HYDROLOGIC ENSEMBLE FORECAST SERVICE (HEFS) IMPROVEMENT EFFORTS

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In this presentation

• HEFS verification for North Texas using GEFS reforecast dataset (1985-2015)
• Improving HEFS ensemble forecast for heavy-to-extreme precipitation using conditional bias-penalized regression (CBPR)
• Improving HEFS ensemble streamflow forecast with Multi-Scale Ensemble Post-Processor (MS-EnsPost)
• Bayesian Model Averaging of multiple streamflow forecasts
Hydrologic Ensemble Forecast Service (HEFS)

From Demargne et al. (2014)
HEFS-RiverWare integrated modeling

- Hindcasting period for precipitation and inflow is 1986-2015
- Hindcasting period for reservoir-pipeline system operation is 2007 – 2015

- HEFS generates inflows into reservoirs
- RiverWare simulates reservoirs and pipeline system (6-month spin-up)
Verification of ensemble outflow forecast from GEFS-forced HEFS, CHPS, and RiverWare

CRPSS (reference fcst is RCLIM)

- Skill due to GEFS
- Skill due to perfect rainfall forecasting
- Skill due to perfect rainfall-inflow modeling
- Skill due to everything else

MEFP-MAP and RQIM are single-valued forecasts for which CRPSS=1-AME_{fcst}/mean CRPS_{RCLIM}

From Limon (2019)
HEFS verification for the Upper Trinity

From Kim et al. (2018)
MEFP-GEFS ensemble fcst of multi-daily streamflow

From Kim et al. (2018)
Event-specific evaluation of 15 day-ahead forecasts

From Limon (2019)
Examine a forecast during May-Jun 2015

From Limon (2019)
Forecast time is May 25, 2015

Largest ensemble members w/ GEFS encompass the observed pool elevation and outflow

From Limon (2019)
Improving ensemble precipitation forecast for heavy-to-extreme amounts with conditional bias-penalized regression (CBPR)

North Fork American
Raw GEFS V.S. Default MEFPE Parameterization

3-day observed precipitation vs. the median of the GEFS ensemble forecast (in red) and that of the MEFP ensemble forecast (in blue) for NFDC1 in the American River Basin, CA (from Within and He 2015).
Study Area: CNRFC Basins

Conditional Bias-Penalized Regression (CBPR) has been comparatively evaluated with a research version of Method 2 of MEFP (Wu et al. 2011) for 18 basins in the CNRFC’s service area for ensemble forecasting of 4-day precipitation over lead times of 1 to 4 days.
RMSE of MEFP, CBPR, and raw GEFS ensemble mean forecast of 4-day precipitation for scbc1hlf, tmdc1hmf - 1000 bootstrapped values from 10-fold cross validation

From Ghazvinian (2019)
Percent reduction in Mean CRPS by CBPR over MEFP for 4-day precipitation for different thresholds of MAP (10-fold cross validation used)

From Ghazvinian (2019)
Improving HEFS streamflow ensemble fcst with multiscale ensemble post-processor (MS-EnsPost)

MS-EnsPost has been developed and comparatively evaluated with a research version of the existing post-processor, EnsPost, for 140 basins in the service areas of 8 RFCs in the Continental US.

From Alizadeh et al. (2019)
The lower and upper ends of each worm are associated with Day-1 and -7 predictions for that basin. The worms stretched downward from the diagonal indicate improvement from MS-EnsPost.

- MS-EnsPost outperformed EnsPost at all lead times in the RMSE sense for 137 out of 140 basins.

- The RMSE is reduced by 5 to 68% for Day-1 to -7 predictions of daily flow.

- MS-EnsPost outperformed EnsPost at all lead times in the mean CRPS sense for 136 out of 140 basins.

- The mean CRPS is reduced by 2 to 62% for Day-1 to -7 predictions of daily flow.

- The improvement is particularly significant for the Upper Trinity River basins in the WGRFC’s service area.

From Alizadeh et al. (2019)
Bayesian Model Averaging of multiple forecasts (w/ Deltares USA, MARFC)

Input forecasts
- RFC operational
- NWM
- HEFS
- MMEFS-GEFS
- MMEFS-NAEFS
- MMEFS-SREF

https://www.weather.gov/erh/mmefs
Very preliminary results

65 headwater basins

102 downstream basins
Prediction skill (hydrology only) measured by CRPSS in reference to sample climatology of historical observed flow

(Most of) TX and OK are a very difficult place to forecast water due to limited predictability.

To make the most of the limited skill, it is necessary to make use of higher-order information (i.e., uncertainty).

From Alizadeh et al. (2019)
Thank you

- For more information, contact:
- djseo@uta.edu
Ensemble forecast of mean daily streamflow: MEFP-GEFS vs. MEFP-RFC

Significant improvement due to GEFS with or without EnsPost except for Days 1 and 2

From Kim et al. (2018)