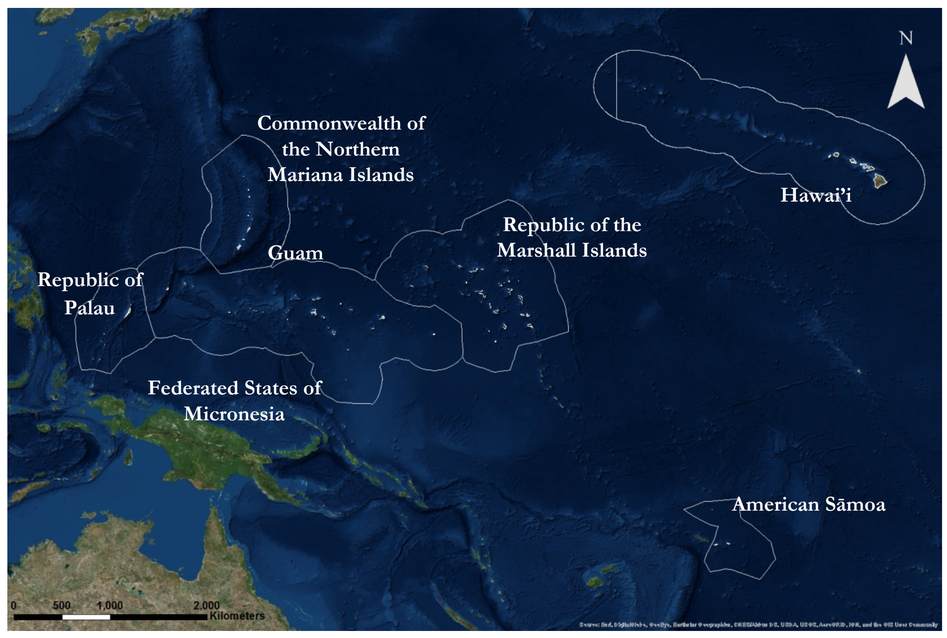
Using Global Climate Models to Project Monsoon and Future Extreme Weather Trends in the Pacific

Abstract

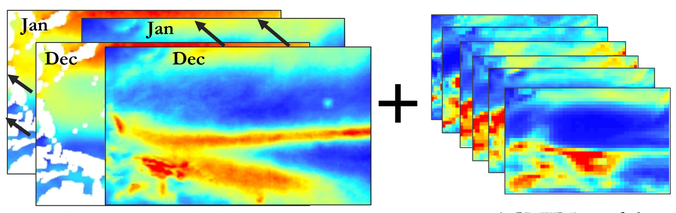
Hawai'i and the U.S. Affiliated Pacific Islands (USAPI) comprise more than 2,000 islands that span thousands of miles of ocean and are home to nearly 1.9 million people. This region is particularly vulnerable to economic, social, and environmental impacts resulting from changes in sea level rise and storm patterns over the next century. Climatologists and regional decision makers are interested in understanding projected long-term changes in extreme weather events for adaptation and mitigation planning. This study provided an initial outlook at regional trends in the location of the monsoon and distribution of the extremes in wind speed and rainfall over the course of the 21st century. Select Global Climate Models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) were verified against historic NOAA satellite data. This project used the future simulations to calculate the projected changes in magnitude for extreme values of wind speed and rainfall rate, return interval frequency for rainfall and wind speed, and distribution of monsoon events. The results include gridded maps of monsoon distribution and extreme wind and rain values, as well as return interval plots for virtual stations within the USAPI and Hawai'i Exclusive Economic Zones on a decadal basis for the years 2030-2100.

Study Area



Methodology

Model Selection – Correlation Test

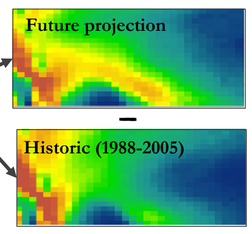


Downloaded PERSIANN and SSM/I climatologies
Historic Period (1988-2005)

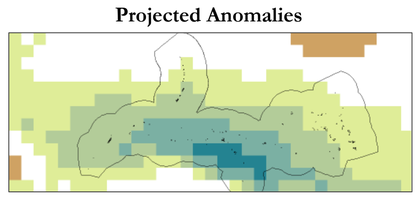
6 CMIP5 models

End Product - Monsoon Maps

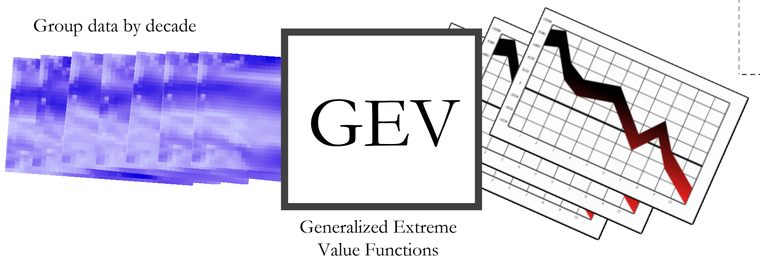
Monsoon Criteria
Rain rate > 0 mm/hr
Southwest wind direction



Projected Anomalies



End Product – Return Interval Plots



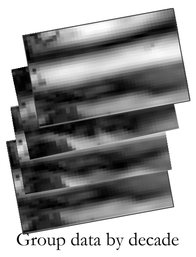
Generalized Extreme Value Functions

End Product - Extreme Wind & Rain Maps

Calculate Future & Historic (1988-2005):

95th Percentile values

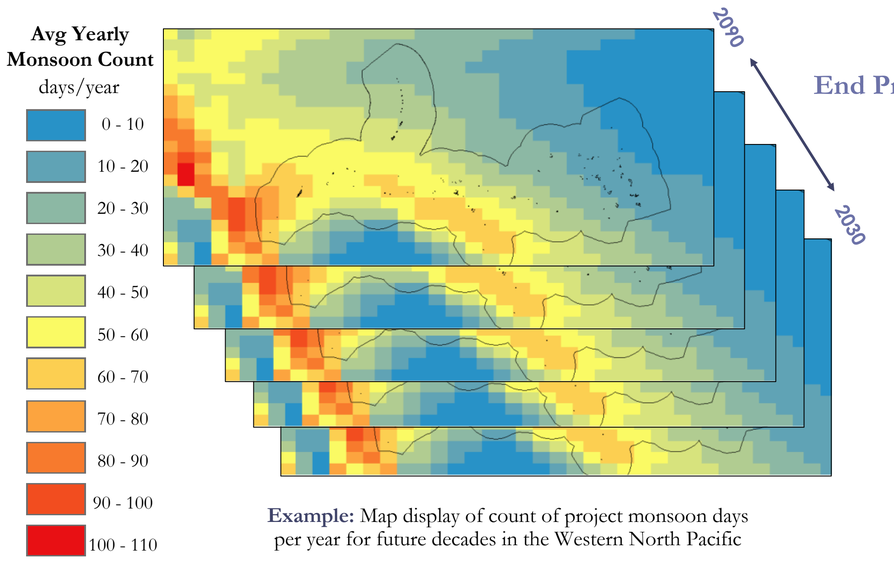
5th Percentile values



Group data by decade

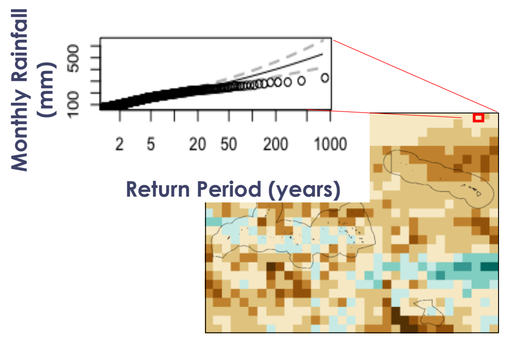
Results

End Product: Distribution of Western North Pacific Monsoon Days



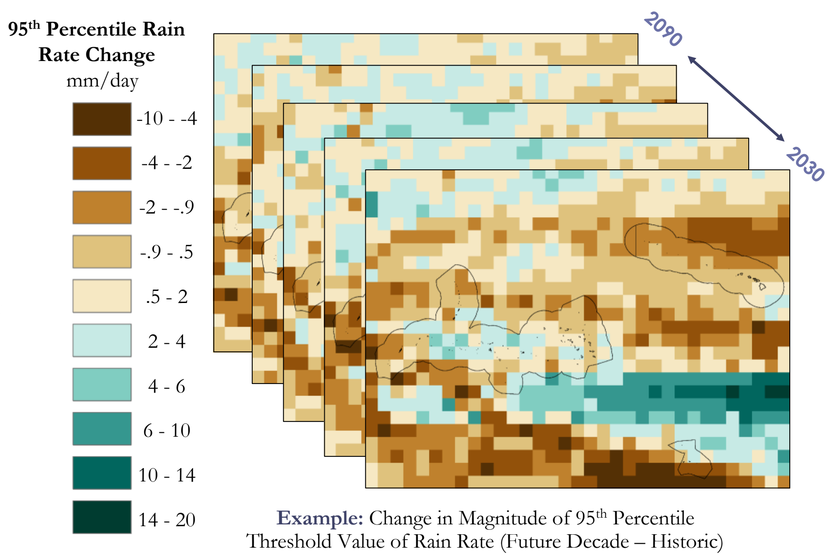
Example: Map display of count of project monsoon days per year for future decades in the Western North Pacific

End Product: Return Interval Plots for Rain Totals and Wind Speed at Virtual Stations



Example: Return Period Frequencies plotted against Monthly Rainfall Levels for a Virtual Station

End Product: Change in Magnitude & Exceedance Days of Extreme Rain Rate & Wind Speed



Example: Change in Magnitude of 95th Percentile Threshold Value of Rain Rate (Future Decade – Historic)

Conclusions

- **Global Climate Model** simulations **varied in performance** against satellite observations
- FSM & and RMI expect to have **more days of intense** rain and **less days of intense wind**
- Return level **values of 50-yr events** is generally **trending upwards** across the region
- **Monsoon** events expect to **increase in frequency** in most of the Western North Pacific

Objectives

- **Verify** historic Global Climate Model datasets with NOAA Climate Data Record platforms
- **Extract** surface wind and rainfall data from Global Climate Model future simulations for the period 2030-2100
- **Determine** projected trends in magnitude and occurrence of extreme wind speed and rain rate (95th and 5th percentile values) for study area
- **Compute** return interval time series of wind speed and rainfall totals at virtual stations for study area
- **Create** projected distribution maps of Western North Pacific Monsoon

Earth Observations

- NOAA Ocean Near-Surface Atmospheric Properties – Climate Data Record (ONSAP – CDR) Special Sensor Microwave Imager (SSM/I)
- NOAA Precipitation Estimates from Remotely Sensed Information Using Artificial Neutral Networks – Climate Data Record (PERSIANN – CDR)

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Project Partners

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