Application of Subseasonal-to-Seasonal (S2S) precipitation forecast for hydrologic Ensemble Streamflow Prediction (ESP) with Bias Correction and Spatial Disaggregation (BCSD)

Lujun Zhang[1], Shang Gao[2], Tiantian Yang[1]

1 School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, OK, USA; 2 School of Natural Resources and the Environment, University of Arizona, Tucson, AZ, USA

Introduction

Streamflow predictions at Subseasonal-to-Seasonal timescale (10 to 30 days into the future) are of great importance for various human activities. The Ensemble Streamflow Prediction (ESP) is a widely applied technique for S2S streamflow predictions. However, ESP's reliance on randomly resampled precipitation limits its predictive capability. In this regard, the available dynamical S2S precipitation forecasts are promising alternatives.

However, prior studies report limited performance of S2S precipitation in many regions (e.g., U.S. central south), making its effectiveness in streamflow forecasting questionable.

In this study, we carry out a series of streamflow prediction experiments at 4 study watersheds in the U.S. South region to validate the hydrologic performance of S2S precipitation from the North America Multi-Model Ensemble Phase II (NMME-2).

Datasets

Multiple S2S precipitation forecast products (1982-2011) from the NMME-2:

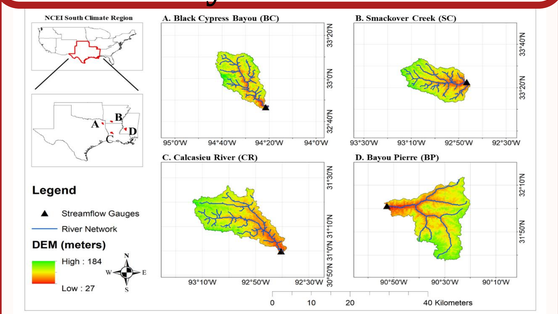
- Daily & 1-degree resolution
- Totaling 40 ensemble members

Reference precipitation from PRISM (Daily & 0.8 km resolution)

Potential evapotranspiration (PET) from North American Regional Reanalysis (Daily & 32 km resolution)

USGS streamflow measurements

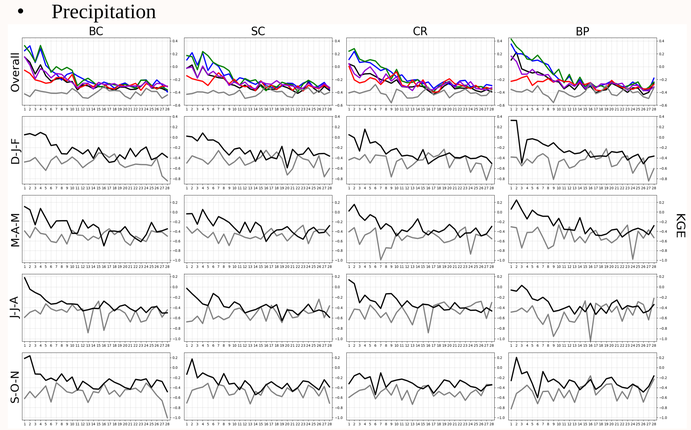
Study watersheds



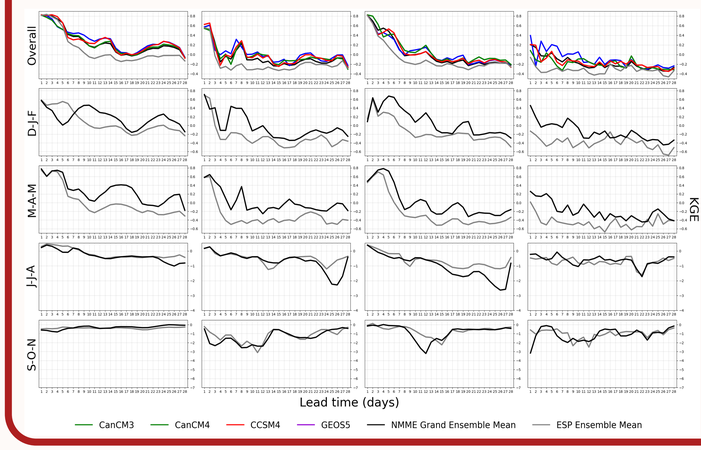
- Precip (little snow) dominates streamflow
- Dry period from June to October

Result

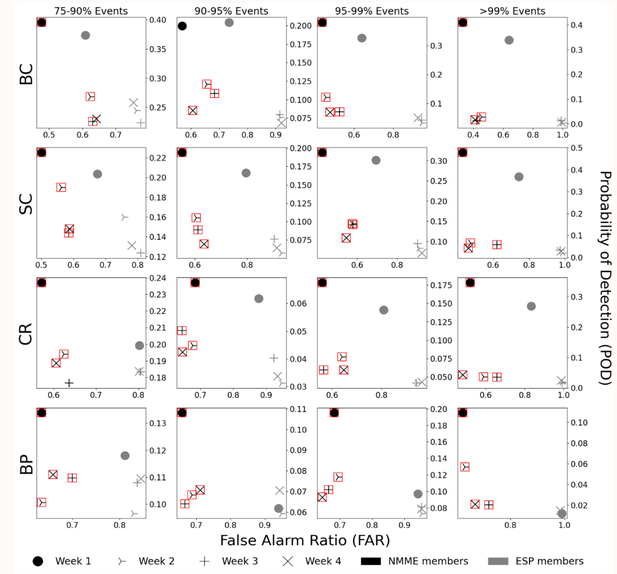
- Overall and seasonal predictive skill
  - Precipitation

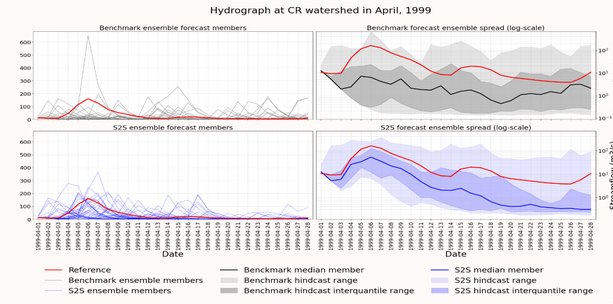


  - Streamflow



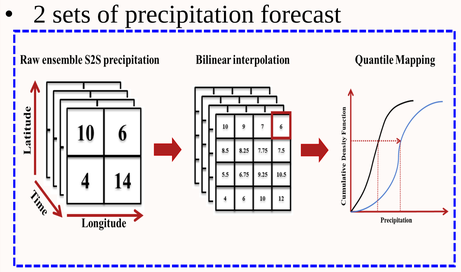
- High-percentile values

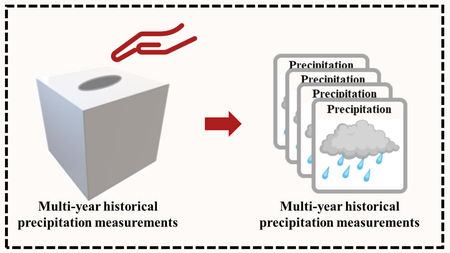




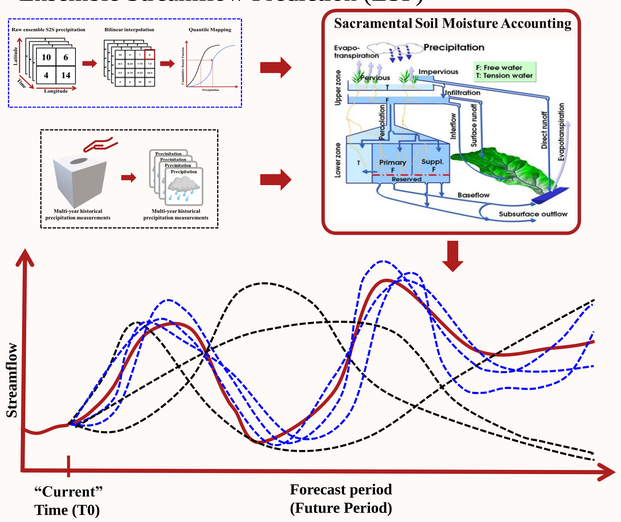
Methodology

- 2 sets of precipitation forecast





- Ensemble Streamflow Prediction (ESP)



Conclusions

- The post-processed S2S precipitation generally presents higher skills than that of the resampled precipitation under the conventional ESP.
- The S2S precipitation-forced streamflow predictions present higher skill than that of the ESP as well. However, the favorable performance of S2S precipitation-forced streamflow predictions is mainly due to improvements in Winer (D-J-F) and Spring (M-A-M) only.
- Evaluation of high-percentile streamflow values suggests that S2S precipitation leads to better categorical predictions on the occurrence of streamflow values above 75%.
- The successful application of the S2S precipitation in one of the most challenging regions demonstrates the potential effectiveness of the S2S precipitation on a broader scale over the contiguous United States.

Reference & Acknowledgement

1. Zhang, L., Kim, T., Yang, T., Hong, Y. and Zhu, Q. (2021) Evaluation of Subseasonal-to-Seasonal (S2S) precipitation forecast from the North American Multi-Model ensemble phase II (NMME-2) over the contiguous US. Journal of Hydrology 603, 127058.
2. Zhang, L., Yang, T., Gao, S., Hong, Y., Zhang, Q., Wen, X., & Cheng, C. (2022). Improving subseasonal-to-seasonal forecasts in predicting the occurrence of extreme precipitation events over the contiguous US using machine learning models. Atmospheric Research, 106502.

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