



HYDROLOGIC ENSEMBLE FORECAST SERVICE (HEFS) IMPROVEMENT EFFORTS

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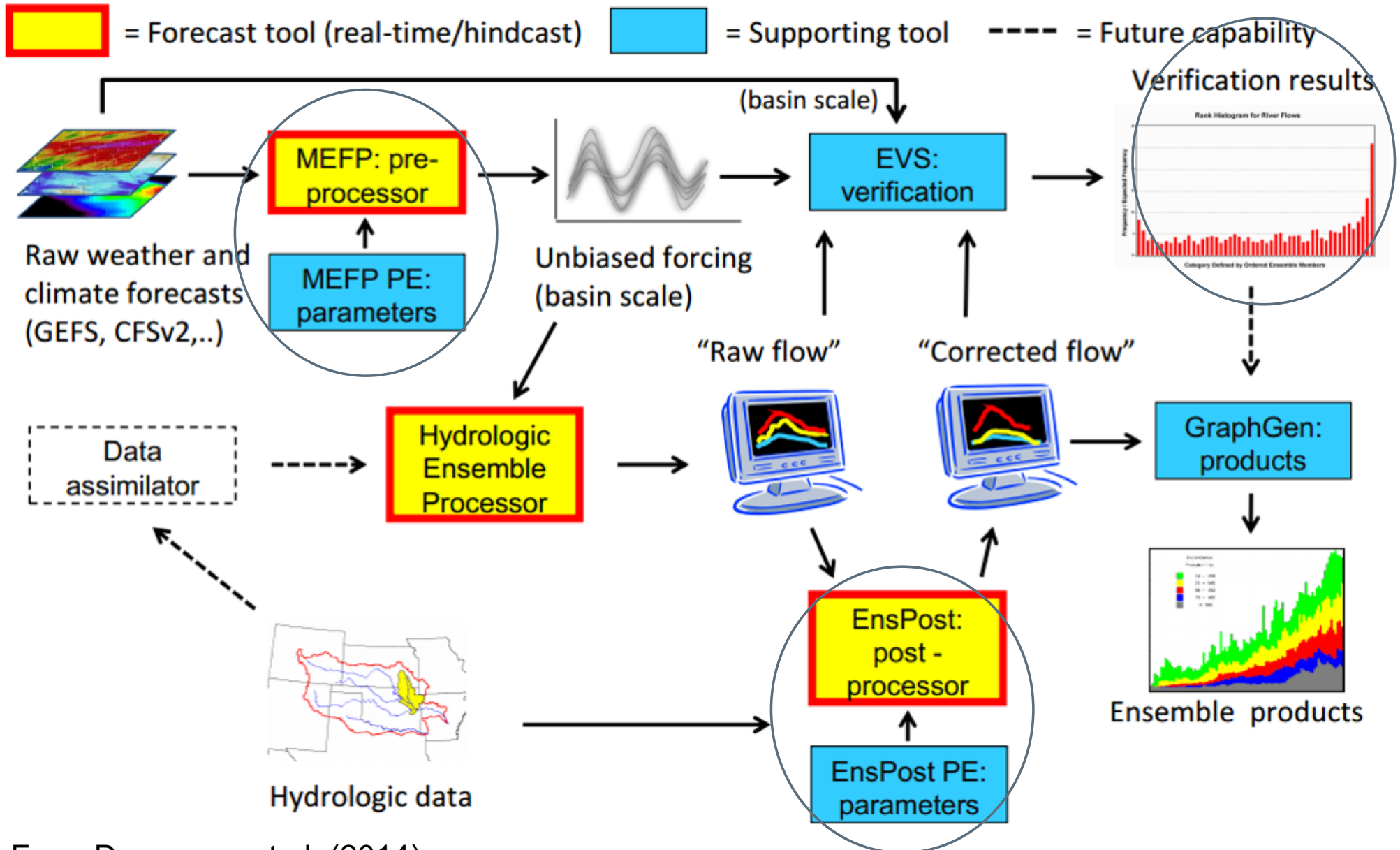
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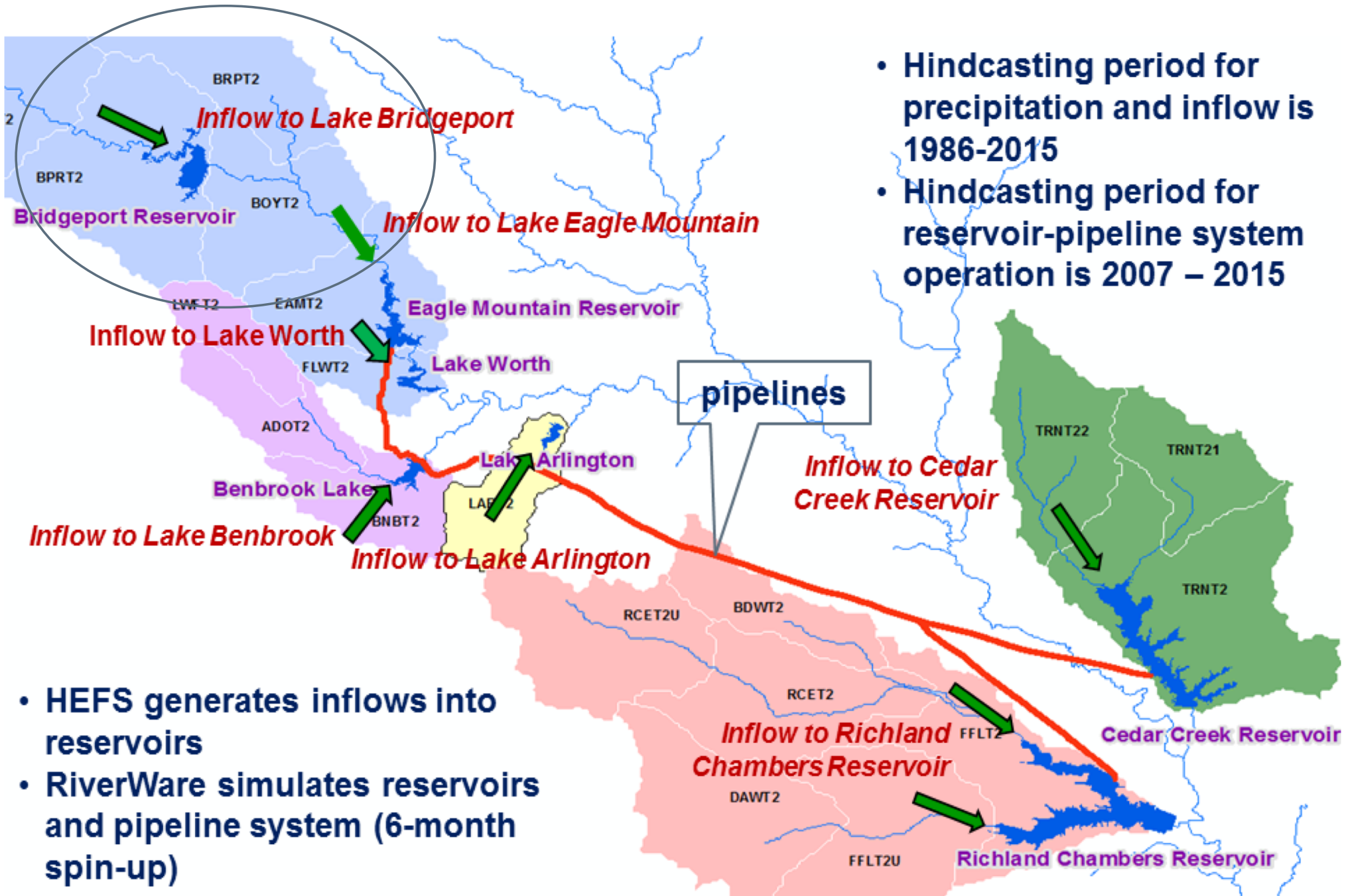
In this presentation

- 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)



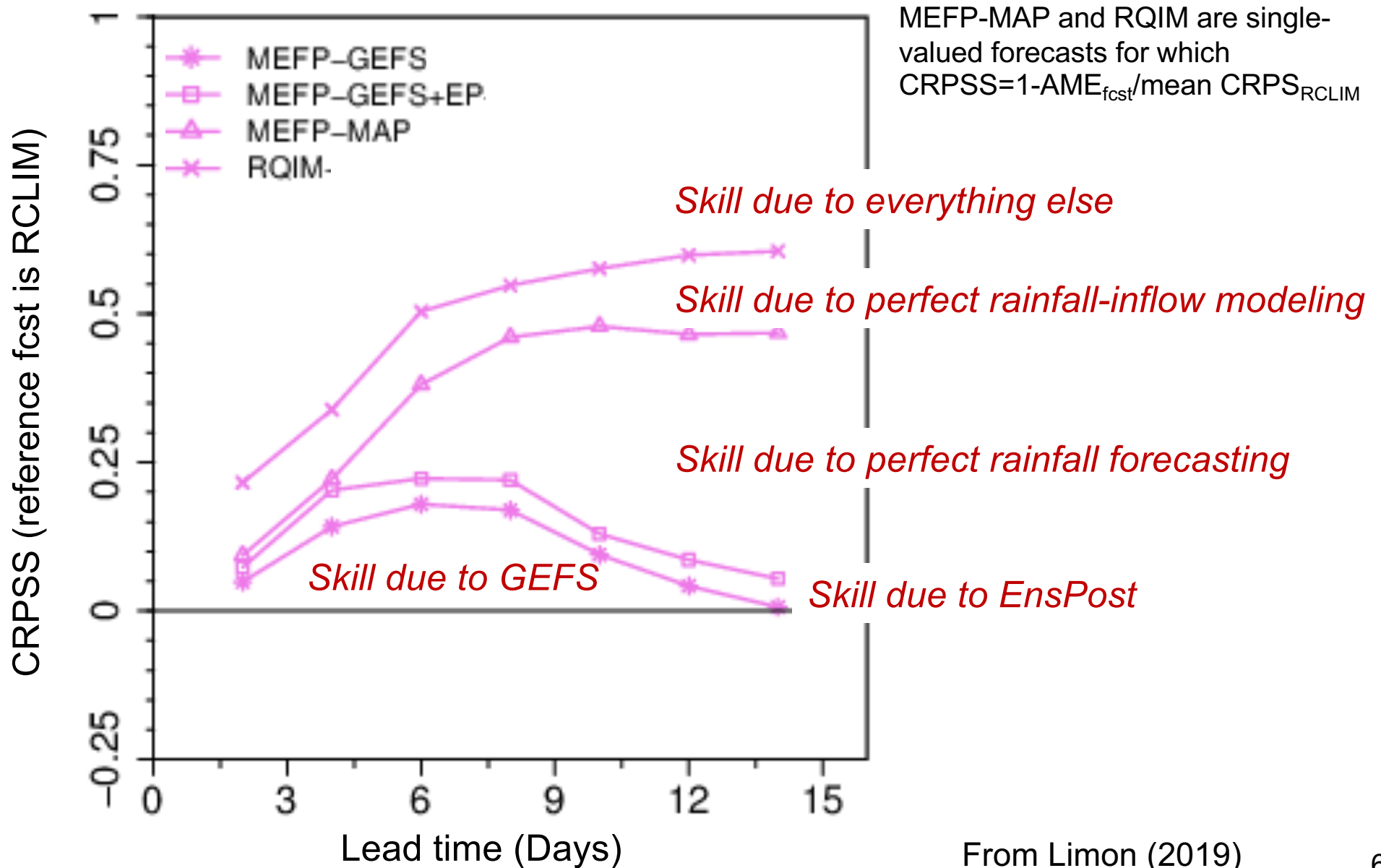
HEFS-RiverWare integrated modeling



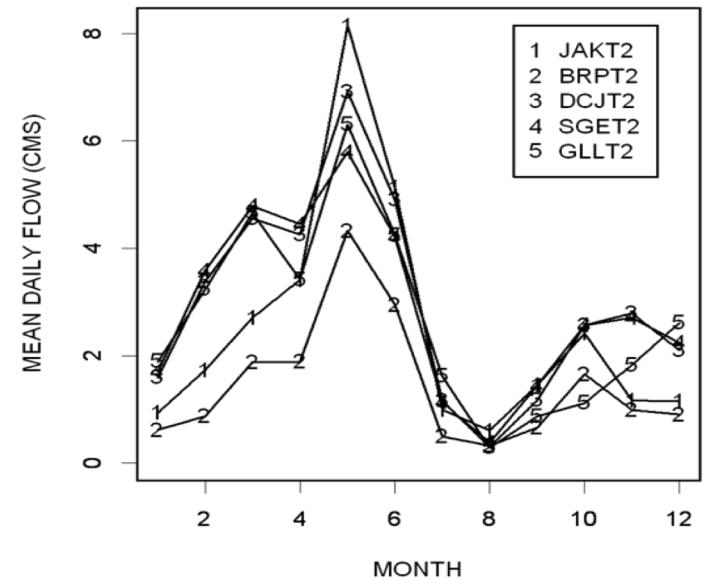
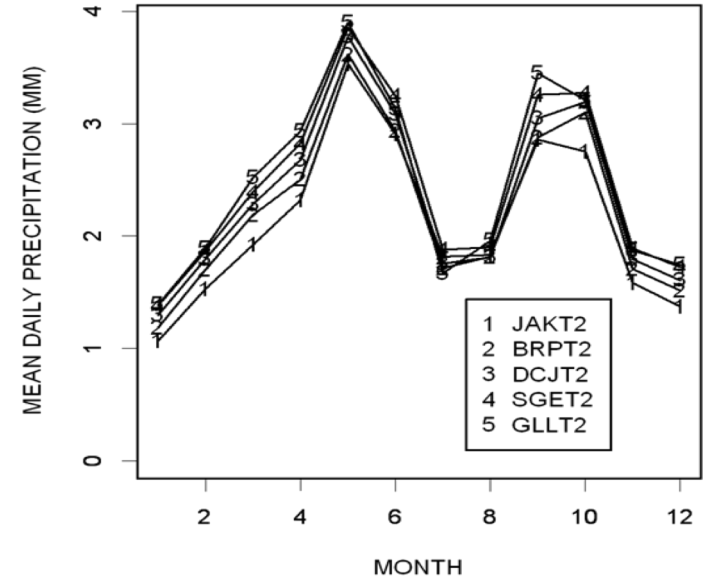
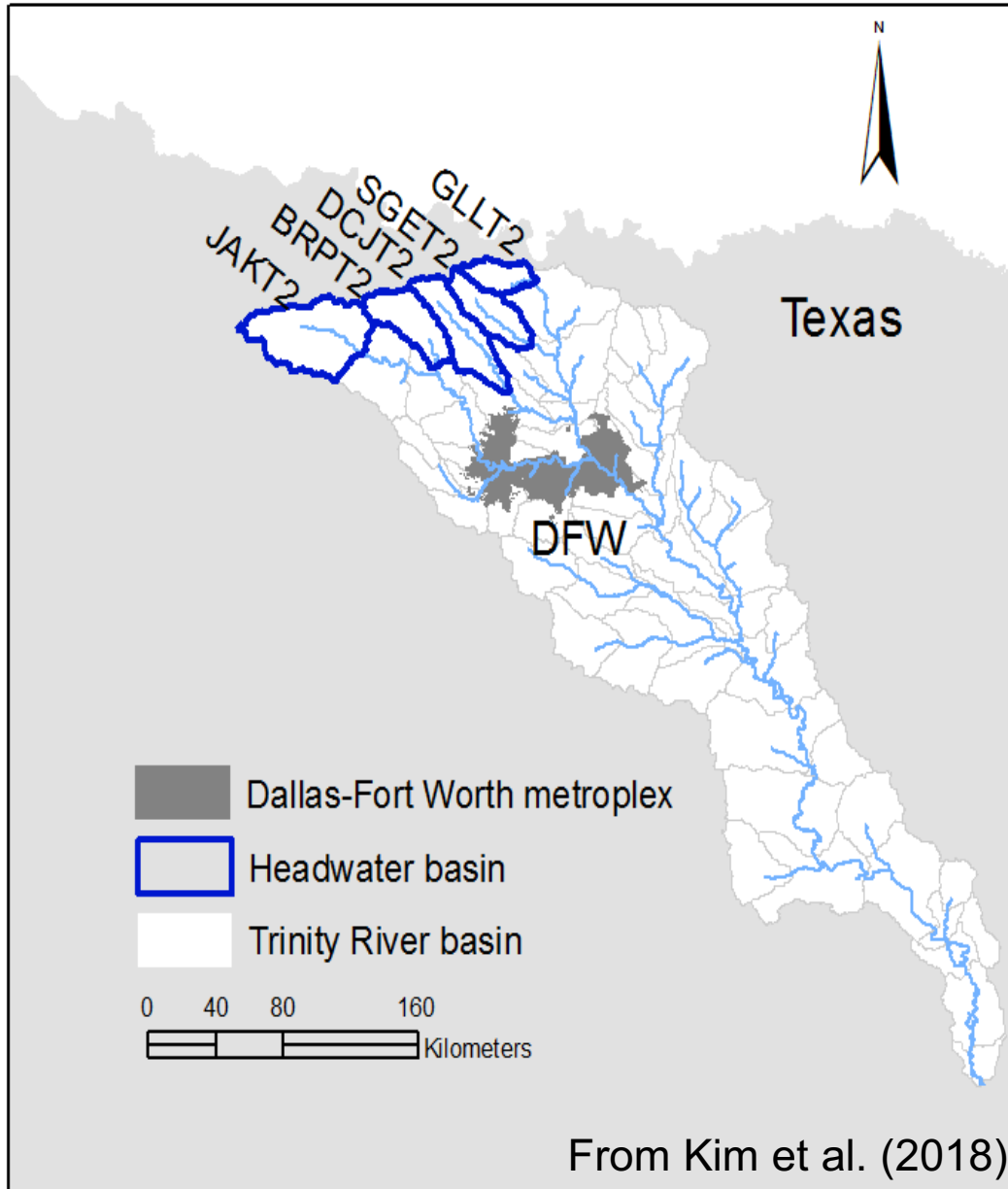
- Hindcasting period for precipitation and inflow is 1986-2015
- Hindcasting period for reservoir-pipeline system operation is 2007 – 2015

- 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

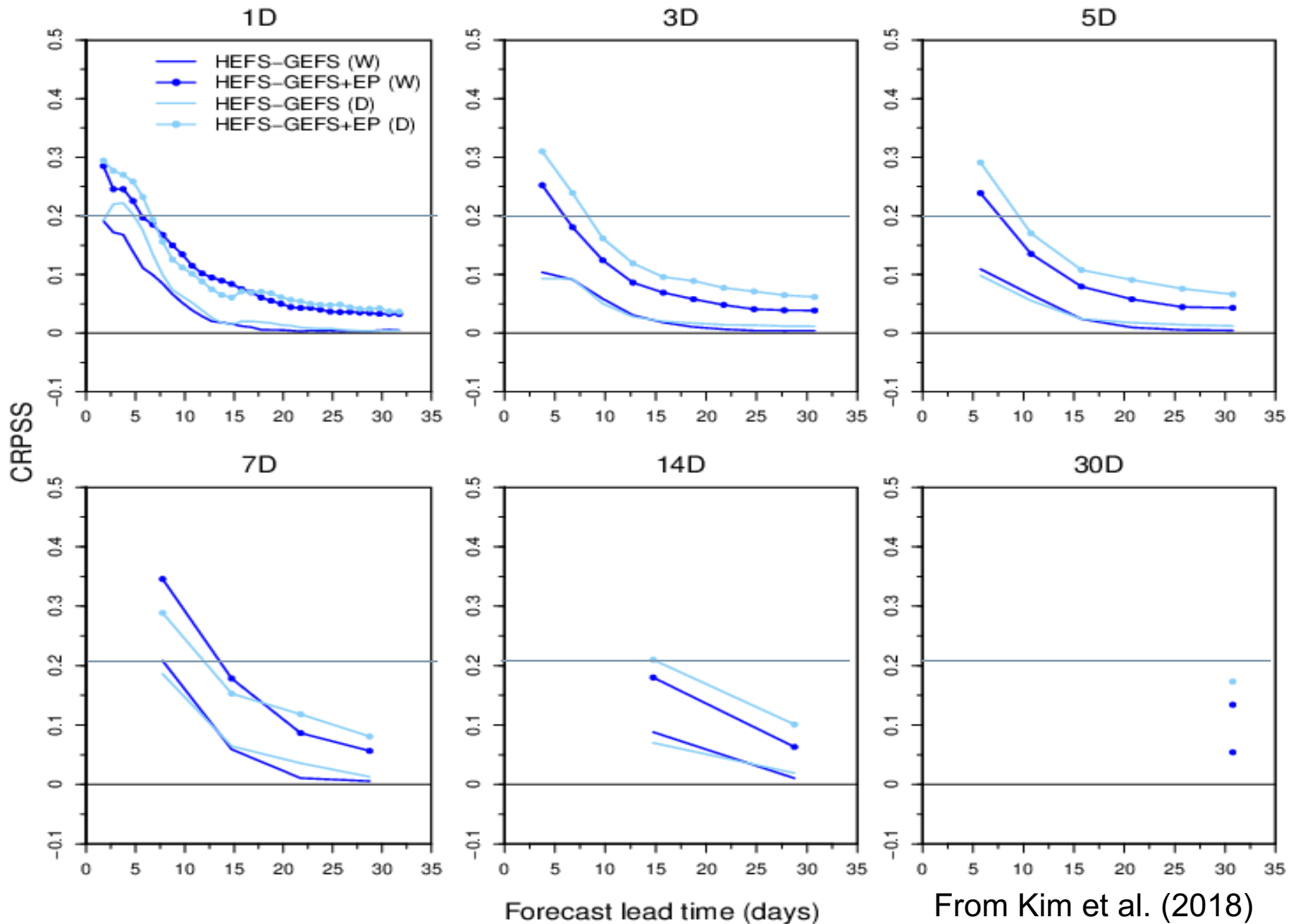


HEFS verification for the Upper Trinity



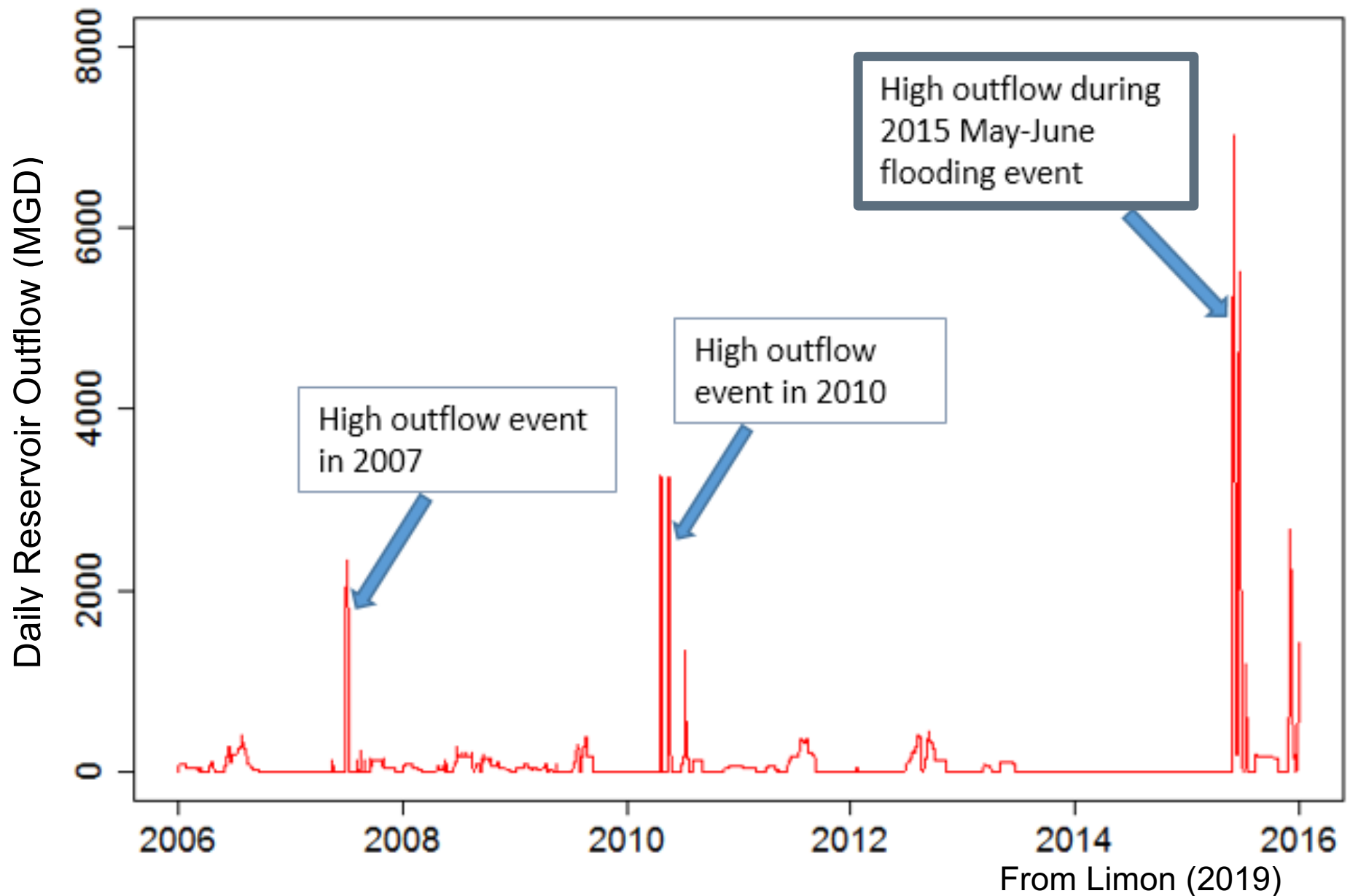
MEFP-GEFS ensemble fcst of multi-daily streamflow

Agg ($> C_Y = 0.99$)

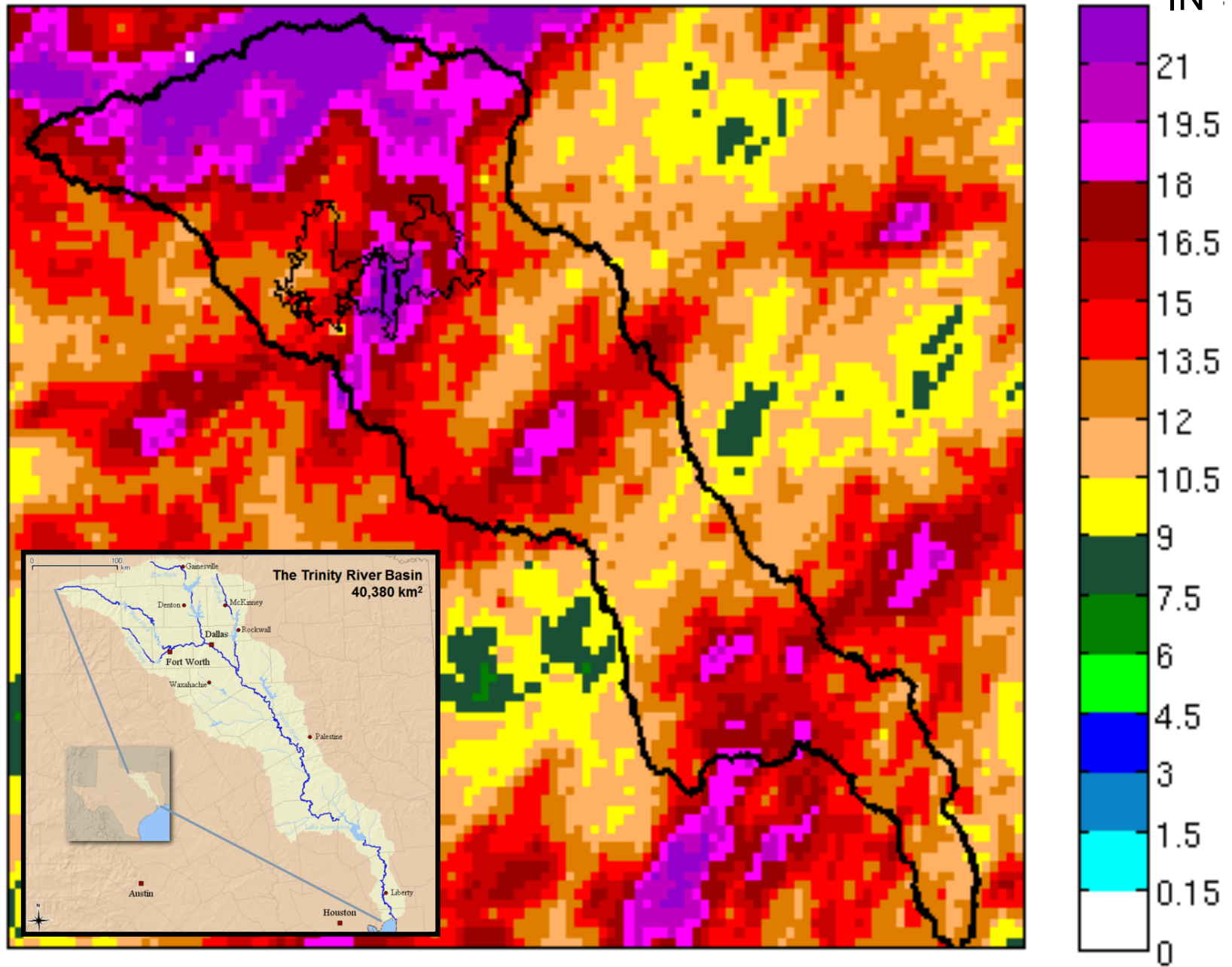


From Kim et al. (2018)

Event-specific evaluation of 15 day-ahead forecasts

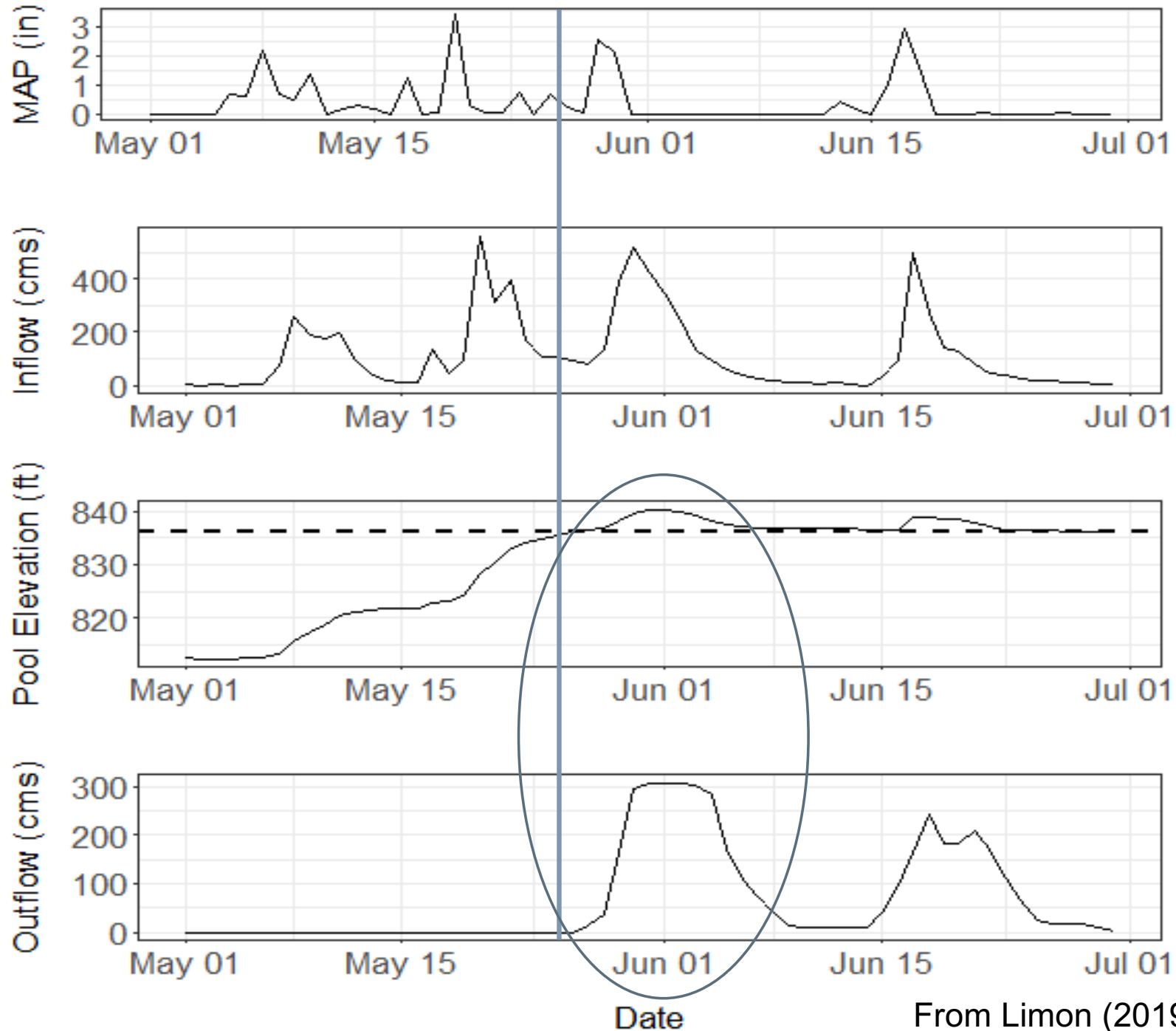


Trinity River Basin Total rainfall-May 2015



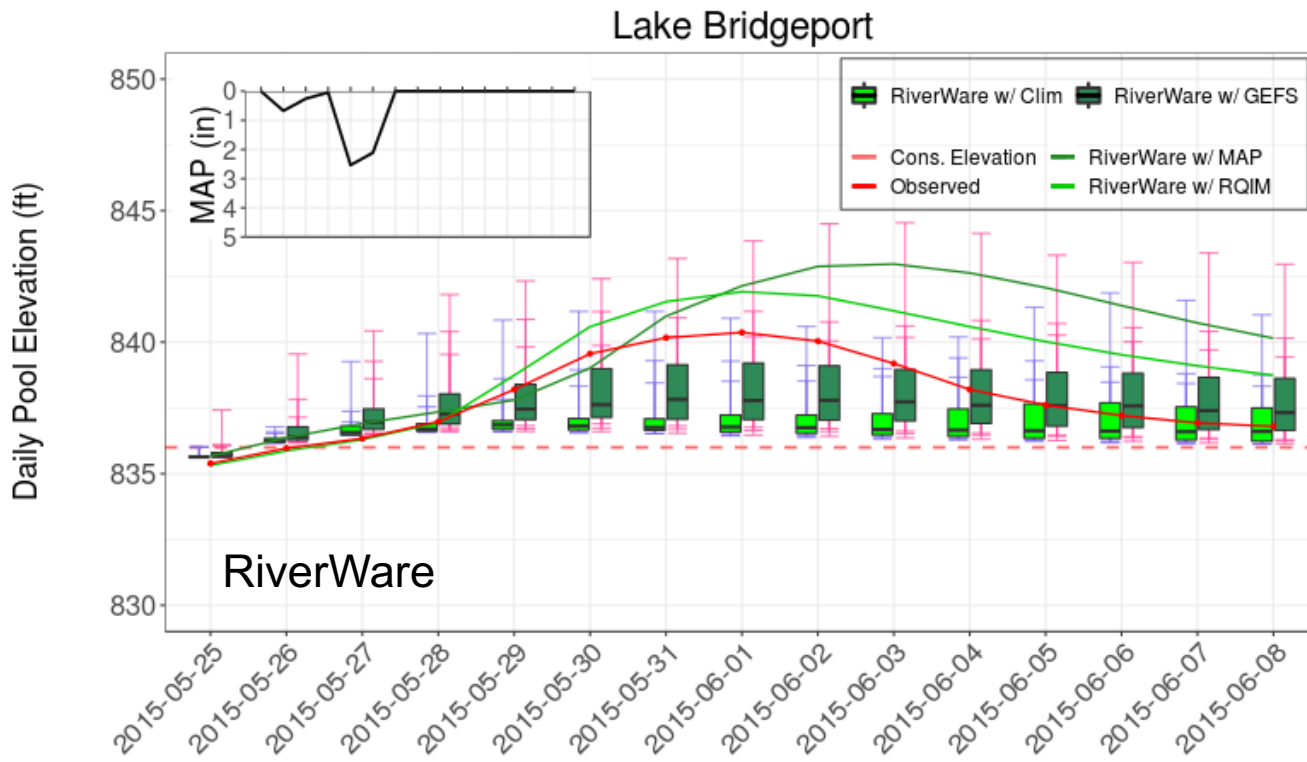
<http://water.weather.gov/precip/>

Examine a forecast during May-Jun 2015

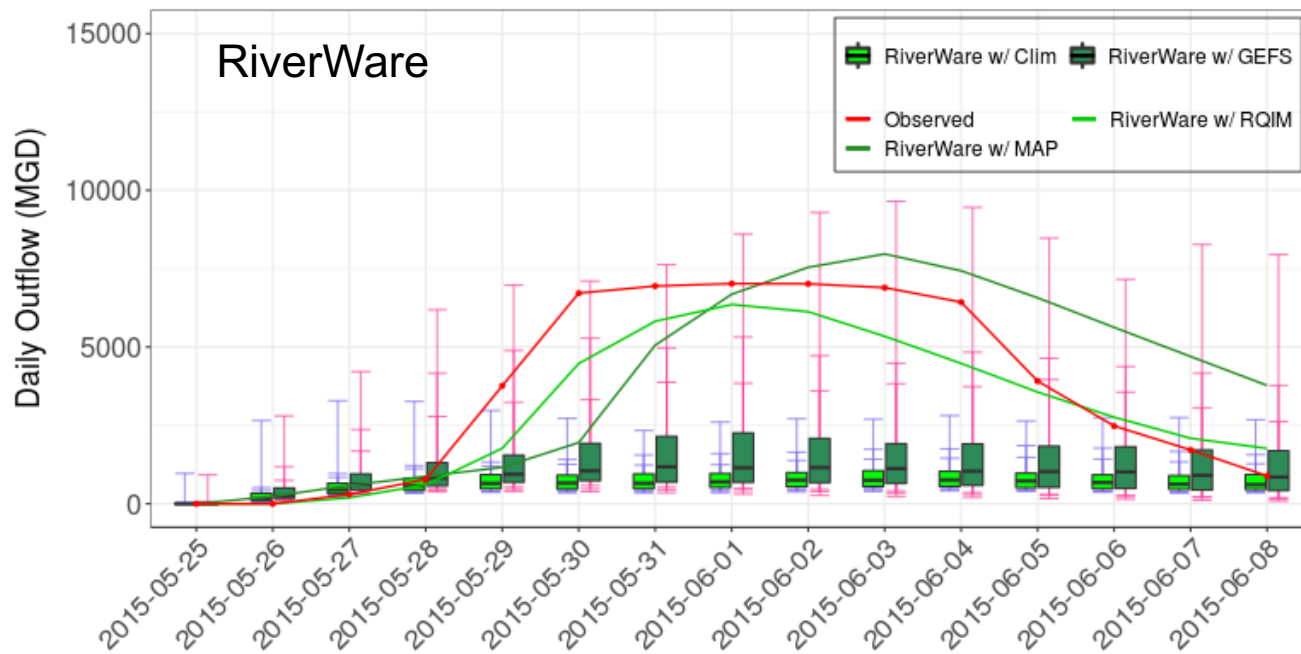


From Limon (2019)

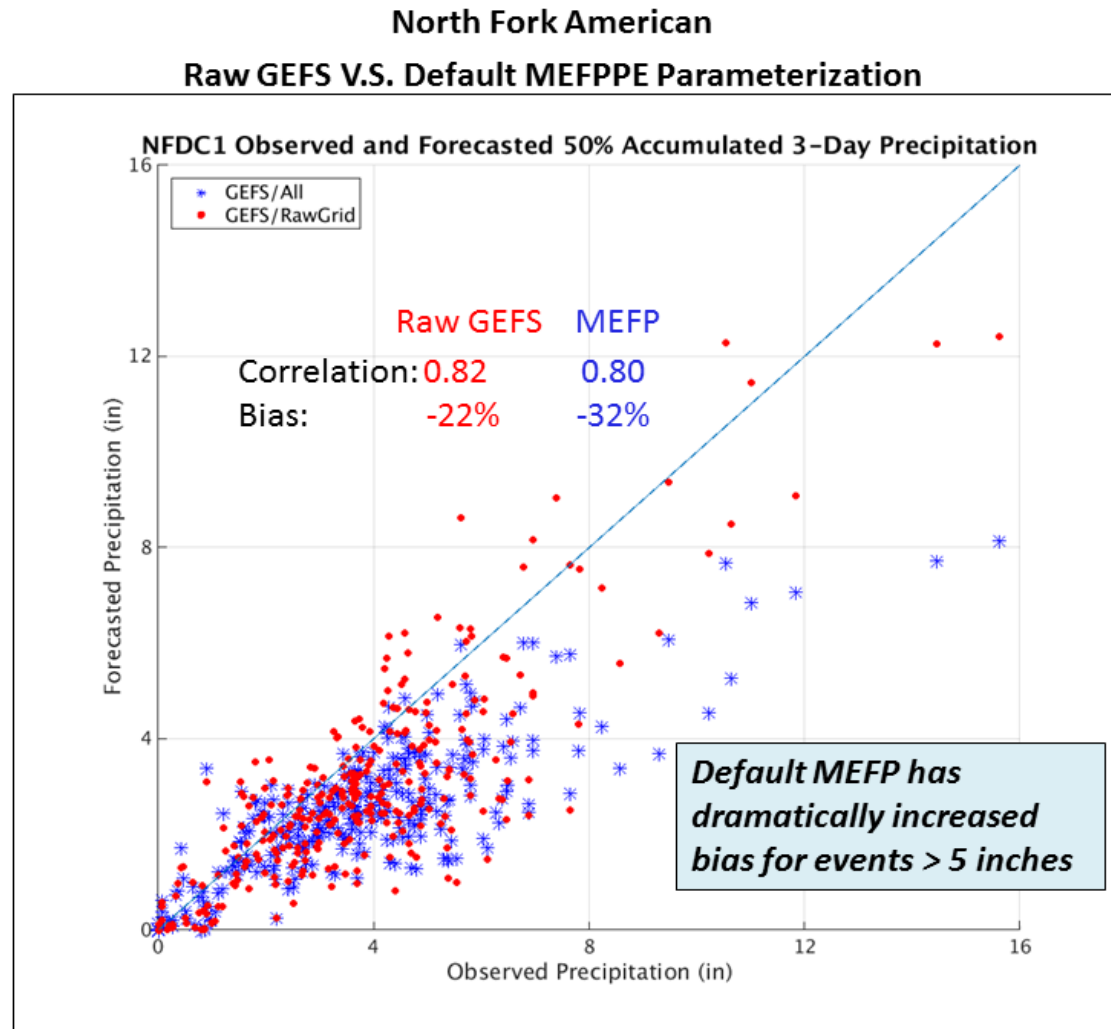
Forecast
time is
May 25,
2015



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

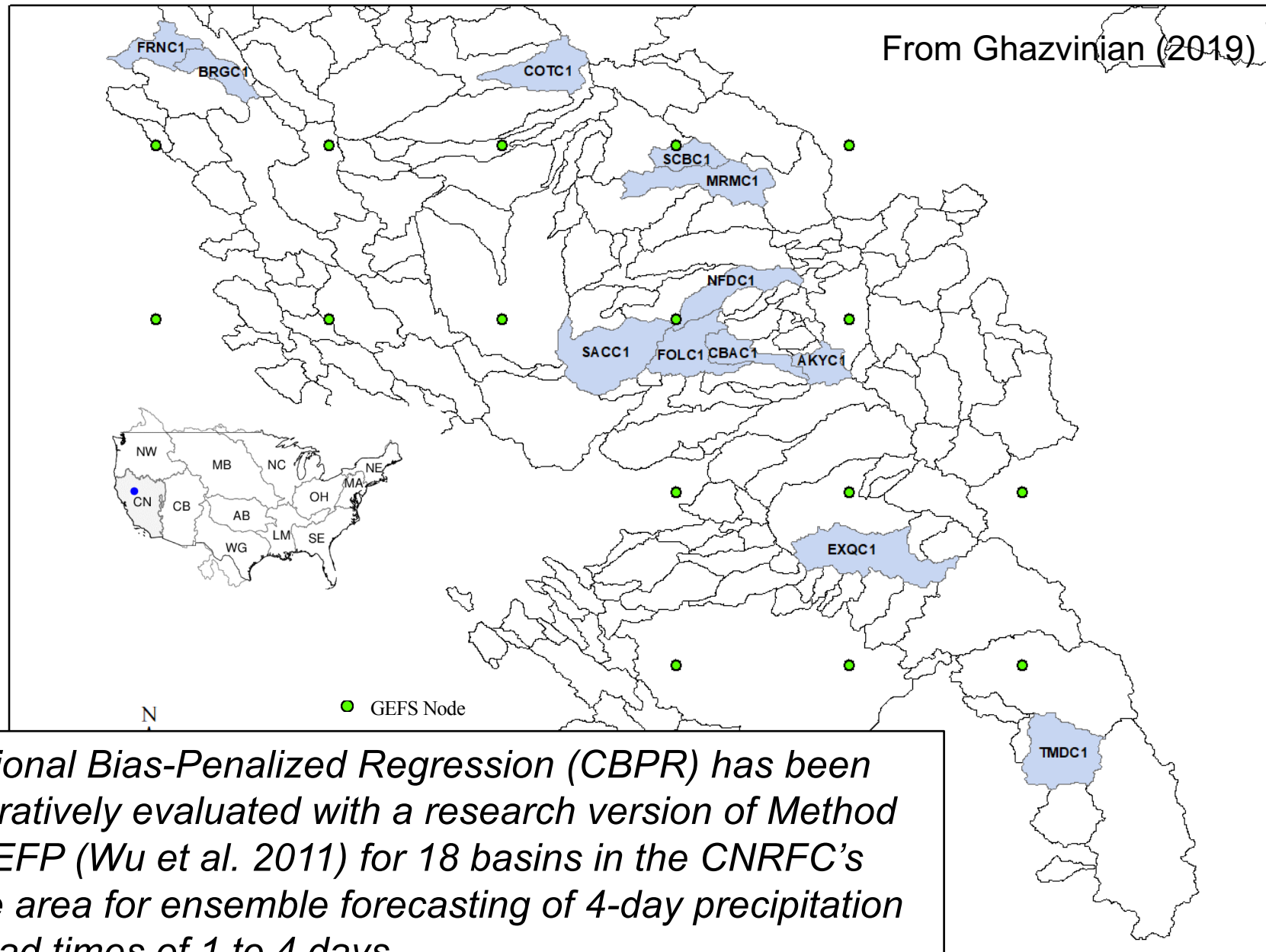


Improving ensemble precipitation forecast for heavy-to-extreme amounts with conditional bias-penalized regression (CBPR)



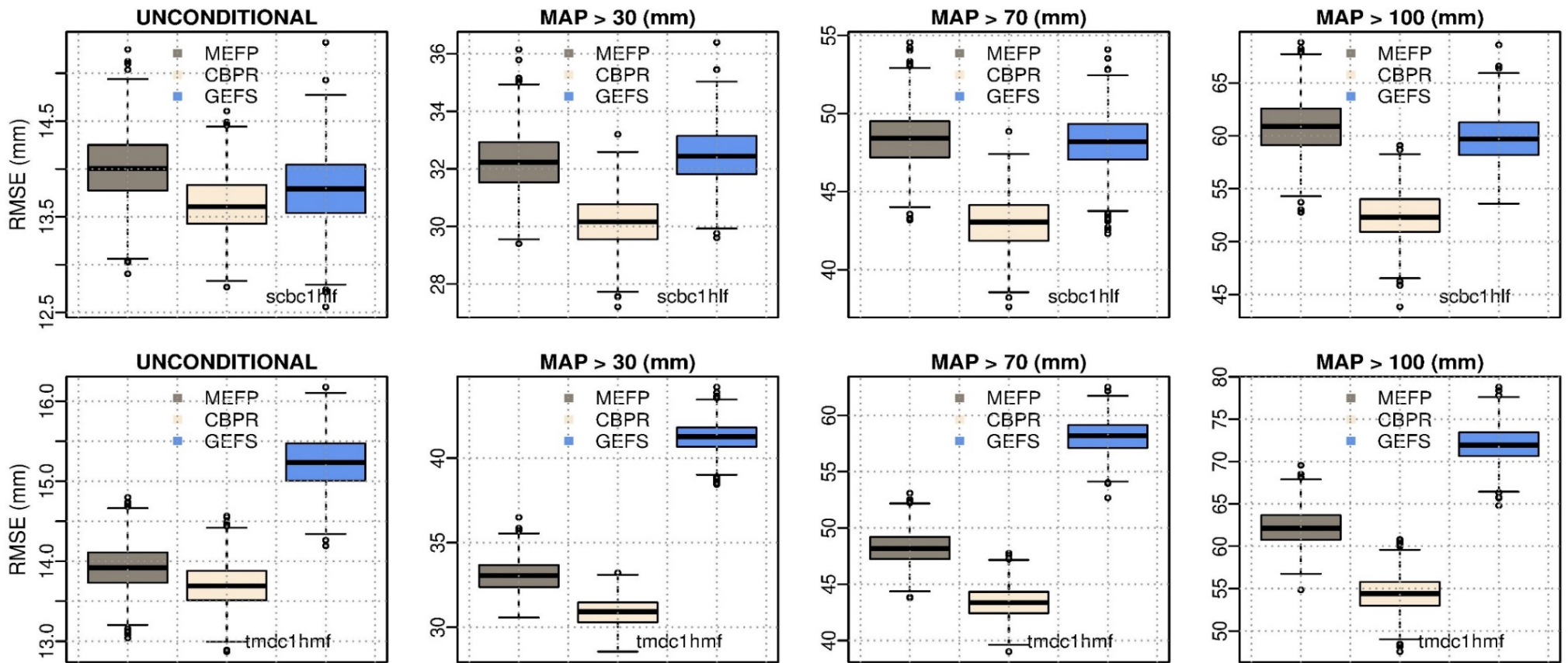
3-day observed precipitation vs. the median of the GEFS ensemble forecast (in red) and that of the MEFP ensemble forecast (in blue) for NFDC1 in the American River Basin, CA (from Within and He 2015).

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.

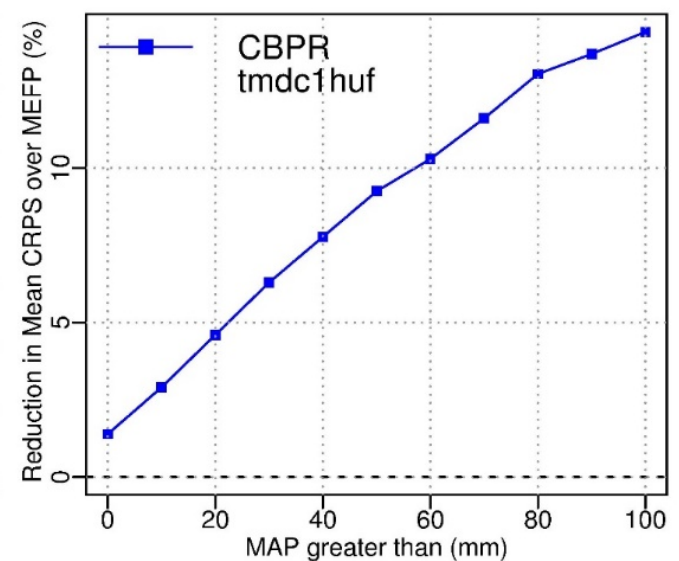
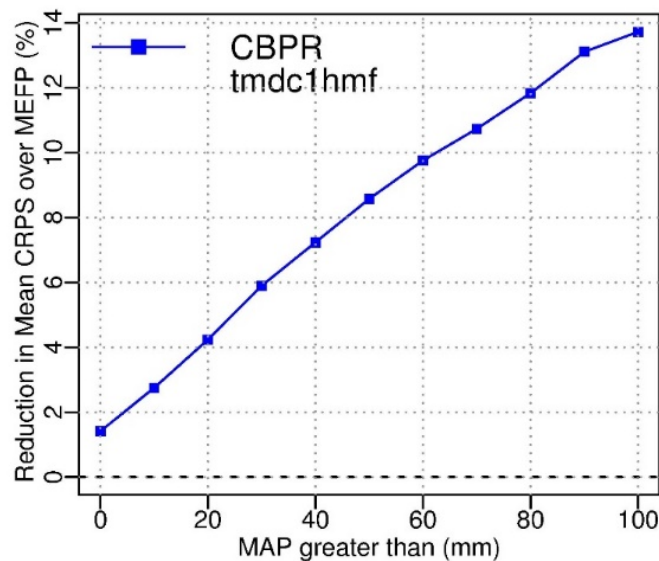
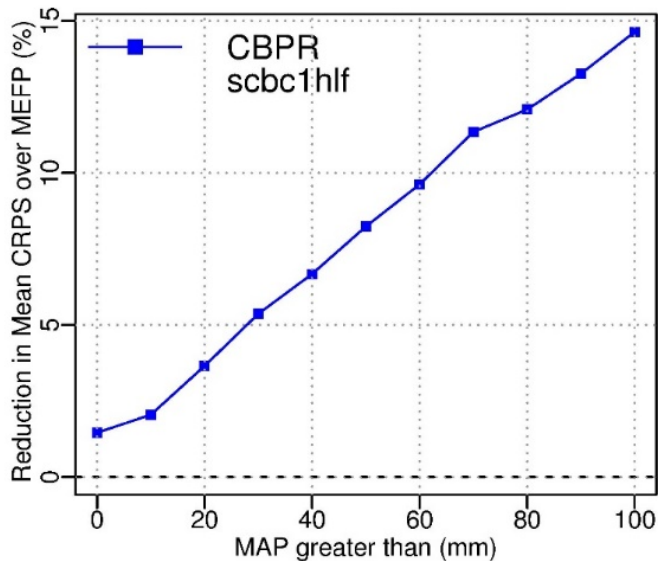
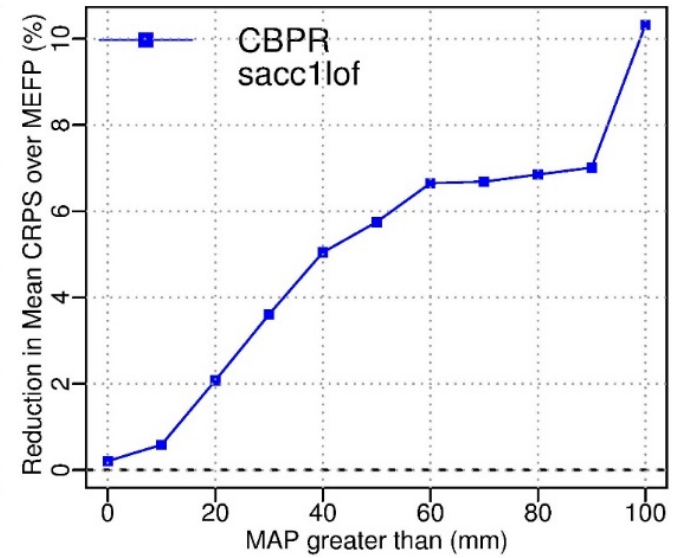
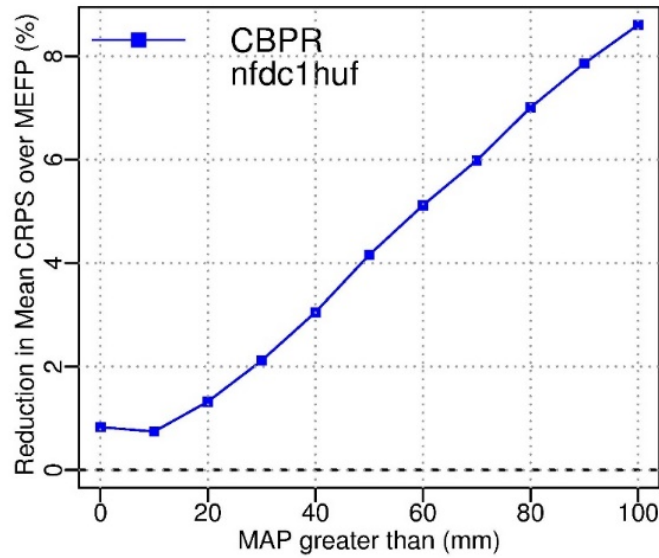
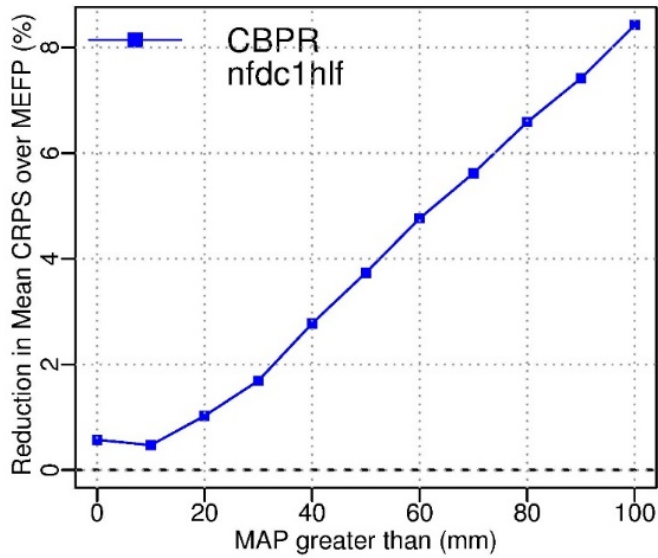
RMSE of MEFP, CBPR, and raw GEFS ensemble mean forecast of 4-day precipitation for scbc1hlf, tmdc1hmf - 1000 bootstrapped values from 10-fold cross validation



Increasing conditioning amount

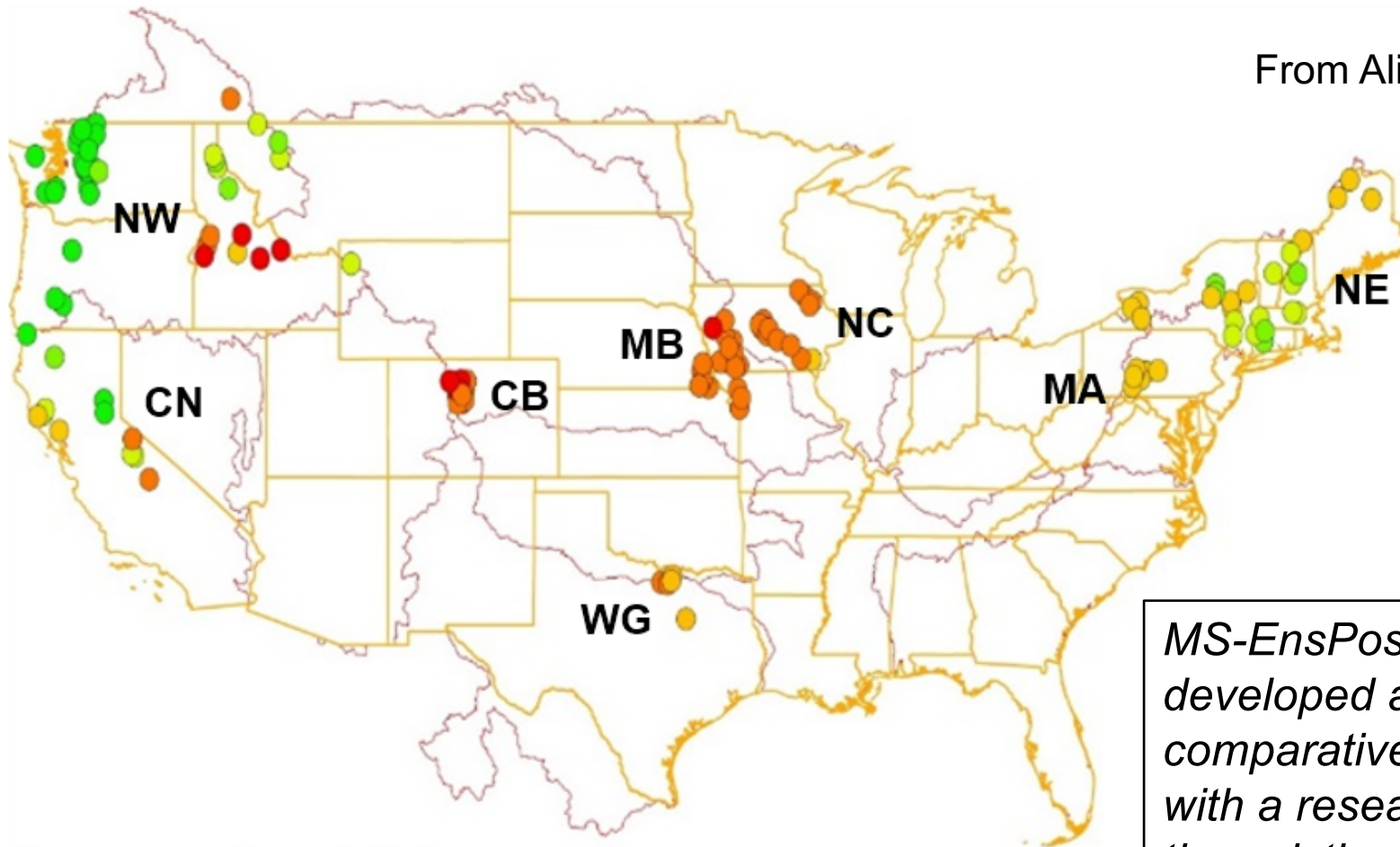
From Ghazvinian (2019)

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



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

From Alizadeh et al. (2019)



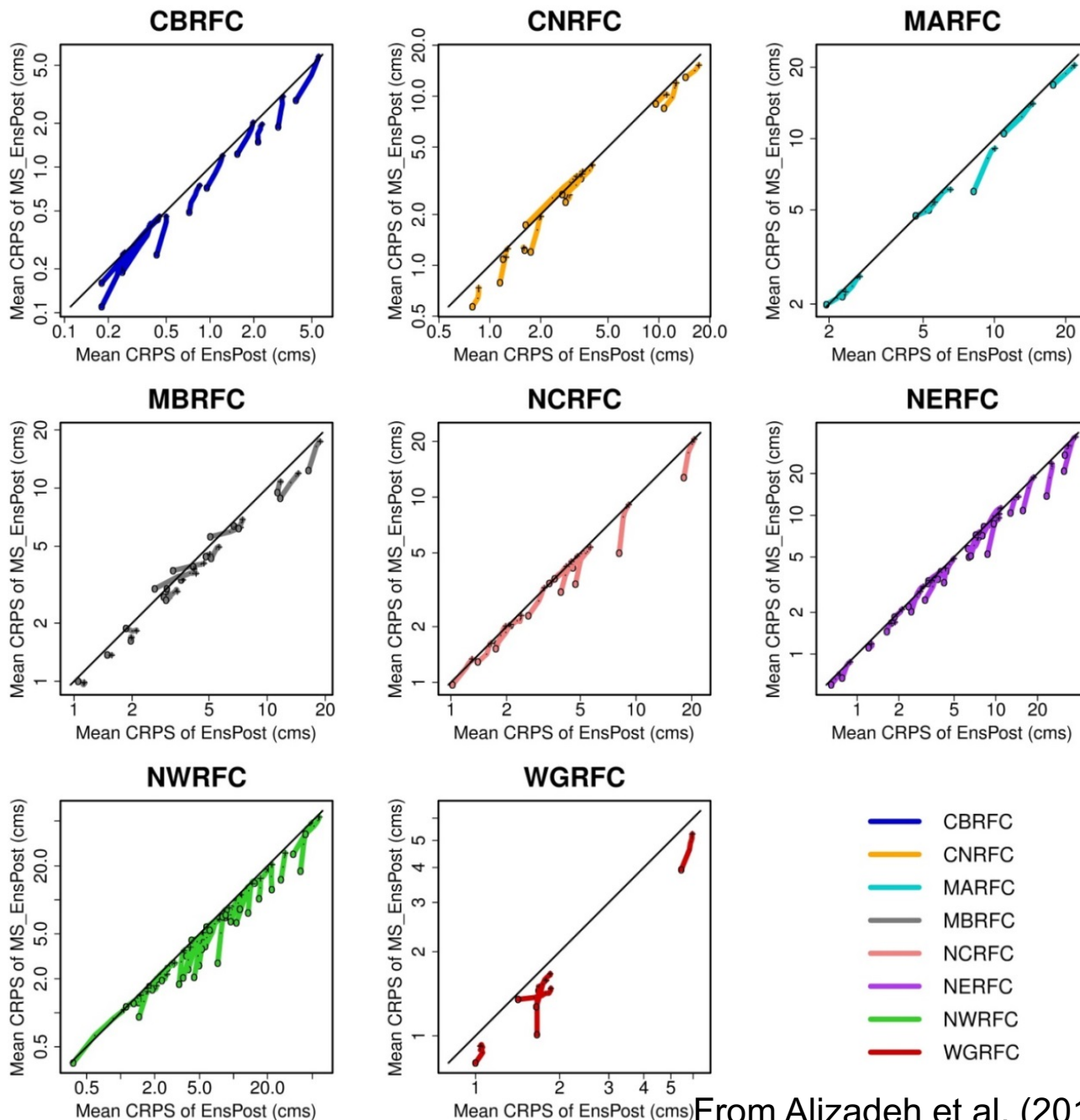
Mean annual precipitation



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.

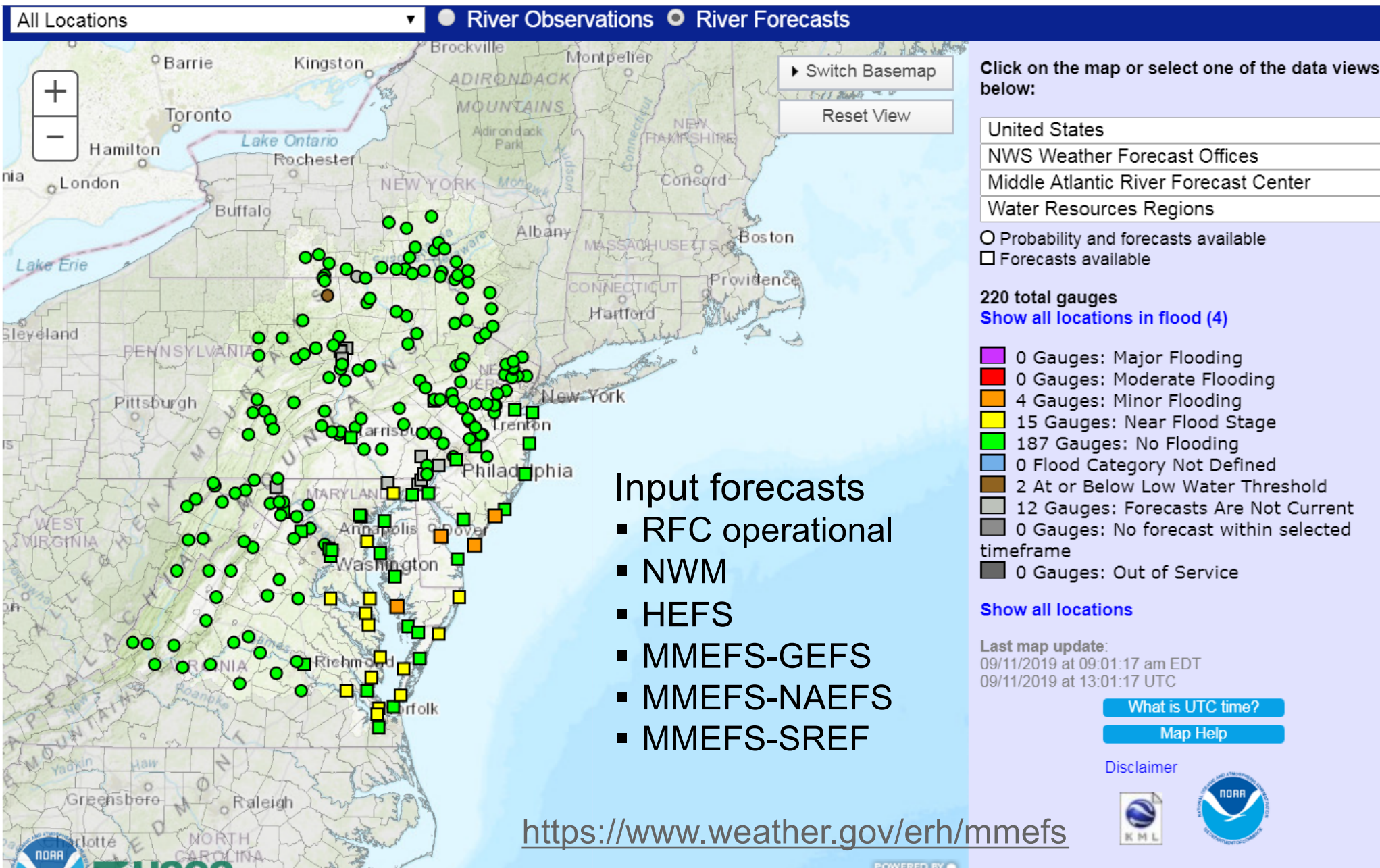
The lower and upper ends of each worm are associated with Day-1 and -7 predictions for that basin. The worms stretched downward from the diagonal indicate improvement from MS-EnsPost

- 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)

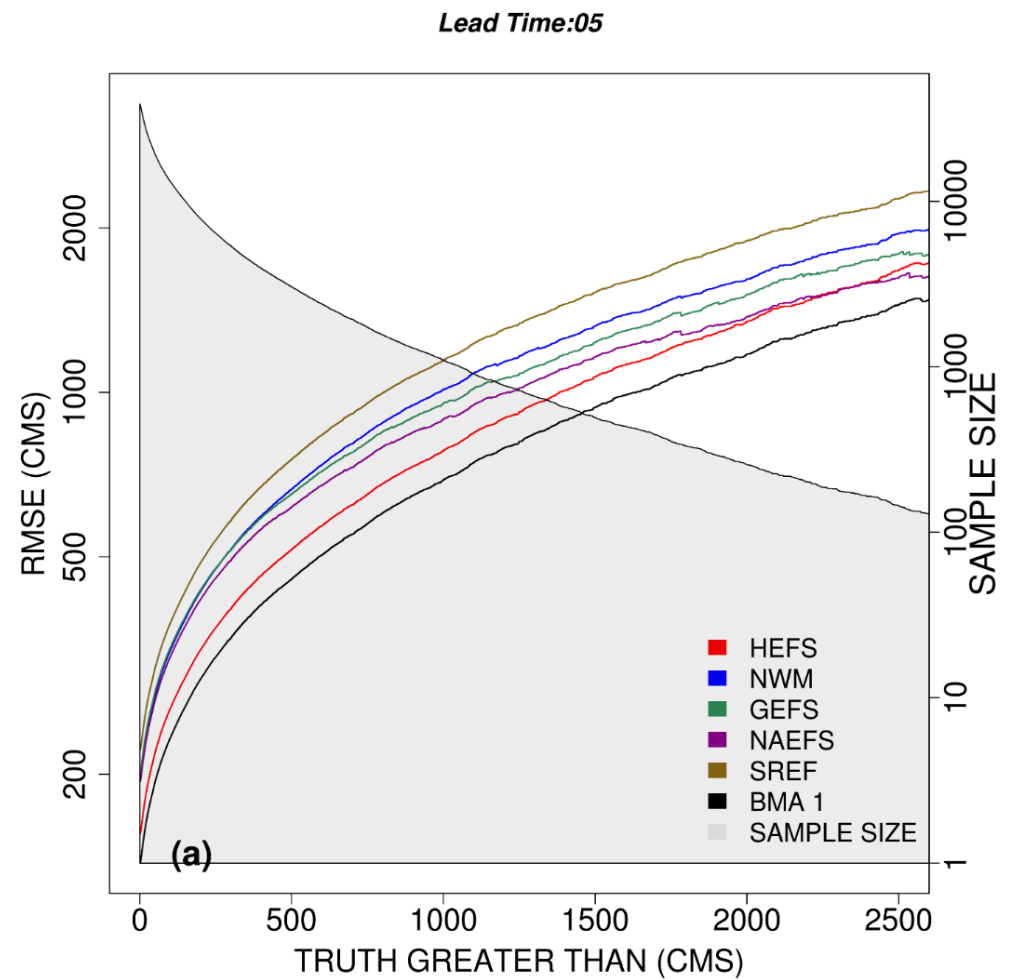
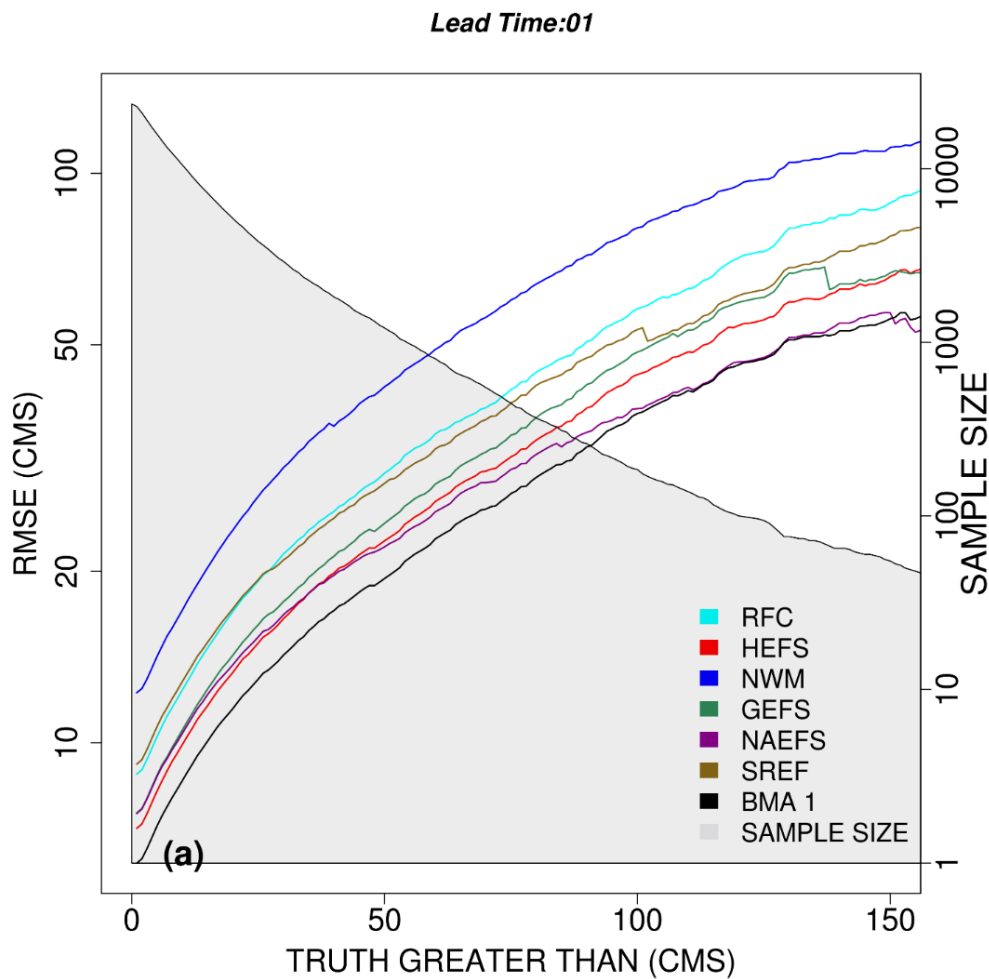


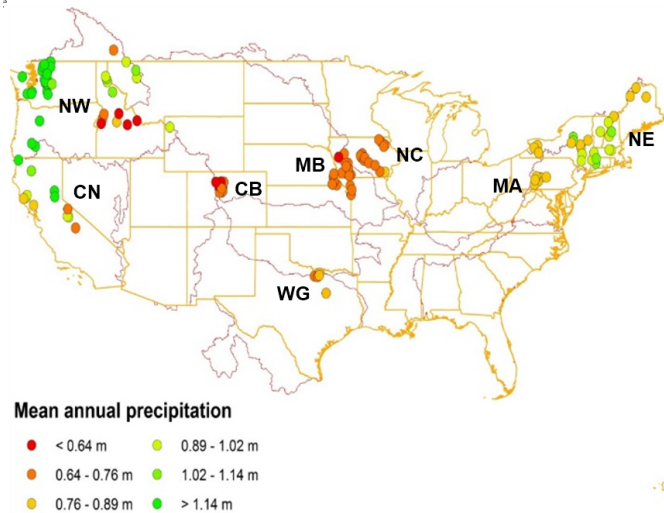
- ### Input forecasts
- RFC operational
 - NWM
 - HEFS
 - MMEFS-GEFS
 - MMEFS-NAEFS
 - MMEFS-SREF

Very preliminary results

65 headwater basins

102 downstream basins

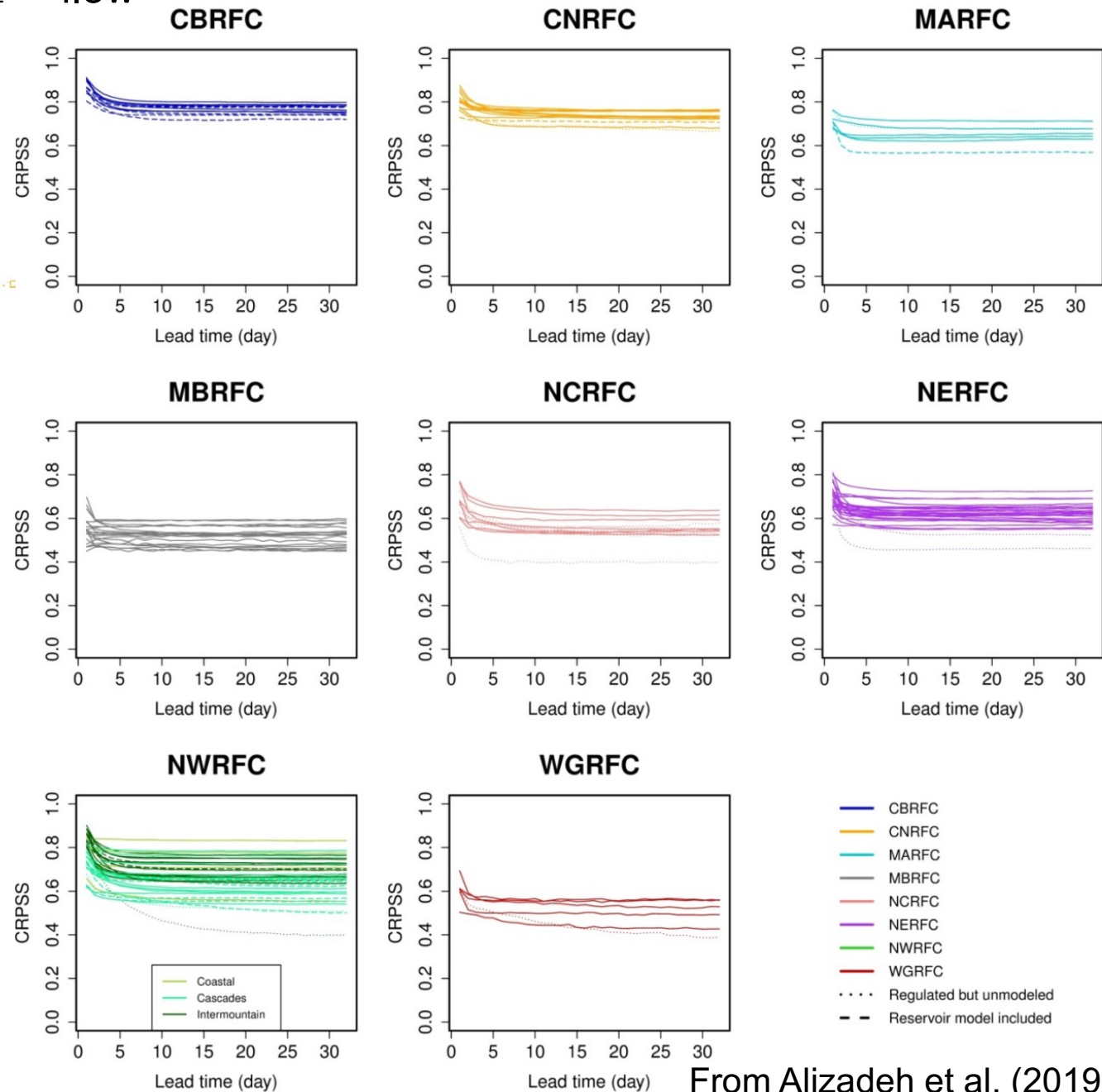




Mean annual precipitation

- < 0.64 m
- 0.64 - 0.76 m
- 0.76 - 0.89 m
- 0.89 - 1.02 m
- 1.02 - 1.14 m
- > 1.14 m

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.

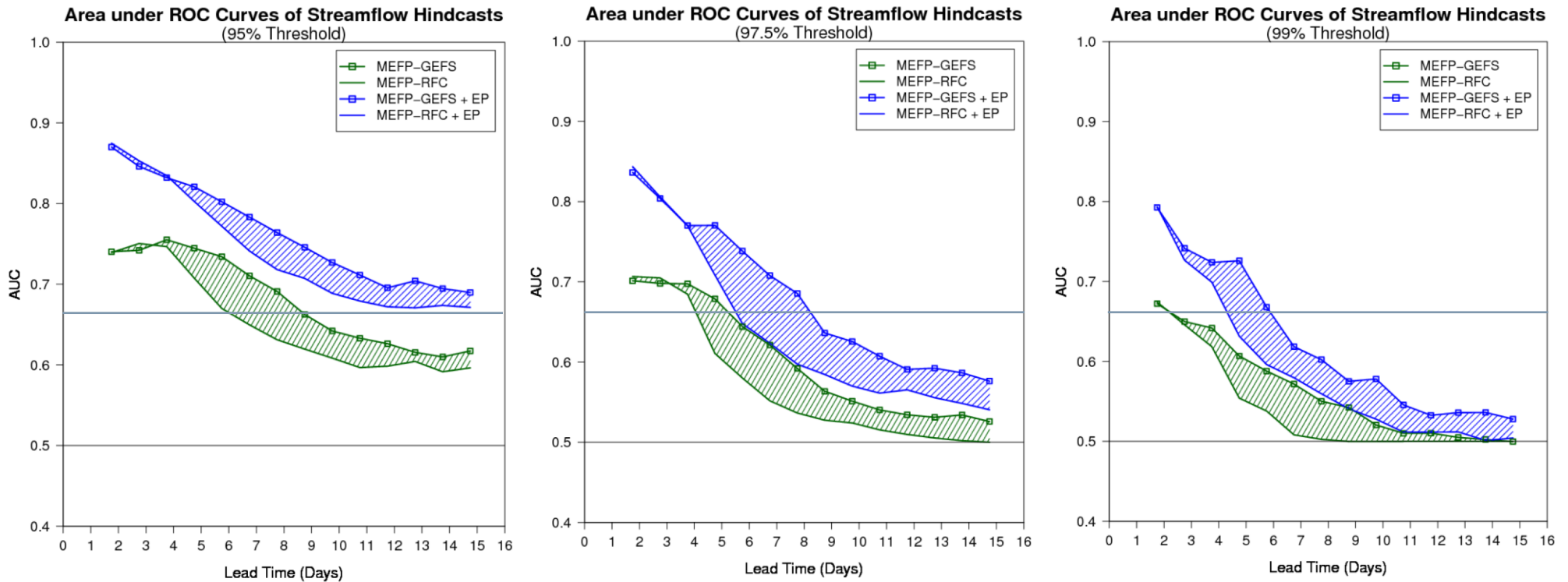
To make the most of the limited skill, it is necessary to make use of higher-order information (i.e., uncertainty).



Thank you

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- For more information, contact:
 - djseo@uta.edu

Ensemble forecast of mean daily streamflow: MEFP-GEFS vs. MEFP-RFC



From Kim et al. (2018)

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