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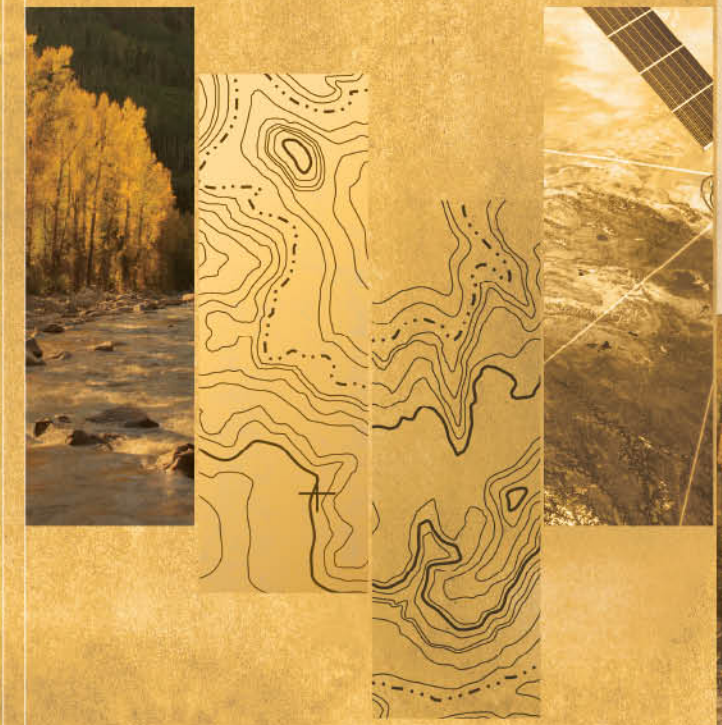
global science solutions

An Ensemble Post-Processor for the New York City Operations Support Tool

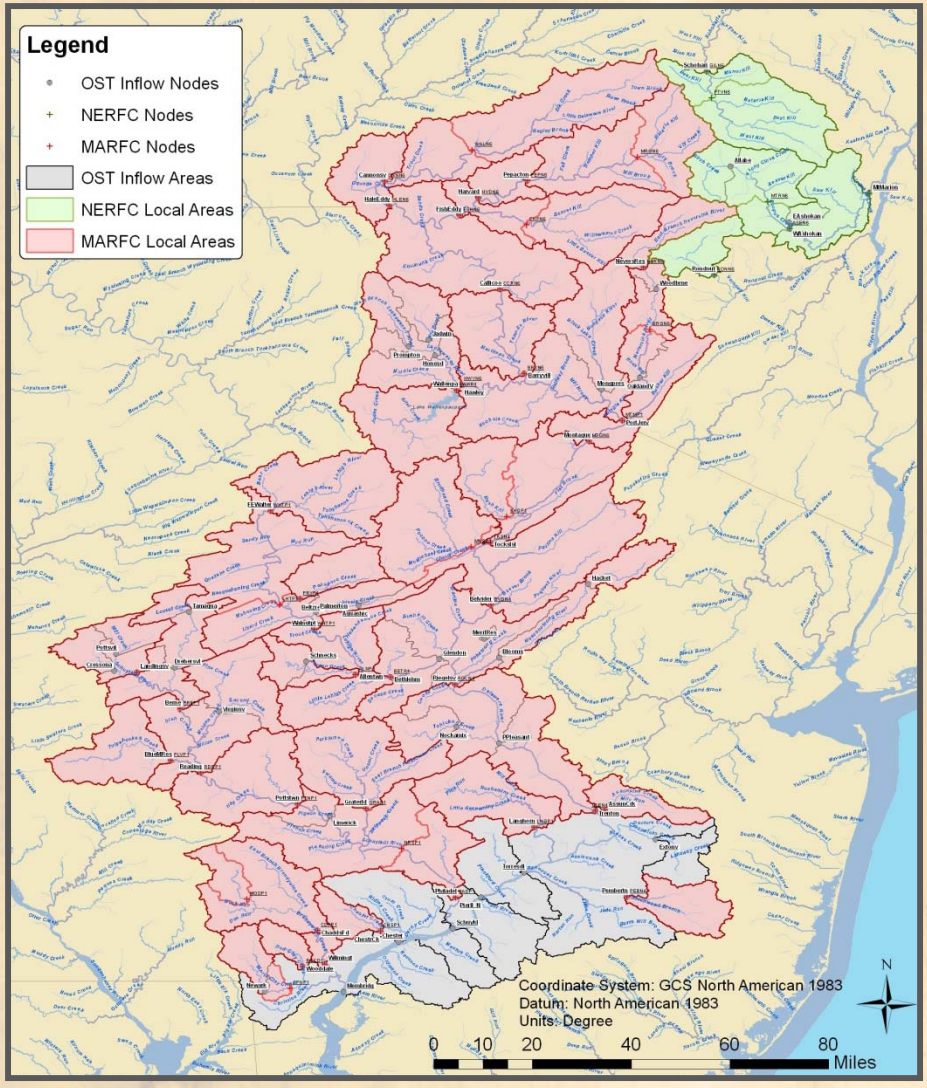


J. Day, Riverside
J. Schaake
M. Thiemann, Riverside
S. Draijer, Riverside
L. Wang, NOVA
D. Sheer, Hydrologics

Need for Hydrologic Ensemble Post-Processing

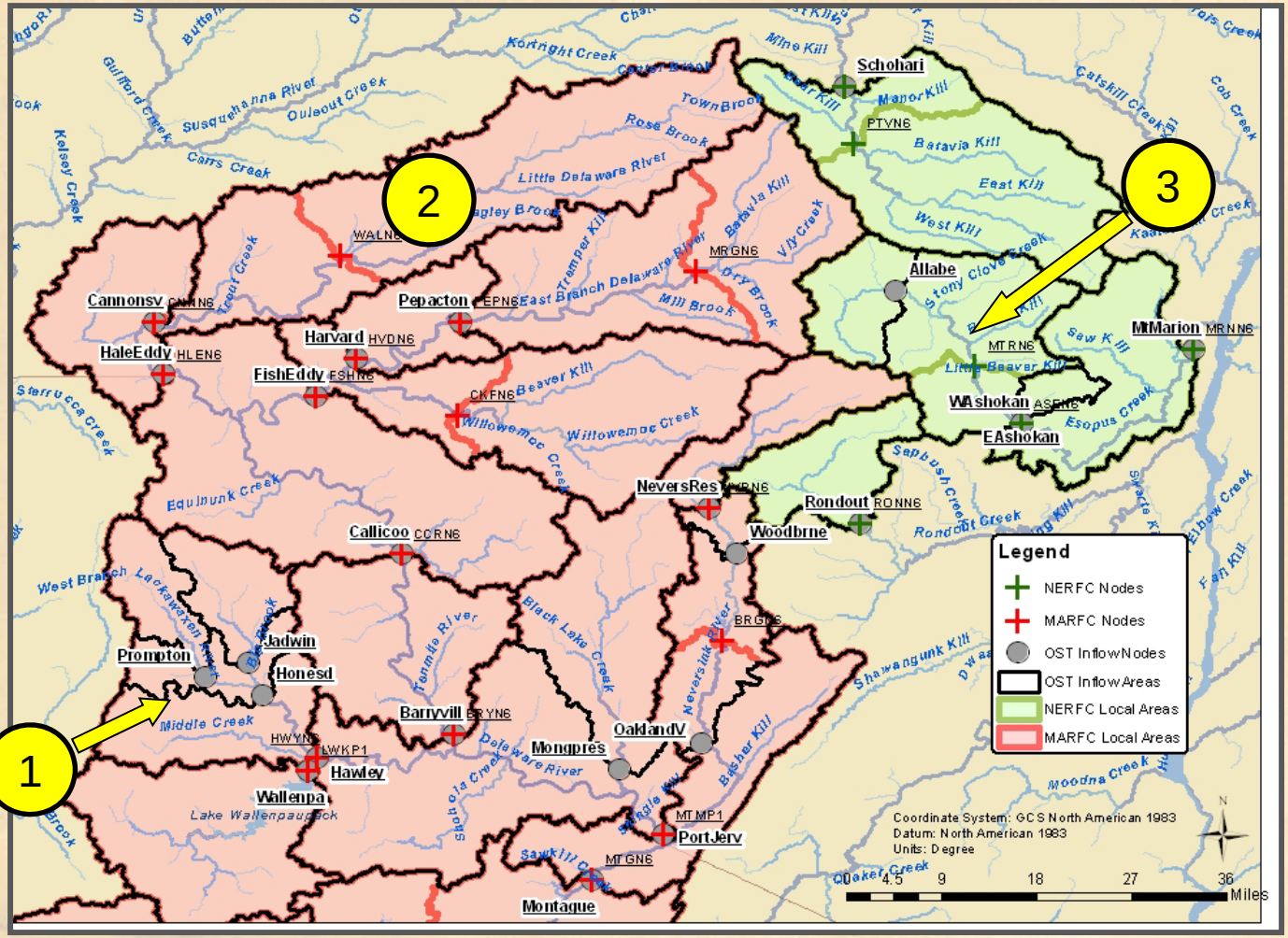
- Hydrologic model simulations cannot produce hydrologic products that are always completely unbiased.
- Current ESP forecasts assume that the initial conditions are known. This causes the ESP spread to be underestimated.
- Hydrologic model simulations do not account for hydrologic model error (structure and parameters). This also causes the ESP spread to be underestimated.

OST and RFC Forecast Nodes



- User locations do not always correspond to Forecast Nodes
- User flows may be inconsistent with hydrologic model calibrations

Mapping Issues



1

Multiple OST Nodes above a single RFC Node

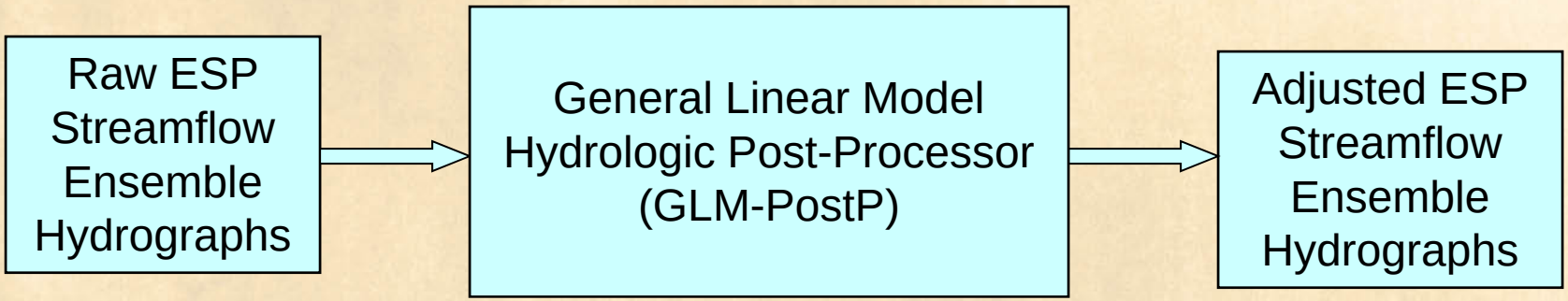
2

Multiple RFC Nodes above an OST Node

3

Different RFC and OST Nodes above a Common Node

Hydrologic Ensemble Post-Processor (to correct raw ESP bias and spread errors)

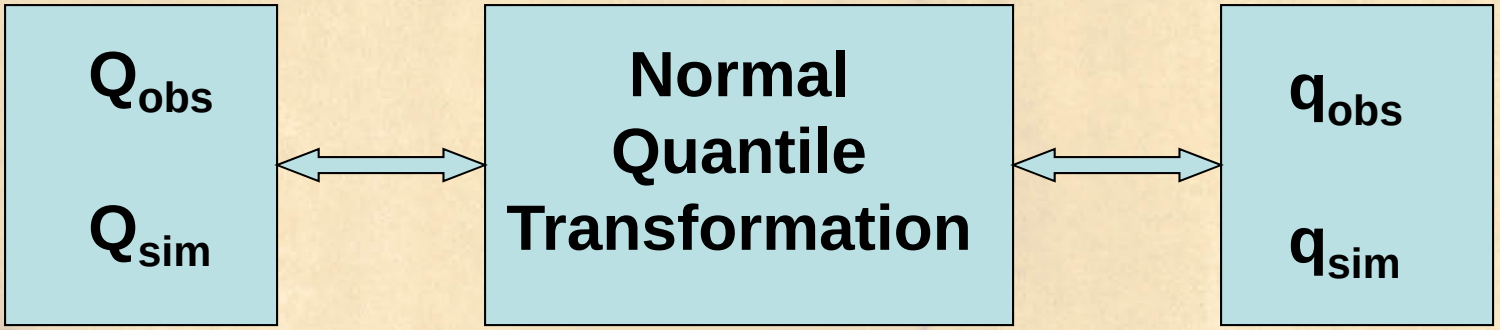


This post-processor attempts to produce adjusted hydrographs that:

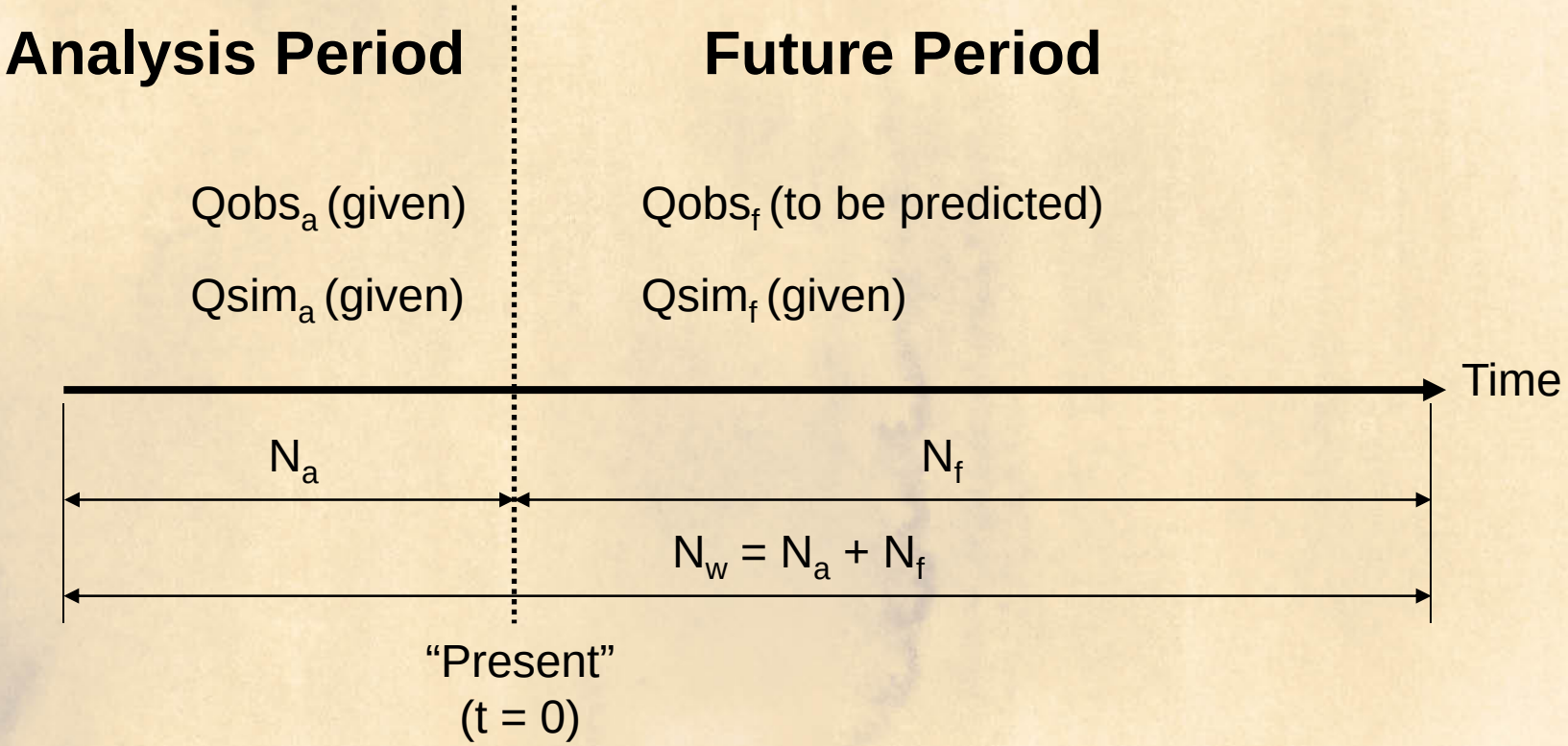
1. Preserve the “skill” of the raw model hydrograph
2. Removes mean bias
3. Produces an ensemble of members that represent in an “equally-likely” sense the observed hydrograph that is being predicted
4. Preserves temporal scale dependency relationships

Data Transformations

The work reported in this presentation uses an empirical CDF for observed and simulated flow and a NQT to transform the observed or simulated flow to a standard normal deviate. Different CDFs are estimated for each day.



Post-Processor Data Window



Variables Qobs$_a$, Qobs$_f$, Qsim$_a$ and Qsim$_f$ are vectors whose elements form time-series of observed and simulated hydrograph components in the analysis (a) and future periods (f).

Vector Hydrograph Post-Processor

Vector Definitions:

$$Z_1 = [qobs_f] = \begin{bmatrix} qobs_1 \\ . \\ qobs_{nf} \end{bmatrix}$$

$$Z_2 = \begin{bmatrix} qsim_f \\ qobs_a \\ qsim_a \end{bmatrix} = \begin{bmatrix} qsim_1 \\ . \\ qsim_{nf} \\ qobs_{-na} \\ . \\ qobs_{-1} \\ qsim_{-na} \\ . \\ qsim_{-1} \end{bmatrix}$$

The objective is to generate an ensemble of values of the vector

Z_1 = [$Qobs_f$],

given the vector values of

Z_2 = [$Qsim_f$, $Qobs_a$ and $Qsim_a$].

We wish to create

$$Z_{1.2} = Z_1 \mid Z_2.$$

To do this, we use the General Linear Model:

$$Z_{1.2} = A * Z_2 + B * E$$

$$E \approx N(0,1)$$

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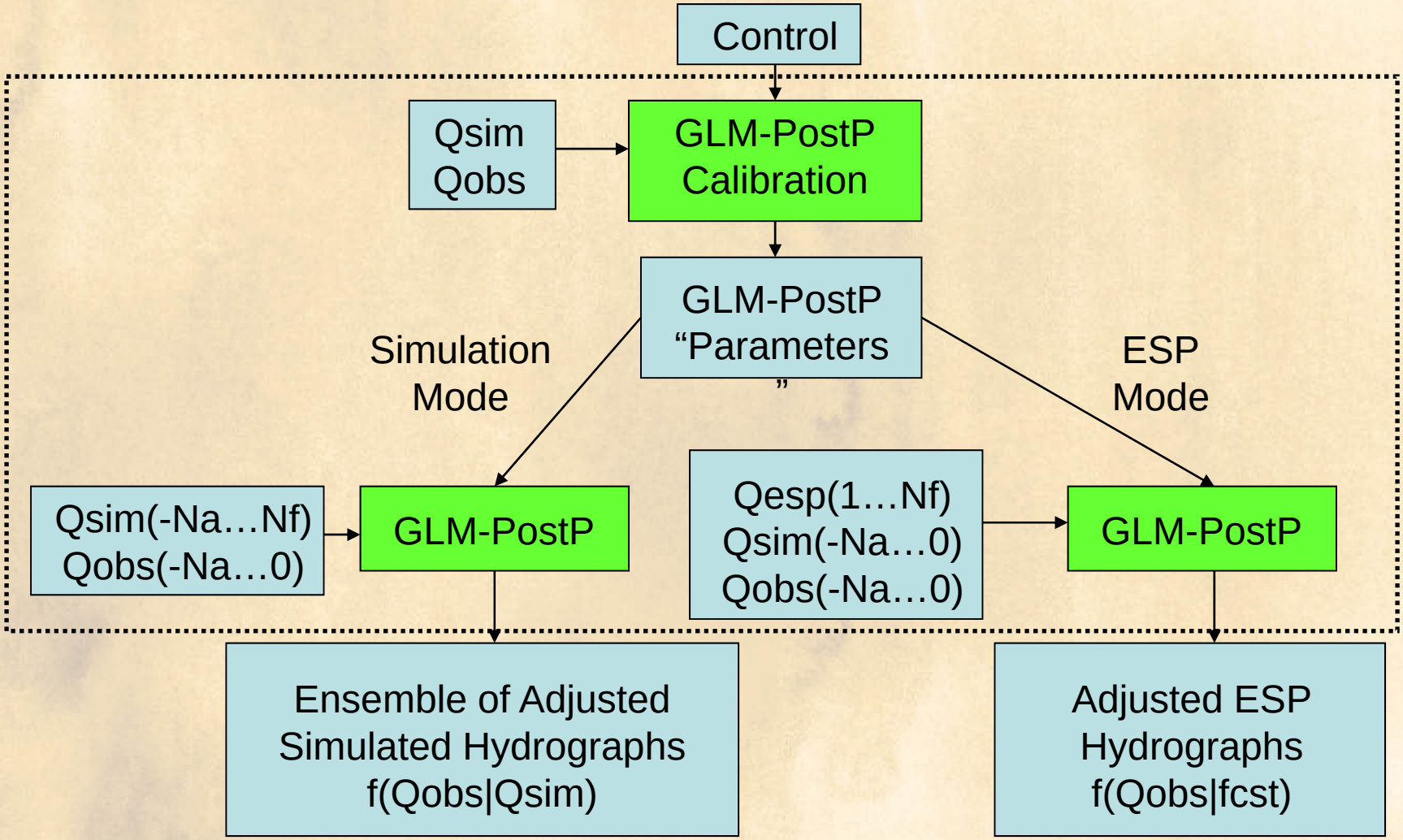
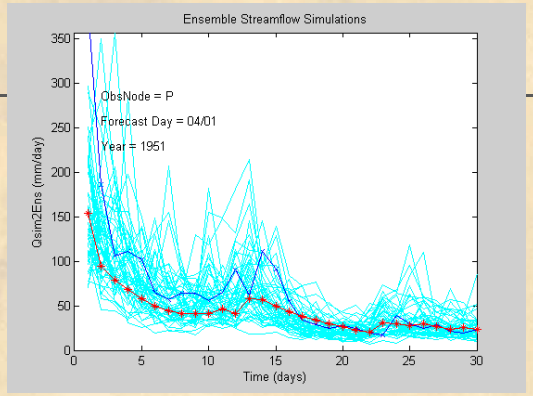
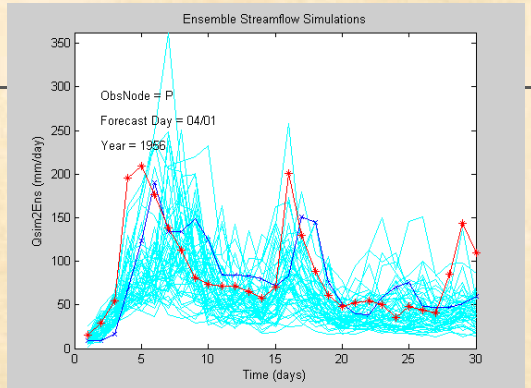
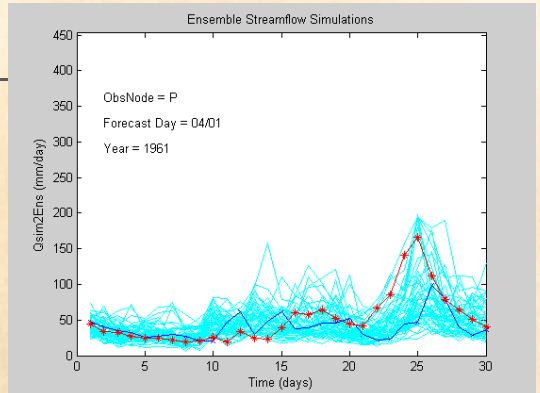
GLM Hydrologic Post-Processor

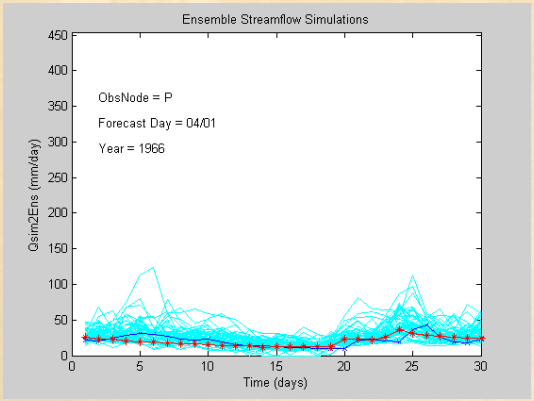


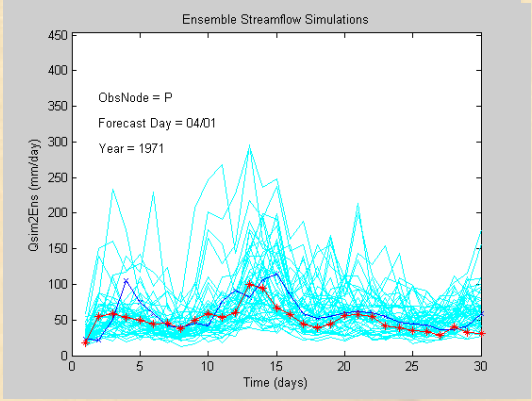
Pepacton – April 1

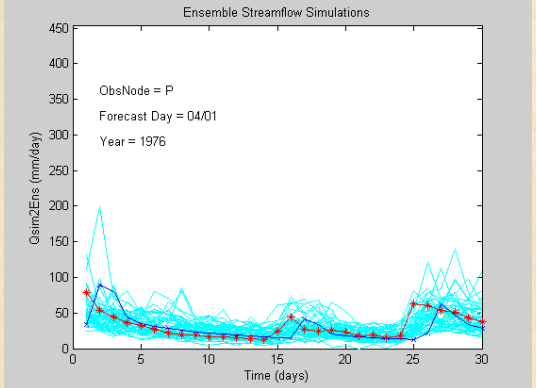


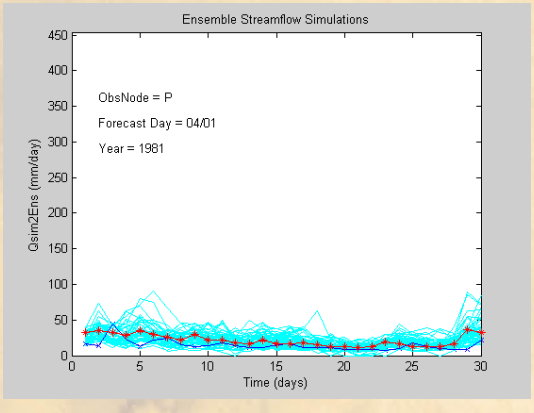


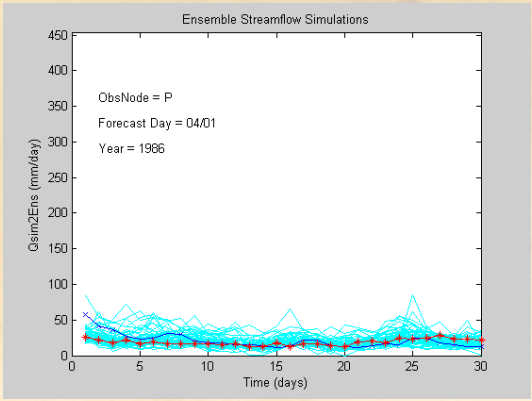


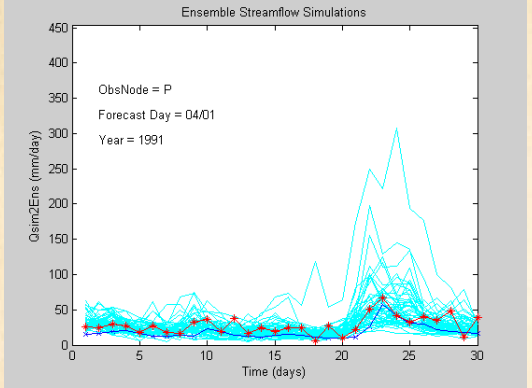












Pepacton – November 1

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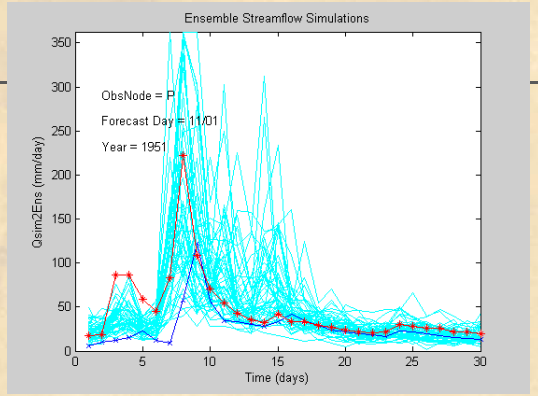
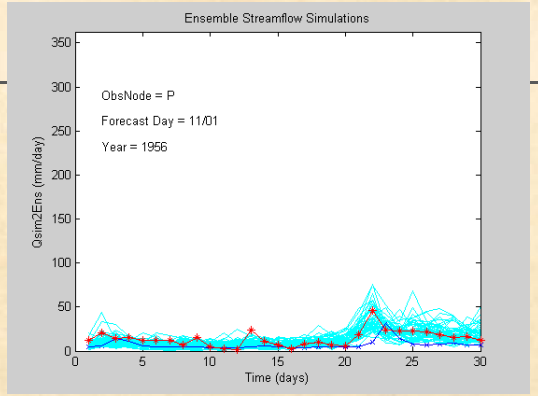
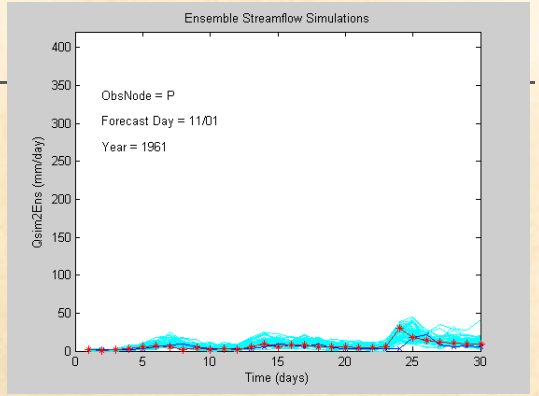
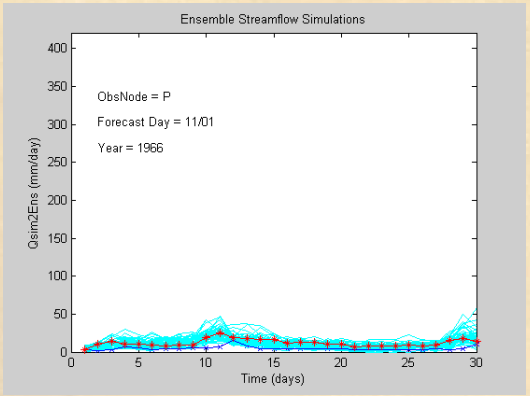
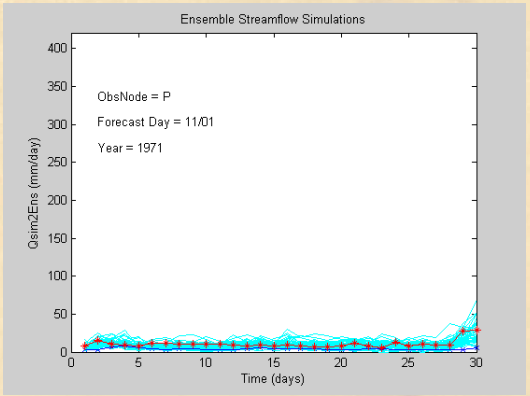
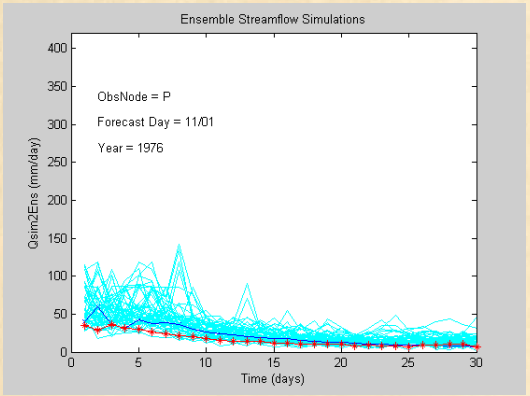


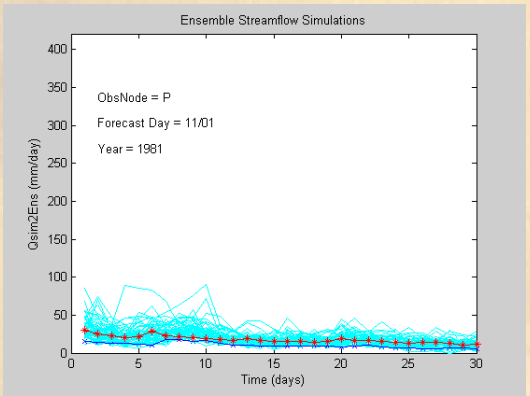


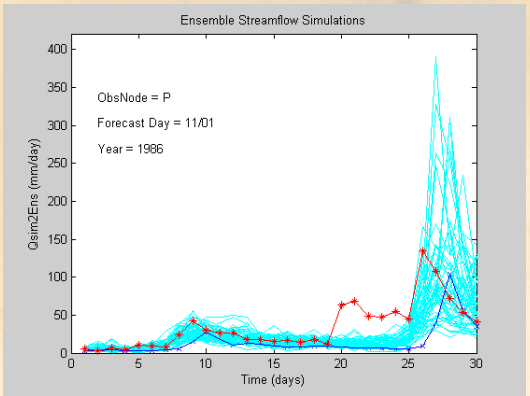


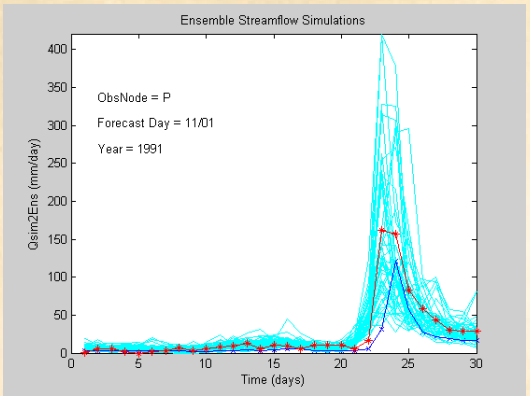




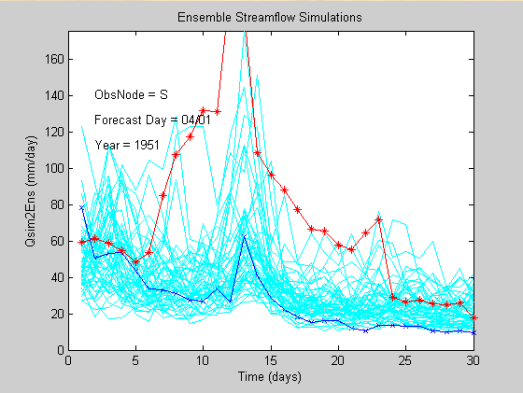


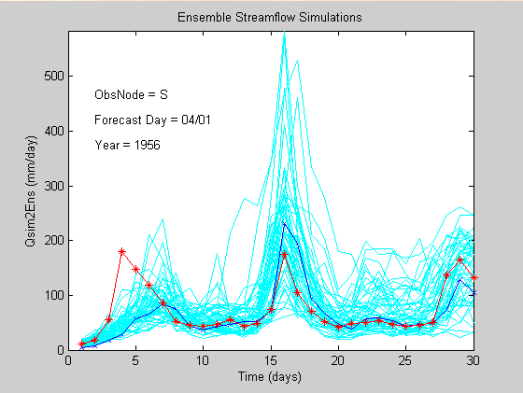


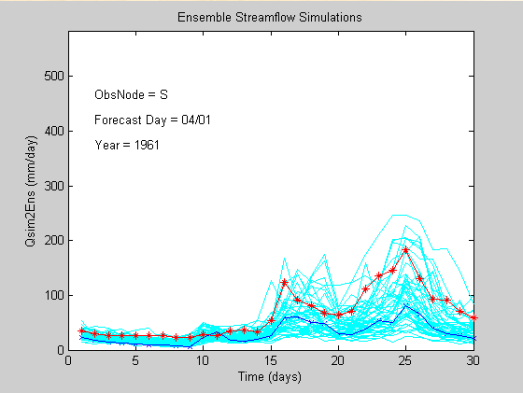


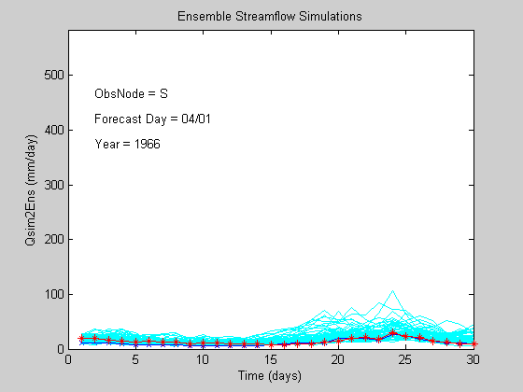


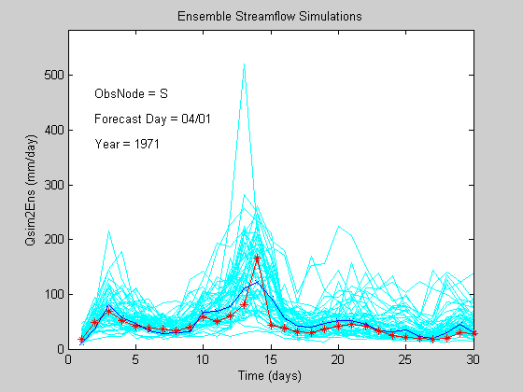
Schoharie – April 1

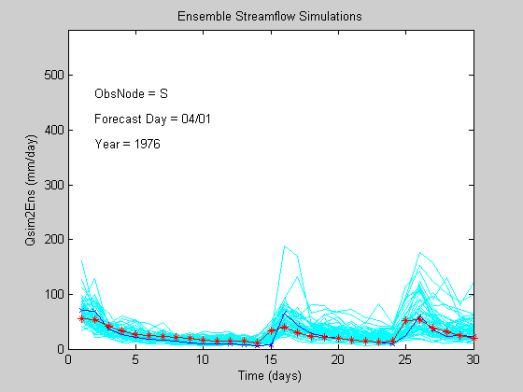


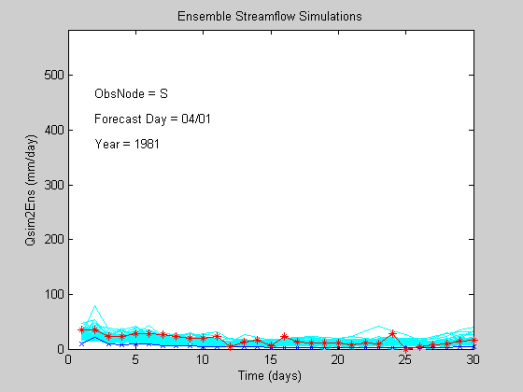


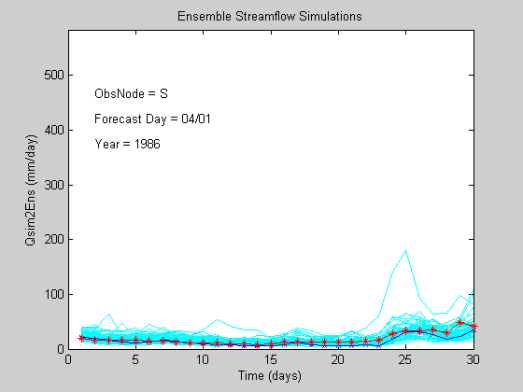


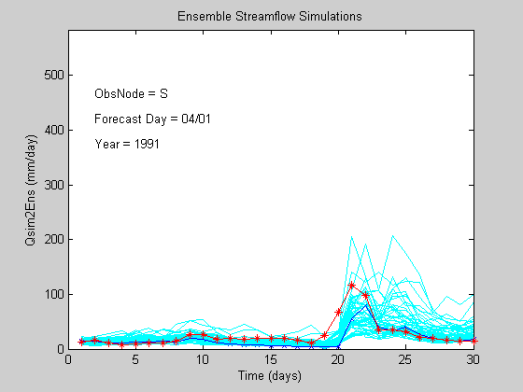




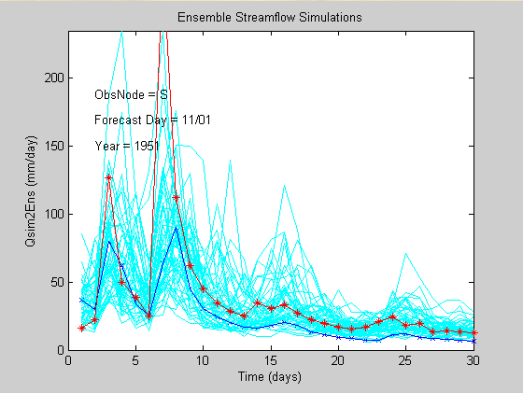


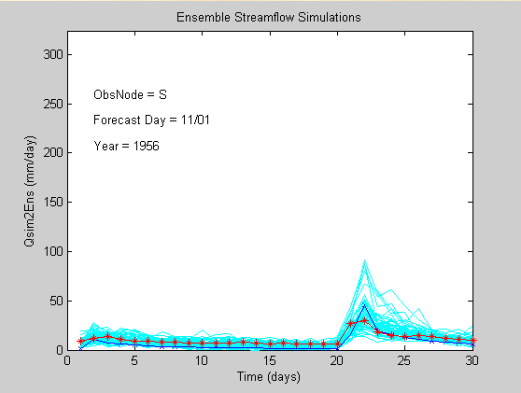


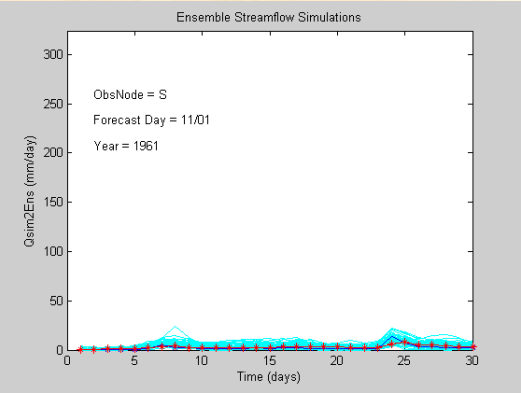


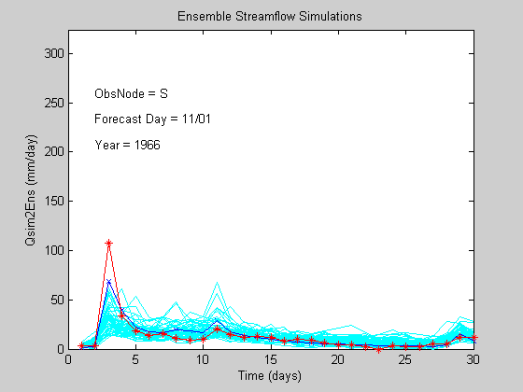


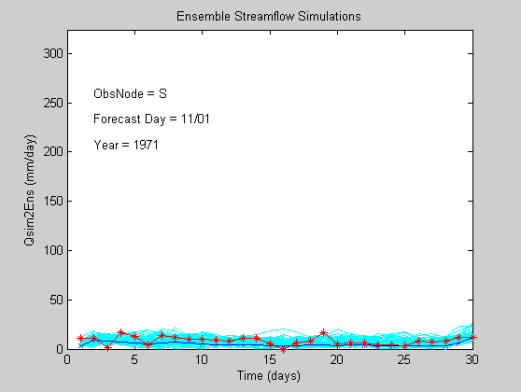
Schoharie – November 1

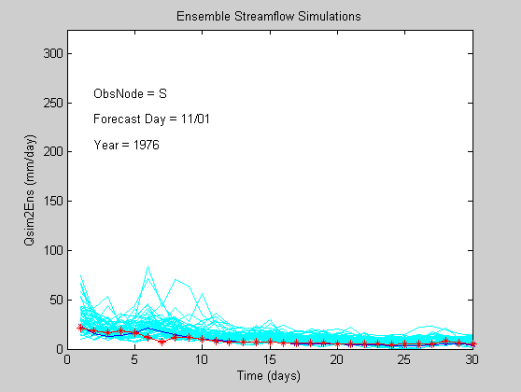


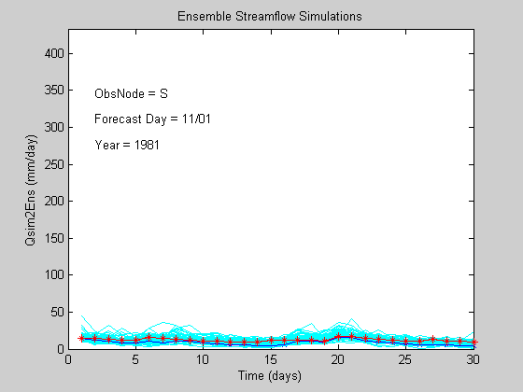


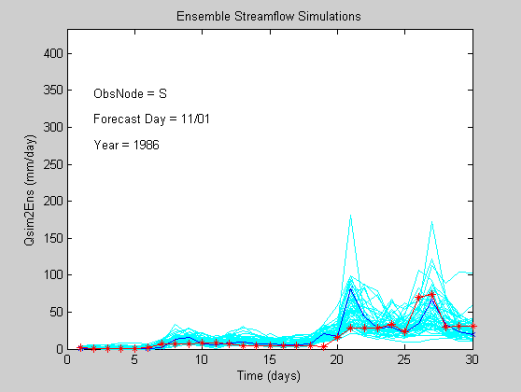


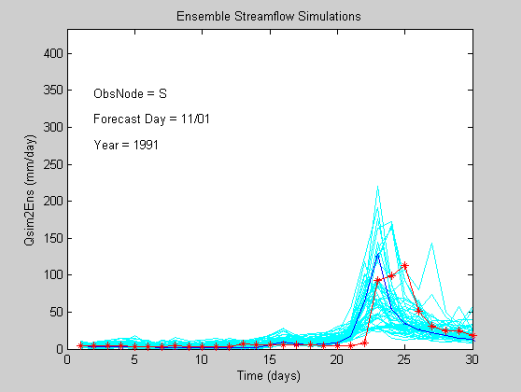




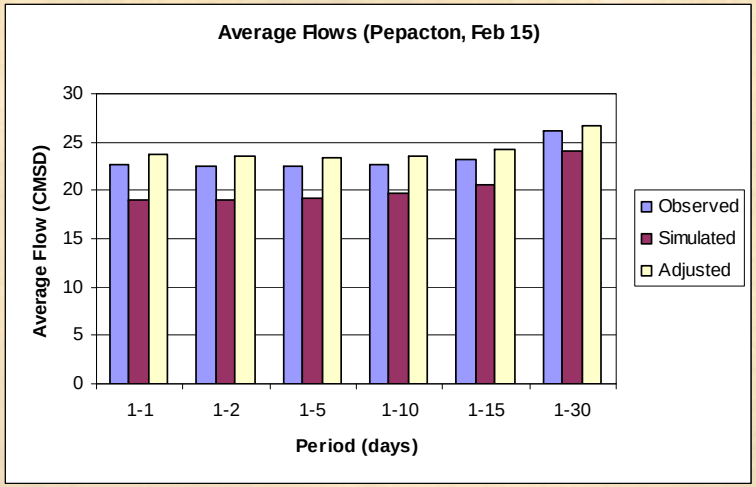


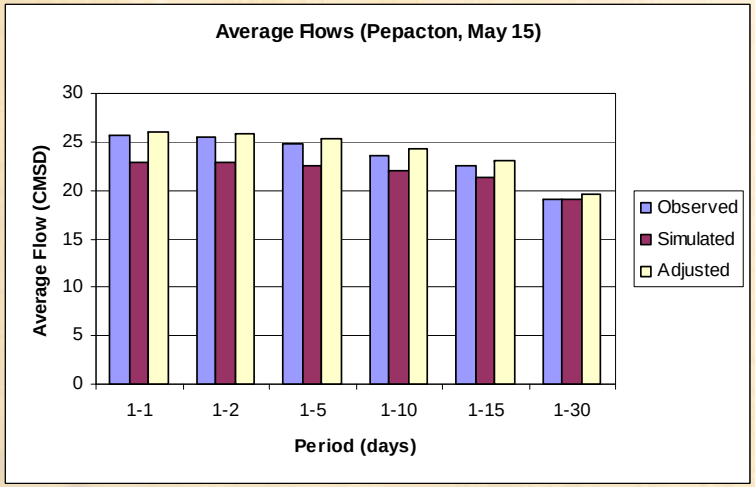


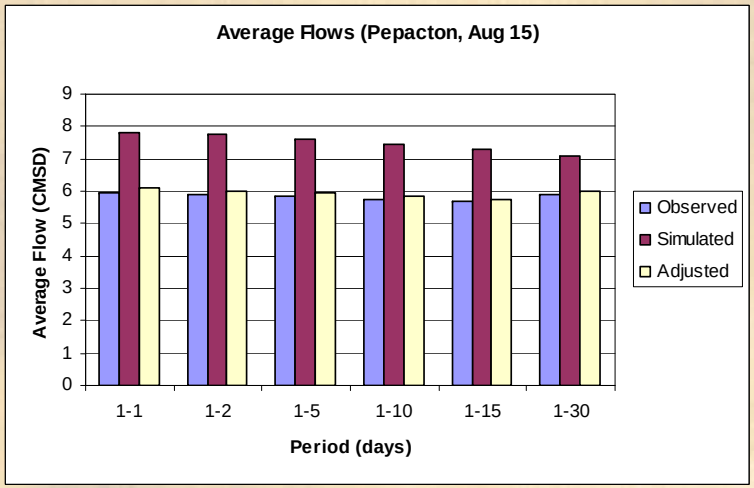


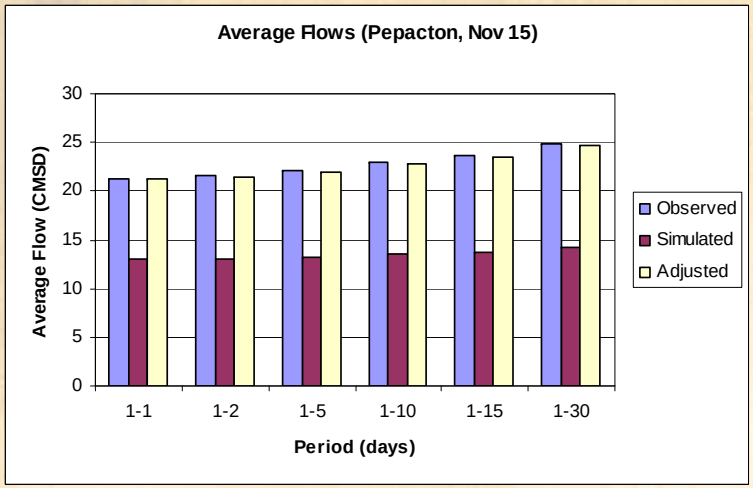


Pepacton Average Flow

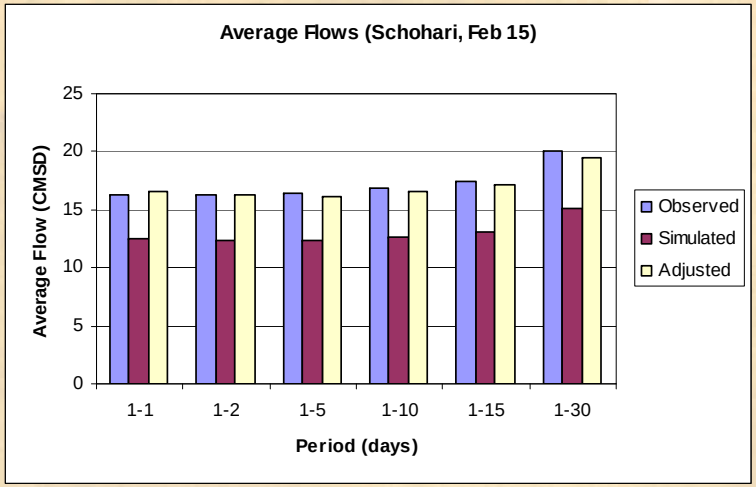


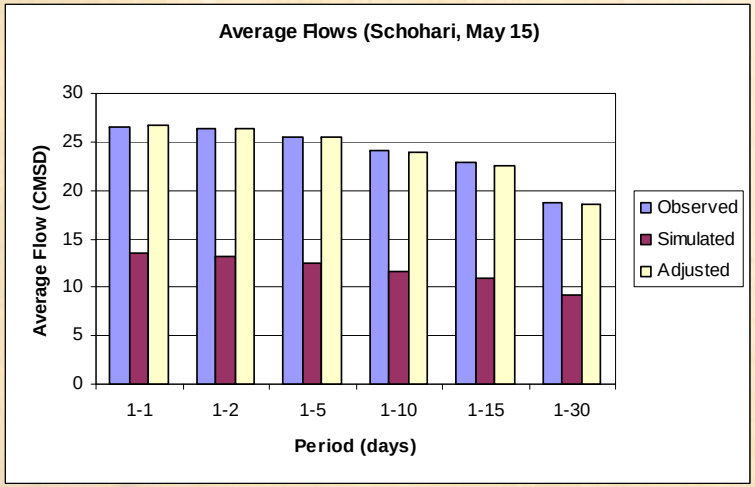


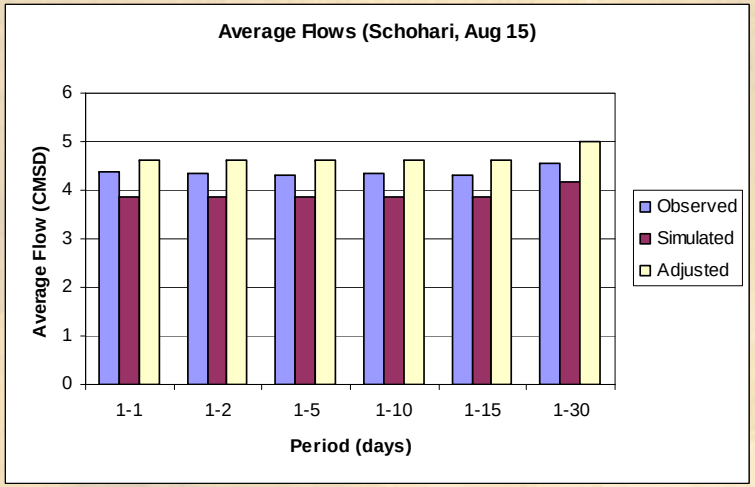


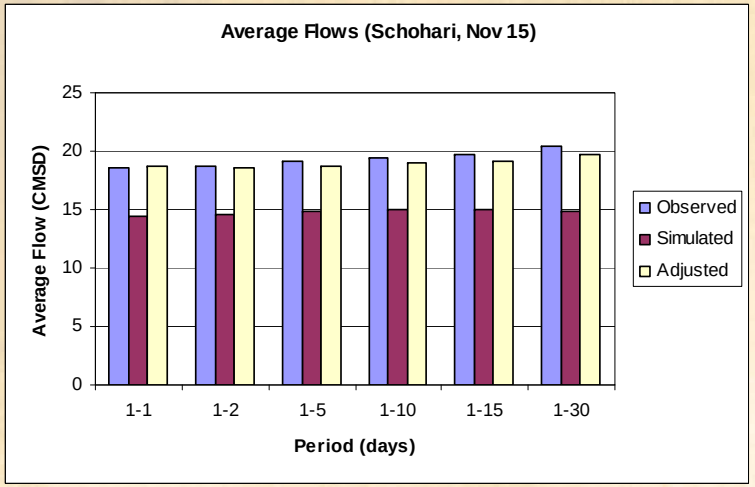


Schoharie Average Flow

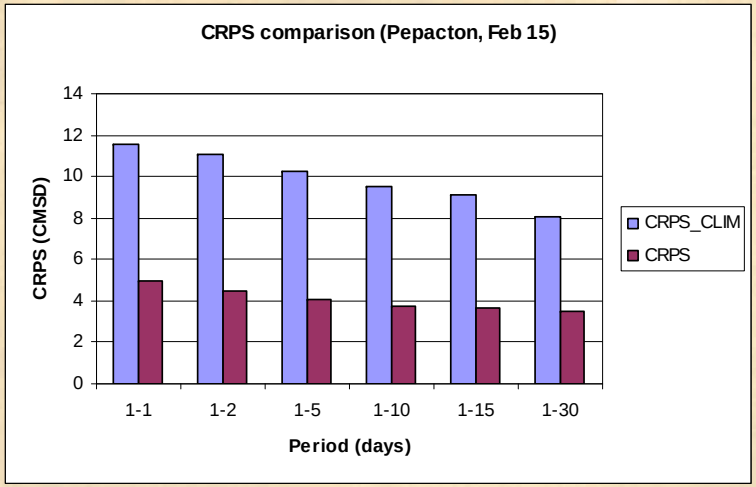


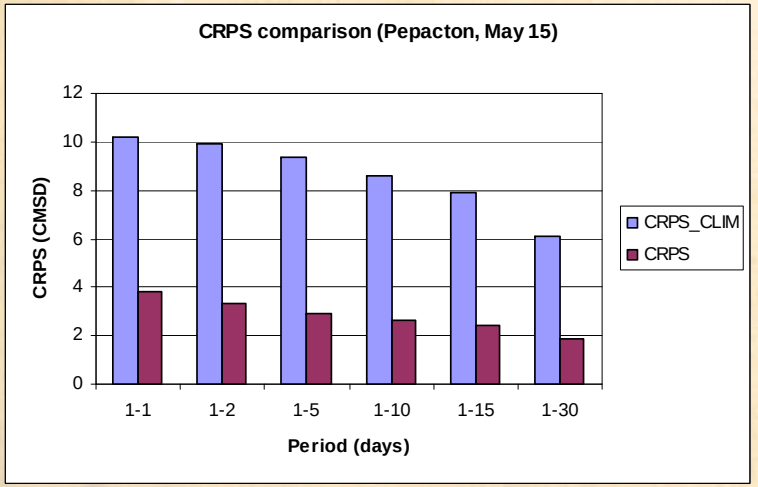


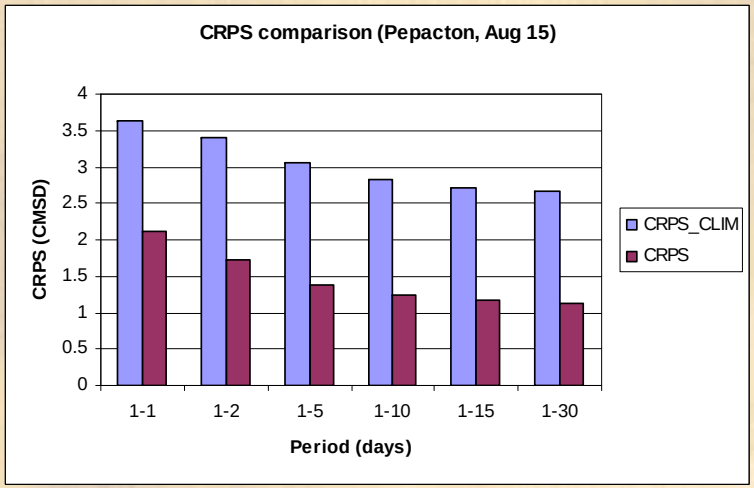


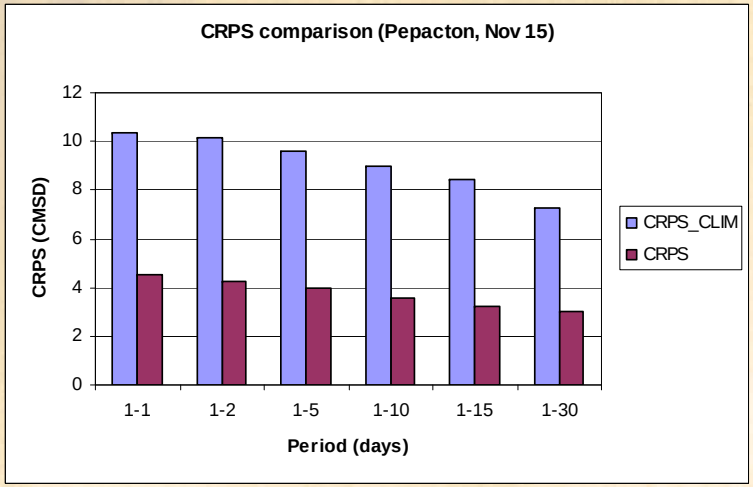


Pepacton CRPS

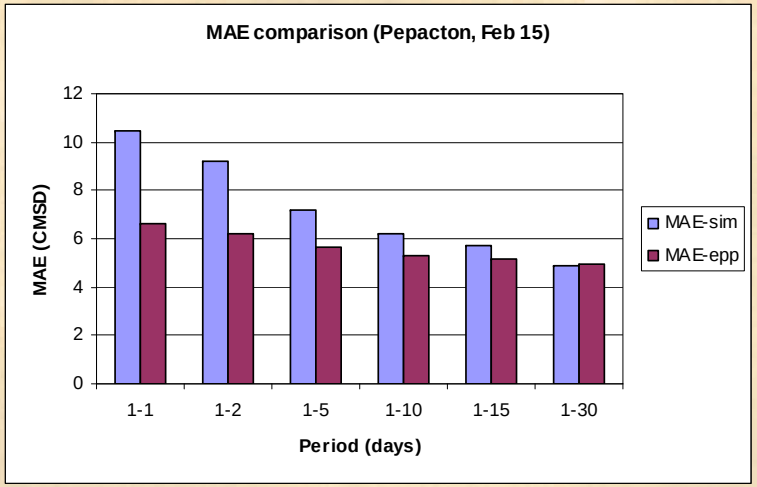


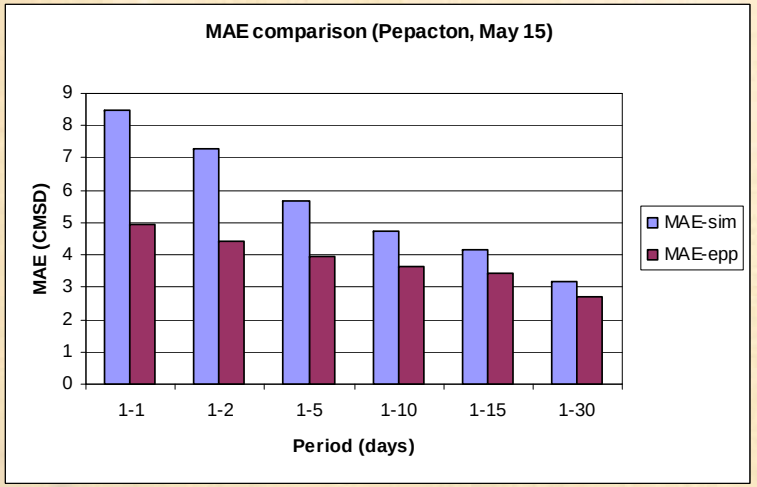


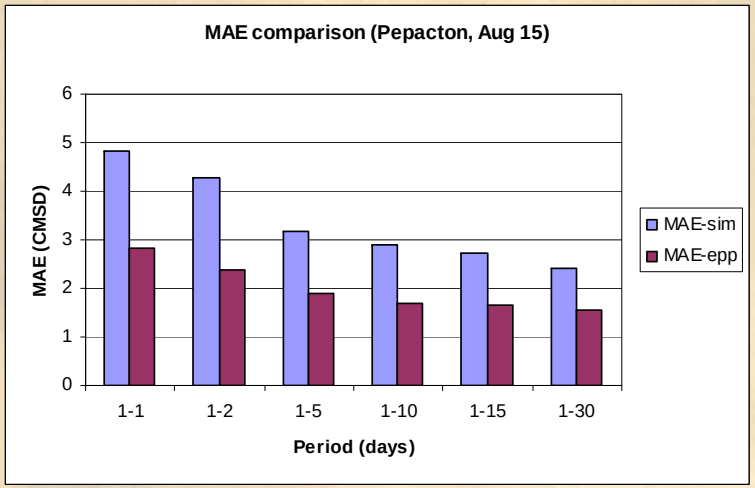


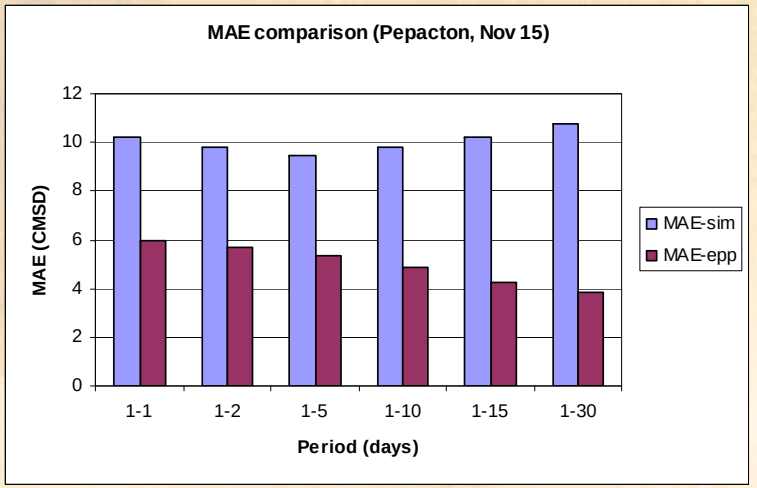


Pepacton Mean Absolute Error

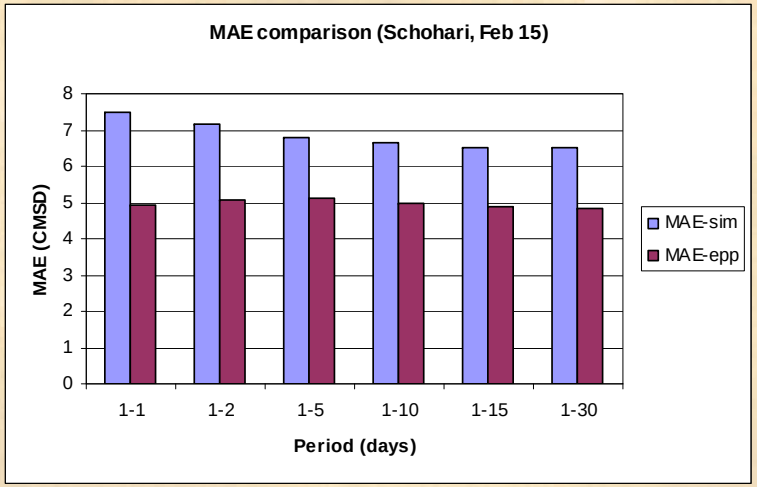


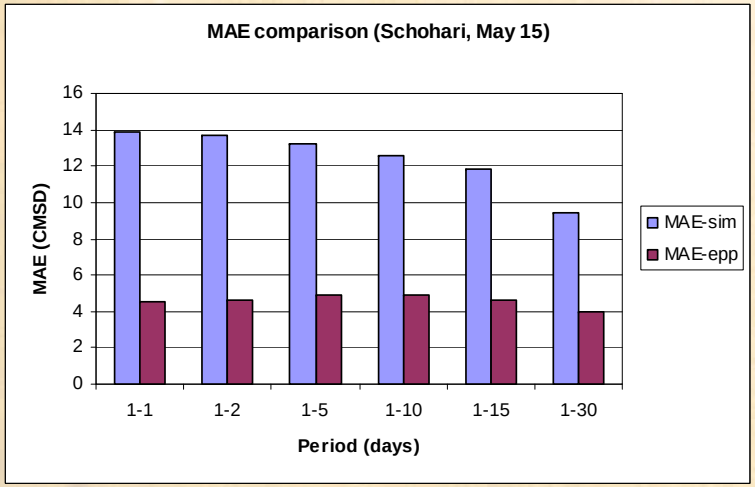


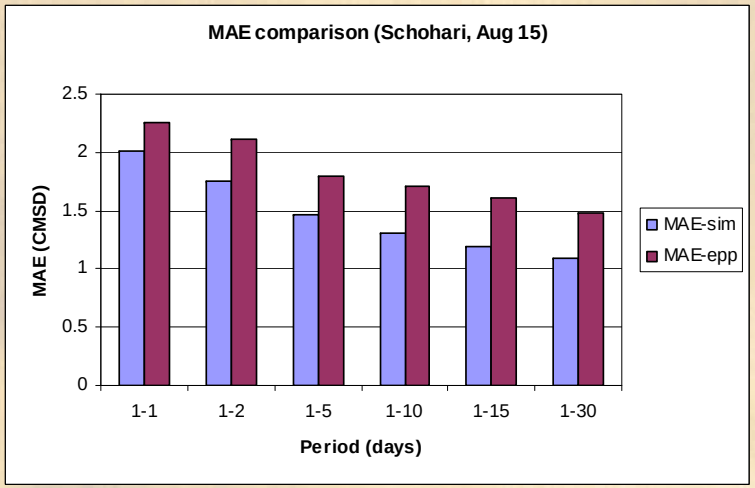


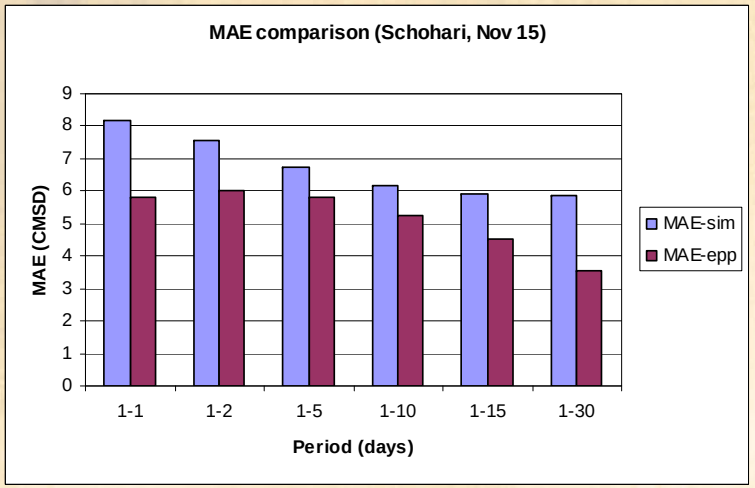


Schoharie Mean Absolute Error

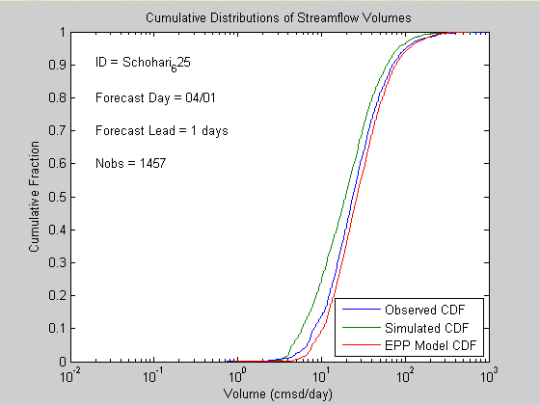


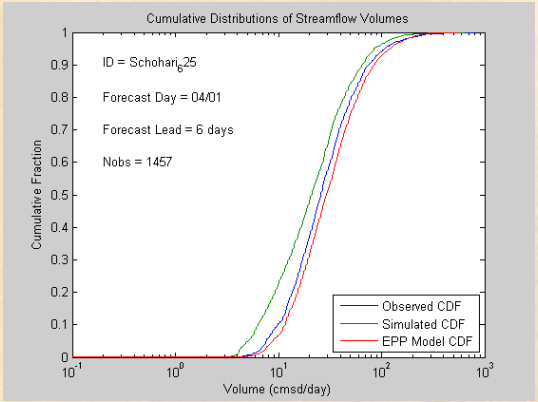


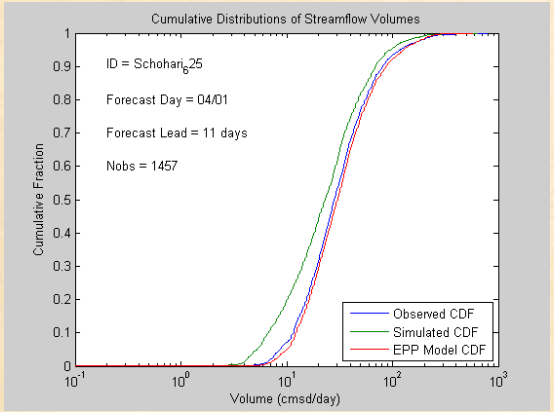


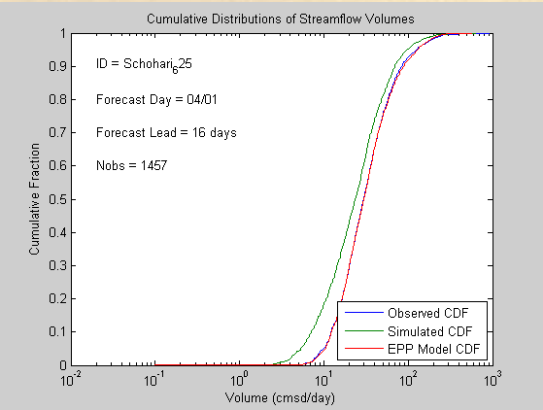


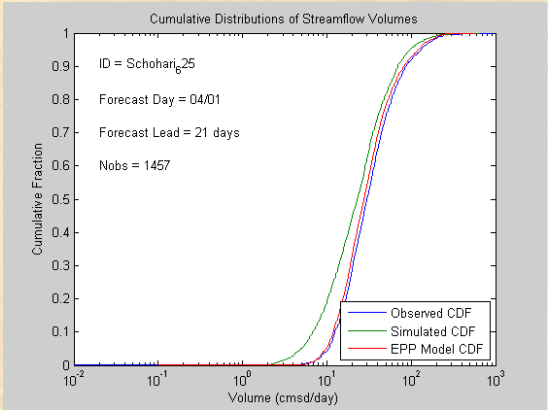
Schoharie – April CDFs

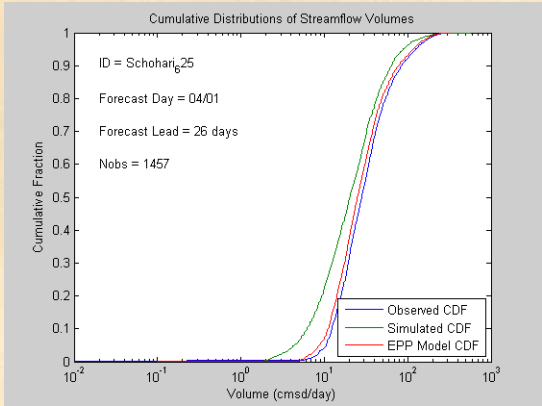




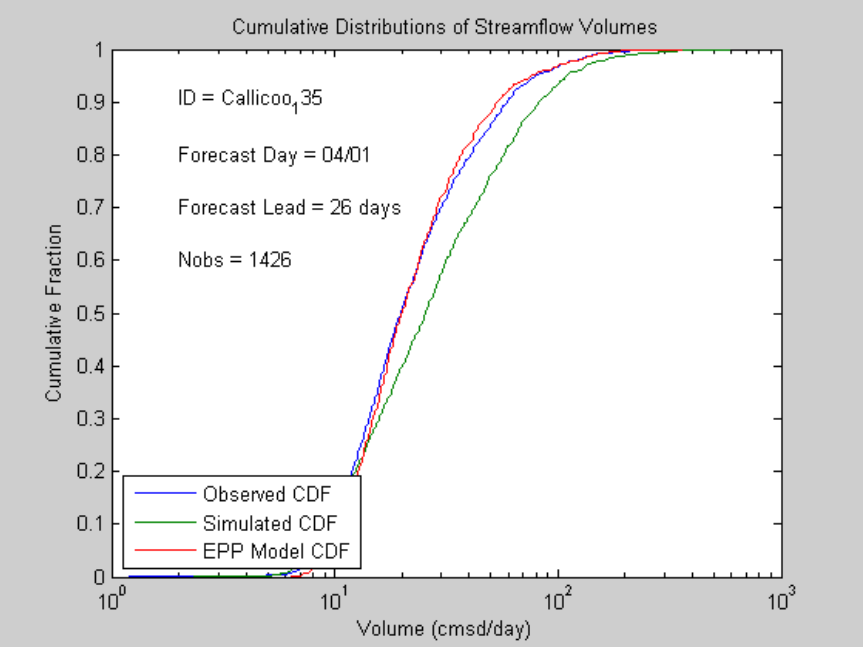




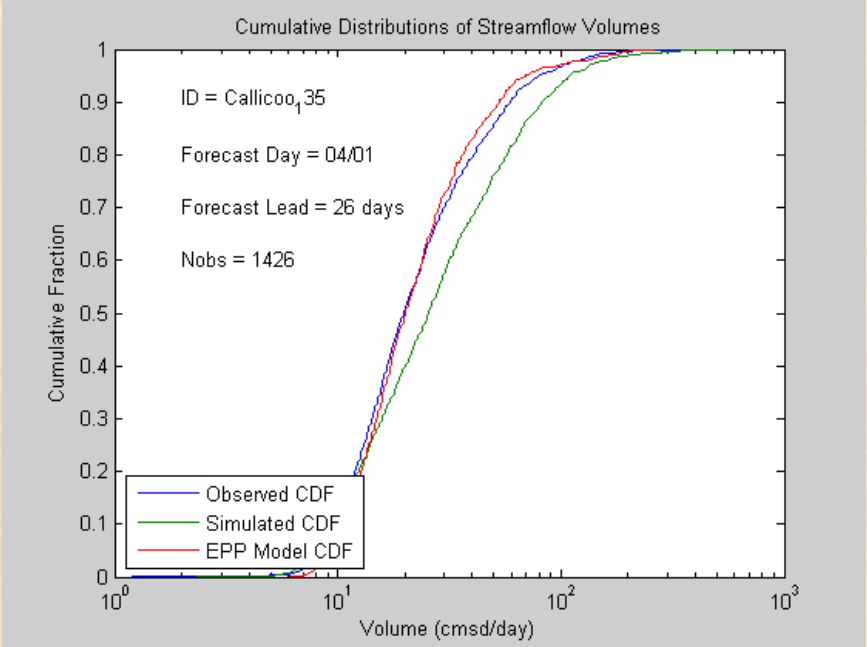




Aggregated Assimilation Periods



30 1-Day periods



5 periods totaling 30 days

Next Steps

- Further testing – additional basins, months
- Test in ESP mode
- Add multi-node capability
- Develop OST operational component
- Develop and test in climate mode