**NASA DEVELOP National Program**

**2017 Fall Project Proposal**

**North Carolina - NCEI**

**Hawaii and U.S. Affiliated Pacific Islands Disasters**

*Using Global Climate Models to Create Projections of Future Extreme Weather Events in the Pacific*

**Project Overview**

***Project Synopsis*:** This project will partner with the Regional Climate Services Director (RCSD) for the Pacific Region, Dr. John J. Marra, under NOAA’s National Centers for Environmental Information (NCEI) to analyze potential future changes in and impacts from extreme weather events based on global climate model outputs. This project will extend the work of a previous studies by Kruk et al. (2015) and Marra et al. (2008) in Hawaii and the US Affiliated Pacific Islands (USAPI) that captured the unique combination of impacts caused by high seas, strong winds, and heavy rains under the collective term “storminess.” Various studies predict that a changing climate will worsen the severity of the aforementioned extreme weather events. The project team will utilize rain rate and wind speed data from NOAA’s Ocean Near-Surface Atmospheric Properties CDR derived from the Special Sensor Microwave Imager (SSM/I) as well as higher resolution precipitation estimates from NASA’s Global Precipitation Measurement (GPM) Mission. The project team will create a set of maps for the years 2030, 2040, 2050, 2060, 2070, and 2100 that highlight the return frequency and distribution of extreme events in the region.

***Community Concern:*** A changing climate is likely to result in more extreme weather events that will lead to increased sea-level rise and worsening coastal hazards. The USAPI are especially at risk due to their geographic location and geological makeup. Many island communities within the region also have low adaptive capacity with high adaptation and mitigation costs in relation to gross domestic product. Users in the USAPI are expressing a strong desire to better understand and quantify “what the future holds” in the region, as climate migration, adaptation, and mitigation options are routinely discussed at workshops, conferences, and other high-level meetings. Regional decision makers need more information about the anticipated changes in the extreme distribution of wind, rain, and high seas events across Hawaii and the USAPI to inform long-term decision making, adaptation planning, and mitigation and/or migration options.

***Source of Project Idea:*** This project comes from Michael Kruk, a research scientist at NCEI, who works closely with Dr. John Marra, the NOAA’s RCSD for the Pacific Region, to provide decision makers in the USAPI with relevant climate research and information. Michael Kruk conducted research looking at changes in storminess over the past 25 years (rain rate and wind speed) over the open water of the Pacific Ocean. Following this research, users in the USAPI expressed interest in understanding expected future changes in storminess to better inform current climate resilience and adaptation planning. As a frequent advisor to NASA DEVELOP project teams at NCEI, Michael Kruk developed this project idea to address decision makers’ interests.

***National Application Areas Addressed:*** Disasters

***Study Location:*** Hawaii (HI) and US Affiliated Pacific Islands (Micronesia, American Samoa, Guam, the Republic of Palau, and the Commonwealth of the Northern Mariana Islands)

***Study Period:*** January1988 – November 2017, Forecast to 2030, 2040, 2050, 2060, 2070, and 2100

***Advisor:*** Michael Kruk (Earth Resources Technology Inc, NOAA NCEI)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| NOAA, Regional Climate Services, Pacific Region | Dr. John Marra, Director | End User | Yes |
| University of Guam | Mark Lander, Professor | Collaborator | No |

***End User Overview***

***End User’s Current Decision-Making Process:*** Dr. Marra currently distributes Quarterly Climate Impact and Outlook Reports to decision makers in the region (http://www.pacificcis.org/dashboard). These reports include precipitation and storm outlooks for the upcoming quarter or season with a maximum 3-month forecast. National Weather Service (NWS) officers in the USAPI and other decision makers use these outlook reports and NWS forecasts to prepare for potential extreme weather events in near-real time. These reports pull together outlooks from a variety of sources and utilize a menagerie of satellite and *in situ* datasets. However, many of these datasets have coarse spatial resolution relative to the size of these island communities and most of the forecasts provided are global forecasts.

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

*NOAA, Regional Climate Services, Pacific Region* – The Pacific Region RCSD, Dr. Marra, is familiar with several NASA Earth observations as well as many NOAA datasets (both satellite and *in situ*). Dr. Marra utilizes satellite data from a variety of sources to perform regional climate analyses and forecasts, which he distributes to decision makers throughout the USAPI. This project would combine past research efforts with more robust satellite derived datasets, both NASA and NOAA, and provide regional decision makers with projected changed in extreme weather events for climate adaptation and resiliency planning.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*University of Guam* – Mark Lander, a Professor with specialties in Pacific weather and typhoons, will provide regional expertise on storminess. Lander has a long history of publishing manuscripts on typhoons, monsoons, and other weather disturbances across the Pacific region, and as such, is often seen as the “go to” expert. Lander will also help mentor the project team and provide key insights not found in the existing literature.

***Dissemination by Boundary Organizations*:**

*NOAA, Regional Climate Services, Pacific Region* – Dr. Marra will distribute project results to regional decision makers including meteorological and hydrological managers, disaster managers and community planners, and coastal resource managers. The University of Guam and potentially the National Weather Service office in Guam will also help to advertise these results and help to identify other potential users beyond the DEVELOP project term.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The project team will communicate with the project partner on at least a weekly basis via email and teleconference. Michael Kruk, the project’s science advisor, will facilitate communication between the project team and the project partner when necessary.

***Transition Plan*:** The project team will hand off all completed results, including maps and figures identifying the return frequency and distribution of extreme events in the region for the years 2030, 2040, 2050, 2060, 2070, and 2100, to the end user at the end of the term via video conference. No software release will be required for the results of this project.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Ocean Near-Surface Atmospheric Properties Climate Data Record SSM/I** | Rainfall rate, wind speed | Rainfall rates and wind speeds will be used to identify extreme events and project expected changes in these events in the future. |
| **GPM GMI & DPR** | Precipitation estimates | Precipitation estimates will be used to identify extreme rainfall events and project expected changes in these events in the future. |
| **Precipitation Estimation from Remotely Sensed Information Using Artificial Neural Networks - Climate Data Record (PERSIANN-CDR)** | Precipitation estimates | Precipitation estimates will be used to identify extreme rainfall events and project expected changes in these events in the future. |
| **Ocean Surface Topography Mission/Jason-2 Poseidon-3 Altimeter and AMR** | Sea-Surface Height anomalies | The work produced by the summer 2017 US Pacific Islands Oceans team will be leveraged to assimilate sea-surface height anomalies to capture the third element of storminess (high seas). |

***Ancillary Datasets:***

World Climate Research Programme – Coupled Model Intercomparison Project Phase 5 – modeling future climate conditions

***Software & Scripting:***

Esri ArcGIS – Geospatial analyses; map creation

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** |
| Storminess Outlook Maps and Figures | These maps will be distributed by the end user and utilized by regional decision makers (e.g., local governments, NWS officers, etc.) for climate adaptation and mitigation planning. For example, the National Weather Service’s Warning Coordination Meteorologists in Guam will use storminess outlooks to inform communities throughout the Marianas of potential future weather risks. | Wind speed and rainfall rates from ONAP and GPM will be used as inputs for the CMIP5 climate model projections with assistance of the project’s collaborator. The model will then be validated using historical ONAP and *in situ* data. | N/A |

***End User Benefit*:** The end products of this project will help regional decision makers make long-term climate adaptation and mitigation plans. The maps will indicate expected outlooks in storminess up to the year 2100, providing small island communities with insight into what storminess will look like in the future. Smaller island communities such as the Republic of the Marshall Islands have little to no resources to analyze expected changes in climate. These results will highlight the return interval of storminess in future decades to give these end users an, "advanced warning," so that decisions can be made sooner, rather than later. This will facilitate an open dialogue between the regional decision makers and the NWS (and other partner offices) on future resilience and adaptation options and planning.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Fall

***Related DEVELOP Work:***

2015 Summer (NC) – Pacific Water Resources I: Rainfall Atlas for Hawaii and the US Affiliated Pacific Islands

2016 Summer (NC) – Pacific Water Resources II: Enhancing Decision Making to Help Manage Freshwater Resources: Using NASA Earth Observations and NOAA CDR's to Provide Near Real-Time Precipitation Estimates for Forecasters in the U. S. Affiliated Pacific Islands.

2017 Summer (NC) – US Pacific Islands Oceans: Utilizing the NASA and NOAA Joint Ocean Surface Topography Mission to Assess Patterns and Trends in Sea-surface Height in the US Affiliated Pacific Islands

2013 Spring (SLU) – Great Lakes Weather: Non-Convective High Wind Events: Investigating the Cloud Features of Non-Convective High Wind Events

**References:**

***References:***

Kruk, M.C., Hilburn, K., & Marra, J.J. (2015) Using microwave satellite data to assess changes in storminess over the Pacific Ocean. Monthly Weather Review, *143*, 3214-3229.

Ramsay, D. (2011). *Coastal erosion and inundation due to climate change in the Pacific and East Timor*. Department of Climate Change and Energy Efficiency, Government of Australia.

Nurse, L. A., Mclean, R. F., Agard, J., Briguglio, L. P., Duvat-Magnan, V., Peleskoti, N., . . . & Webb, A. (2014). Small Islands. Retrieved May 4, 2017, from <https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap29_FINAL.pdf>

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