Acknowledgements

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Background

- MEFP is a key component of NWC's Hydrological Ensemble Forecast Service (HEFS).
- MEFP is capable of statistically processing deterministic and ensemble precipitation and temperature forecasts to generate forcing ensembles for hydrological applications.
- MEFP is a basin-based system, designed to produce forcing ensembles for lumped hydrological models.
- NWC is moving toward implementing WRF-Hydro, a framework linking models of atmosphere and terrestrial hydrology. Gridded forcing ensembles are needed.

MEFP Overview

- Objective: Producing reliable forcing ensembles that capture the inherent skill of the raw meteorological forecasts.
- Using the meta-Gaussian distribution (MGD) to model the relationship between the observed and forecast.
- Generating ensemble members from the conditional distribution of the MGD, given a single-valued forecast.
- Applying the Schaake Shuffle to maintain spatial and temporal coherence for ensemble members.
- Using temporal aggregation to capture forecast skill.
- Forecast data sources: WPC/RFC single-valued forecasts, GEFS ensemble forecasts, CFS forecasts.

Mixed-type MGD Model for Precipitation

- Joint distribution of forecast (X) and observation (Y):

$$F(x,y) = p_{00}+p_{10}G_X(x)+p_{01}G_Y(y)+p_{11}P(X \le x,\ Y \le y \mid X > 0, Y > 0).$$

- MGD constructed for $P(X \le x,\ Y \le y \mid X > 0, Y > 0)$:

$H(x, y) = B(Z, W; \rho)$, where $Z = Q^{-1}(F_X(X))$, $W = Q^{-1}(F_Y(Y))$

B is bivariate standard normal distribution function.
Q is standard normal distribution function.
ρ is Pearson correlation coefficient between *Z* and *W*.

- Conditional distribution has an analytical form and can be easily computed.

$$H_{Y|X}(y|x) = Q\left(\frac{Q^{-1}(F_Y(y)) - \rho\, Q^{-1}(F_X(x))}{\sqrt{1-\rho^2}}\right)$$

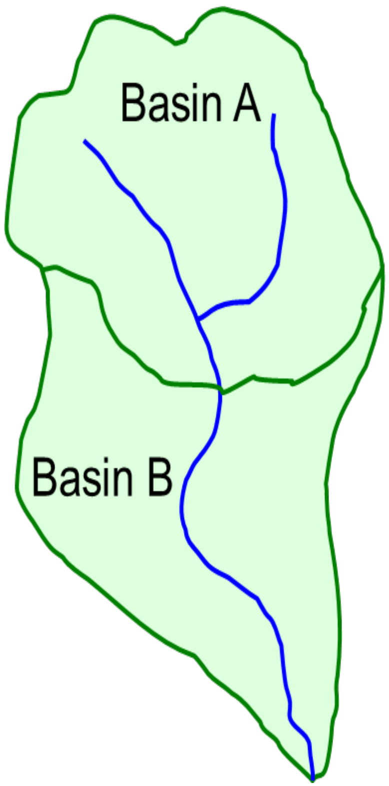
Preserve Space-time Coherence

- Meteorological events tend to be correlated in space and time.
  - Temperatures tend to be correlated from basin to basin and from one day to the next, as well as during the day.
  - Large-scale storms can be more persistent in space and time than rain showers.

- These correlations can be captured by the **rank structure** of historical observations over any relevant spatial domain and for any time period.

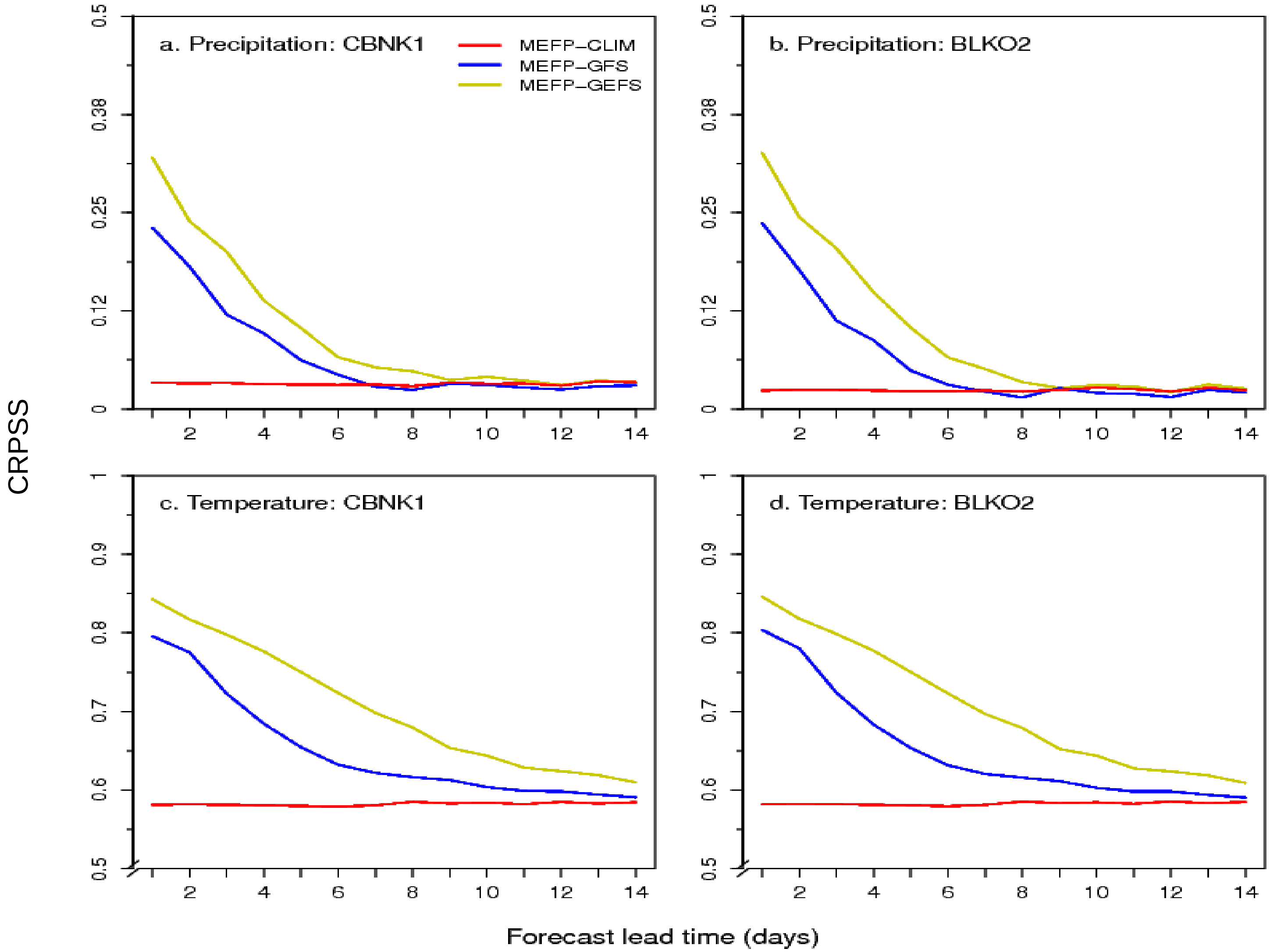
- A rank structure can be thought as a table where past observations, their associated years, and their ranks are tabulated.

- **Schaake Shuffle (SS)**: A scheme that arranges ensemble members to have the same rank structure as that of the historical observations.



MEFP Validation

CRPSS measures the overall quality of probabilistic forecasts against reference forecasts. The larger the value, the better.



Working with Grids

- A prototype of gridded MEFP (GMEFP) for precipitation is under development at NWC.

- The mixed-type MGD model is applied to individual cells in the grid.

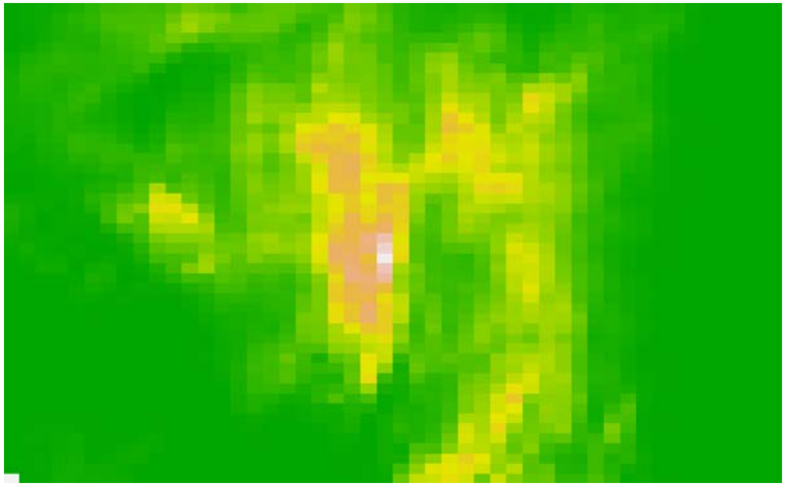
- For maintaining space-time coherence, the SS is applied with rank structure provided by GEFS ensemble forecast fields.
  - Would historical observed fields work for SS?
  - Can we use analogs?
  - Should we impose any constraints?

- Space-time aggregation
  - Suitable time aggregation interval for a given lead time and location?
  - Suitable spatial aggregation for a given lead time and location?

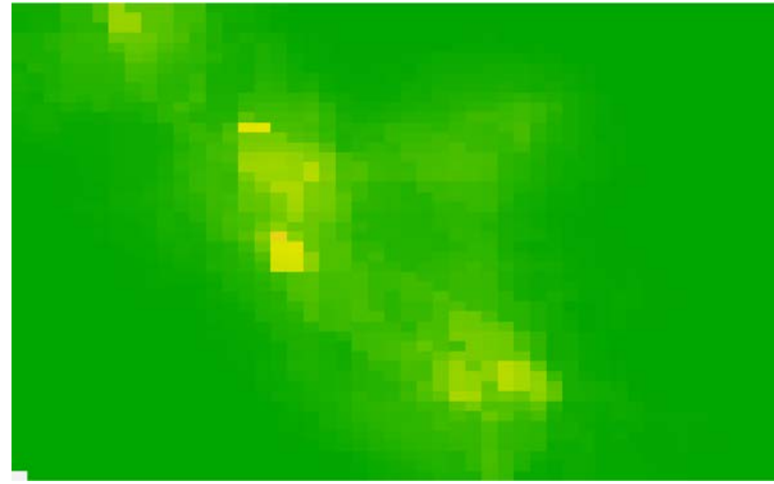
GMEFP Preliminary Results

- Forecast domain: Middle Atlantic River Forecast Center
- Grid resolution: ~ 20 km
- Time interval (6 hrs): 2011041618z-2011041700z
- GMEFP ensembles: Generated by post-processing downscaled GEFSv9 reforecasts (18-hr lead time)
- Verifying observations: Multisensor precipitation estimates

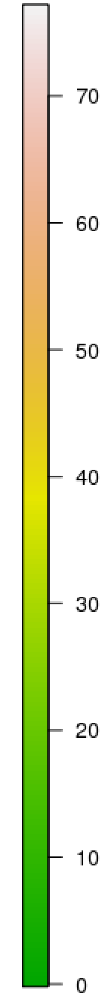
GMEFP Preliminary Results

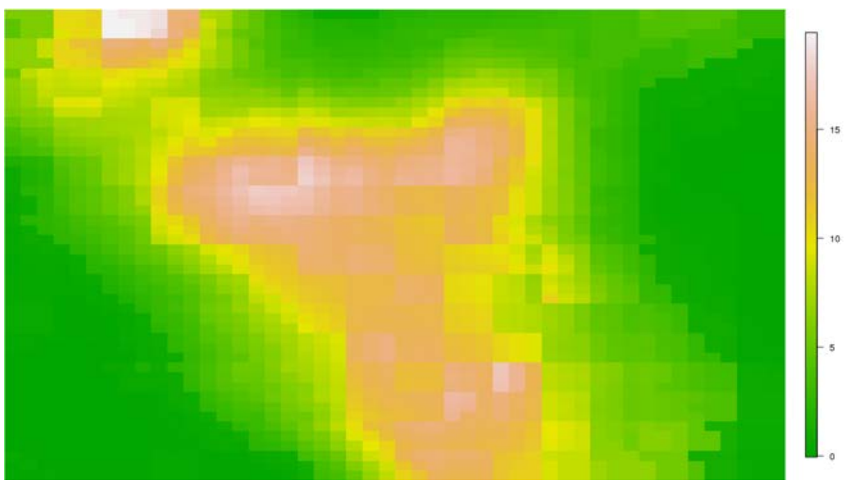


MPE, max=76.4 mm

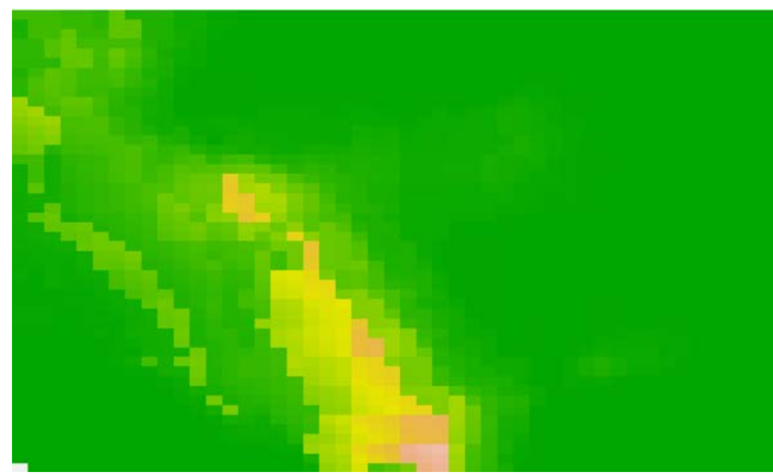


Ensemble member 1, max=41.2 mm





Ensemble Mean, max=19.4 mm



Ensemble member 2, max=65.9 mm

Thank You !