NYC's water supply Experience in using HEFS Ensemble Forecast

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NOAA's Subseasonal and Seasonal Application Workshop

Towards Increasing Collaborations among Users, Modelers and Researchers

NOAA NCWCP, College Park, Maryland, September 4-6, 2024

Presentation Outline

- New York City (NYC) water supply
- NYC Operations Support Tool (OST)
- Collaboration with NERFC, MARFC and OWP
- Importance of NWS products
  - HEFS Ensemble forecasts
  - Meteorological forcings
  - Historical Simulations and Hindcasts
- NYC Goals/Priorities

NYC
Environmental
Protection
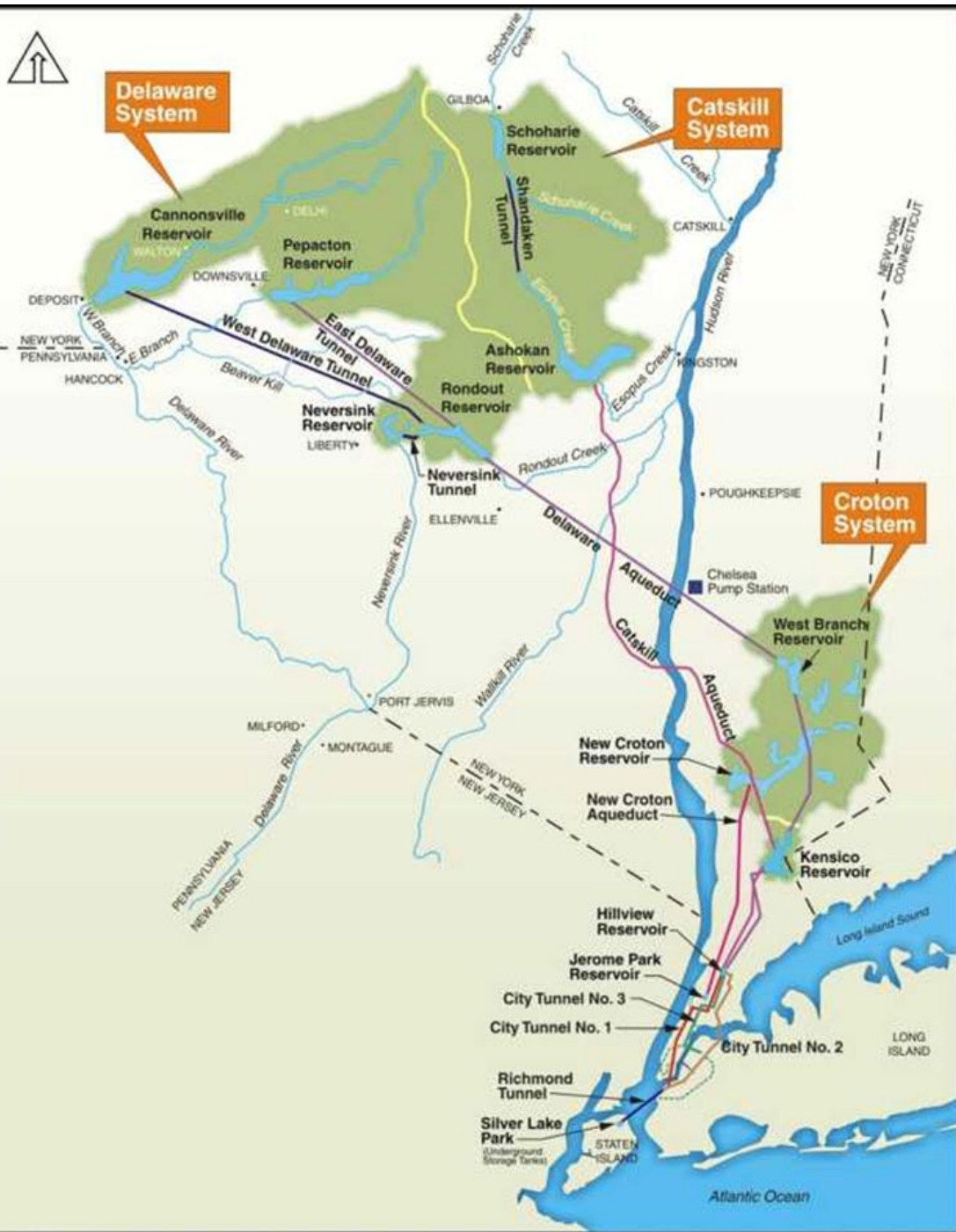
NYC Water Supply

- Three sub-systems
- 2,000 square mile watershed, including 19 reservoirs and three controlled lakes
- Deliver 1.1 billion gallons of water to 9.8 million New Yorkers
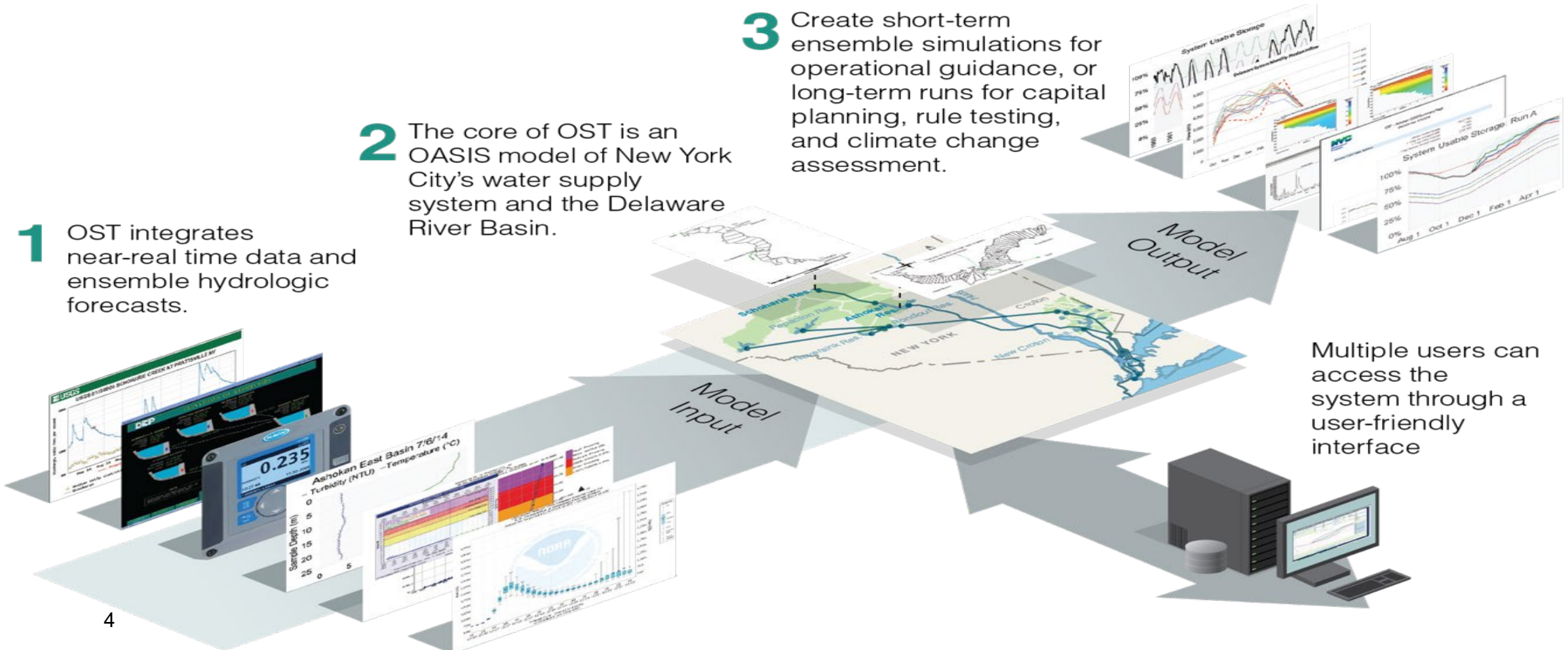- 570 BG storage capacity
- Managed by NYC DEP

NYC Operations Support Tool (OST)

A software that allows to evaluate all aspects of NYC Water Supply system

1 OST integrates near-real time data and ensemble hydrologic forecasts.

2 The core of OST is an OASIS model of New York City's water supply system and the Delaware River Basin.

3 Create short-term ensemble simulations for operational guidance, or long-term runs for capital planning, rule testing, and climate change assessment.

Model Input

Model Output

Multiple users can access the system through a user-friendly interface

4

NYCDEP, NERFC, MARFC, OWP Collaboration

Available OST

- HEFS
- AHPS
- Historical non conditional
- Hirsch
- E-Hirsch

Collaboration started 2013

- 2014 - First GEFSv10 HEFS Raw Forecasts (38)
- Currently GEFSv12 HEFS (60)
- MARFC replaced API with SAC-SMA
- Improving NERFC HEFS MEFP for high precipitation
- Current Products include:
  - EnsPost HEFS
  - Updated Historical Simulations and Hindcasts

NWS Products: *HEFS Ensemble Forecast*

- Positional Analysis (PA) Mode
  - 1-Year Long Simulation
  - Supports Daily Operations
- Regular Runs
  - Open
  - Current Operations
  - Test Operational Alternatives
  - Infrastructure Repair and Shutdown Support

OST PA Mode
Relies on daily HEFS Ensemble Forecasts by NERFC & MARFC
Raw and EnsPost post-processed
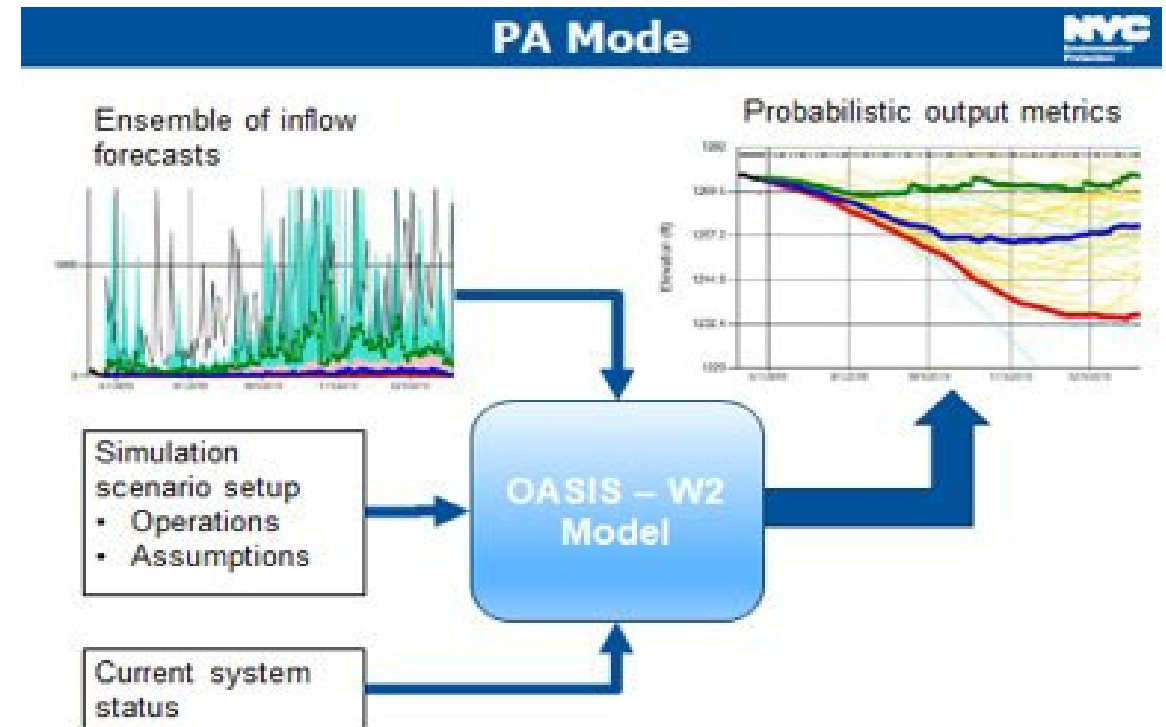
HEFS Ensemble Forecast

Supports Flexible Flow Management Program

When more water is available, more water is released

Conversely when less water is available, less water is released

OST-2017 FFMP Release Summary
Decision Day: 8/18/2024

Reservoir inflow accumulated through Jun 1 is used to calculate Delaware basin NYC reservoirs mass balance

General Release Mass Balance

Combined Pepacton, Cannonsville, and Neversink (PCN) Storage:	227,698	MG
+ PCN Inflow Forecast Accumulated to Jun 1:	403,237	MG
- Expected PCN Diverson Accumulated to Jun 1:	37,846	MG
-Jun 1 Storage Target:	267,460	MG
= Available Release Quantity Accumulated to Jun 1:	325,630	MG

Available Release Quantity Evenly Distributed to June 1

Available Release Quantity Accumulated to Jun 1:	325,630	MG
/ Number of Days to Distribute Release Quantity:	287	days
Current PCN Release Target:	1,135	mgd
Current PCN Release Target:	1,755	cfs

Current Storage Zone for Schedule Selection

	Usable Storage	Usable Storage + Snow Storage	Zone
PCN	85.1%	*	L2
Pepacton	91.2%	*	L2
Cannonsville	80.3%	*	L2
Neversink	73.8%	*	L2

*Not applicable (snow storage is included in the forecast)

Use Release Target and Storage Zone to Select Release Schedule

	Storage Zone, Summer (cfs)			
	Pepacton	Cannonsville	Neversink	PCN
	L2	L2	L2	L2
Table-4a	100	190	75	365
Table-4b	110	245	80	435
Table-4c	115	300	90	505
Table-4d	125	360	95	580
Table-4e	135	415	100	650
Table-4f	140	460	110	710
Table-4g	150	500	115	765

NWS Products: *Meteorological Forcings*

- **Required for Reservoir Water Quality CE-QUAL-W2 (W2) Model Simulations**

NYC
Environmental
Protection

W2 WQ Model

- 2-Dimensional
  - Hydrodynamic
- Simulate
  - Turbidity
  - Water Temperature

NWS Products: *Historical Simulations*

EPP v1
- Based on General Linear Model (GLM)
- Using the **statistical relationship** between two sets of data (historical simulation and observed/estimated natural flow)

2012

EPP v2
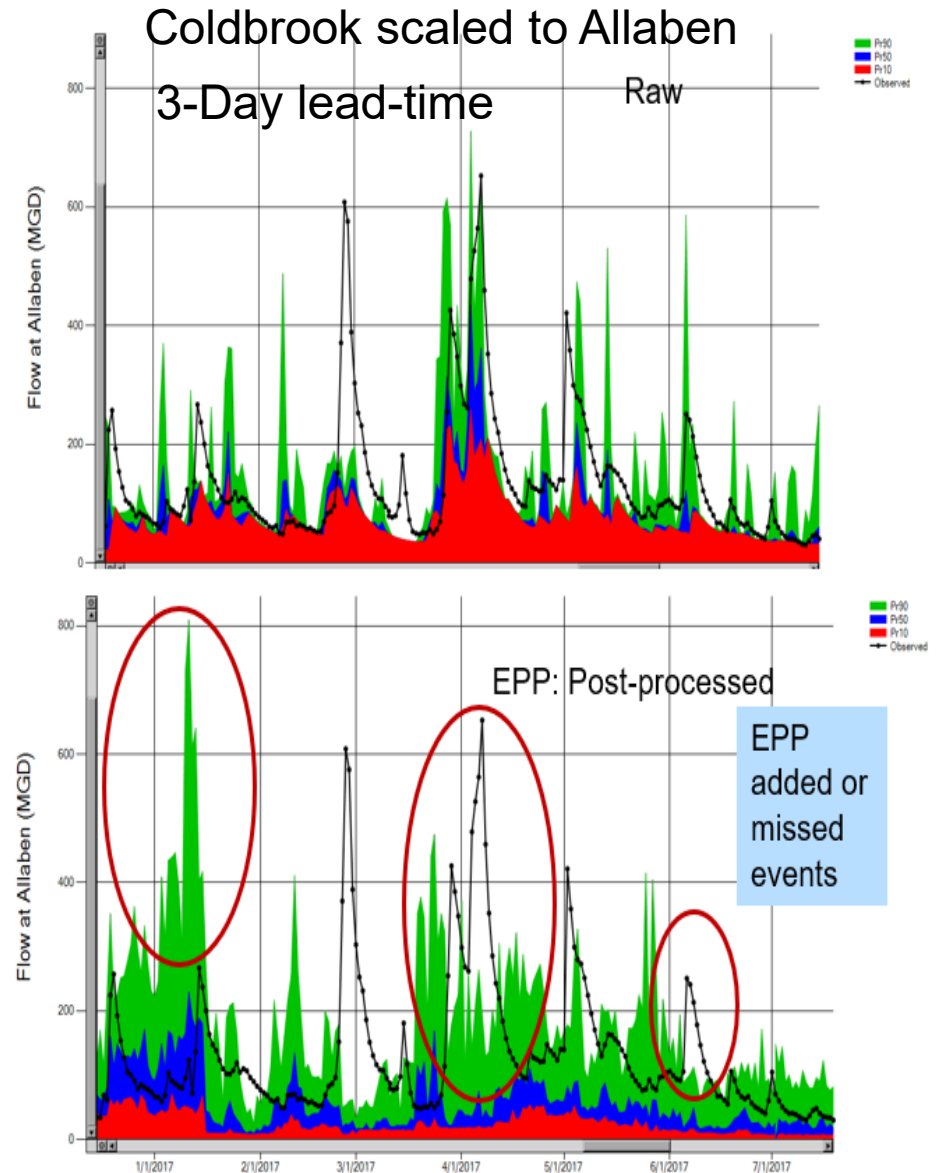- Same as EPP v1 but intended to improve statistical relationship

2016

Quantile-Quantile Mapping (QQM)
- Adjust distribution of simulated flow at one location to match with the distribution of the observed flow at another/same location(s)
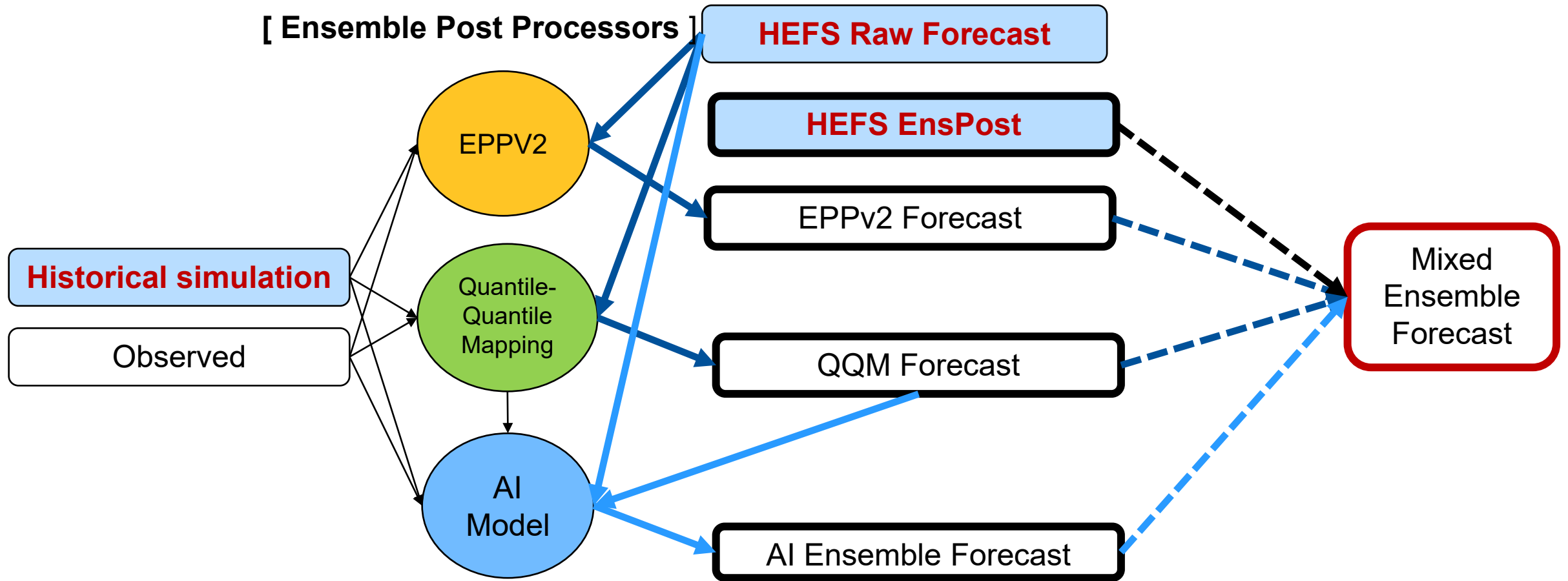
2023-25

Long Short-Term Memory (LSTM)
- A Recurrent Neural Network based Artificial Intelligence model
- Captures diverse patterns in the data instead of using predefined relationships.
- Known to work well in time-series forecasting where system memory plays important role

Coldbrook scaled to Allaben

3-Day lead-time

Raw

EPP: Post-processed

EPP added or missed events

NYCDEP Ensemble Forecasting Flow Diagram

GOALS / Priorities

- HEFS forecast skill improvements (beyond day 15)
- Looking forwards for GRFSv14 HEFS and SFSv1
  - Raw and EnsPost Forecasts
  - Meteorological forcings
  - Historical simulations and hindcasts
- Continue EPP Improvements
- Explore blending forecasts
- Explore seasonal and regime-based forecast options
- Potential implications for collaboration

NYC Environmental Protection

Thank You!

OST Review by the NASEM Expert Panel

- *"One of the most advanced and complex support tools for water supply operations of its kind in the world." (NASEM)*