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A New Multivariate Approach in Generating Ensemble Meteorological Forcings for Hydrological Forecasting

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Producing reliable and accurate hydrologic ensemble forecasts are subject to various sources of uncertainty, including meteorological forcing, initial conditions, model structure, and model parameters. Producing reliable and skillful precipitation ensemble forecasts is one approach to reduce the total uncertainty in hydrological applications. Currently, National Weather Prediction (NWP) models are developing ensemble forecasts for various temporal ranges. It is proven that raw products from NWP models are biased in mean and spread. Given the above state, there is a need for methods that are able to generate reliable ensemble forecasts for hydrological applications. One of the common techniques is to apply statistical procedures in order to generate ensemble forecast from NWP-generated single-value forecasts. The procedure is based on the bivariate probability distribution between the observation and single-value precipitation forecast. However, one of the assumptions of the current method is fitting Gaussian distribution to the marginal distributions of observed and modeled climate variable. Here, we have described and evaluated a Bayesian approach based on Copula functions to develop an ensemble precipitation forecast from the conditional distribution of single-value precipitation forecasts. Copula functions are known as the multivariate joint distribution of univariate marginal distributions, which are presented as an alternative procedure in capturing the uncertainties related to meteorological forcing. Copulas are capable of modeling the joint distribution of two variables with any level of correlation and dependency. This study is conducted over a sub-basin in the Columbia River Basin in USA using the monthly precipitation forecasts from Climate Forecast System (CFS) with 0.5x0.5 Deg. spatial resolution to reproduce the observations. The verification is conducted on a different period and the superiority of the procedure is compared with Ensemble Pre-Processor approach currently used by National Weather Service River Forecast Centers in USA.