# Improving Seasonal Predictions of Climate Variability and Water Availability at the Catchment Scale

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## Research Initiative

- The Earth's oceans have a vast storage of energy that helps drive the climate variability on continental land masses at seasonal to interannual time scales. Consequently, variability in ocean states (e.g. sea surface temperatures, SSTs) can help provide predictive information about the hydroclimate in regions across the globe.
- Instead of using climate indices, such as NINO3 or PDO, can predictors be obtained that cater more specifically to the hydroclimate of a particular basin?
  - Unique statistical relationships can be found between SSTs and the seasonal hydroclimate of a specific basin at varying time lags. The basin's predictor for each combination (SST month, seasonal hydroclimatic variable, time lag) then corresponds to the SSTs in the oceanic window that maximizes the correlation. This more dynamic approach can subsequently be used to make quantitative hindcasts of past events. Finally, one can assess the hindcast skill for this methodology in contrast to using some of the standard climate indices.

## Study Area and Data


•Little Colorado River Basin
- 69,400 km2
- Average yearly discharge
  1.98*108 m3/year (161,000 acre*ft/year)

•Data

Precipitation, Temperature - 1/8th degree interpolated data set for the contiguous US (daily data)

Discharge - USGS

Sea Surface Temperatures – International Comprehensive Ocean Atmosphere Dataset (2 degree resolution, monthly)

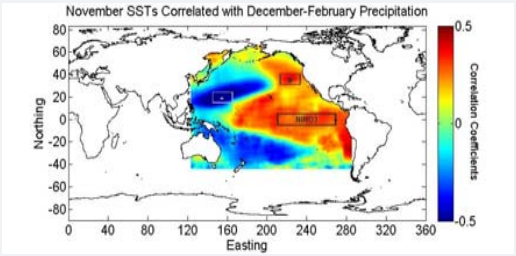
•Preparing the Data

Spatially average precipitation, then sum precipitation over tri-monthly intervals (JFM, FMA …)

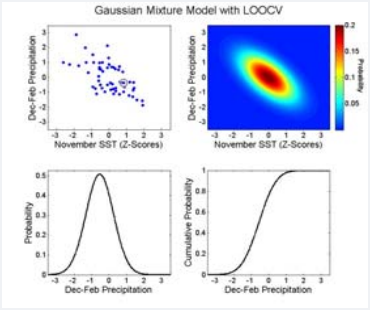
Spatially average SSTs over 20° longitude by 10 ° latitude moving windows to smooth data and fill in spatial or temporal gaps

## Basin-Specific Climate Prediction

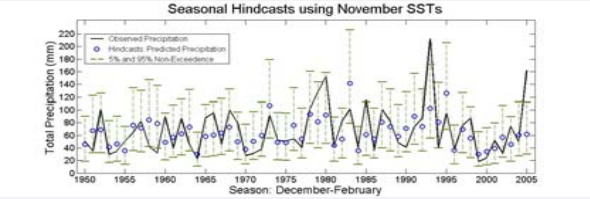
**As an example of basin-specific climate prediction (BSCP), November SSTs are correlated with winter precipitation in the Little Colorado:**




The oceanic window where the SST time series maximizes the correlation is located, which in this case is the negatively correlated window. This time series is used to hindcast winter precipitation. Leave-one-out cross-validation (LOOCV) is employed with a Gaussian mixture model to ascertain a range of most probable quantities of precipitation.

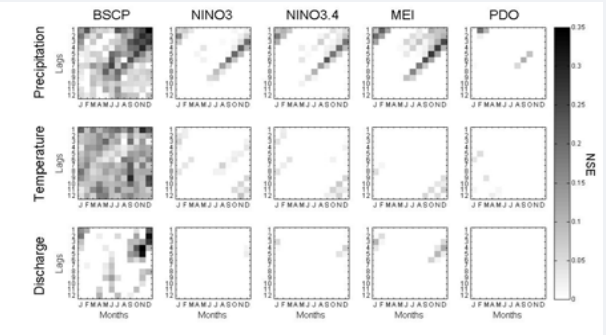



This methodology is repeated for the entire time series yielding the following hindcasts:




## Hydroclimatic Hindcast/Forecast Skill

- **The BSCP methodology is performed for precipitation, temperature and discharge. Seasonal predictions are made up to a year in advance.**
- **In addition to BSCP, hindcasts were made using the following climate indices: NINO3, NINO3.4, MEI and PDO.**
- **The Nash-Sutcliffe Efficiency Parameter (NSE) is used to assess the skill of the hindcasts, where values greater than zero reflect a predictive skill that exceeds using the hydroclimatic seasonal means and a value of one is perfect prediction.**




## A Work in Progress

Ways to Improve Current Research

1. The BSCP methodology requires testing on additional catchments.
2. The gap between the precipitation/temperature and discharge hindcast/forecast skill needs to be reduced.
3. Non-stationarity necessitates consideration. The oceanic windows that maximize the correlation can shift due to natural variability and global climate change. For this reason, the data and the predictors must be updated each year.

## Acknowledgements

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