**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**North Carolina – NCEI**

**Carolinas Disasters**

*Utilizing Extreme Precipitation Estimates from NASA and NOAA Earth Observations to Enhance Decision Support for Extreme Events in the Carolinas*

**Project Overview**

***Project Synopsis*:** This project will work closely with Adam Stein of NOAA’s Office for Coastal Management (OCM) in addition to collaborators at the University of North Carolina Asheville, National Environmental Modeling and Analysis Center (NEMAC) to test the feasibility of using satellite derived Quantitative Precipitation Estimates (QPEs) to monitor extreme precipitation as related to detrimental flooding events and provide a historical analysis of extreme precipitation trends. The project team will expand upon past research using precipitation data from NASA’s Tropical Rainfall Measuring Mission (TRMM) and from NOAA’s Climate Data Records (CDRs) program to evaluate the impact of extreme precipitation over the Carolinas. The team will also use recently available data from NASA’s Global Precipitation Measurement Mission (GPM). The project results will be integrated into NOAA’s Climate Resilience toolkit under the guidance of NEMAC to provide readily available actionable data to regional governments, organizations, and individuals to address the risk of extreme precipitation in the Carolinas.

***Community Concern:*** In October of 2015, the state of South Carolina suffered from a 1,000-year rainfall event that caused catastrophic flooding across the state. The event resulted in 19 fatalities and approximately $1.492 billion dollars in damages for South Carolina. Detrimental flooding impacts on local infrastructure threaten vulnerable populations and can severely damage critical assets (e.g., equipment, building damage, etc.). In order to avoid these detrimental impacts, accurate and timely estimates of extreme precipitation are necessary for resilience and mitigation planning. Coastal locations along the Carolina coasts are experiencing increases in flooding severity and frequency. Charleston, SC has seen more than a 200% increase in annual flooding events over the past 50 years with two to three days of tidal flooding a year in the 1970’s to a current average of 10 or more annually.

***Source of Project Idea:*** This original project idea came from Dr. Olivier Prat and Dr. Jennifer Runkle of the Cooperative Institute for Climate and Satellites – North Carolina. Dr. Prat with Dr. Brian Nelson of NOAA NCEI recently published several papers evaluating the ability of satellite QPEs to capture extreme precipitation. Dr. Prat and Nelson have a strong interest in testing real-life applications of satellite QPEs as related to extreme precipitation. After approaching node leadership with this research interest, they worked together to identify an end user and impactful application of these precipitation datasets.

***National Application Areas Addressed:*** Disasters, Transportation and Infrastructure, Urban Development, Water Resources

***Study Location:*** NC, SC

***Study Period:*** January 1950 – December 2017

***Advisors:*** Dr. Olivier Prat (Cooperative Institute for Climate and Satellites, NOAA NCEI), Brian Nelson (NOAA NCEI)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **NOAA, Office for Coastal Management** | Adam Stein, Coastal Hazards Specialist | End User | Yes |
| **University of North Carolina Asheville, National Environmental Modeling and Analysis Center** | Matt Hutchins, Research Scientist and Environmental Change Project Lead | Collaborator | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The OCM recognizes flooding as their foremost natural disaster concern as well as the most probable. Operating under the direction of the Coastal Zone Management Act (1972), the OCM seeks to keep the natural environment, developed areas, quality of life, and economic growth of coastal areas in balance utilizing technology, data, and management techniques with local state and national organizations. The OCM addresses these concerns through the National Coastal Zone Management Program, the Natural Estuarine Research Reserves, the NOAA Coral Reef Conservation Program and the Digital Coast website.

***End User’s Capacity to Use NASA Earth Observations:***

*NOAA, Office for Coastal Management* – The end user has not directly used NASA Earth observations for emergency management. This project will enhance their disaster preparedness capacity by providing them with a more thorough understanding of NASA Earth observation data applications to assess vulnerability to extreme precipitation and flooding events.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*University of North Carolina Asheville, National Environmental Modeling and Analysis Center* – NEMAC will assist the teams by guiding them through NOAA’s Climate Resilience Framework with the end users. For the first term, NEMAC will work with the team to ensure that the first term’s end products are applicable to the Climate Resilience Framework.

***Dissemination by Boundary Organizations*:**

*NOAA, Office for Coastal Management* – Adam Stein will distribute project results to regional decision makers including meteorological and hydrological managers, disaster managers and community planners, and coastal resource managers. OCM will further help to distribute project results via the Digital Coast Partnership, a NOAA sponsored website is focused on helping communities address coastal issues, and the National Coastal Zone Management Program, a federal and state partnership that provides the most direct implementation of coastal management policy.

*University of North Carolina Asheville, National Environmental Modeling and Analysis Center* – Decision makers that utilize project results include anyone from regional city planners and community leaders to natural resource managers, and organizational decision makers. Dissemination of project results will be facilitated by NEMAC through the Climate Resilience Toolkit. An inter-agency initiative hosted by NOAA’s National Centers for Environmental Information (NCEI), the Climate Resilience Toolkit was developed and is edited by NEMAC to illustrate climate related vulnerabilities on a local, regional, and national scale.

.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will meet with project partners weekly or bi-weekly via emails and in-person meetings. Communication with end users will occur weekly or bi-weekly via email and teleconferences. After initial partner and advisor meetings, facilitated by node leadership at the NC node, the project lead will serve as the main point of contact.

***Transition Plan:*** The project team will hand off all completed results to the NOAA Office for Coastal Management and the National Environmental Modeling and Analysis Center via a video conference or in-person meeting. The team will also present the results of their extreme precipitation analysis and predicted precipitation changes in the future during the aforementioned hand off meeting. The team will also provide a thorough documentation of their results and methods to NC node leadership to maintain for the second project term.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **GPM GMI & DPR - IMERG** | Precipitation estimates | Precipitation estimates will be used to measure extreme rainfall events associated with flooding. Long-term records from multiple QPE products will be used to project expected precipitation changes in the future. |
| **TRMM TMPA** | Precipitation estimates | Precipitation estimates will be used to measure extreme rainfall events associated with flooding. Long-term records from multiple QPE products will be used to project expected precipitation changes in the future. |
| **PERSIANN-CDR** | Precipitation estimates | Precipitation estimates will be used to measure extreme rainfall events associated with flooding. Long-term records from multiple QPE products will be used to project expected precipitation changes in the future. |
| **CMORPH CDR** | Precipitation estimates | Precipitation estimates will be used to measure extreme rainfall events associated with flooding. Long-term records from multiple QPE products will be used to project expected precipitation changes in the future. |

***Ancillary Datasets:***

NOAA Global Historical Climatology Network-Daily (GHCN-D) *In Situ* Precipitation Measurements – QPE validation

World Meteorological Organization Global Precipitation Climatology Centre (GPCC) Gridded Precipitation Data - QPE validation

NOAA Storm Event Database – Identify extreme events and provide monetary costs estimates and human casualty counts for each event (extreme precipitation, tropical storms, flash floods, storm surges, etc.)

USGS Stream Gauge Data – Measuring discharge and comparing it to elevation data to identify flood zones

***Software & Scripting:***

Esri ArcGIS – Geospatial analyses; map creation

Matlab – Data acquisition, processing, validation, and various statistical analyses

R – Data acquisition, processing, validation, and various statistical analyses

Python – Data acquisition, processing, and validation

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Evaluation of Satellite Derived Quantitative Precipitation Estimates’ Ability to Monitor Extreme Precipitation** | This evaluation will be used by the end users and collaborators to determine which satellite dataset(s) most accurately measure extreme precipitation events. | GHCN-D and/or GPCC gridded precipitation data will be used to validate precipitation estimates from GPM IMERG, TRMM TMPA, PERSIANN-CDR, and CMORPH-CDR. | N/A |
| **Expected Changes in Future Precipitation Maps and Figures** | These maps and figures will inform end users and collaborators of expected future changes in precipitation that will help inform the climate resilience planning in the second term. | Climate trends in precipitation derived from long-term precipitation data and estimates from GHCN-D and/or GPCC. Contextualize projected changes with respect to shorter period of record derived from GPM IMERG, TRMM TMPA, PERSIANN-CDR, and/or CMORPH-CDR will be used to analyze projected changes in precipitation. | N/A |

***End-User Benefit*:** OCM will utilize these end products to inform future disaster management planning against flooding events. Maps and figures of the expected changes in future precipitation will give OCM a better understanding of future vulnerabilities to extreme precipitation.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term

***Related DEVELOP Work:***

2016 Spring (VA) – Wise County Disasters: Utilizing NASA Earth Observations to Identify and Predict the Extent of Flooding and to Mitigate its Risks in Wise County, Virginia

2016 Spring (NC) – Cascades & Sierra Water Resources: A Comparison of Remotely-Sensed Climate Data Records over the Cascade and Sierra Nevada Mountains for Improved Climate Monitoring

**Notes & References:**

***References:***

Spanger-Siegfried, E., Fitzpatrick, M., & Dahl, K. (2014). Encroaching Tides How Sea Level Rise and Tidal Flooding Threaten U.S. East and Gulf Coast Communities over the Next 30 Years (pp. 8-11). Cambridge, MA: Union of Concerned Scientists