

Hurricane Florence: Is that our Future?

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Hurricane Florence Rainfall: Where and How Much?

September 14-17, 2018



Hurricane Florence Rainfall



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Hurricane Florence Rainfall



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Hurricane Florence rainfall

- Point rainfall totals
 - o 35.94" Elizabethtown, NC
 - o 35.71" Lumberton, NC
 - o 33.99" Swansboro, NC
 - o 31.26" near Wilmington, NC



Daily Rainfall at Wilmington

Hurricane Florence Daily Rainfall for Wilmington, NC

September 10-20, 2018







How does this event compare with historical events?

National and State Perspectives





- Period of analysis: 1949-2018
- Looking for the biggest multi-day rainfall events over the entire U.S.
- Identified the top 100 events for 1949–2018



Entire U.S.: 20,000 square miles

4-day precipitation events: 20,000 square miles





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4-day precipitation events: 14,000 square miles







Top 10 Events: 20,000 square miles

Rank	Precipitation (inches)	Year	Dates	Location
1	24.1	2017	August 27-30	Texas (Harvey)
2	15.8	1998	September 27-30	Central Gulf Coast (Georges)
3	14.2	2016	March 8-11	northern Louisiana
4	13.7	2016	August 13-16	southern Louisiana
5	13.3	1962	October 11-14	northern California
6	13.3	1994	October 16-19	southeast Texas
7	12.9	2018	September 14-17	Carolinas (Florence)
8	11.7	1986	Feb. 16-19	central California
9	11.4	1994	July 4-7	eastern Gulf Coast (Alberto)
10	11.3	1967	September 20-23	south Texas (Beulah)









Higher Florence Analysis

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Hurricane Florence Analysis

Largest Rainfall Events -Eastern NC: 20,000 square miles





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Trends in Extreme Precipitation

National and Regional





Historical Trends

2-Day Precipitation Events Exceeding 5-Year Recurrence Interval







Historical Trends

Observed Change in Heavy Precipitation







What about the Future?





- Global warming virtually certain global temperatures will increase if atmospheric greenhouse gas concentrations continue to increase
- Regional warming it is very likely that NC temperatures will increase if global warming continues
- Question: How will extreme precipitation respond to warmer temperatures?



Giobal Warming->Saturation Water Vapor Increases





 Recent research indicates that the amount of rainfall in the heaviest events is determined by the amount of water vapor in the atmosphere



Extreme Precipitation Amounts vs Water Vapor



The amount of precipitation in historical extreme precipitation events increases (on average) monotonically with the amount of atmospheric water vapor

Kunkel, K.E., S.E. Stevens, L.E. Stevens, and T.R. Karl, 2020: Observed climatological relationships of extreme daily precipitation events with precipitable water and vertical velocity in the contiguous United States. *Geophys. Res. Lett.*, **47**, e2019GL086721. doi.org/10.1029/2019GL086721



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How will water vapor change in the future?

Ocean surface temperatures will be the primary determinant





- Ocean surface temperatures will be the primary determinant
 - Above water bodies, the atmospheric water vapor content is near the saturation value
 - The saturation value increases by 4% per degree F
- Historical increases in ocean surface temperatures



Historical SST changes – Northern Hemisphere



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Steady historical increase in Northern Hemisphere sea surface temperatures and associated near surface humidity





Gulf of Mexico Warm Season Averaged SST

Years





What About Future Changes in Hurricanes?





- There is no scientific consensus whether the number of hurricanes will increase or decrease in the future
- However, there is a consensus that hurricane rainfall will increase, because of the water vapor effect IF
 - Atmospheric greenhouse gas concentrations continue to rise

