Development of Multimodel Streamflow Forecasts for Various River Basins in Different Hydroclimatic Settings

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Introduction

- Seasonal and sub-seasonal streamflow forecasts can be valuable in
  - planning and management of water resources
  - scheduling agricultural operations
  - optimizing hydropower generation
  - and creating emergency plans for drought mitigation
- However; the forecasting skill varies geographically and seasonally, which limits application of forecasts in real-time decision making.
- In this study we used Principal Component Regression (PCR) modeling to reduce the uncertainty, utilizing precipitation, temperature, and the previous month streamflow as predictors.

Objectives

- Develop monthly updated retrospective streamflow forecasts for multiple River basins using climate forecasts information and evaluate the predictability skill during different seasons
- Reduce uncertainty in developed streamflow forecasts by multimodel combinations.

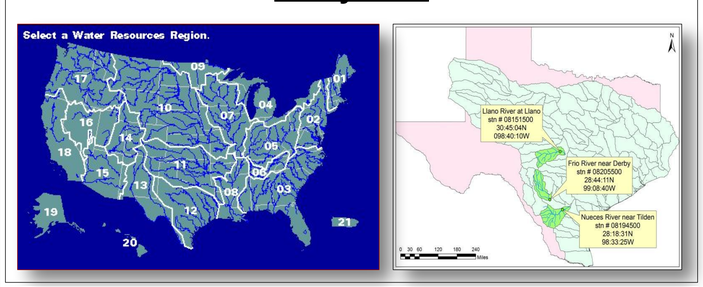
Theory

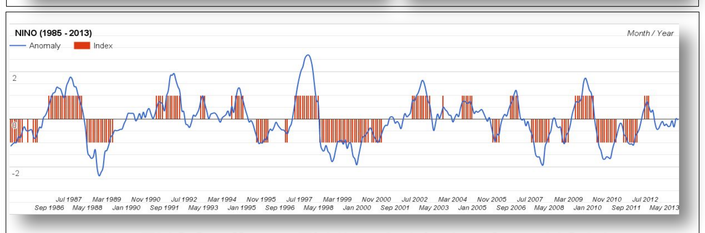
$$Q_{(m)} = fn\{Prcp_{(m)}, ST_{(m)}, Q_{(m-1)}\}$$

$Q_{(m)}$ streamflow of the month *m*
$Prcp_{(m)}$ average precipitation
$ST_{(m)}$ average temperature
$Q_{(m-1)}$ streamflow of the previous month

The precipitation and temperature data for 1 to 6 months lead time was downloaded for two different General Circulation Models (GCM): ECHAM4.5 and Coupled Forecast System version 2.0 (CFSv2).

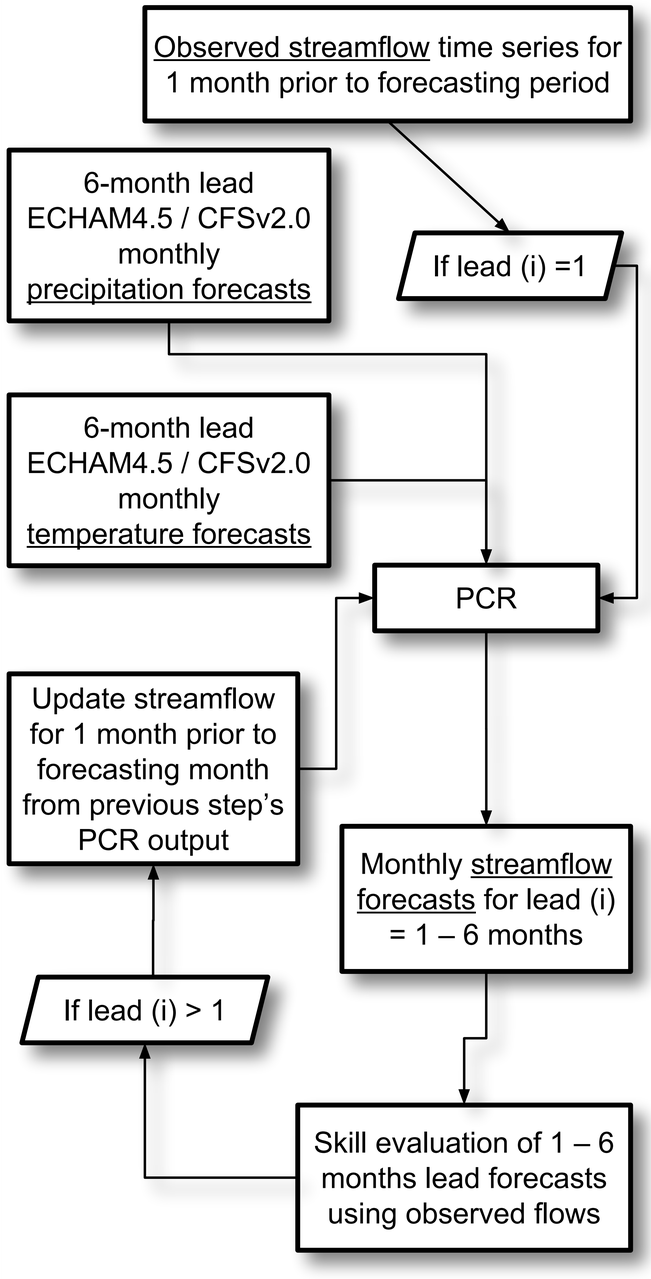
Study Area





The ENSO effect - El Niño 3.4 Index from NOAA

Methodology



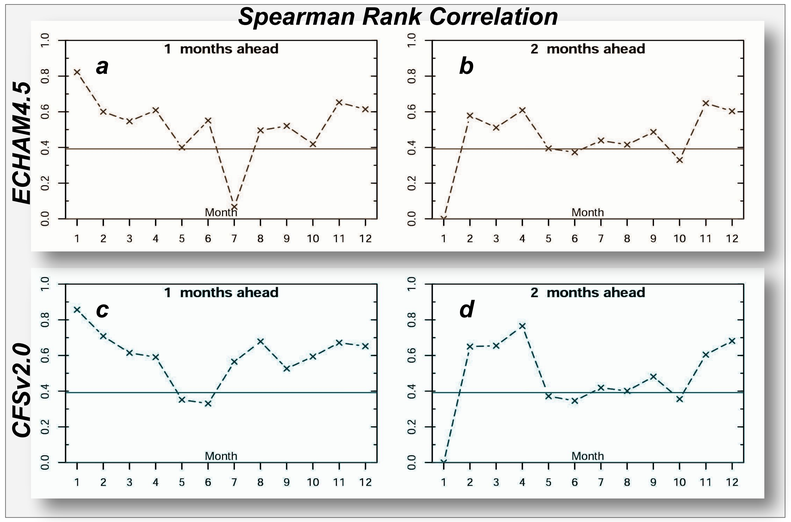
$$r_s = \frac{cov(rg_X, rg_Y)}{\sigma_{rg_X}\sigma_{rg_Y}}$$

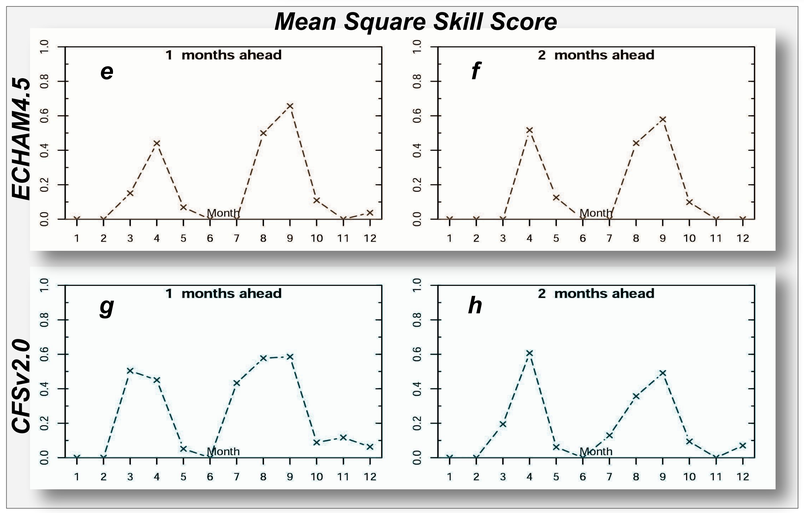
$$MSSS = 1 - \frac{MSE_{(fcst)}}{MSE_{(clim.)}}$$

Spearman Rank Correlation between observed as well as predicted streamflow using ECHAM4.5 data at: ***(a)*** 1- month and ***(b)*** 2-month lead time and using CFSv2.0 data at: ***(c)*** 1- month and ***(d)*** 2- month lead time. The 0.05 significance level line is also shown.

Results

The model's performance is evaluated on the basis of Spearman Rank Correlation (CORR) and the Mean Square Skill Score (MSSS)





Mean Square Skill Score (MSSS) of the predicted streamflow using ECHAM4.5 data for ***(e)*** 1-month and ***(f)*** 2-month lead time and , of estimated streamflow using CFSv2.0 data for ***(g)*** 1-month and ***(h)*** 2-month lead time

- Forecasting period is from 1982 to 2010 (29 yrs)
- Erroneous monthly precipitation and temperature (e.g. zero Kelvin) values were replaced by climatological values for that month.

A quick comparison of the results shows the following:

- CFSv2 outperforms ECHAM4.5 in predicting summer and early fall (Jul-Sep) season streamflow
- Under both models the forecasting skill deteriorates with lead time as expected

Potential Future Work

- Combine multimodel forecasts to reduce uncertainty.
- Implement process-based distributed models such as Variable Infiltration Capacity (VIC) and Penn State Integrated Hydrologic Model (PIHM) to enhance seasonal forecasting skills due to representation of land cover, topography, soil, initial conditions and surface water-groundwater interactions.
- Integrate the developed forecasts to a web-based online portal to communicate the utility of streamflow forecasts for different river basins.
- The online portal can also be linked to water management models for selected reservoirs to utilize streamflow forecasts for better managing water resources during droughts and floods.