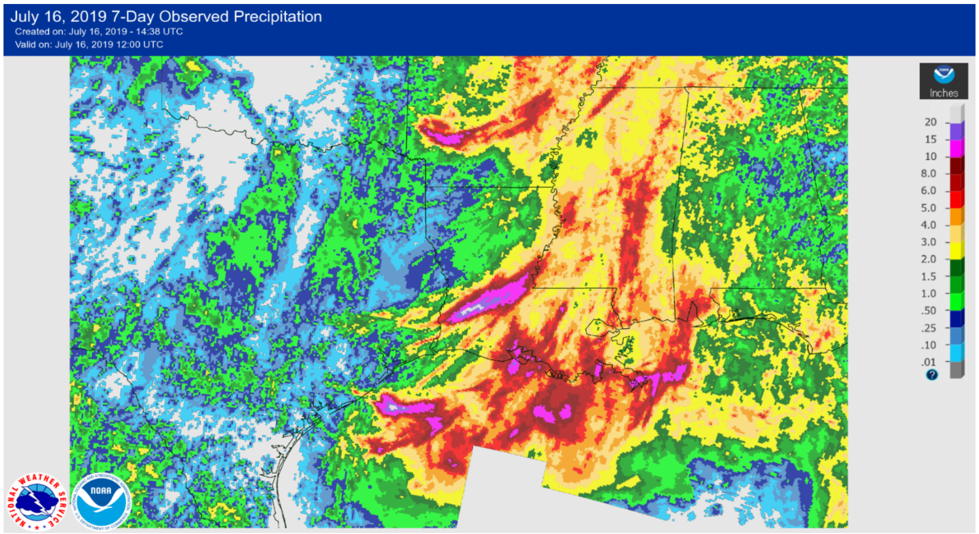

Figure 2. National Weather Service's Advanced Hydrologic Prediction Service 7-day (7/9–716) Quantitative Precipitation Estimates. https://water.weather.gov/precip/

New Research Studies of Interests

Margret Boone, SCIPP Program Manager

An emerging tropical cyclone—deadly heat compound hazard

New research from scientists at Loughborough University in the UK and Maynooth University in Ireland suggests that climate change may increase the risk of dangerous heat events following strong tropical cyclones. Due to the increasing reliance on air conditioning, a combination of high heat index values and power outages may impact larger proportions of the global population. For their study, their criteria for high heat index was values greater than or equal to 105 F (40.6 C), and tropical cyclone pressure of less than or equal to 945 mb (945 hpa). From observational records (1979-2017). Using these criteria, there were 4 tropical cyclones events with subsequent high heat index over the observational record period. These were classified as TC-heat events. However, under climate change scenarios, researchers found a rapid, non-linear increase in these TC-heat events. An increase in TC-heat events means a larger percentage of the population could be affected. These heat events following a tropical cyclone could be dangerous and deadly as vulnerable populations are at risk.

For more information: https://doi.org/10.1038/s41558-019-0525-6

Extended U.S. Tornado Outbreak During Late May 2019: A Forecast of Opportunity

New research released in Geophysical Research Letters discusses the use of subseasonal forecasting tools that were successful in forecasting one of the most active periods of severe weather in the last few decades, including the 374 tornadoes, that occurred between May 17-29, 2019. Researchers from Northern Illinois University, IBM, Central Michigan University, and the United States Naval Academy created the Extended Range Tornado Activity Forecast (ERTAF) team. The ERTAF team focused on following the synoptic-scale conditions that have been shown, through previous research, to be favorable precursors to periods of active severe weather and tornadic development. The team focused on the synoptic-scale and global patterns in the subseasonal forecast period, which is 2 weeks to 2 months before an event. Multiple variables were considered by the ERTAF team, and can be found in more detail in their research article. However, along with several other features, the Madden-Julian Oscillation (MJO) convection can serve as a leading indicator of potential upcoming tornadic activity. Synoptically, conditions that led to a persistent upper-level trough over the western US and a ridge aloft over the eastern US were signals to watch for forecasting potential tornadic activity. Subsequently, the ERTAF team was able to issue a forecast of "Above Normal" tornado frequency on May 5, 2019 for the period May 19-25, 2019. These forecasts may be the first successful forecast of tornado activity at the subseasonal scale.

For more in-depth information: https://doi.org/10.1029/2019GL084470

Weather and Climate Impacts on Military Operations

Margret Boone, SCIPP Program Manager

In September 2018, representatives from six Oklahoma military installations along with members of the weather and climate research community across the University of Oklahoma participated in the workshop, Weather and Climate Impacts on Military Operations. The SCIPP team, in conjunction with the Colleges of Atmospheric and Geographic Sciences and Engineering, hosted this workshop. The six military installations represented included: Altus Air Force Base, Tinker Air Force Base, Vance Air Force Base, Ft. Sill Fires Center of Excellence, McAlester Army Ammunition Plant (MCAAP) and the Oklahoma National Guard. This was an accomplishment to bring together representatives from all 6 Oklahoma military installations, 9 University of Oklahoma weather and climate programs, and 4 federal agencies for a one-day workshop.

The purpose of the workshop was to begin a conversation about the impacts of weather and climate on missions and operations at the six military installations in Oklahoma and broader regional, national, and global operations, as well as how the weather and climate programs at the University of Oklahoma and the National Weather Center could assist with analyzing weather- and climate-related risks. This workshop also discussed the latest technology, research, measurements, and operations that could be harnessed to help address weather-related concerns.

Several recurring topics arose from the breakout discussions, including the need for a more national level discussion, a need for a better understanding of winter weather, and better tools for predicting and forecasting both winter weather and hail events, more opportunities to learn from forecasters in the state, and more tools and products related to hydrologic modeling. There was also interest in continuing the discussion, with more in-depth topics. The findings from this initial workshop indicated the need and desire to continue communication between these two entities and provided motivation for future endeavors in increasing collaborations and opportunities to help reduce weather and climate impacts on Oklahoma's military installations.

Figure 1. Afternoon breakout discussion during the Weather and Climate Impacts on Military Operations workshop on September 10, 2018.

Building off of this September meeting, CIMMS, in conjunction with NOAA's National Severe Storms Laboratory and SCIPP, submitted a proposal to NOAA to work with the Oklahoma National Guard on enhancing long-term preparedness. The project seeks to improve integration of climate and forecast information into National Guard operations to improve their ability to anticipate and respond to events that may require deployment. Climate change is increasing the frequency and severity of flooding, the intensity of hurricanes, and the frequency of large wildfires, all of which requires National Guard resources. The project will examine advance warning of significant events, use of Warn-on-Forecast information to keep deployed personnel safe, and examination of economic impacts of significant events on National Guard operations and facilities. This proposal was accepted and the project started in September 2019.

Similarly, additional discussions have resulted in further collaboration with Altus Air Force Base. A contingent from the Base visited the National Weather Center to expand upon discussions initiated from the September 2018 meeting hosted by SCIPP. The discussions led to connection to training opportunities for weather-related incidents, discussions about use of the Wet Bulb Globe Temperature thresholds used for training safety, and potential climatological analyses that can improve scheduling and operations. These topics will be examined in further detail moving forward.

COCA Engagement Update

Vincent Brown, SCIPP Research Assistant/LSU Department of Geography

Recent research conducted by SCIPP's Dr. Vincent Brown and Dr. Barry Keim on changes in hourly precipitation across the Southeast United States was published in the Journal of Hydrometeorology (https://journals.ametsoc.org/doi/abs/10.1175/JHM-D-19-0004.1). The manuscript, titled "Climatology and Trends in Hourly Precipitation for the Southeast United States", highlighted the increasing intensity and decreasing duration of hourly precipitation events across the region from 1960—2017. This research was presented at the Plaquemines Parish Historical Society and New Orleans Department of Homeland Security and Emergency Preparedness at New Orleans City Hall in August. In attendance (in New Orleans) were representatives from the Office of Resilience and Sustainability, New Orleans Sewer and Water Board, Port of New Orleans, City of New Orleans Office of Homeland Security and Emergency Preparedness, and many more (Fig 1). The City of New Orleans, like many cities across the United States, has experienced frequent heavy precipitation events that often overwhelm the cities current flood prevention infrastructure. Local officials were eager to hear how precipitation has fluctuated in the past as well as how it might change in the future.

Local media outlets were also interested in the published research, as four separate media outlets requested interviews. The Advocate, a popular news source in Louisiana, wrote an article, titled "Why is Louisiana seeing more 'showers on steroids,' intense downpours these days?" related to results from the previous mentioned manuscript. Dr. Brown also did radio interviews with WWL (radio station in New Orleans, LA), Louisiana Radio Network, and WWNO (National Public Radio Station in New Orleans, LA). Following the presentations and interviews, Dr. Brown and Dr. Keim received multiple emails requesting more information. The two have an upcoming presentation scheduled with the City of New Orleans Sewer and Water Board and hope to continue to collaborate with stakeholders in the region.

NOTE: This article is an extenstion to the Feature Article about Hurricane Barry.

Figure 1. Dr. Vincent Brown presenting at New Orleans City Hall on precipitation in a changing climate. August 8th 2019.

Some Facts about the Mississippi River

Barry Keim, Louisiana State Climatologist

I think all Louisianians, Mississippians, and Arkansans have at least some rudimentary understanding of the importance of the Mississippi River. For example, without it, southeastern Louisiana wouldn't exist, as the very land resting beneath the Mercedes Benz Louisiana Superdome was lain down by the Mississippi River. The following are some interesting facts that you may not have known about the River. From the headwaters at Lake Itasca in Minnesota to Pilottown in Plaquemines Parish, the meandering river's length is about 2,300 miles long according the United States Geological Survey. The straight line distance from Lake Itasca to the mouth of the river is about 1,300 miles. As such, we have an extra 1000 miles of twists and turns of river. There are 221 bridges that cross the River — 10 of which are in Louisiana. At New Orleans, the river water flows at about 3 mph, but at slower rates farther north — more like 2 mph. The river's flow tends to peak in late Spring (April and May), following the snowmelt season up north, and is generally at low flow in September and October, after a long summer of high evaporation rates across the country, which serves to reduce runoff. Over the 2300 miles of river, the average drop in elevation per mile is about 8 inches. The river drains approximately 40 percent of the contiguous United States, which includes parts or all of 31 States and 2 Canadian Provinces. At the average flow rate, the river carries about 810 tons of sediment every day, which comes to nearly 300,000,000 tons of sediment every year. It would take over 11 million dumptruck loads to move all the sediment that passes by New Orleans on the river every year. We could build a lot of land with that! It is unfortunate, but most of that sediment is now dumped in the depths of the Gulf of Mexico because our current levee system on the River doesn't allow the River to flood naturally across the wetlands. If you have any questions, feel free to contact me at keim@lsu.edu. Sources for some of this information comes from the following:

<http://www.americaswetlandresources.com/background_facts/detailedstory/MississippiRiverAnatomy.html> and <http://www.nps.gov/miss/riverfacts.htm>.

Rachel Riley

Rachel Riley, Louisiana State Climatologist

Rachel Riley joined the SCIPP team in 2010 as a Research Associate for a 1-year appointment to assess the climate-related needs of decision makers across Oklahoma. Nine years later, she is now SCIPP's Deputy Director.

Rachel grew up in suburban Minneapolis, Minnesota and began aspiring to become a meteorologist during middle school. She attended Iowa State University (ISU) to obtain a B.S. in meteorology and minor in journalism and become a broadcast meteorologist. However, the opportunity to participate in a 10-week summer internship between her junior and senior years at ISU called the National Weather Center (NWC) Research Experiences for Undergraduates (REU) Program, funded by the National Science Foundation, changed her career trajectory. Not only did the REU program lead Rachel to become interested in research, but it also sparked a desire to combine social science and meteorology to improve societal outcomes of hazardous weather events. Rachel went on to the University of Oklahoma and obtained an interdisciplinary M.S. degree in communication and meteorology. The mix of social and physical science knowledge was an excellent fit for SCIPP, which is highly interdisciplinary.

The Oklahoma climate information needs assessment, for which Rachel was originally hired, led to many other research and engagement projects at SCIPP. Over the years Rachel has worked with a variety of decision makers and conducted research on their decision contexts and to understand ways in which climate information can be more useful and usable so that the risks and costs associated with climate-related events to communities across the South Central United States can be reduced. In recent years, she has worked particularly closely with city and regional planners and emergency managers across the SCIPP region, including developing the Simple Planning Tool for hazard mitigation and related plans.

Rachel is an author on several papers and a book chapter and has mentored several undergraduate students through subsequent NWC REU programs and senior capstone projects. She is a member of the American Society of Adaptation Professionals, American Meteorological Society, American Association of State Climatologists, and the Earth Science Women's Network.

Southern Climate Monitor Team

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From Our Partners

USDA Southern Plains Climate Hub

Join Dr. Richard Seager of Columbia University as he presents an examination of arid versus humid regions on the settlement patterns of people and agricultural development as a result of the 100th meridian division of the North American continent.

Dr. Richard Seager is the Palisades Geophysical Institute/Lamont Research Professor at Lamont Doherty Earth Observatory of Columbia University. His current work emphasizes how global hydroclimate will change in the near future as a consequence of rising greenhouse gases. Dr. Seager's main focus is on the implications for humans and ecosystems in semi-arid regions such as southwest North America, the Mediterranean, the Middle East and Africa.

Dr. Seager received his Ph.D. at Columbia University in 1990, following his undergraduate studies at Liverpool University in England. During his career, Dr. Seager has studied ocean processes, mainly in the tropics, and the influence oceans have over the Earth's climate on a seasonal to millennial timescales. Currently at Columbia, Dr. Seager uses multiple tools such as climate models and proxy reconstructions to study the causes of droughts and floods of the past and present. These analysis aid in the understanding of physical processes between the atmosphere and ocean, as well as how these processes impact climate from agricultural practices.

Contact Us

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For any questions pertaining to historical climate data across the states of Oklahoma, Texas, Arkansas, Louisiana, Mississippi, or Tennessee, please contact the Southern Regional Climate Center at (225)578-5021.

For questions or inquiries regarding research, experimental tool development, and engagement activities at the Southern Climate Impacts Planning Program, please contact us at (405)325-7809 or (225)578-8374.

Monthly Comic Relief

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