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Producing calibrated and optimized operational streamflow forecasts for Bangladesh with informative ensemble dispersion.

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Post-processing of hydrologic model output can be viewed as an extension of the hydrologic model itself, such as in the case of under-dispersive hydrologic ensemble forecasts, where post-processing of the ensemble dispersion can implicitly account for missing scales of hydrologic variability or mis-representation of physical processes. In this study we present an approach for accounting for and minimizing sources of hydrologic modeling error under the operational forecast setting of the Climate Forecasting Applications for Bangladesh (CFAB) project. CFAB issues ongoing operational probabilistic forecasts of severe flooding as part of a humanitarian effort to mitigate the impacts of these events on the country of Bangladesh. The flood forecasting system developed utilizes weather forecast uncertainty information provided by the European Centre for Medium-Range Weather Forecasts (ECMWF) ensemble weather forecasts, along with raingauge and satellite-derived precipitation estimates from NASA and NOAA.

To account for all sources of discharge forecasting uncertainty, we employ a post-processing step to blend weather forecast uncertainty with the remaining sources of uncertainty. Although data assimilation techniques can be used to account and correct for forecast uncertainties, however with a long enough historical record, we argue that conditionally sampling modeled streamflow hindcasts may in fact outperform such approaches in terms of probabilistic forecast reliability and sharpness. The approach used here first conditionally forecasts and corrects for auto-correlative hydrologic errors using a new statistical approach used in the hydrometeorological literature. In a second step, the hydrologic forecast model is driven with the current weather forecasting variables to produce an ensemble of forecasts whose uncertainty is dependent on weather forecast uncertainty alone. In the final step, the forecast weather input uncertainty is convolved with the conditional probability distribution function (PDF) of hydrologic model uncertainty using a Monte Carlo approach to produce the final calibrated streamflow forecast PDF.

Throughout this error assimilation scheme, we use a step-wise cross-validation approach that ensures the resultant forecasts will outperform both a “climatological” and “persistence” forecast. Further, we introduce in the post-processing a model selection methodology that generates ensemble forecasts with an informative ensemble skill and spread relationship by conditionally selecting different historic scenarios for model development with similar stability properties, and explore what states of the hydrologic system inform this selection process. Finally, we gauge the performance of the system at providing credible probabilistic forecasts during different hydrologic conditions and forecast lead-times.