Utilizing Precipitation Estimates from NASA Earth Observations & NOAA Climate Data Records to Enhance Understanding of Extreme Events in the Carolinas

Abstract

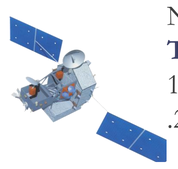
In October 2015, the state of South Carolina experienced a recording-breaking precipitation event leading to detrimental flooding that caused 19 fatalities and over one billion dollars of damages, which has prompted researchers and resource managers to enhance their understanding of extreme precipitation. This project explored multiple satellite-derived Quantitative Precipitation Estimates (QPE) in an effort to capture historical extreme precipitation patterns and risk-prone areas in both South Carolina and the greater southeastern United States. Using NASA Earth observations and NOAA Climate Data Records, we analyzed the benefits of using short-term, high-resolution datasets to measure extreme precipitation patterns compared to surface observations. Satellite observations included NASA's Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Measurement (GPM) mission, as well as NOAA's Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks Climate Data Record (PERSIANN-CDR). Surface observation records were retrieved from the Global Historical Climatology Network-Daily (GHCN-D) estimates, a network of global rain gauge stations. We highlighted areas prone to extreme precipitation with bias adjusted precipitation estimates. Results also assessed variability in precipitation measurements for recent years in an effort to integrate high-resolution QPE into regional climate resilience planning and to address spatial gaps in surface observation datasets. This project served to provide a better understanding of climate stressors for the Carolinas and to pose a discussion on effective methods of developing climate resilience practices integrated with satellite-derived datasets.

Objectives

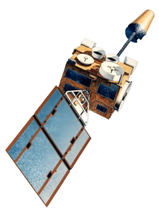
- **Demonstrate** utility of NASA Earth observations (NASA EO) & NOAA Climate Data Records (NOAA-CDR) to measure extreme precipitation in the southeastern United States
- **Evaluate** performance of satellite-derived precipitation estimates (variability & bias) in comparison to rain-gauge observations
- **Collaborate** with project partners (NEMAC & OCM) to engage data-user needs and develop a precipitation data-users guide

Earth Observations

NASA EO:
GPM IMERG
2014-present
.1° resolution

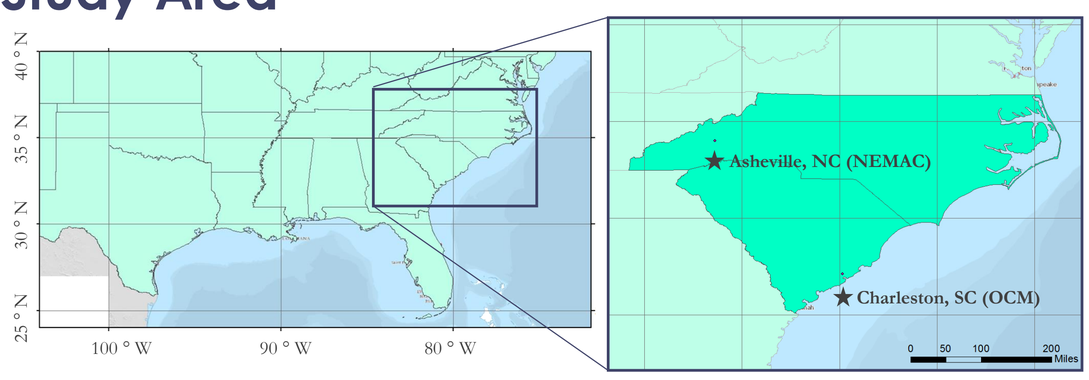


NASA EO:
TRMM TMPA
1998-present
.25° resolution



NOAA-CDR:
PERSIANN
1983-present
.25° resolution

Study Area



Methodology

Data Acquisition
- GPM-IMERG
- TRMM-TMPA
- PERSIANN-CDR
- GHCN-D

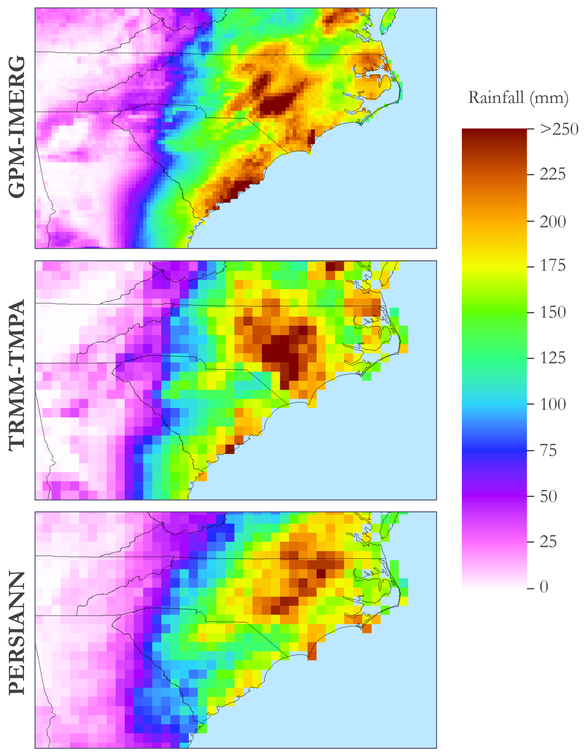
Data Processing
- Subset to the Study Area
- Quality Assurance

Computation & Analysis
- "Extreme" Value Calculations
- Conditional Bias
- Event-based Accumulation

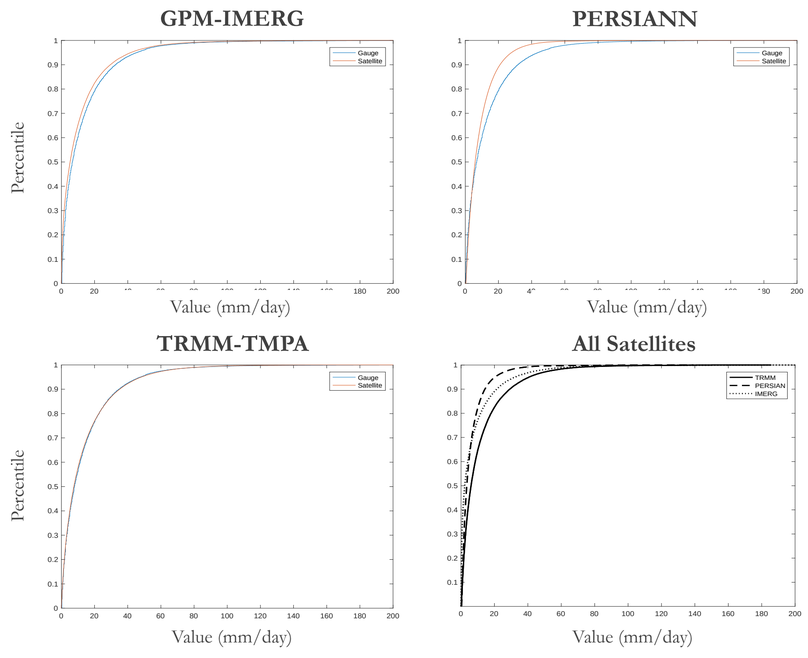
Visualization & Synthesis
- Cumulative Distribution Function
- Scatterplots & Bias Charts
- Percentile & Threshold Maps
- Event Mass Curves & Maps

Results

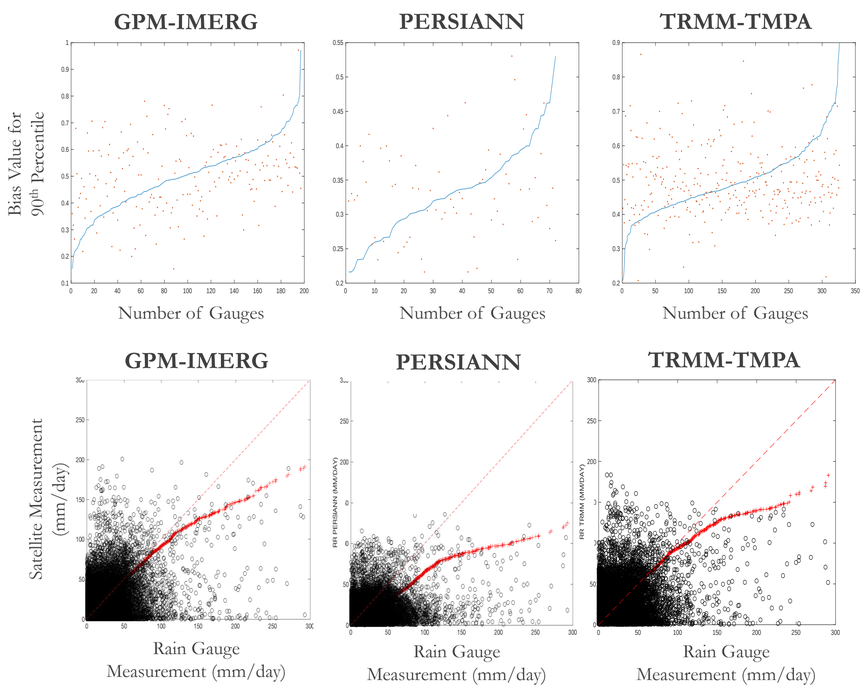
Event Accumulation Maps for Hurricane Matthew (Sept 25, 2016 – Oct 10, 2016)



Cumulative Distribution Function for Satellite vs. Rain Gauge Measurements (2014 – 2016)



Bias Charts & Scatterplots for Satellite vs. Rain Gauge Measurements (2014 – 2016)



Conclusions

- PERSIANN provided long-term (30+ years) information for accurate low to median value precipitation measurements in the region to better capture historical patterns and events.
- GPM IMERG and TRMM TMPA better represented rain-gauge based (GHCN) precipitation observations at extreme values (90th percentile and above) compared to PERSIANN.
- All satellite datasets displayed bias with GHCN as the true value of precipitation. However, GHCN stations showed limited spatial coverage and gaps in data record for some extreme events.
- GPM IMERG provided the highest spatial resolution data in the region and will be a useful dataset to measure precipitation trends as the period of data record increases in the future.

Project Partners

- University of North Carolina at Asheville, National Environmental Modeling and Analysis Center
- NOAA, Office for Coastal Management

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