

Hydrologic Ensemble Forecast Service

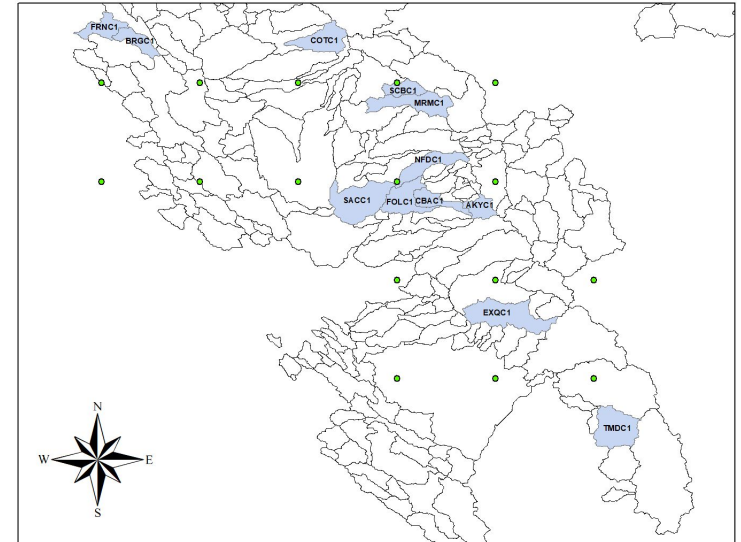
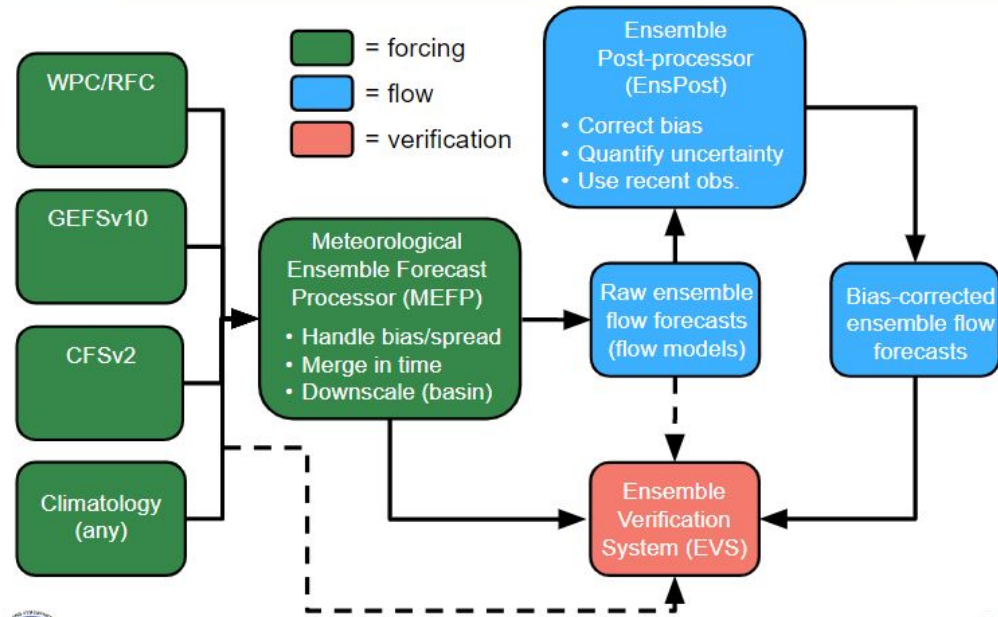
- What is to be done**

Yu Zhang, UT Arlington
Sep 22, 2023

Background of HEFS

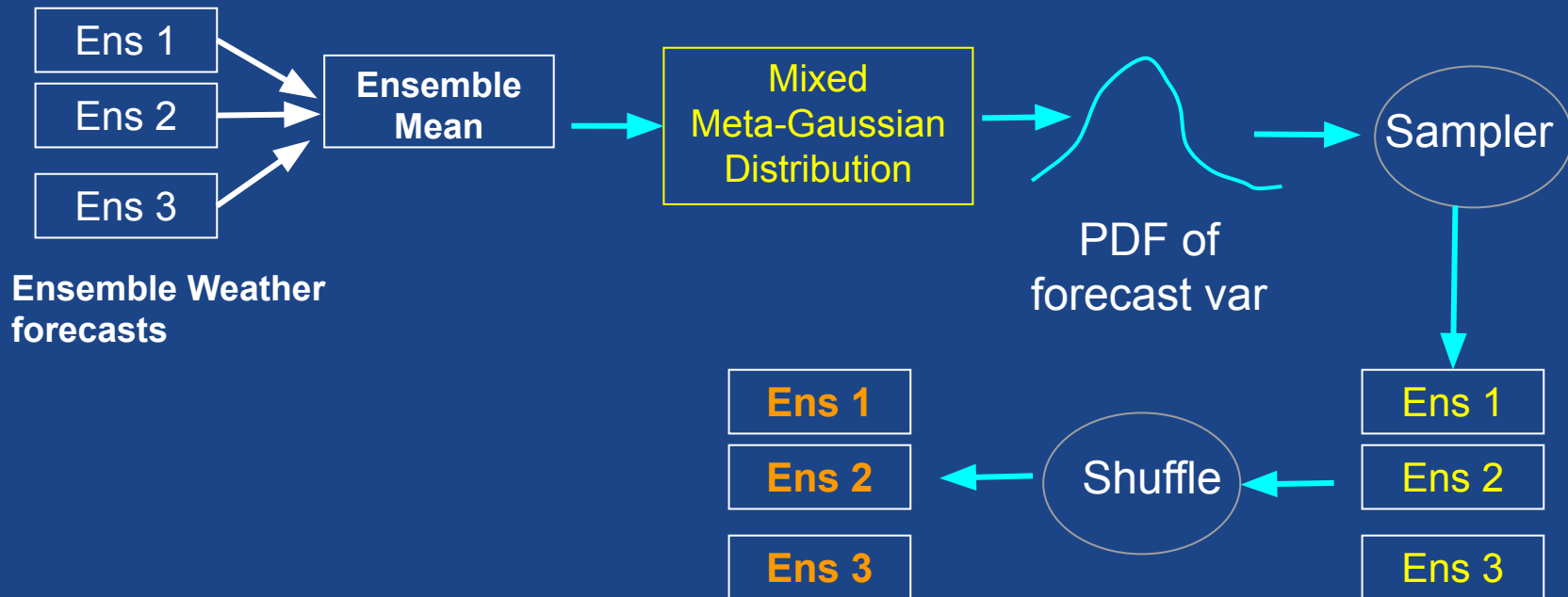
- Extended (Ensemble) Streamflow Prediction (ESP)
 - Uses historical precipi/temperature traces only
 - Not exploiting increasing skills of weather predictions
- NWS Hydrology Lab started to develop HEFS
 - Led by John Schaake, then by Dong-Jun Seo
 - Incorporate precip/temp forecasts from weather models
- Backbone for FIRO activities over California, New York, and now Texas

HEFS Overview



It ingests forcing and produces streamflow forecasts for basins (forecast points)

HEFS Meteorological Forcing Processor

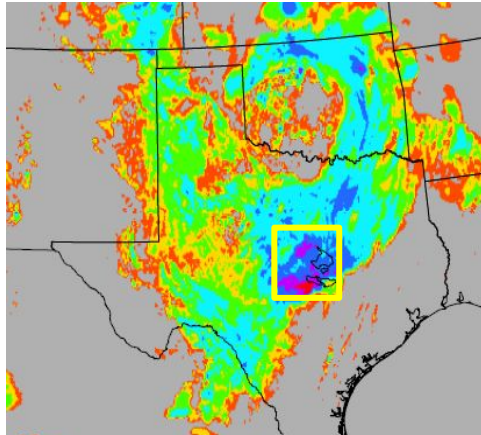


Key Limitations of HEFS

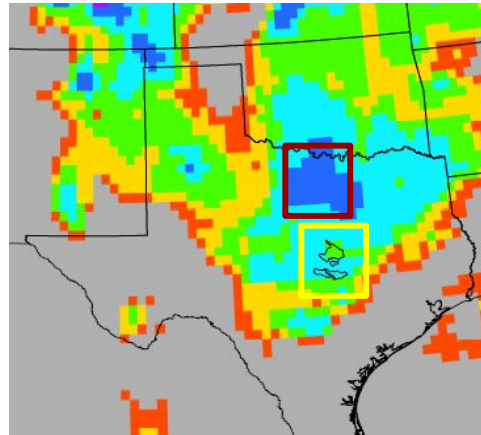
- Unable to reliably depict range of uncertainty in precipitation
 - Location errors in model forecasts often large
 - Uses ensemble mean forecast only not ensemble members
- Underforecast magnitude of extreme rainfall
 - HEFS processing method exacerbates underforecast
- Lack robust mechanisms to postprocess seasonal forecast
- Difficulty in parameter estimation for arid/semi-arid regions

Location Errors in Model Forecasts

Observed (MPE)

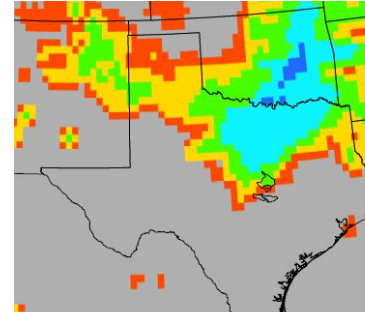


GEFS - Control

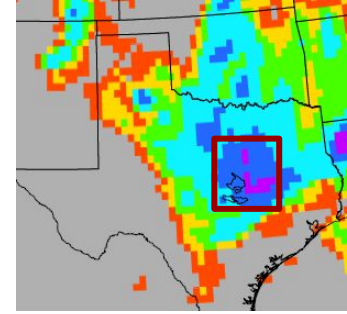


Variation in ensemble members foretells large location errors

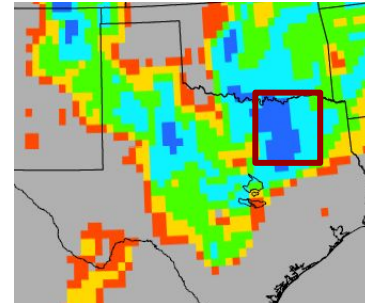
GEFS - P1



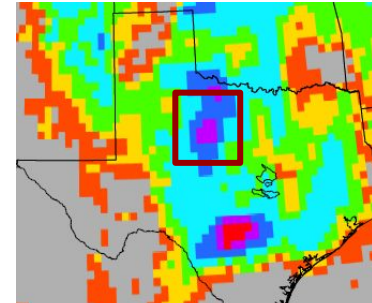
GEFS - P2



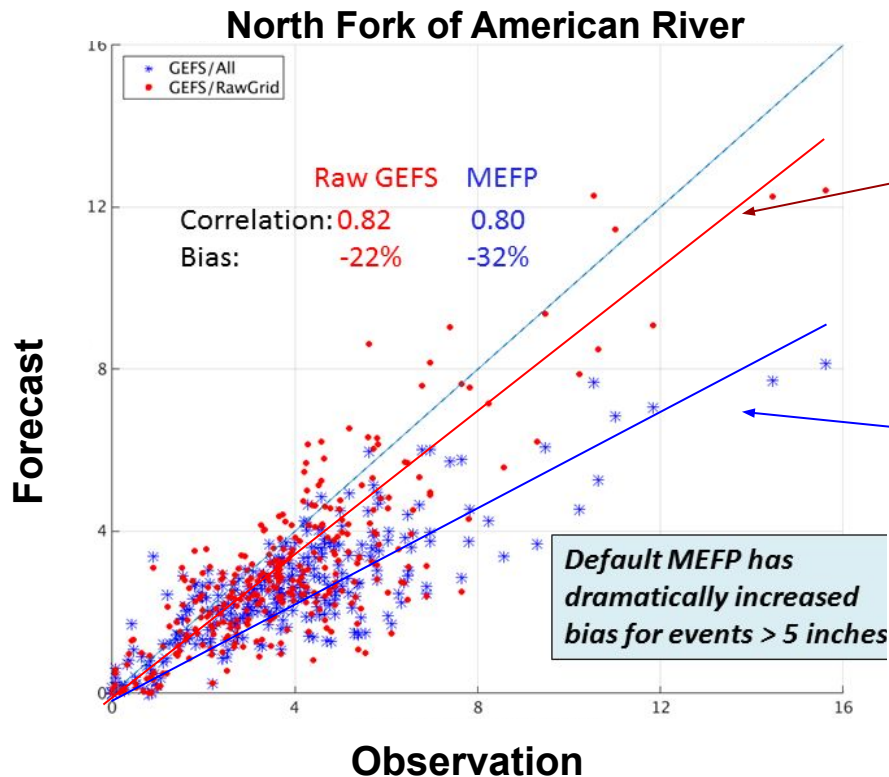
GEFS - P3



GEFS - P4



Underforecast for Major Events

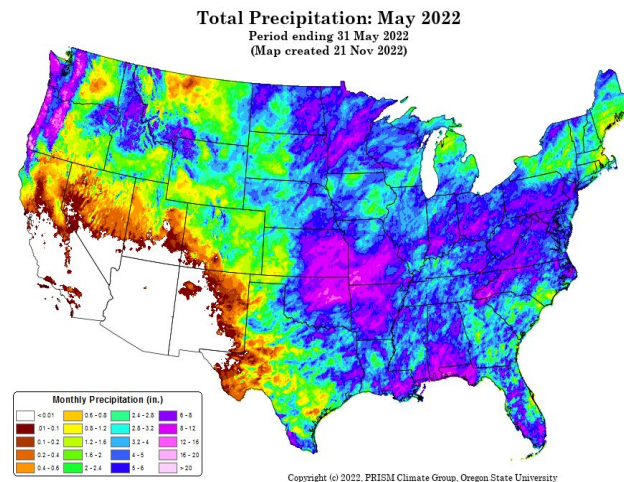
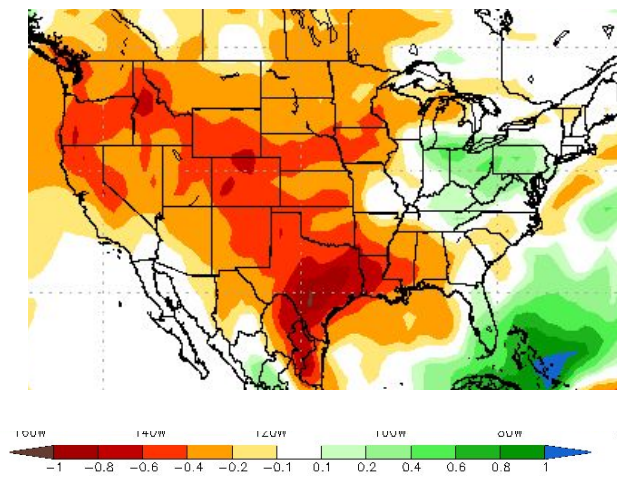


Raw forecast tends to be biased low for larger amount

Meteorological processor in HEFS worsens this negative bias

Lack Robust Mechanism for Seasonal Forecast

- Imprecise seasonal forecasts may still provide useful info
- HEFS requires large reforecast/observation pairs
 - Not available for seasonal forecasts

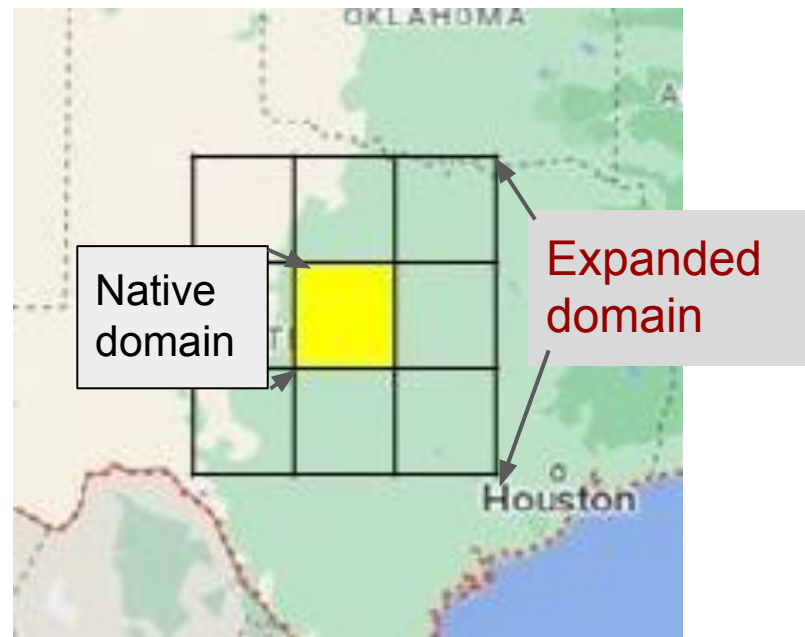


What Should be Done:

- Replace current basin-based postprocessor with a gridded version
- Account for variation in ensemble members (spread) in determining forecast uncertainty
- Implement alternative approaches in HEFS
 - to create longer-range precipitation/temperature predictions
- Introduce systematic mechanisms for parameter estimation over arid/semi-arid regions

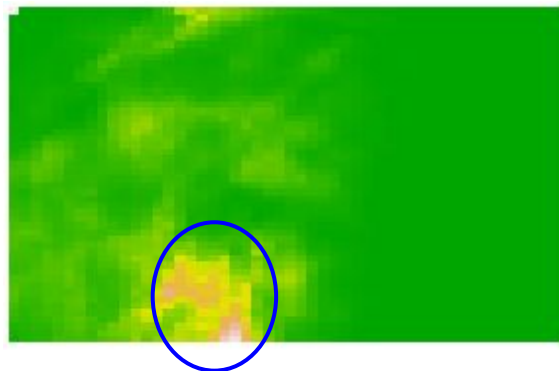
Gridded Ensemble Forcing Processor

- Gridded processor developed by PI and colleagues at NWS in 2015-16
 - Uses expanded domain
 - Alternative Schaake Shuffle schemes



Gridded Ensemble Forcing Processor

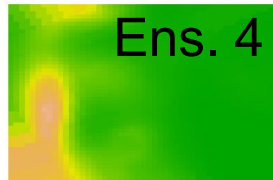
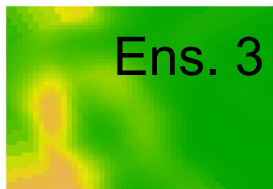
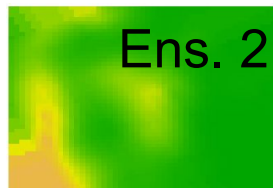
Observation



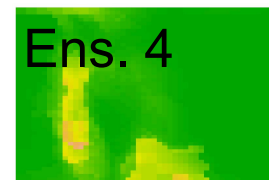
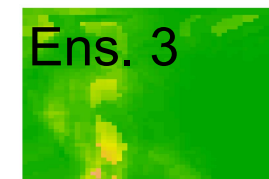
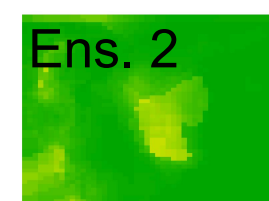
Stage IV: 25 Jan 2010 06Z

This is an event in the mid-Atlantic region for which forecasts were biased to the west

GEFS Ensemble



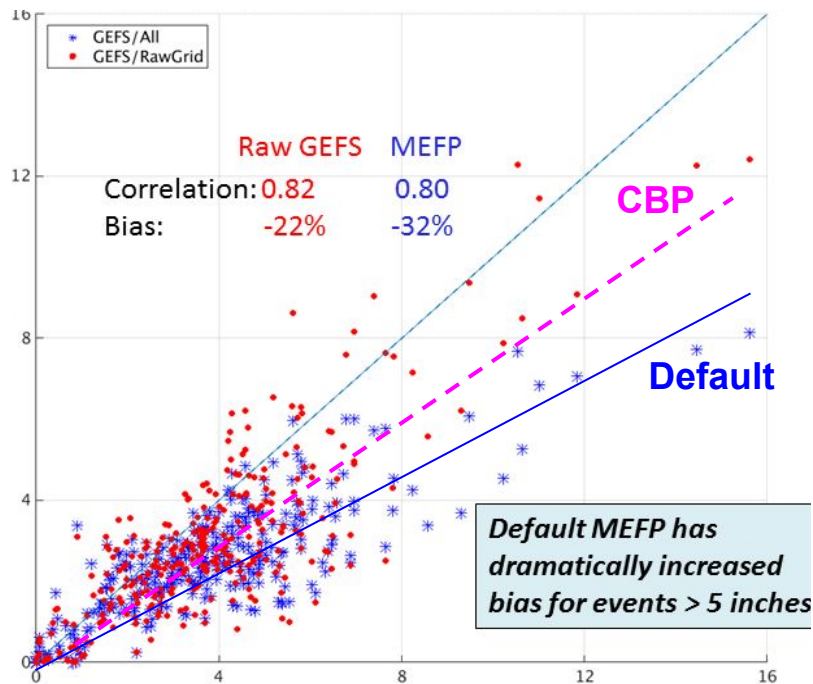
Processed Ensemble



Alternative Postprocessors from PSL

- Tom Hamill, Michael Scheuerer and others at PSL have developed postprocessors for precipitation forecasts
 - Forecast analog
 - Quantile mapping best member dressing
 - Censored Shifted Gamma Distribution
 - Incorporates ensemble spread in determining forecast uncertainty bound

Conditional Bias Penalization



DJ Seo developed a **conditional bias penalization** scheme to reduce tail bias

Need For a Regional HEFS Testbed

- Identify and address regionally unique challenges
- Experiment with emerging paradigms
 - Establish research to operation pathway
- Synergy with WPC, CPC and NWC Testbed Activities
 - Introduce new model and mechanisms
- Inform NWS on requirements for, say, reforecasts

Thank You!