**NASA DEVELOP National Program**

NCEI - Asheville, NC

**Spring 2016**

**Short Title: Cascade and Sierra Nevada Mountains Water Resources**

**Subtitle:** A comparison of remotely-sensed Climate Data Records (CDRs) over the Cascade and Sierra Nevada Mountains for improved climate monitoring by the Western Region Climate Center (WRCC), and National Weather Service River Forecast Centers (NWS RFCs).

**VPS Title:** Rain or Snow: Remotely-Sensed Precipitation Data in the Cascade and Sierra Nevada Mountains

**Project Team & Partners**

**Project Team:**

Sam Swanson (Project lead), sam.swanson@noaa.gov

Kevin Rapa

Jessica Sutton (CL)

**Advisors & Mentors:**

Mike Kruk (ERT, Inc.)

**Partner Organizations:**

Western Region Climate Center (WRCC) (End-User), POC: Nina Oakley

National Weather Service (NWS), POC: Andrea Bair; Boundary Organization

**Project Details**

**Applied Sciences National Applications Addressed:** Water Resources, Climate, and Weather

**Study Area:** Cascade mountain range in Washington (WA), Oregon (OR) and California (CA), and Sierra Nevada mountain range in California (CA) and Nevada (NV)

**Study Period:** January 1998 - Present

**Earth Observations & Parameters:**

CMORPH-CDR, Microwave - precipitation estimate

GPM, merged - precipitation estimate

NOHRSC - merged, snow water equivalent (SWE)

**Ancillary Datasets Utilized:**

* NRCS Snow Telemetry Dataset (SNOTEL) - Snowpack and precipitation measurements\*
* Cooperative Observer Network (COOP) - Precipitation measurements\*
* Remote Automatic Weather Stations (RAWS) - Precipitation measurements\*
* Automated Surface Observation System (ASOS) - precipitation measurements\*
* Parameter elevation regression on independent slopes model (PRISM Climate Data)) - Precipitation measurements

\*Included in an umbrella dataset, the Global Historical Climate Network (GHCN)

**Models Utilized:**

N/A

**Software Utilized:**

Microsoft Excel - data compilation and visualization

R Statistical Program - data mitigation, statistical analysis

ArcGIS - raster manipulation/analysis, image enhancement & map creation

**Project Overview**

**80-100 Word Objectives Overview:**

An increasing problem in the western United States is wet-season drought, resulting from decreasing snowpack and an earlier onset spring melt. This project facilitates a comparison and analysis of remotely-sensed and *in situ* precipitation data in the Sierra Nevada and Cascade mountain ranges to gauge the usefulness of satellite data in mountainous regions. To this end, we hope to enhance the understanding of water availability in mountainous snowpack and inform climate monitoring and water resource management efforts across the western United States.

**Abstract:**

Shifting hydrologic processes have grown to be a significant problem in California, Oregon, and Washington. In recent years, average winter temperatures have risen, spring snowmelt has occurred earlier, and a greater portion of precipitation has fallen as rain rather than snow in the Sierra Nevada and Cascade mountain ranges. The natural reservoir of water stored in mountain snowpack has declined alarmingly, limiting water availability in the summer and forcing water managers to reassess their water management regimes. Current methods of understanding orographic, or mountainous, precipitation in the West are limited to ground-station and volunteer-based observations, which are spatially-limited in such areas. Considering the needs of Nina Oakley (Western Region Climate Center) and Andrea Bair (National Weather Service), this project enhanced the understanding of precipitation in the Sierra Nevada and Cascade mountain ranges, using the NOAA CPC Morphing technique (CMORPH) and Global Precipitation Model (GPM) satellite data records. A comparison between satellite and *in situ* datasets revealed information about the usefulness of remotely-sensed data in estimating orographic precipitation. Ultimately, this project created several output products for the end-user: maps comparing *in situ* and satellite data, detailing precipitation variability, showing anomalies in precipitation, and identifying regions that lack *in situ* data while performing well at the remotely-sensed level. Altogether, we hope this project greatly assists in the difficult decision-making processes that already present themselves in the West.

**Community Concerns:**

* Climate change is rapidly changing the water cycle in the West, with earlier onset of snowmelt in the spring and higher occurrences of rain than snow during the winter, creating low summertime water availability. During the summer of 2015, reservoirs around California hit record lows, reaching levels unseen since the placement of their dams.
* *In situ* monitoring stations of precipitation are spatially limited in the Sierra Nevada and Cascade mountains, creating uncertainty when assessing available water resources for agriculture, recreation, and other means of human and ecological use during the normally dry summer months.
* The Western Region Climate Center would like to use remotely-sensed data, if applicable, to strengthen their decision making and climate monitoring processes concerning water resources.

**Current Management Practices & Policies**:

According to the end-users, remotely-sensed data is not utilized in their mission to “disseminate high quality climate data and information pertaining to the western United States”. Currently, the WRCC primarily uses PRISM, a gridded network derived from ground-station data, and ground-station data itself, from the Global Historical Climate Network (GHCN) when assessing their region’s current water status. PRISM Climate Data interpolates data throughout the mountain ranges of the West by bias-correcting station-based measurements to areas of similar geography. In our study area, the GHCN is comprised of data from the Cooperative Observer Program Network (COOP), Remotely Automated Weather Stations (RAWS), Snow Telemetry (SnoTel), and the Automated Surface Observation System (ASOS). When assessing snowpack, the California Snow Survey and the 8- and 5-Station Indices are also used, but infrequently.

**Decision Support Tools & Benefits:**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Precipitation variability maps making comparisons of different satellite and ground data sets | CMORPH, GPM | Considering that the NWS and WRCC do not use satellite data, these maps will show how/if satellite data will be useful in decision-making and forecasting efforts |
| Monthly anomaly maps making comparisons of normal precipitation years to abnormal years | CMORPH, GPM | This will further enhance understanding of precipitation variability by showing which areas receive more or less precipitation during abnormal events |
| Spatial variability maps showing how precipitation normally varies over a typical year | Derived from precipitation variability maps, after assessing which satellites are useful | Enhancing understanding of precipitation variability using satellites |
| Benefits maps, to show where satellite and ground data agree and where ground stations do not exist, thus determining where satellites can fill in data gaps | The most effective satellite product between CMORPH and GPM | Because ground observation data is very limited over mountains, this will show where satellites can best fill in the resulting gaps |
| Similar maps, instead for snow (SWE) analysis | NOHRSC | SWE is a highly important variable, showing which areas will produce more or less water runoff |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

Category I- no software release required