Ensemble Hindcaster for Precipitation, Temperature, & Streamflow Ensemble Forecast Verification

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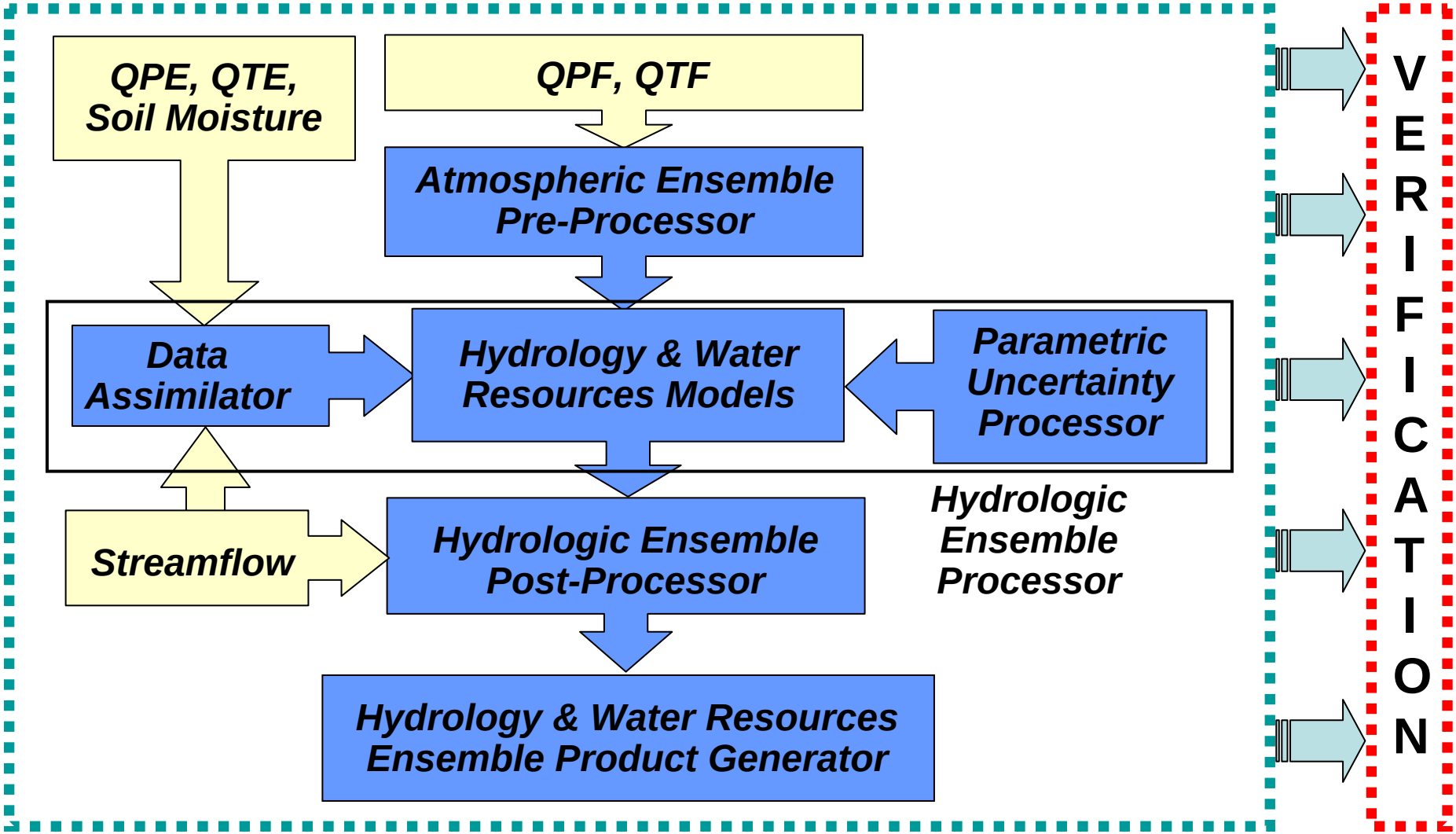
Overview

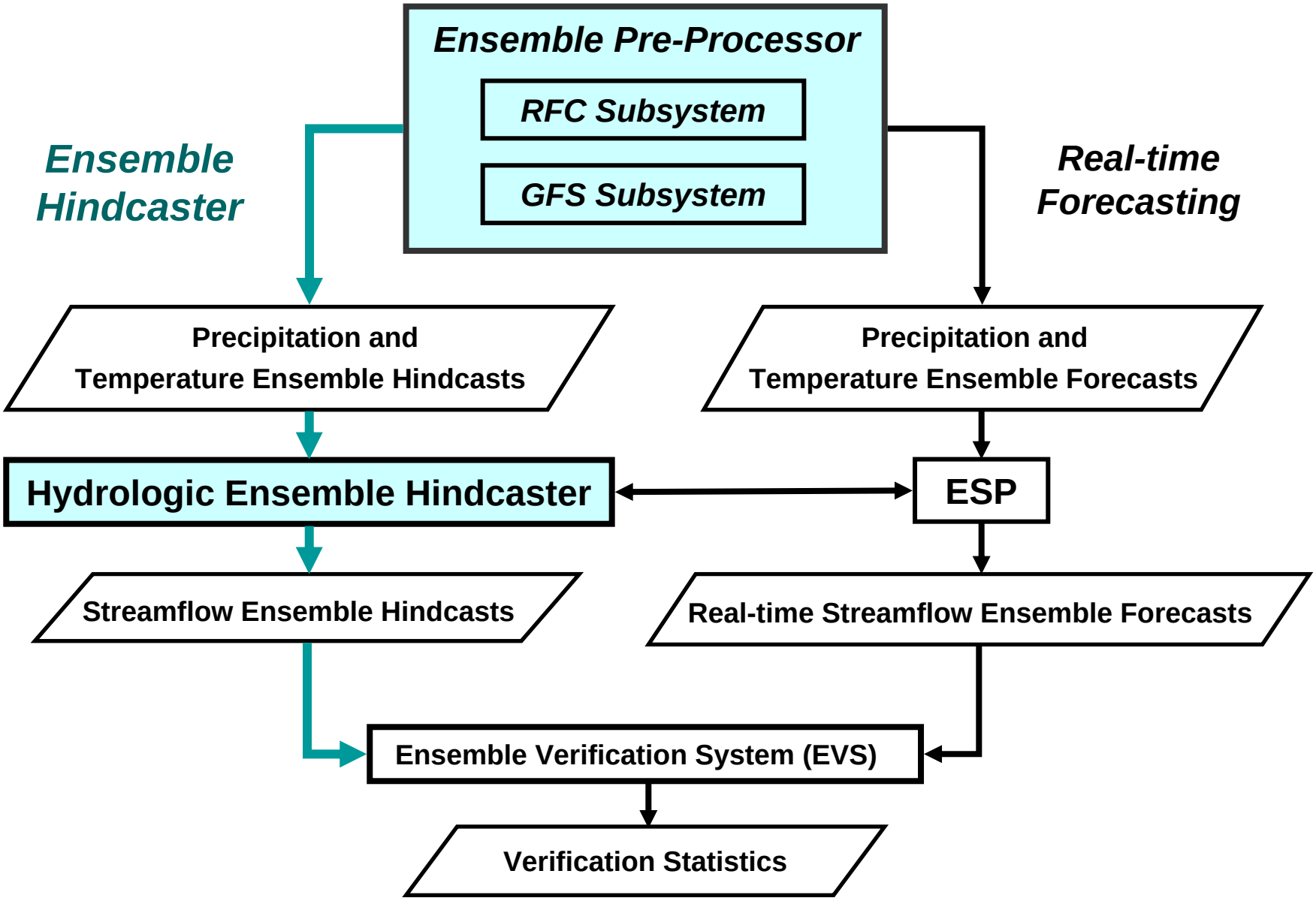
- Hindcaster Presentation
- Ensemble Hindcaster
  - Hindcasting Process
  - Hydrologic Ensemble Hindcaster Prototype
  - Input and Output Data
- Issues
- Examples
- Future steps

Elements of a Hydrologic Ensemble Prediction System

Real-time forecasting & hindcasting modes



Ensemble Hindcaster Components



Ensemble Hindcaster

- Goal: capability for systematic hindcasting (re-forecasting) based on operational and experimental forecasting system to evaluate probabilistic forecast performance and validate ensemble science

- Benefits:
  - improve predictions and validate improvements relative to forecast reliability and skill
  - serve RFC's operational need for ensemble system calibration and forecast validation

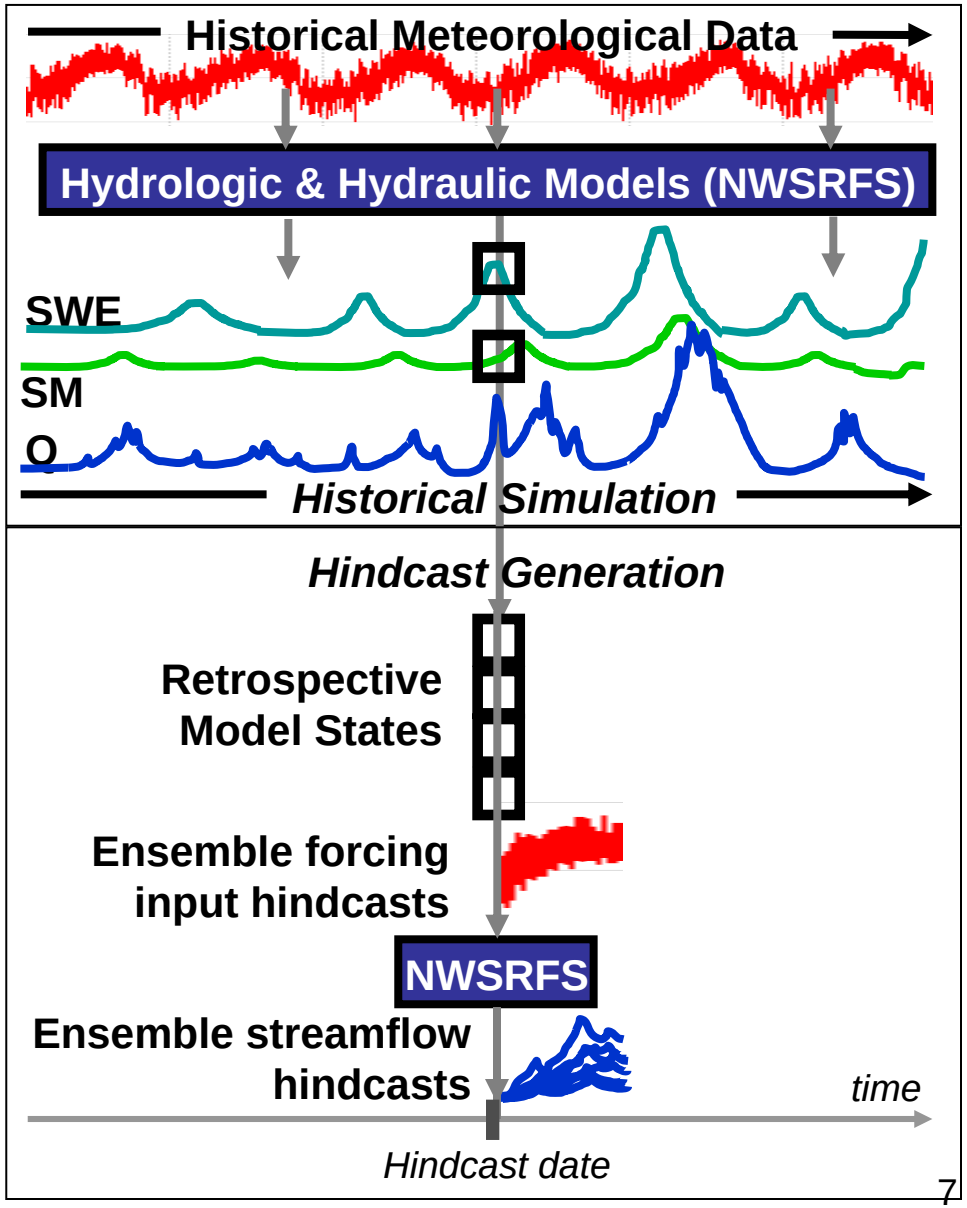
Ensemble Hindcaster

- Previous capabilities:
  - limited capability with ETSGEN gui with operational ESP
  - hindcasting capability for CBRFC Pre-Processor
  - limited capability at OHD for short-term precipitation and temperature ensembles produced by experimental EPPI

- Current Ensemble Hindcaster prototype:
  - Meteorological Ensemble Hindcaster: Ensemble Pre-Processor in hindcasting mode to produce forcing input hindcasts
  - Hydrologic Ensemble Hindcaster (HEH): 2 Korn shell scripts to produce corresponding streamflow (and stage) hindcasts from retrospective model states

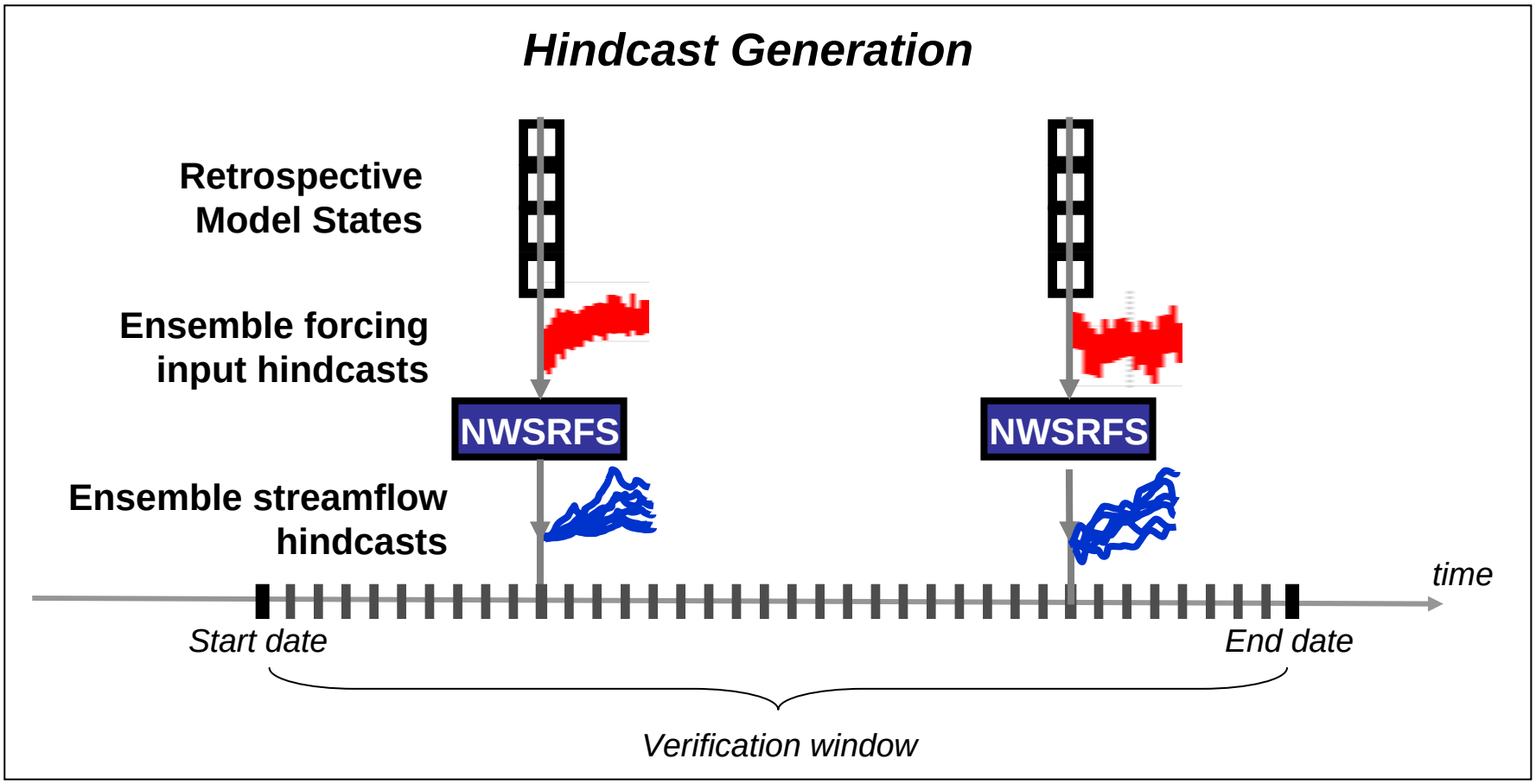
Ensemble Hindcaster: Process

- Hindcasting Process consists of generating and archiving for a range of dates and for a given verification time period:
  - retrospective model states using historical simulation mode
  - forcing input hindcasts from a meteorological hindcaster
  - streamflow hindcasts using conditional simulation mode



Ensemble Hindcaster: Process

- Hindcast generation: done once for a given forecast scenario and a given verification time period

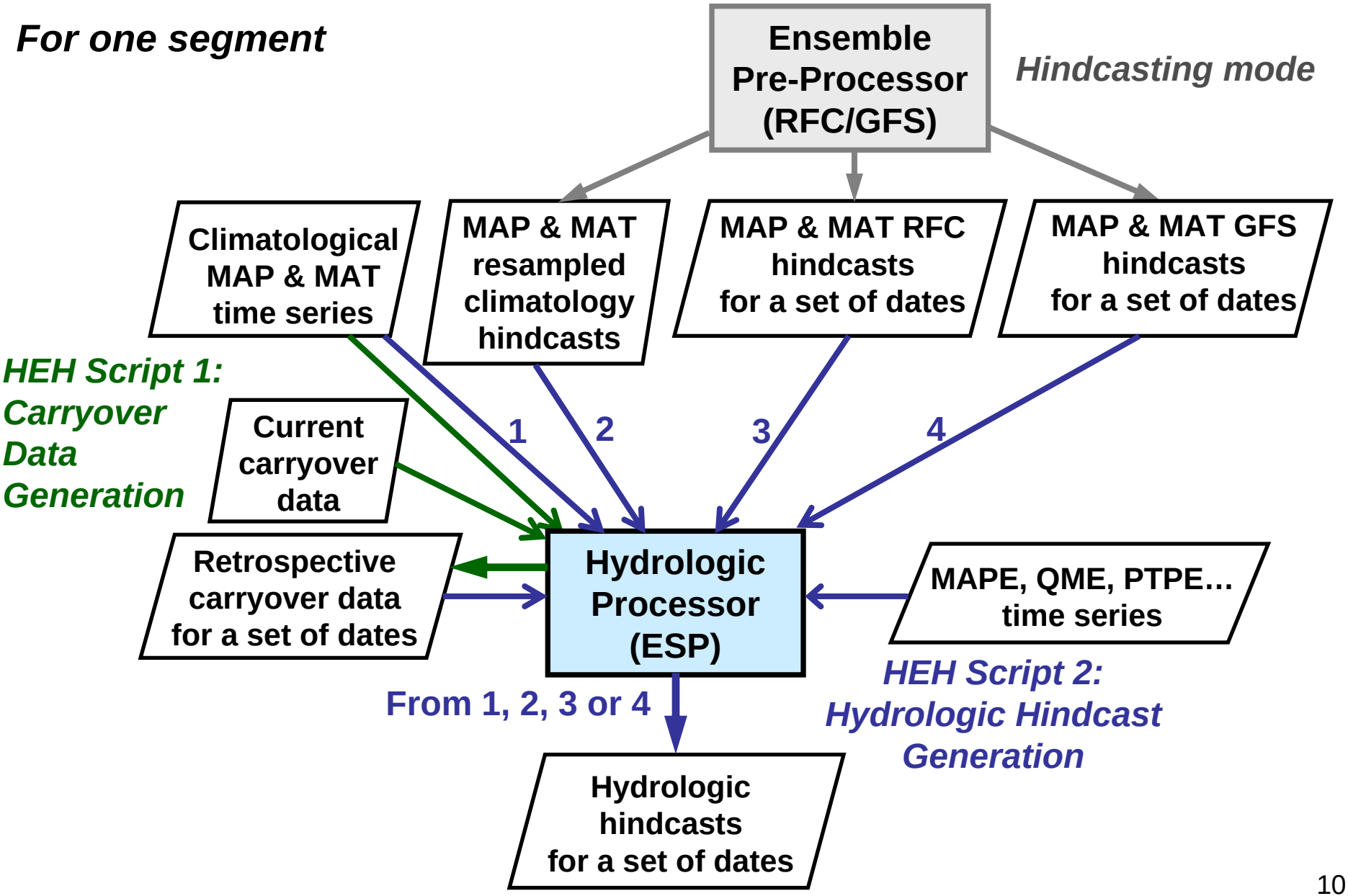


Ensemble Hindcaster: Prototype

- **Hydrologic Ensemble Hindcaster**
  - Developed by Julie Demargne and HEP team
  - 2 Korn shell scripts: 1) generate retrospective carryover data
    2) generate ensemble flow hindcasts
  - Input data: forcing input observations (datacard files) and existing carryover data, forcing input hindcasts (datacard files with date stamp)
  - Output ensemble hindcasts for a range of dates: CS files for flow hindcasts with date stamp

- Capability for a segment or forecast group:
  - Generating retrospective model states by running OFS FCST ESP in simulating mode
  - Generating hydrologic hindcasts from a set of forcing input hindcasts by running OFS FCST ESP in conditional mode (forcing input hindcasts either in local time or GMT)

Ensemble Hindcaster: Prototype



Ensemble Hindcaster: Data

Required input data for ensemble generation and verification:

- Precipitation:
  - MAP observations, up to present, datacard format
  - HPC/RFC forecasts and/or GFS forecasts, up to present
- Temperature :
  - MAT observations, up to present, datacard format
  - HPC/RFC forecasts and/or GFS forecasts for TMax and TMin, up to present
- Other inputs (MAPE, PTPE, QME, etc.) up to present
- Streamflow:
  - Observations, up to present, datacard format

Ensemble Hindcaster: Data

Output data:

- Precipitation hindcasts: 1 file for each date (month/day/year) with date stamp
  <year yyyy><month mm><day dd><time series ID>. MAP06

- Temperature hindcasts: 1 file for each date (month/day/year) with date stamp
  <year yyyy><month mm><day dd>< time series ID >. MAT

- Retrospective model states: 1 file for each Julian day (month/day) for all historical years

  <segment ID>.<month mm>.<day dd>.24.<time zone XST>

- Streamflow (CS) hindcasts: 1 file for each date (month/day/year) with date stamp

  <segment ID>.< time series ID>.QINE.06.VS.<year yyyy><month mm><day dd>

- Simulated flow (HS) files: 1 file for the whole verification period

  <segment ID>.<time series ID>.QINE.06.HS

Ensemble Hindcaster: Issues

- Generation of retrospective model states:
  - From existing carryover data, simulation w/ historical forcing input
  - Raw Model without forecaster MODs vs. with forecaster MODs
  - with automated state updating

- Identify and quantify the different error sources in forecast process for both deterministic and probabilistic approach: various hindcasting scenarios
  - Integrating other preprocessor methodologies: GFS-based ensembles, SREF-based ensembles, CFS-based ensembles, etc.
  - Integrating other hydrologic forecast scenarios (state updating, calibrated model parameters, post-processor, etc.)

- Use of various reference flow values to identify and quantify error sources:
  - Flow from forcing input forecasts vs. simulated flow from perfect forcing input
    - forcing input uncertainty
  - Flow from forcing input forecasts vs. observed flow
    - forcing input uncertainty + hydrologic uncertainty

Ensemble Hindcaster: Examples

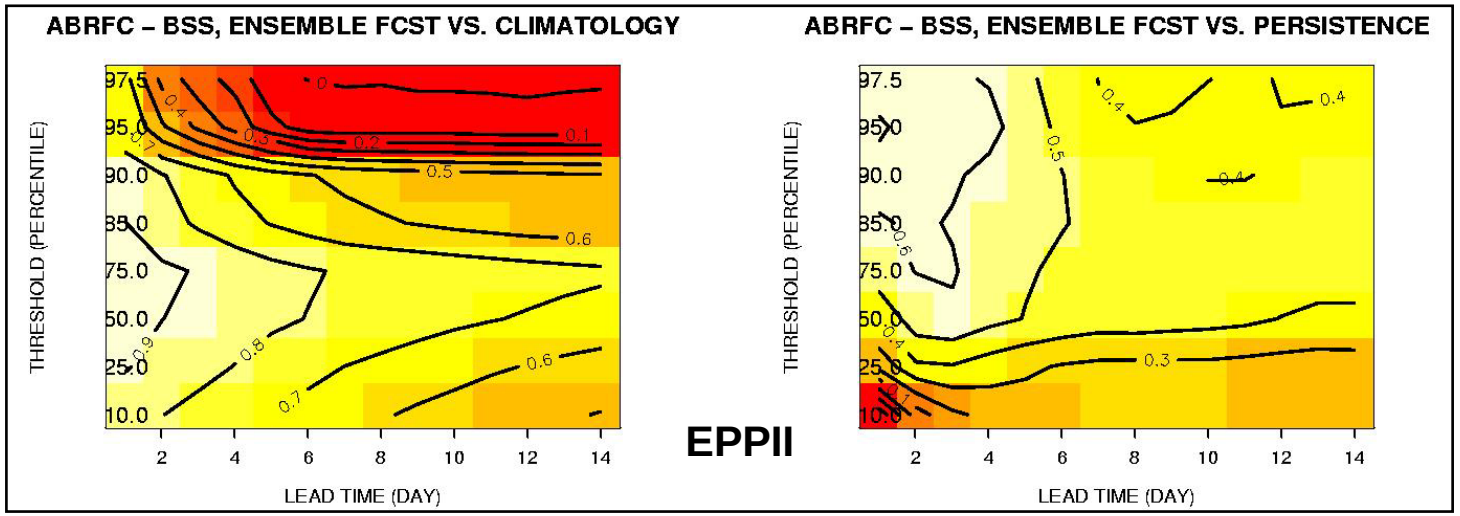
- Comparison of Brier Skill Scores (BSS) for streamflow generated from EPPII forcing inputs and GFS forcing inputs

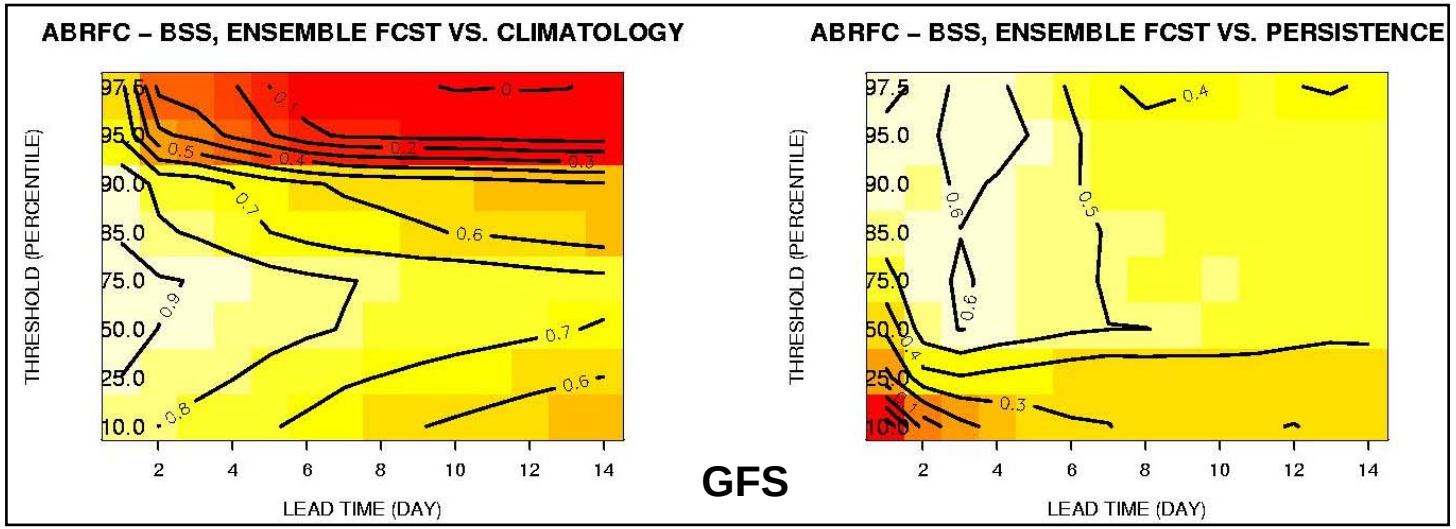
Aggregate BSS for 24-hr flows generated for 5 ABRFC basins from 03/06/2003 to 12/31/2004

Brier Score *measures mean squared probability error*

Perfect score: BSS=1

Reference flow: simulated (shows input uncertainty)





Future Steps

- Enhance user-friendliness (prototype user interface?)
- Release and support Hydrologic Ensemble Hindcaster experimental prototype => RFC feedback
- Develop other forecast scenarios: pre-processor, post-processor, state updating, etc.
- Evaluate separately uncertainties from forcing inputs, initial conditions, parameters, other forecast elements
- Link with Deterministic Hindcaster

Thank you