Using Soil Moisture Responses to Diagnose Extreme Rainfall Events Associated with Tropical Cyclones

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Introduction and Background

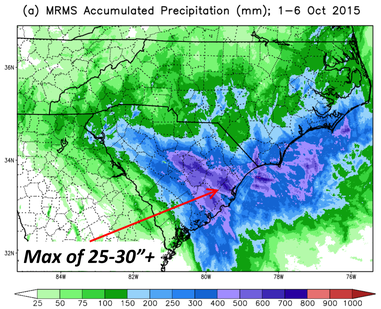
- After a record long 12-year drought in land-falling major hurricanes in the U.S., two major hurricanes struck the U.S. during the 2017 season: Harvey in Texas (24-29 August) and Irma in Florida (9-11 September).
- This poster highlights the modeled soil moisture response to the rainfall from both storms, particularly focusing on the impact of record rainfall from Hurricane Harvey.
- Modeled soil moisture responses are presented through soil moisture percentiles relative to a county-based, 33-year (1981-2013) soil moisture climatology.

Tools, Data, and Methods

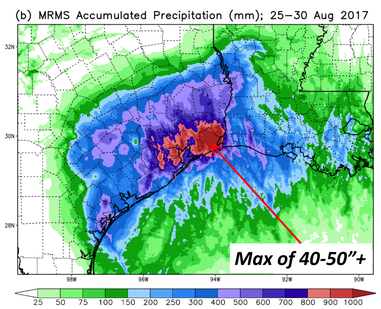
- NASA Land Information System (LIS): Land surface modeling and data assimilation framework for simulating soil moisture, soil temperature, snowpack, and heat/moisture fluxes into the atmosphere.
- SPoRT manages its own real-time instance of the LIS (called the "SPoRT-LIS"), which runs over a Continental U.S. domain at ~3-km resolution with 6-hourly updates.
- SPoRT-LIS is disseminated to partner NOAA/NWS forecast offices. Forecasters use the data to help increase situational awareness, and make more informed decisions on drought monitoring and assessing areal flooding potential.
- A 33-year county-based climatology of the SPoRT-LIS (1981-2013) is used to place current soil moisture values into historical context during major rainfall events from four tropical cyclones: Joaquin (2015), Harvey (2017), Irma (2017), and Florence (2018).

Total Rainfall Comparison

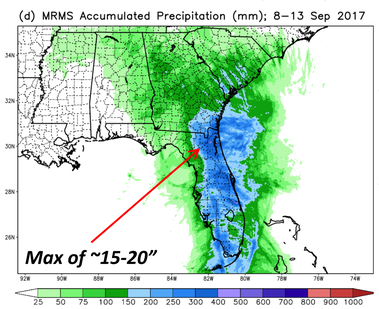
Hurricane Joaquin (2015)



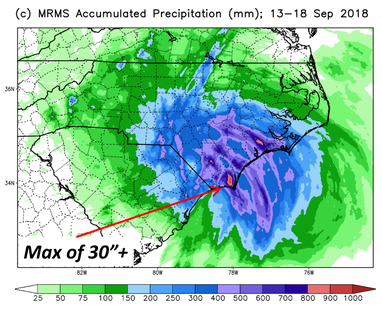
Hurricane Harvey (2017)



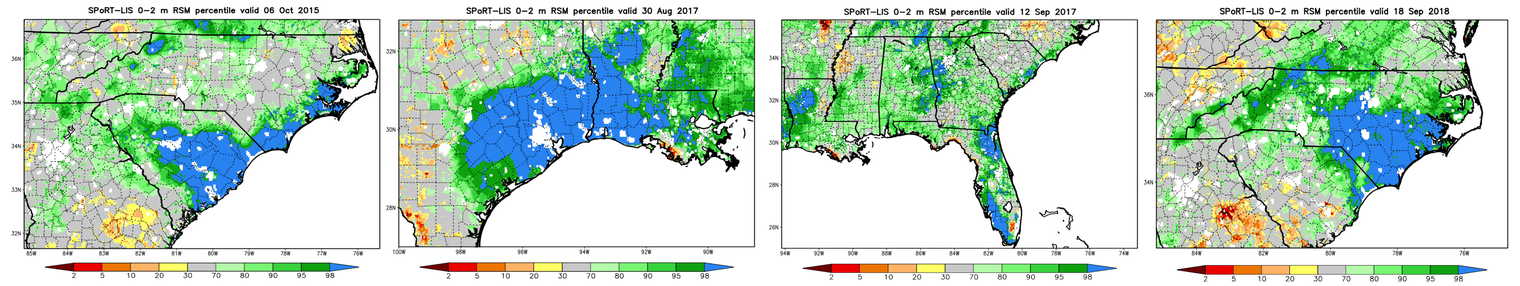
Hurricane Irma (2017)



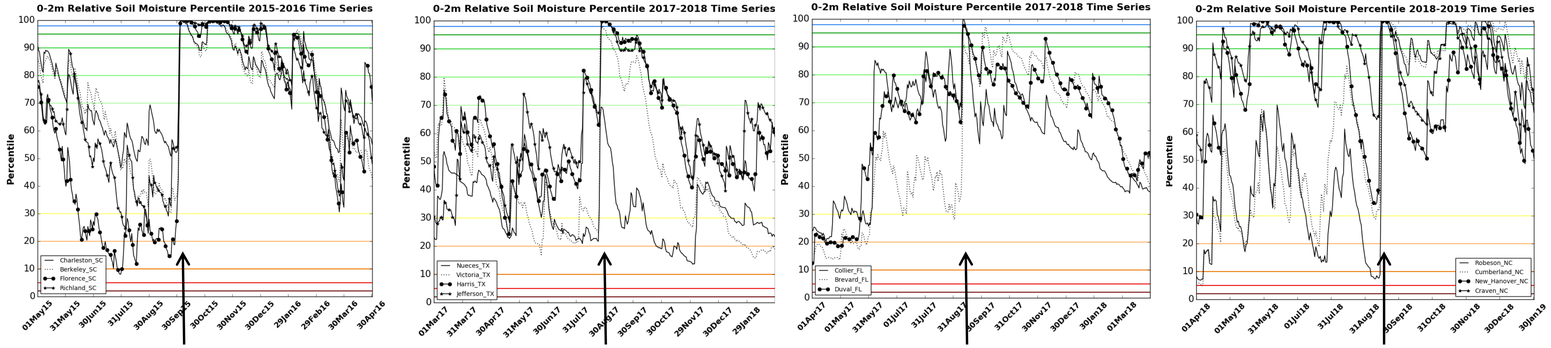
Hurricane Florence (2018)



Post-Storm Modeled 0-2 meter SPoRT-LIS Soil Moisture Percentiles



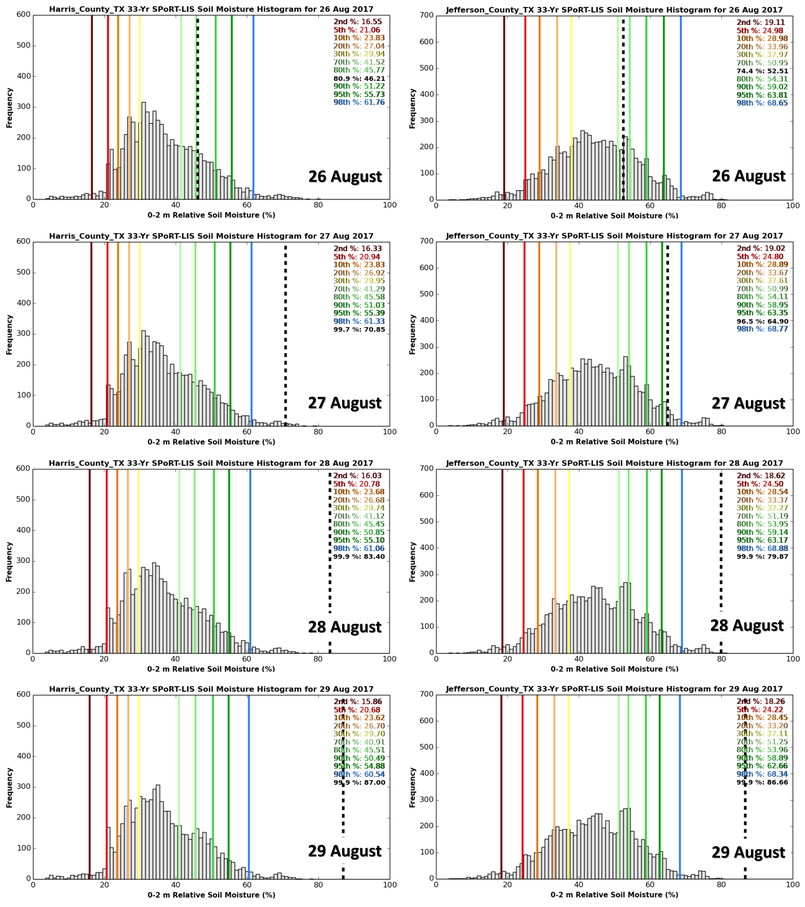
Time Series of County-Averaged 0-2 meter Soil Moisture Percentiles



A Closer Look at Hurricane Harvey Impacts on Soil Moisture:

County-averaged daily 0-2 m percentiles during flooding event

Harris County (Houston) | **Jefferson County (Beaumont/Pt. Arthur)**



***Key for daily histograms:** gray bars denote 1981-2013 climatology distribution for all model grid points residing in a given county; colored vertical lines are reference percentiles used by drought & hydrological communities along with tabular listing of soil moisture values; dashed vertical line is the county-averaged percentile for the current day from August 2017 and corresponding tabular value listed.*

Discussion / Conclusions

- Analysis of soil moisture responses from four tropical cyclones (three of which had extreme flooding rainfall) place each event in historical context, relative to a 1981-2013 climatology database.
- Each tropical cyclone resulted in a significant post-storm areal footprint of soil moisture percentiles above the 98th percentile, except for Hurricane Irma in Florida.
- Rainfall associated with Hurricane Joaquin produced the greatest pre- and post-storm contrast of soil moisture, transitioning from drought to unusually wet over central & eastern South Carolina.
- The residence time of post-storm wetness anomalies ranged from ~3-6 months, but varied widely among storms depending on post-storm rainfall regimes.
- The extreme rainfall of Hurricane Harvey resulted in county-averaged soil moisture values that far exceeded the wet tail of the 1981-2013 distribution for late August in the Houston, TX and Beaumont, TX areas.