**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**National Centers for Environmental Information**

**U.S. Pacific Islands Oceans**

*Utilizing the NASA and NOAA Joint Ocean Surface Topography Mission to Assess Patterns and Trends in Sea-surface Height in the U.S. Affiliated Pacific Islands*

**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 National Centers for Environmental Information (NCEI) to analyze near-real time (i.e., weekly) spatial and temporal patterns and trends in sea-surface height (SSH) around the U.S. Affiliated Pacific Islands (USAPI). The project team will utilize *in situ* and satellite data from tide gauges and NASA’s SSH climate record, derived from the TOPEX/Poseidon mission, and Ocean Surface Topography Mission data from Jason-2 and Jason-3 satellites. This project will create a near-real time inundation risk metric that assesses island inundation risk as a function of sea-surface height anomalies using OSTM data and current tidal data from in-situ measurements. The tool will be used and distributed by the project partner, Dr. John Marra, to coastal hazard and climate adaptation decision makers in the USAPI.

***Community Concern:*** The vast majority of the USAPI are low lying islands and are highly vulnerable to coastal hazards influenced by changes in sea-level. SSH in the USAPI follows seasonal changes and can be influenced by ENSO events. The majority of Pacific Island populations, urban centers, and infrastructure are located near the coast, compounding their vulnerability to coastal hazards such as erosion, storm surges, and inundation. The Pacific Islands are also subject to some of the most extreme changes in climate. Between 1993 and 2009 the tropical Pacific experienced rates of sea-level rise four times the global average, approximately 12 mm per year and 3.3 mm per year respectively. Tide gauges, currently used to monitor sea-level changes, offer an expansive temporal record but fail to provide continuous spatial coverage. *In situ* measurements are sparse when compared to the number of and broad distribution of the USAPI.

***Source of Project Idea:*** This project idea was developed by Michael Kruk at NCEI who regularly serves as a science advisor for the NASA DEVELOP node at NCEI and NOAA’s Regional Climate Services Director for the Pacific Region, Dr. John J. Marra. The current Center Lead, Alec Courtright, and Michael Kruk briefly discussed this project idea at the end of the summer 2016 term. In the following months, Michael Kruk worked with this project’s intended project partner, Dr. John Marra, to define the goals of this project idea and the needs it would fulfill.

***National Application Areas Addressed:*** Oceans, Climate

***Study Location:*** U.S. Affiliated Pacific Islands (HI, AS, FM, GU, MH, MP, PW)

***Study Period:*** January 1992 – December 2016

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

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| NOAA Regional Climate Services, Pacific Region | Dr. John Marra, Director | End-User | Yes |

***End-User Overview***

***End-User’s Current Decision-Making Process:***Dr. John J. Marra and local organizations throughout the USAPI currently use tide gauges and ocean buoys to measure sea-level and monitor anomalies. The Pacific Islands Ocean Observing System (PacIOOS), housed within the University of Hawai’i at Mānoa’s School of Ocean and Earth Science and Technology, provides near real-time wave, tide, and sea-level measurements and forecasts for islands with available data. This information helps to inform decision makers of potential coastal hazards. The University of Hawaii’s Sea Level Center (UHSLC) also produces sea-level forecasts on a monthly basis and has strong desire for timelier information. However, relatively sparse stations, as compared to the number and expansive distribution of islands, causes *in situ* sea-level measurements to show a limited view of actual sea-surface height.

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

*NCEI 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 provide Dr. Marra,UHSLC staff, and USAPI coastal hazards managers with better SSH spatial resolution and the capacity to perform spatially continuous, near real-time SSH anomaly analyses.

***Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**Dr. Marra will distribute project results to regional decision makers including meteorological and hydrological managers, disaster managers and community planners, and coastal resource managers.Near real-time SSH anomaly maps will be incorporated into Quarterly Climate Impact and Outlook Reports for the Pacific Region (http://www.pacificcis.org/dashboard) created by Dr. Marra and our science advisor, Michael Kruk. The quarterly reports are created for and read by farmers, island municipalities, and other interested locals as well as congressional staff in Washington DC. Dr. Marra will also disseminate the findings of this project to interested coastal hazards decision makers throughout the USAPI directly based on need.

***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 an SSH climatology and near real-time anomaly map created by the team, to the end-user at the end of the term via video conference. A software release will be required to hand over the Anomalous SSH Map Tool to Dr. Marra. Until the software release process is complete, a team member or NCEI’s Center Lead will create anomaly maps for the quarterly climate impact reports after sending all maps through NASA’s export control process. The project partner will also disseminate the SSH climatology and example anomaly map to interested decision makers within the USAPI immediately following the project term.

***Letters of Support*:** May receive a letter of support in the coming months.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Ocean Surface Topography Mission/Jason-2 Poseidon-3 Altimeter and AMR** | Sea-surface height (SSH)  | The OSTM/Jason-2/3 mission will be used to create SSH average maps with continuous spatial resolution. Near real-time data from this mission will also be used to perform anomaly analyses and create near-real time SSH anomaly maps. |

***Ancillary Datasets:***

NASA PODAAC –Integrated Multi-Mission Ocean Altimeter Data for Climate Research v1.0 sea surface height (MEaSUREs) – This climate data record will be used to assess normal sea surface height conditions in the Pacific Region during ENSO events of various strengths and neutral conditions.

PacIOOS – Tide Gauge SSH – *In situ* will be used to validate satellite derived SSH and project results.

University of Hawaii - Monthly Sea Surface Heights from Satellite Altimetry – This data record will be used as a SSH climatology.

UHSLC – Tides: <http://uhslc.soest.hawaii.edu/products/slforecasts/dev/Tide_Predictions/uhslc/LST/>

<http://www.aviso.altimetry.fr/en/data/products/auxiliary-products/global-tide-fes/description-fes2014.html>

Sea surface height: <http://uhslc.soest.hawaii.edu/products/slforecasts/data/>

Wavewatch III: <http://polar.ncep.noaa.gov/waves/download.shtml>

***Software & Scripting:***

Esri ArcGIS – Geospatial analyses; SSH climatology and anomaly 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 Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Near-Real Time Island Inundation Risk Tool** | This tool will enable the project partner to monitor weekly SSH anomalies throughout the region to assess local island risk to an inundation event and results will be distributed to USAPI decision makers. | The tool will download near real-time OSTM/Jason-2/3 SSH data and combine tidal predictions (harmonic), island-centered altimetry averages (AVISO or NASA-JPL), and wave analyses/forecasts (Wavewatch III) to develop an inundation risk metric | III |

***End-User Benefit*:** These end products will help our project partner, NCEI’s RCSD for the Pacific Region, and affiliates monitor changes in sea-level surrounding the USAPI. The Near-Real Time Island Inundation Risk Tool will enable the project partner to measure abnormal sea-level conditions throughout the USAPI and help relevant, regional decision makers prepare accordingly for potential inundation events. This tool will also provide a

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Summer

***Related DEVELOP Work:***

2015 Summer (NOAA National Centers for Environmental Information) – Pacific Water Resources I: Using NOAA CDRs and Satellite Data to Connect Phases of the El Niño Southern Oscillation (ENSO) with Precipitation across Hawaii and the U.S. Affiliated Pacific Islands (USAPI)

2016 Summer (NOAA National Centers for Environmental Information) – 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

**Notes & References:**

***Notes*:**

PacIOOS Website: <http://www.pacioos.hawaii.edu/>

* Near real-time tide gauge measurements, wave height time-series, sea-level forecasts…etc.
* Interactive map of ocean conditions in the Pacific Region

***References:***

Pacific Possible. (n.d.). Retrieved December 29, 2016, from http://pubdocs.worldbank.org/en/ 720371469614841726/PACIFIC-POSSIBLE-Climate.pdf