**NASA DEVELOP National Program**

Langley Research Center/NCDC

**Summer 2014**

**California Climate**

*Improving the Utility of Seasonal Outlooks of Anomalous Precipitation for California*

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**Past or Other Contributors:**

N/A

**Applied Sciences National Applications Addressed:**

Climate, Water Resources

**Study Area:** The Sierra Nevada Mountains within California Climate Divisions 2 and 5

**Study Period:** October-April 1983-2009

**Partners/Collaborators**

Project Partners

* National Oceanic and Atmospheric Administration, National Climatic Data Center
* Cooperative Institute for Climate and Satellites, North Carolina State University

Other Contributors

* California Department of Water Resources: Jeanine Jones, Interstate Resources Manager
* San Francisco Public Utilities Commission: David Behar, Climate Program Director; Alexis Dufour, Water Resources Engineer; Amod Dhakal, Water Resources Engineer
* Hetch Hetchy Water and Power: Chris Graham, Water Resources Engineer; Adam Mazurkiewicz, Water Resources Engineer
* California Department of Water Resources: Mike Anderson, State Climatologist
* Climate Prediction Center: Jon Gottschalck, Head of Forecast Operations

**80-100 Word Blurb**

This project aimed to improve the utility of seasonal climate outlooks for water resource managers in southern California. It was accomplished through assessing correlations and performing multivariate regressions between multiple atmospheric teleconnection indicesand precipitation patterns documented by the National Climatic Data Center’s Climate Data Records (CDRs). An investigation of teleconnections’ effects on extreme drought or flooding can be used to improve the utility of seasonal weather forecasts. A secondary end product was an inventory of seasonal forecasts, tools, and methods currently used by California decision makers based on a survey of state and local water resource managers. This project laid the foundation for incorporating CDRs into additional NASA DEVELOP projects.

**Community Concerns**

* Compared to short-range (several days to one week) forecasts, mid-range (90-day to 2-year) forecasts tend to have less skill and reliability for predicting seasonal precipitation anomalies, such as drought or flooding.
* Forecasts with these lead times are important for long-term decision making in many economic sectors, including agriculture, water resources, energy, and public health.
* California periodically experiences severe and prolonged droughts. These droughts have serious impacts on water availability for smaller communities and on the frequency and severity of wildfires. With the continued progression of anthropogenic climate change, these drought periods are expected to become more frequent and severe.

**Current Management Practices & Policies**

The state of California is currently experiencing a major drought. As a result, the governor of California has recently issued a directive to the California Department of Water Resources to refine seasonal weather and climate forecasts to better prepare for future drought events.

California water resource managers currently use statistical models and historical climate information to make decisions about the future. They do not use seasonal forecasts produced by agencies such as the Climate Prediction Center to make decisions and they do not widely use satellite observations in their forecast models. Despite the fact that seasonal forecasts are not widely used by decision-makers in California, forecasts of weather conditions in the wet season and of changes in snowpack extent are desired by surveyed officials.

**Abstract**

California’s population grew by over 10 million from 1980 to 2000 and is expected to reach a total of 48 million by 2030. This will create additional strain on a water supply already stretched by severe, prolonged droughts that are expected to become more frequent in the region due to the progression of anthropogenic climate change. The ability to anticipate precipitation for the coming seasons can help water resource managers make decisions and mitigate the effects of seasonal anomalies such as droughts. Due to the need for better predictive abilities for water resources, this project aimed to improve the utility of seasonal climate outlooks through analysis of past climatic signals. Compared to forecasts with shorter lead times, seasonal forecasts have the least level of skill and are often considered the most challenging to predict. Therefore, this project incorporated National Oceanic and Atmospheric Administration (NOAA) Climate Data Records (CDRs), National Aeronautics and Space Administration (NASA) satellite data, and in-situ data to correlate with atmospheric teleconnection indices during seasons with anomalous precipitation (i.e. flooding or drought). The seasons were defined using past observations from the National Climatic Data Center’s Global Historical Climatology Network in California Climate Divisions 2 and 5. A secondary product of this project was a compilation of survey results from water resource managers that describes the degree to which seasonal forecasts, as well as NOAA CDRs and NASA earth observations, are currently used for decision-making. Results of this project will potentially aid California resource managers and policy-makers in preparing for and mitigating the impacts of future anomalous precipitation seasons. This project will also assist forecast producers and agencies such as NOAA and NASA in tailoring satellite data products and seasonal climate outlooks to water resource managers’ needs.

**Decision Support Tools**

● Image/geospatial analysis product: animated image demonstrating an analog in a CDR(s) and how a teleconnection affects seasonal snow cover and precipitation in the Sierra Nevada Mountains

* Assessment of correlations between teleconnection indices and snow cover and precipitation in the Sierra Nevada Mountains
* Microsoft Excel analysis of the probability of Eurasian snow cover extent, as well as ENSO, MJO, AO, and PDO teleconnection indices, being associated with months with extremely high or low precipitation

**Benefit to End-User:**

* Improved accessibility and awareness of NCDC Climate Data Records and NASA Satellite data and potential incorporation of these satellite records into seasonal forecasting and decision making
* An improved understanding of how teleconnections are associated with seasonal precipitation anomalies. This improved understanding will potentially better inform the decision-making process for water resources in California.
* Improved reporting of extreme seasonal weather and climate event predictions
  + Will result in improved preparation for adverse events, lessening the impact on human health, agriculture, and the economy
  + Potential improvements in early warning systems and mitigation efforts for droughts and floods

**Earth Observations & Parameters**

CDR - Satellite (Sensor)

* Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN) - GOES-8, GOES-10, GMS-5, Metsat-6, and Metsat-7-long wave infrared channel for 30-minute rain rates; Tropical Rainfall Measuring Mission (TRMM), NOAA, and Defense Meteorological Satellite Program (DMSP) satellites for instantaneous rainfall estimates

**Future Applicable NASA Missions**

Satellite - Parameter

* CYGNSS - extreme weather parameters (e.g. ocean surface roughness and wind speed)
* GRACE-FO - climate variability and water cycle (e.g. geopotential difference observations reduced by effects from tides, Earth rotation, and atmospheric and oceanic influences)

**Models Utilized**

Agency & Model Name

* National Center for Atmospheric Research (NCAR), Nested Regional Climate Model
* NCAR/NOAA/Forecast Systems Laboratory/Air Force Weather Agency/Naval Research Laboratory/University of Oklahoma/Federal Aviation Administration, Weather Research & Forecasting Model

**Ancillary Datasets Utilized**

* NCDC Global Historical Climatology Network (GHCN) - precipitation and temperature (in situ)
* NASA National Land Data Assimilation System (NLDAS) - snowfall, snow cover, and snowmelt

**Software Utilized**

* Weather and Climate Toolkit - animation/analysis of PERSIANN precipitation \and snow cover estimates
* R-Programming and Python - calculate correlations between the statistics of each dataset and the indices of ENSO, MJO, PDO, and AO
* ArcGIS