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

Andrew Shannon[1*], Shelby Ingram[2], Michael VonHegel[2], Matt Hutchins[3], Adam Stein[4], Aaron Mackey[5], Brian Nelson[6], and Olivier Prat[7]

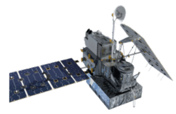
Abstract

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 (CDRs), 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-CDR (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.

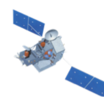
Objectives

- **Demonstrate** utility of NASA Earth Observations (NASA EO) and NOAA Climate Data Records (NOAA-CDR) to measure extreme precipitation in the southeastern United States
- **Evaluate** performance of satellite-derived precipitation estimates (variability and bias) in comparison to rain-gauge observations
- **Collaborate** with project partners (NEMAC and OCM) to reduce data uncertainty and expand information available to users and decision-makers.

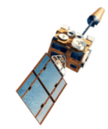
Earth Observations



NASA EO:
GPM-IMERG
2014-present
0.1° resolution

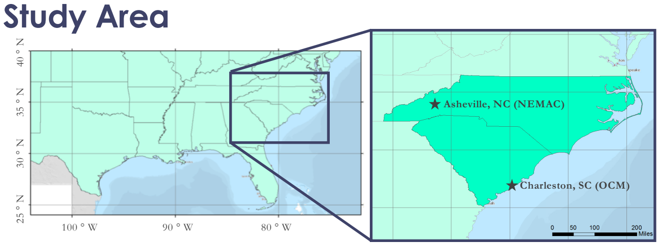


NASA EO:
TRMM-TMPA
1998-present
0.25° resolution



NOAA-CDR:
PERSIANN-CDR
1983-present
0.25° resolution

Study Area



Methodology

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

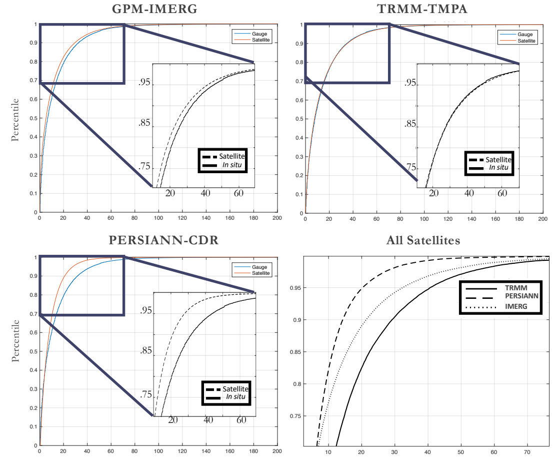
Processing & Computation
- Quality Assurance
- "Extreme" Value Calculations
- Conditional Bias
- Event-based Accumulation

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

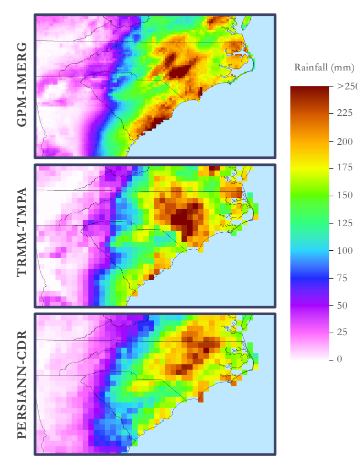
Results

Unconditional and Conditional Bias
Satellite vs. Rain Gauge Measurements (2014-2016)

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



Event Accumulation Maps
Hurricane Matthew (25 Sept-10 Oct 2016)



Project Partners

- University of North Carolina at Asheville (UNC-A)–National Environmental Modeling and Analysis Center **(NEMAC)**
- National Oceanic and Atmospheric Administration–Office for Coastal Management **(OCM)**

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***corresponding author: andrew.shannon@noaa.gov**

Conclusions

- GPM-IMERG products offer enhanced spatial resolution, while PERSIANN-CDR offers longer-term period of record.
- While the satellite products underestimate and show bias from *in situ* observations, TRMM-TMPA and GPM-IMERG estimates more closely match *in situ* values than PERSIANN-CDR at the highest percentiles (90th, 95th, and 99th).
- Satellite data provide homogenous spatial coverage and continuous data records, while *in situ* observations display temporal and spatial gaps, particularly while measuring extreme events.
- Tropical cyclone events can contribute 20-50% of annual water budget in the Carolinas.

Andrew Shannon

Shelby Ingram

Michael VonHegel

Carolina Disasters

Carolinas Climate Resilience Conference
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