Northwest River Forecast Center

Ensemble Streamflow Prediction (ESP) Water Supply Forecast Procedure

Telephone Conference : 1-888-819-6075
Pass Code : 32317

Presentation available after brief at:
www.nwrfc.noaa.gov/presentations/presentations.cgi

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Presentation Outline

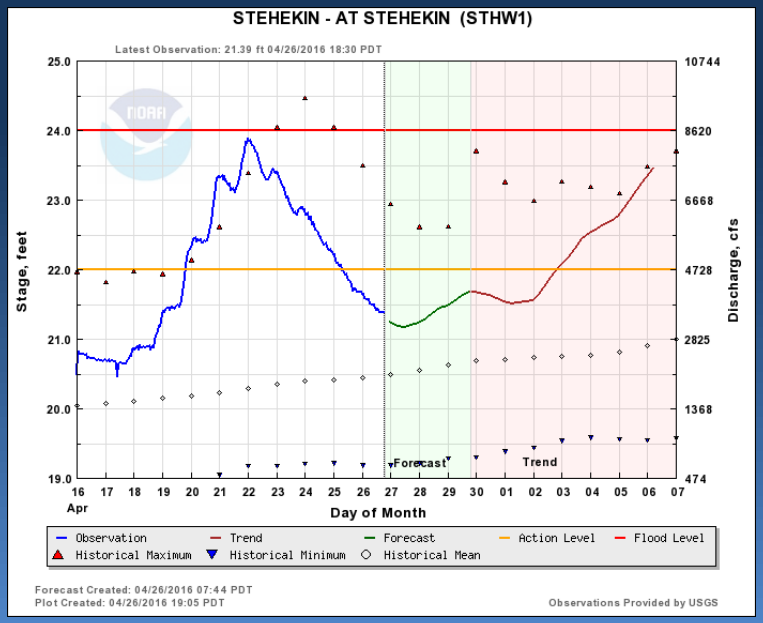
- Forecast Model and Operation Description
- Seasonal Volumetric Forecasts Using ESP
- Web Services and Products

NWRFC Forecast Model

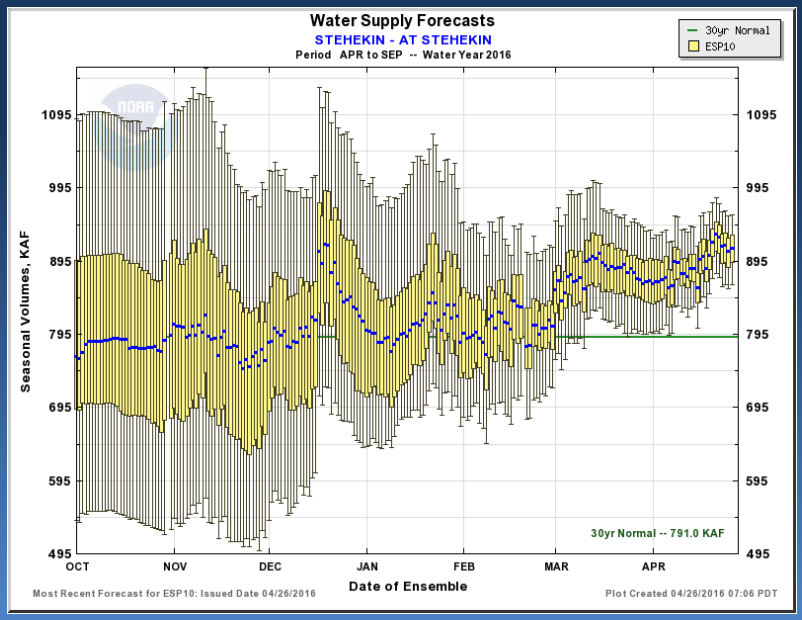
Community Hydrologic Prediction System (CHPS)

- Forced by *Precipitation and Temperature* (Obs and Fcst)
- Short and Long-term Forecast Capability

10 Day Deterministic River Forecast

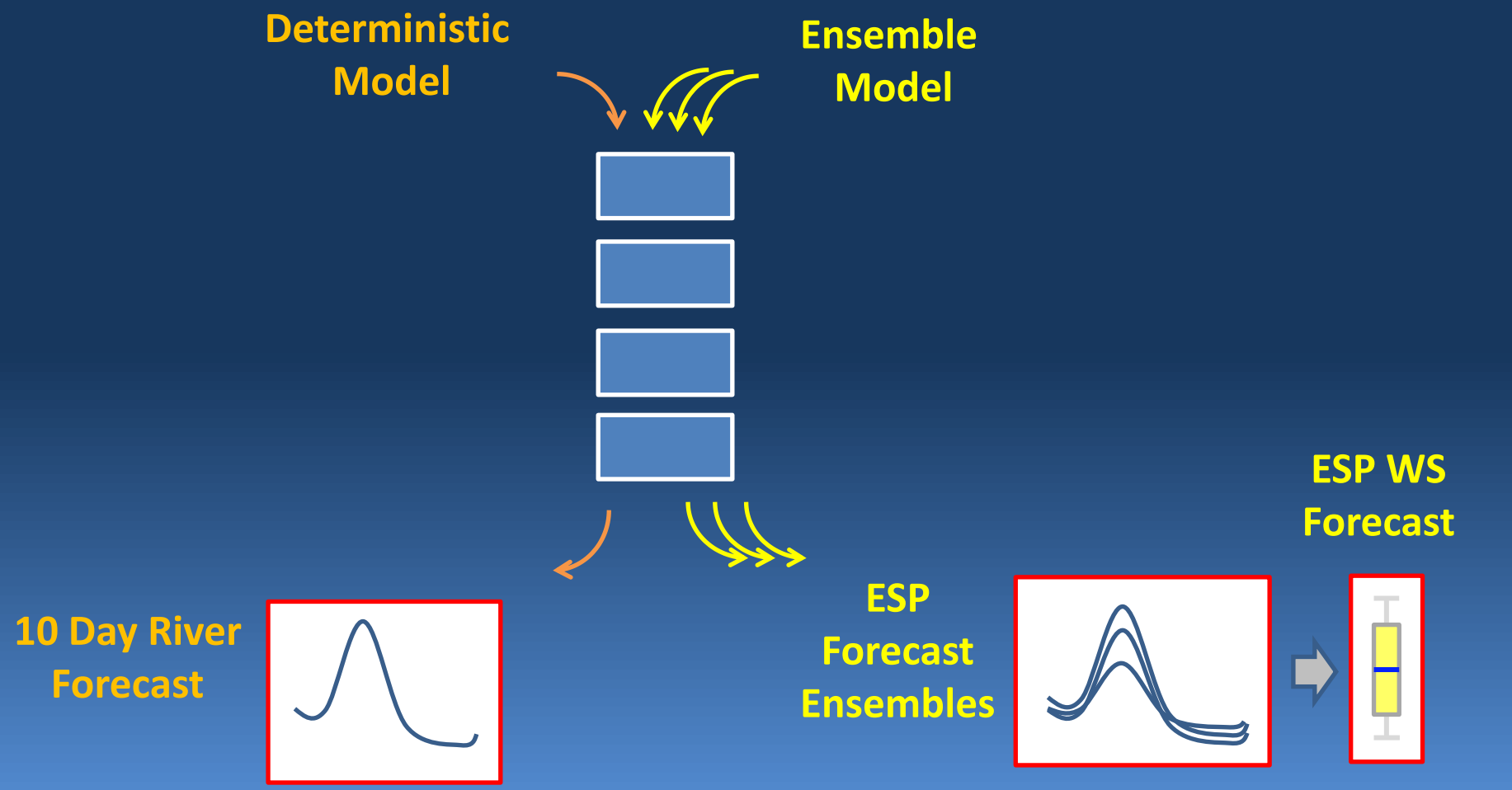


Seasonal Probabilistic Forecast (ESP)



Conceptual Hydrologic Model

Multiple Uses – Same Model



Understanding the CHPS Forecast Model

Input Forcings: *Obs &Fcst*

- ***Precipitation***
- ***Temperature***

Model Operations

- ***SNOW17***
- ***SAC-SMA***
- ***Consumptive Use***
- ***Regulation***
- ***Routing***

Model States

- ***Snow Water Equivalent***
- ***Snow Cover***
- ***Soil Moisture***
- ***River/Reservoir Levels***

Deterministic Output Hydrograph

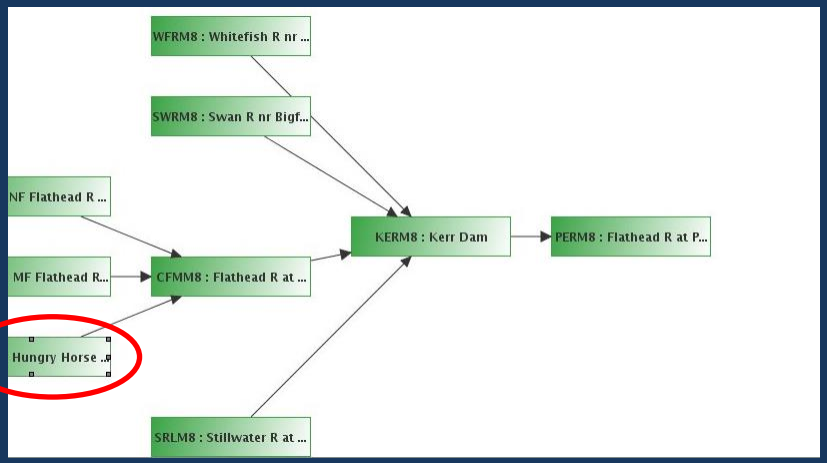
- ***River Flow***
- ***River Stage***
- ***Pool Elevation***

Deterministic Mode

- **ONE forcings set and ONE output**

CHPS Configuration for Flathead River Basin

SF Flathead River - Hungry Horse Reservoir



Model Construction for HHWM8

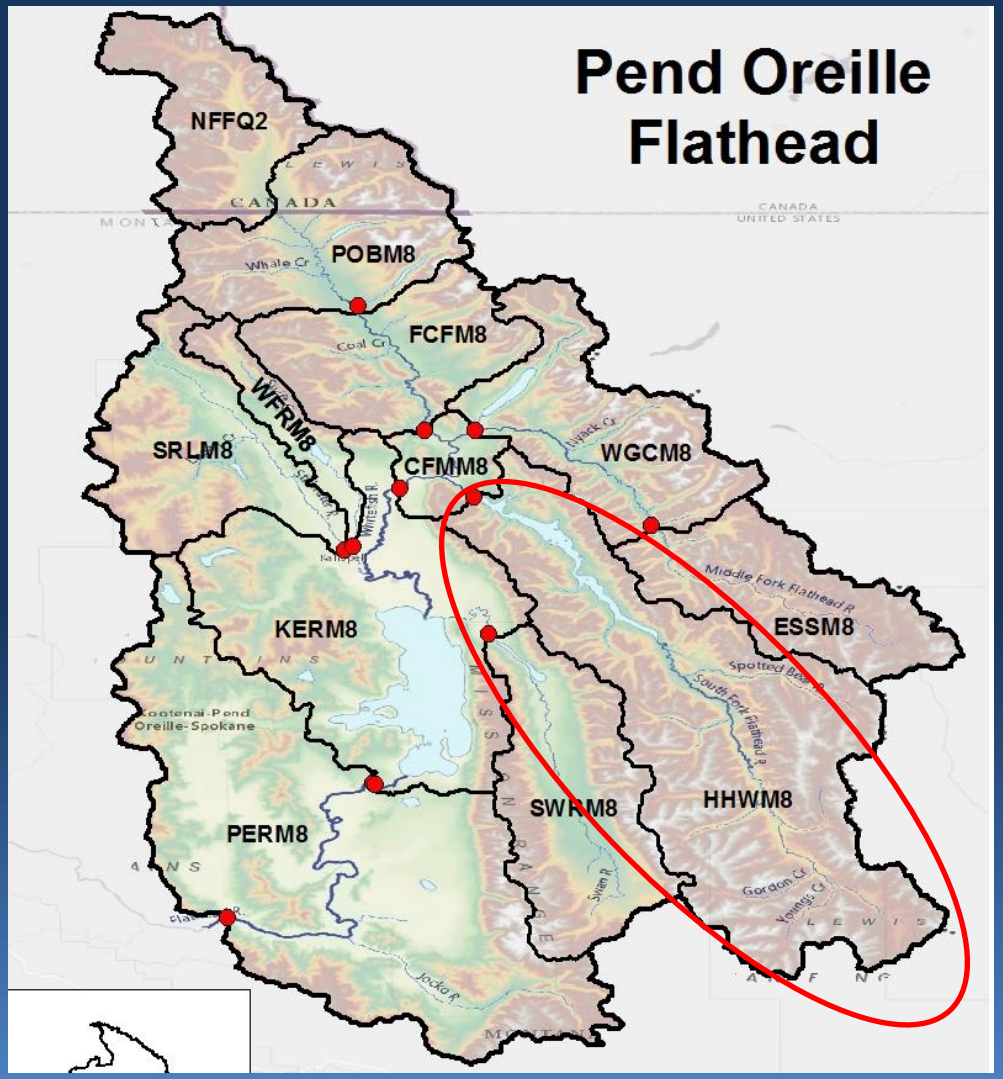
- Upper Elevation Zone 6500'-8520'
- Lower Elevation Zone 3540'-6500'

Model Operations Applied at Each Zone:

- Computed Mean Areal Forcings
- Rain-Snow Operation
- Snow Model (SNOW-17)
- Soil Moisture Model (SAC-SMA)

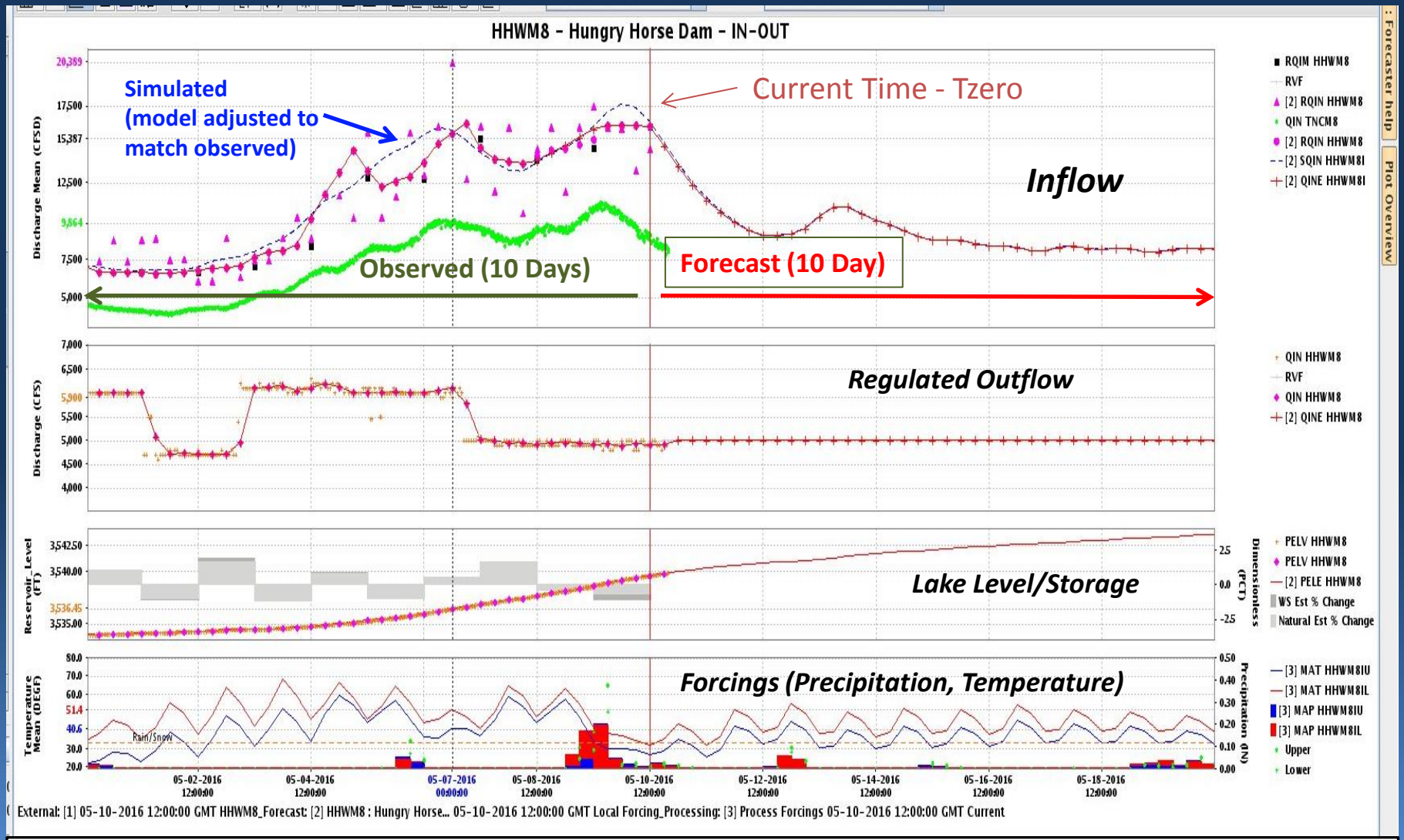
Runoff Converted to Flow and Routed

- Unit Hydrograph
- Reservoir Model (SSARRESV)



Community Hydrologic Prediction System (CHPS)

Interactive Forecast Display (Forecast Plot)

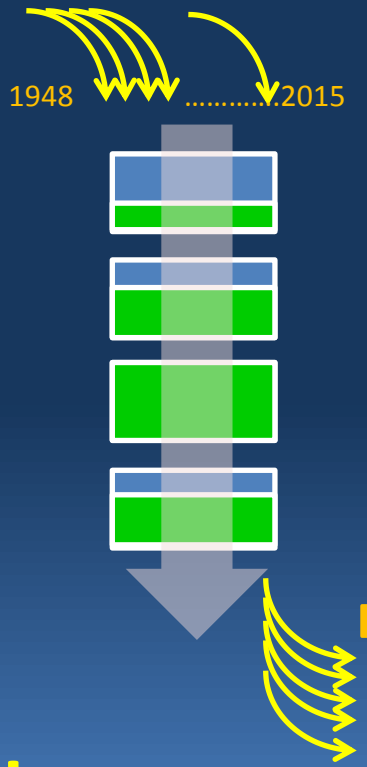


← *Observed | Forecast* →

Ensemble Streamflow Prediction (ESP)

Input Forcings: Ensemble of Weather Years *(1948-2015)*

- ***Precipitation***
- ***Temperature***

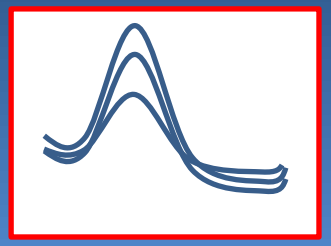


Combined with Current Model States

- ***Snow Water Equivalent***
- ***Snow Cover***
- ***Soil Moisture***
- ***River/Reservoir Levels***

Ensemble of Output Hydrographs (67 Traces)

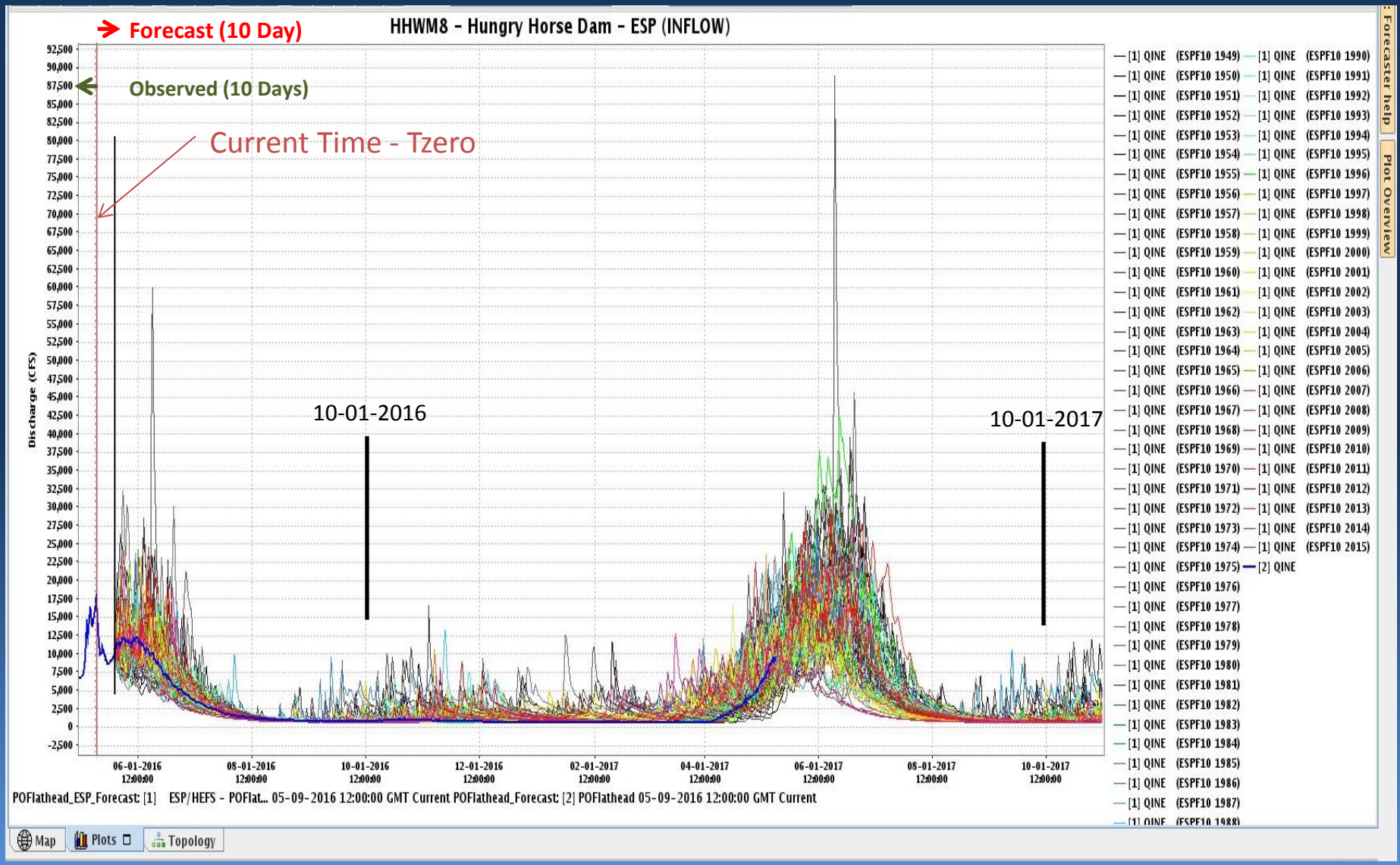
- ***River Flow***
- ***River Stage***
- ***Pool Elevation***



Ensemble Mode

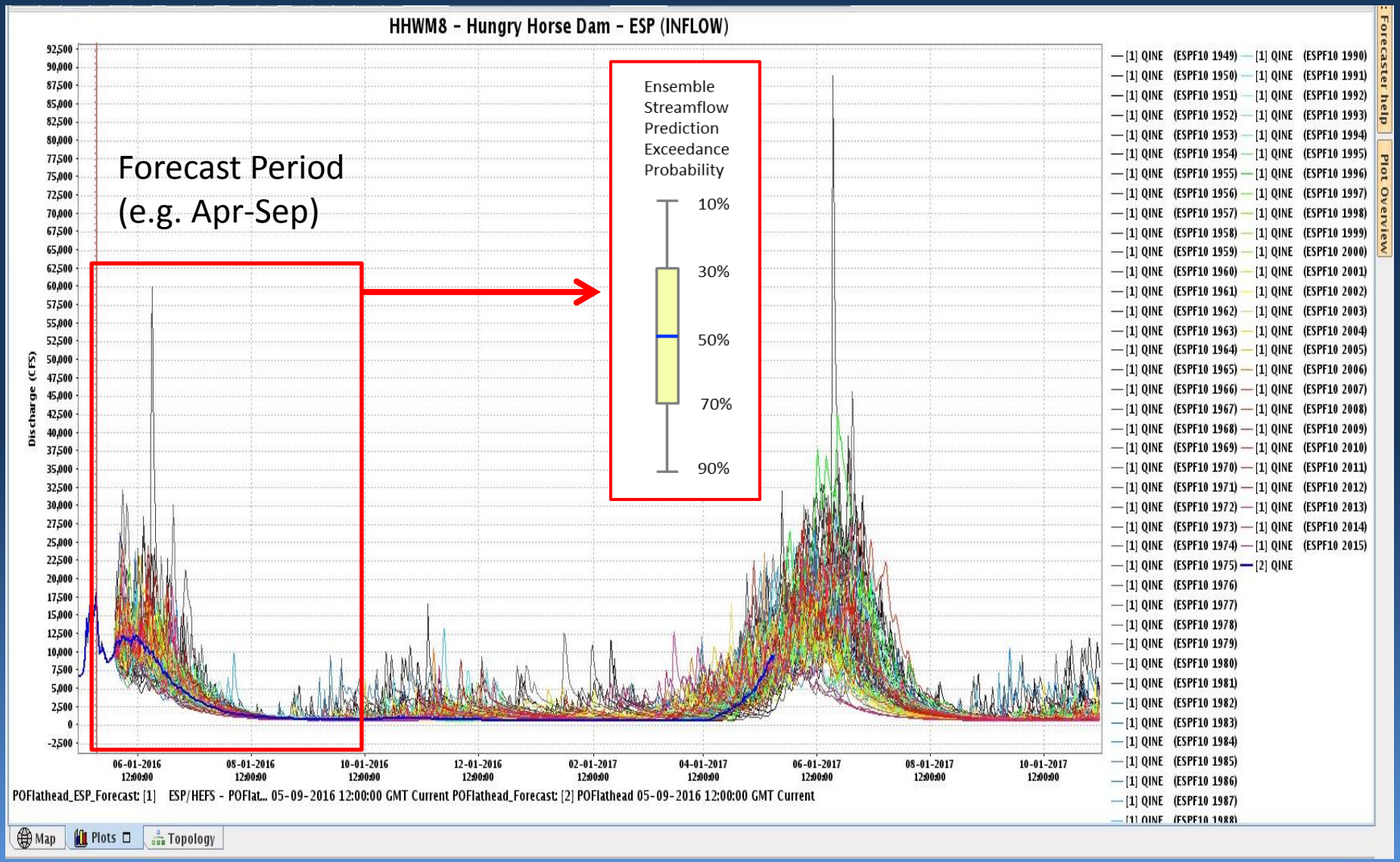
- **MANY forcings and ONE output for EACH**
- **EACH assumed to be EQUALLY LIKELY**
- **DISTRUBUTION represents UNCERTAINTY**

Ensemble of Inflow Hydrographs



Statistical Summary of ESP Water Supply

Ensemble Traces Conveyed as Exceedance Probabilities



Statistical Summary of ESP Water Supply

Seasonal Exceedance Probability Forecasts displayed for entire water year

SF FLATHEAD - HUNGRY HORSE DAM (HHWM8)
Forecasts for Water Year 2016

Official Forecast

10 days QPF: ***Ensemble:*** 2016-05-10 ***Issued:*** 2016-05-10

Forecast Period	Forecasts Are in KAF				30 Year Average (1981-2010)
	90 %	50 %	% Average	10 %	
APR-SEP	1708	1862	94	2129	1988
APR-JUL	1613	1745	93	2021	1871
APR-AUG	1665	1814	94	2087	1936
JAN-SEP	1988	2142	97	2409	2215
JAN-JUL	1893	2025	97	2301	2098
OCT-SEP	2133	2287	93	2554	2447

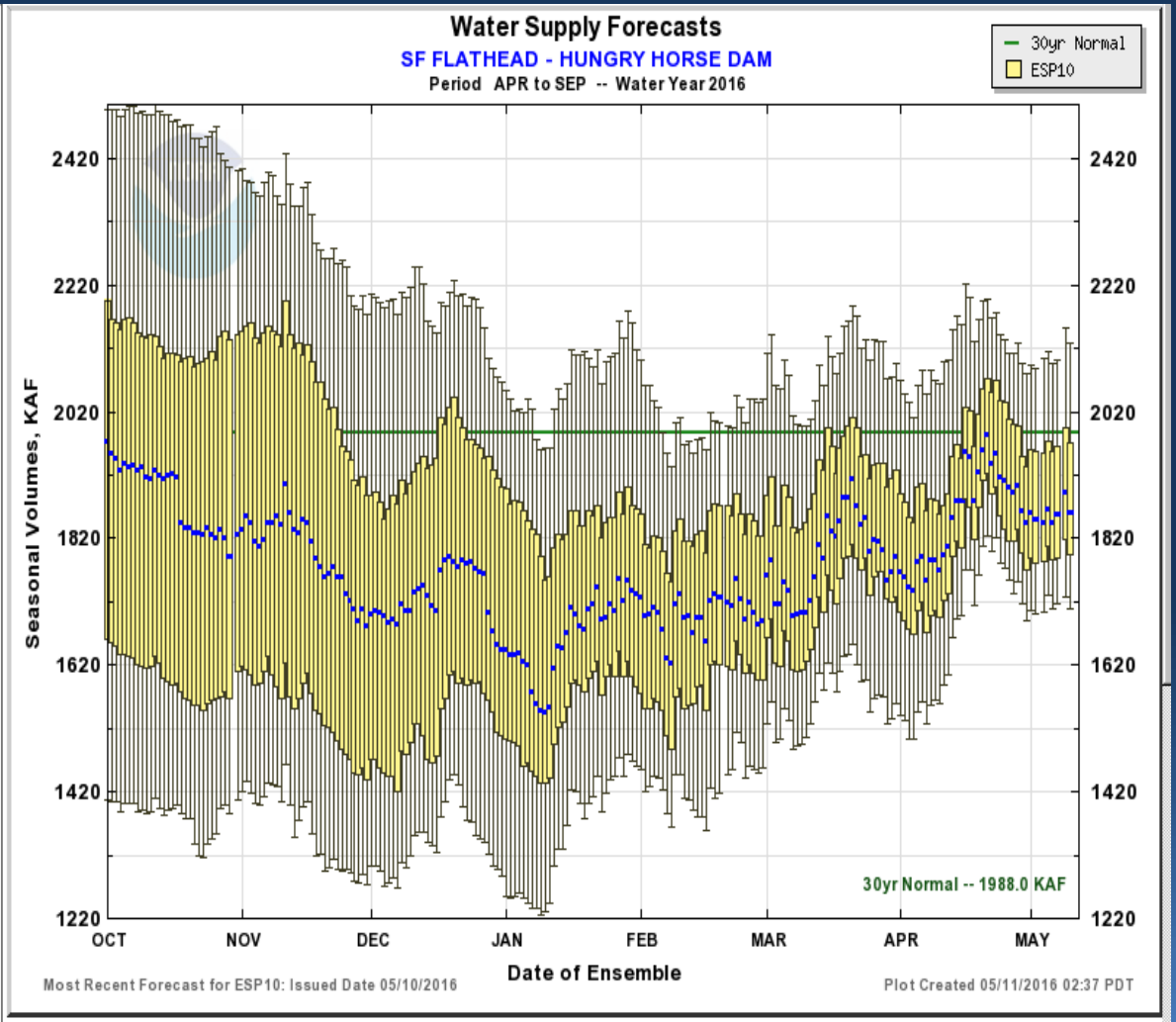
5 days QPF: ***Ensemble:*** 2016-05-10 ***Issued:*** 2016-05-10

APR-SEP	1745	1899	96	2146	1988
APR-JUL	1660	1774	95	2038	1871
APR-AUG	1707	1844	95	2104	1936
JAN-SEP	2025	2179	98	2426	2215
JAN-JUL	1940	2054	98	2318	2098
OCT-SEP	2170	2323	95	2571	2447

0 days QPF: ***Ensemble:*** 2016-05-10 ***Issued:*** 2016-05-10

APR-SEP	1773	1938	97	2169	1988
APR-JUL	1678	1816	97	2064	1871
APR-AUG	1724	1885	97	2129	1936
JAN-SEP	2053	2218	100	2449	2215
JAN-JUL	1958	2096	100	2344	2098
OCT-SEP	2198	2362	97	2594	2447

Move the mouse over the desired "Forecast Period" to display a graph.



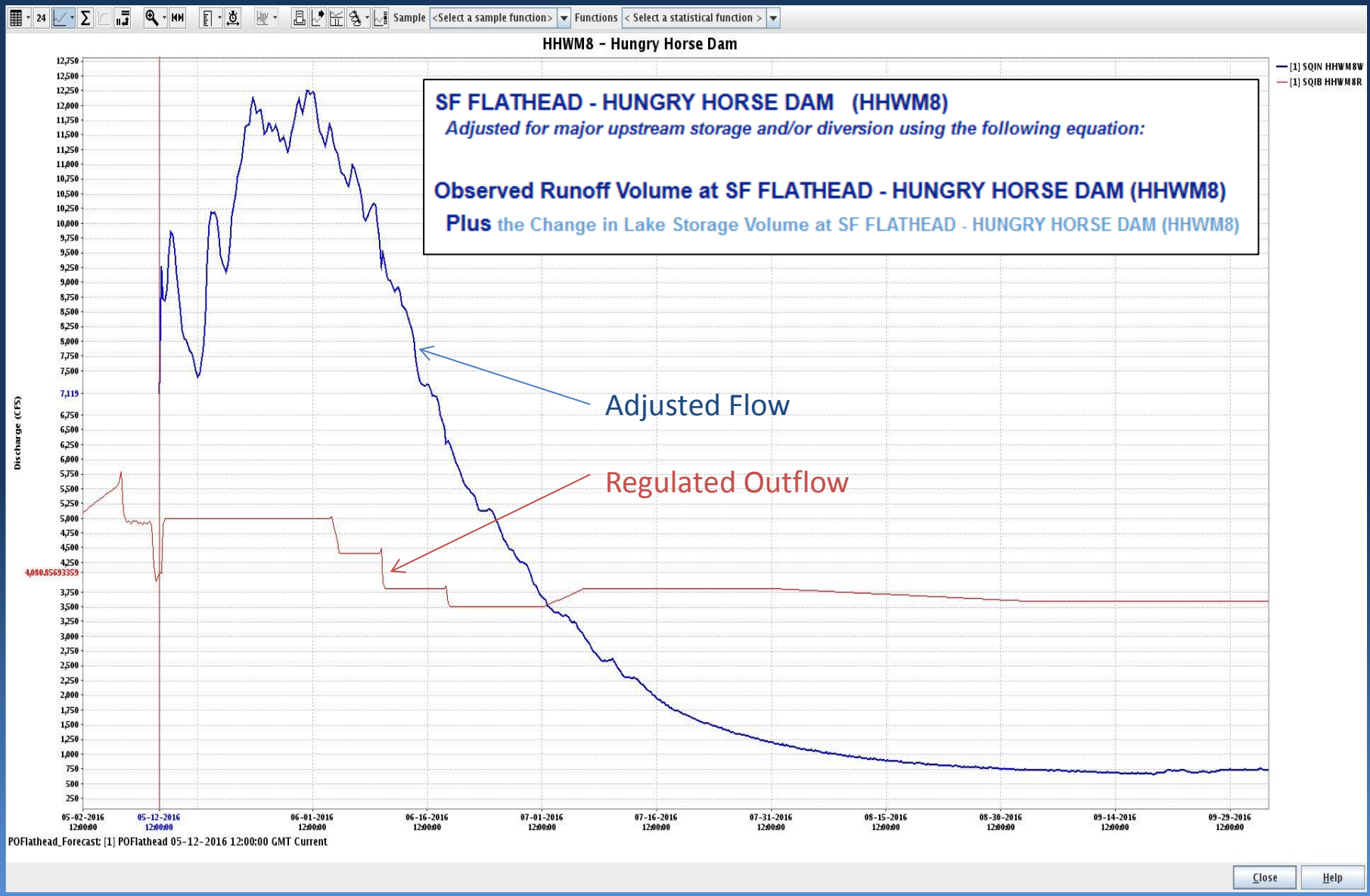
Flavors of ESP Forecasts

- Number of Days of Deterministic Precip/Temp (10,5,0 Days)
  - Short-term weather forecast included for first 10, 5, or 0 days
  - ESP10 (NWS Official Water Supply Forecast)
  - ESP5 (used by COE to regulate Columbia River system)
  - ESP0 (no short-term weather forecast, historic forcings only)

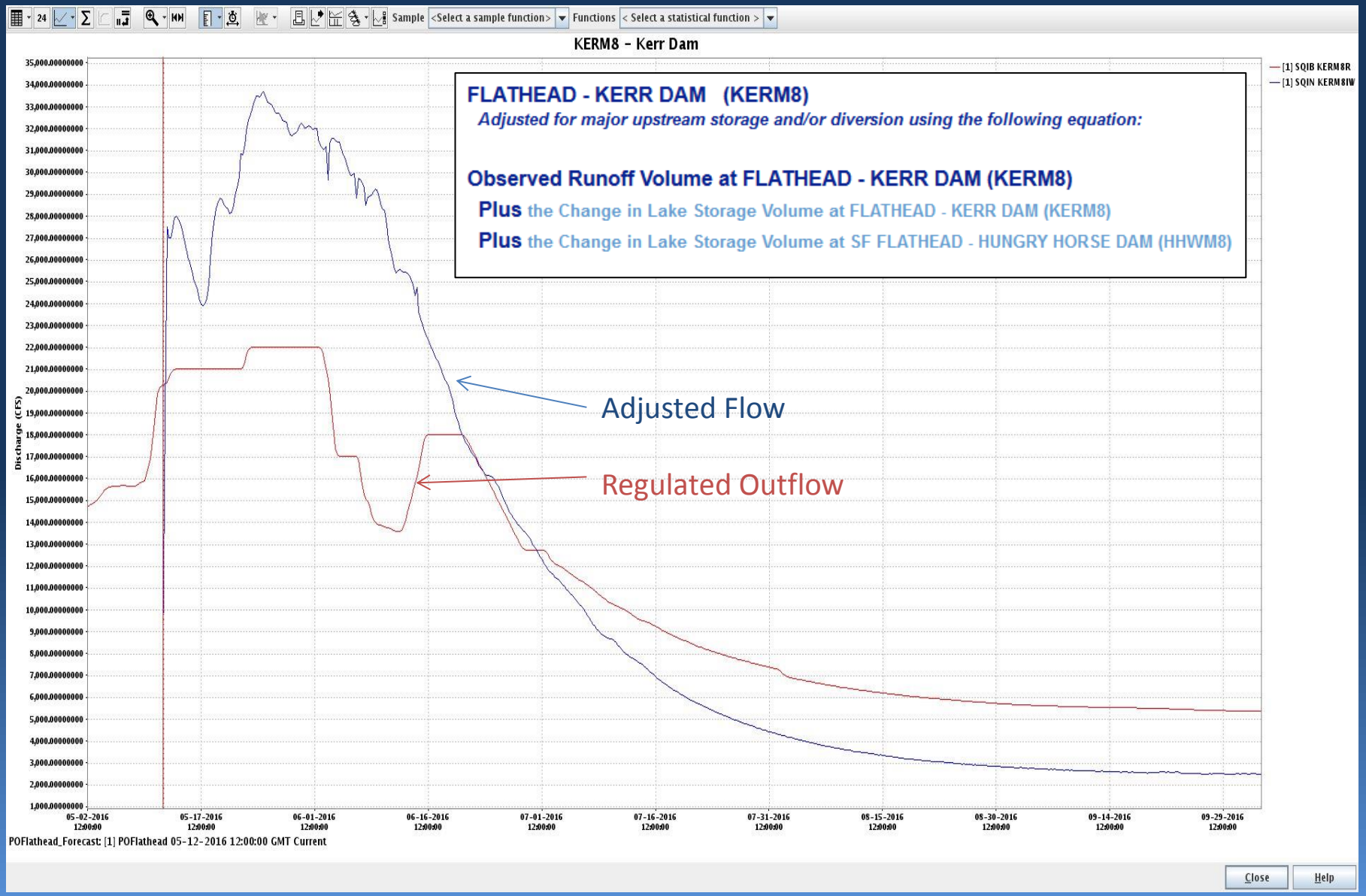
- Flow Configuration
  - Unadjusted (observed in the river)
    - deterministic outflow below a project
    - Observed and forecast flow at a point

  - Adjusted
    - *ESP water supply* (adjusted for upstream storage, no routing)
    - *ESP natural water supply* (adjusted for ALL modeled upstream alterations; includes routing)
      - Storage
      - Consumptive Use
      - Channel Loss/Gain
      - Channel Routing

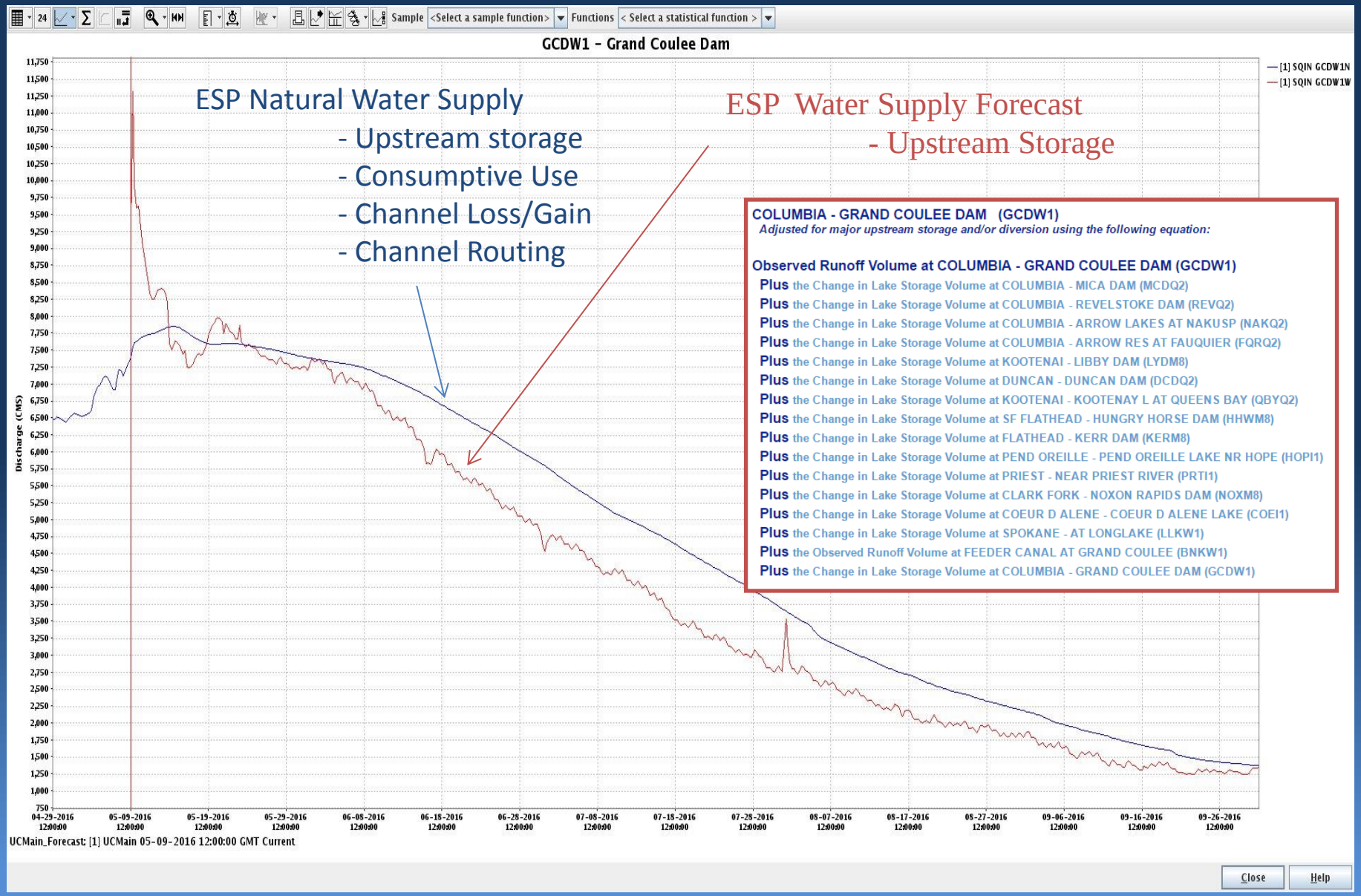
ESP Water Supply Forecast



ESP Water Supply Forecast

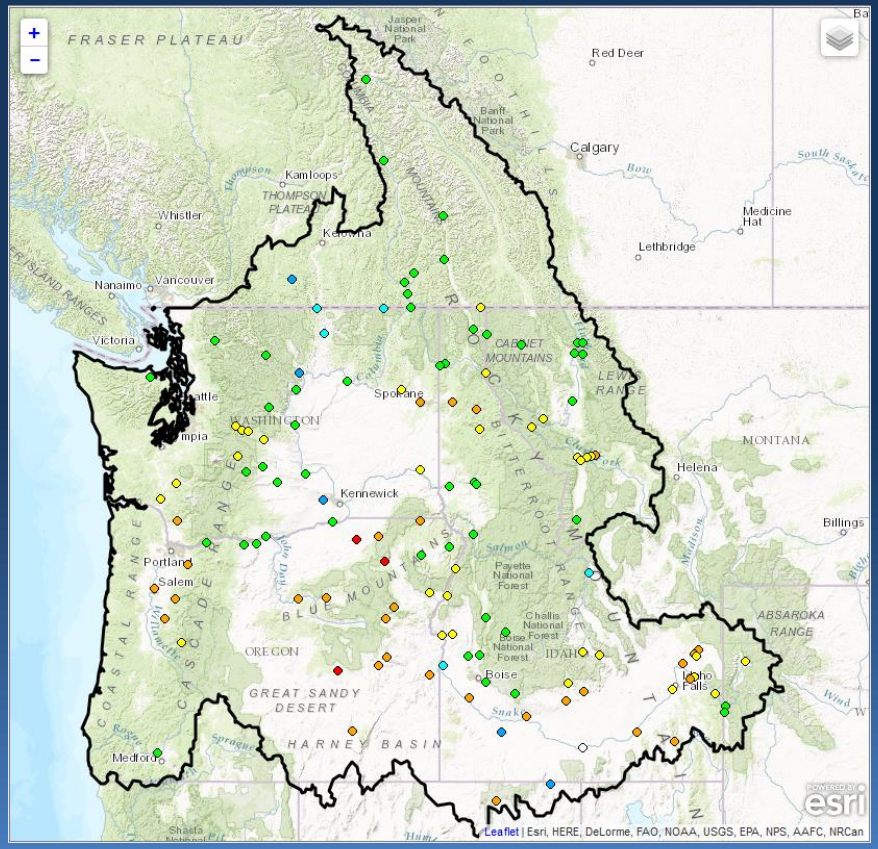


ESP Natural Water Supply Forecast

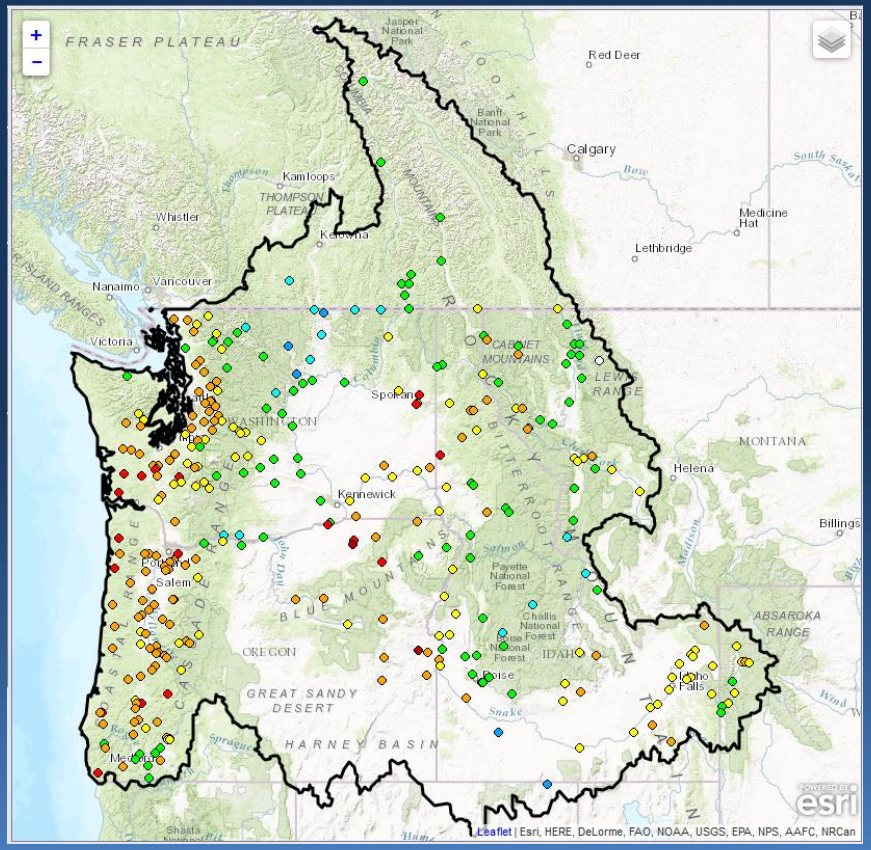


ESP Forecast Point Network

ESP Legacy WSF – 126 Locations



ESP Natural WSF – 330 locations



1981 – 2010 Seasonal Volume Normals – KAF

ESP WSF vs ESP Natural WSF

SF Flathead at Hungry Horse Dam				
	Apr - Sep	Apr – Jul	Jan - Jul	Oct - Sep
ESP WSF	1988	1871	2098	2447
ESP Natural WSF	1988	1867	2098	2459

Columbia R at the Dalles Dam				
	Apr - Sep	Apr - Jul	Jan - Jul	Oct - Sep
ESP WSF	92704	79855	101368	130518
ESP Natural WSF	96012	82019	102438	132349

ESP: Strengths and Challenges

- Strengths
  - Provides probabilistic information for risk planning
  - Issued Daily, 365 days a year
  - Flexible (multiple flavors, configurations, forecast periods)
  - Includes weather forecast (out to 10 days)
  - Full Integration with NWRFC short term river models
  - Evolving operational procedure (improvements expected)

- Challenges
  - Uncertainty due to observed forcings and model states not accounted for (model spread is not a wide as it should be)
  - Forecasts can be subject to day to day instability
  - Complicated (hard to troubleshoot, challenge to articulate)

ESP WSF Compared to Statistical Water Supply

- In Common
  - Calibrated against streamflow/runoff
  - Forecasts presented as statistical summary
  - Forecasts compared to 30yr Average Runoff (1981 – 2010)

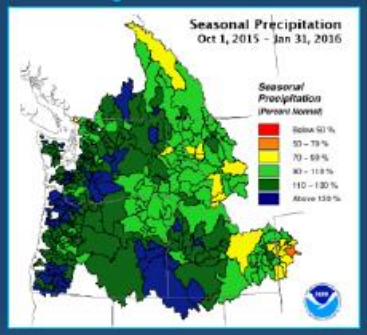
- Not in Common
  - Model Design (continuous conceptual vs statistical regression)
  - ESP issued daily; SWS monthly
  - ESP uses observed and future forcings (SWS uses obs only)
  - ESP is part of a larger modeling system; SWS is specific to task

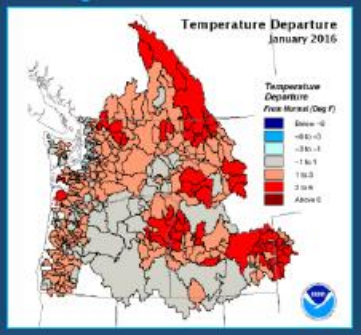
Additional Products and Services

Regional Conditions / Historical Observations
Rankings / Data / Contextual Information

Monthly/Seasonal Conditions

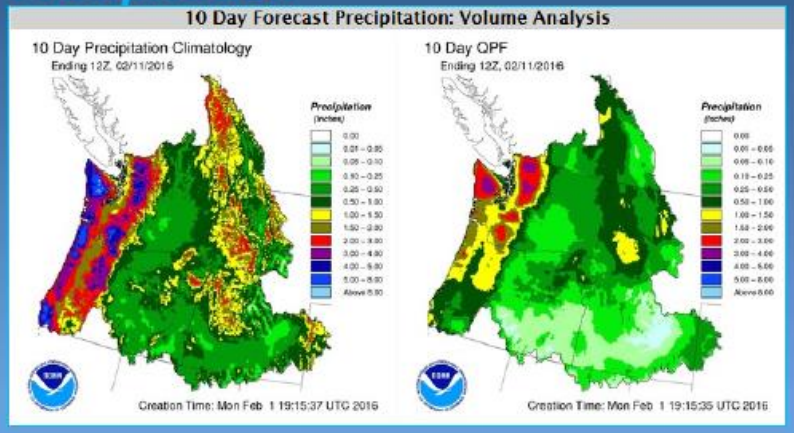
Precipitation & Temperature





10 Day Forecast

Precipitation



Live: Water Supply Webinars

Next Briefing: 2017

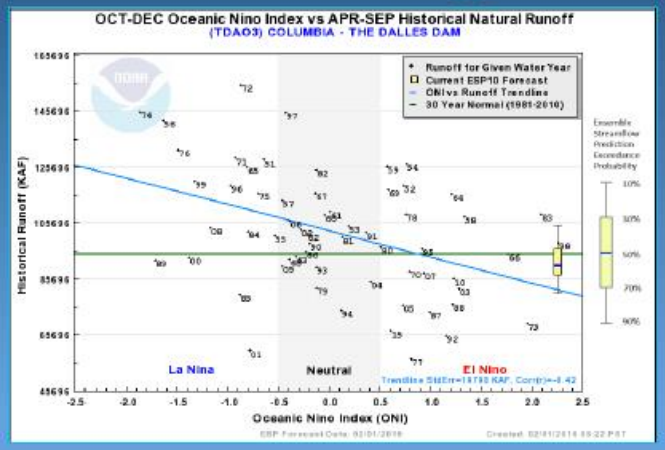
Data Downloads:

Forecasts, Forcings, Runoff

Northwest River Forecast Center
Data Download

Ensembles, Forcings, Runoff

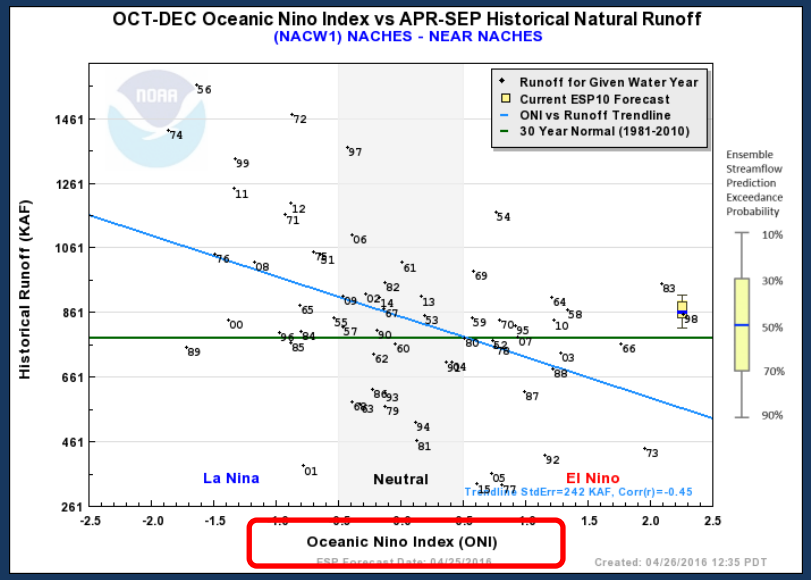
NEW: *ENSO vs Runoff Plots*



NWRFC Summer Web Enhancements

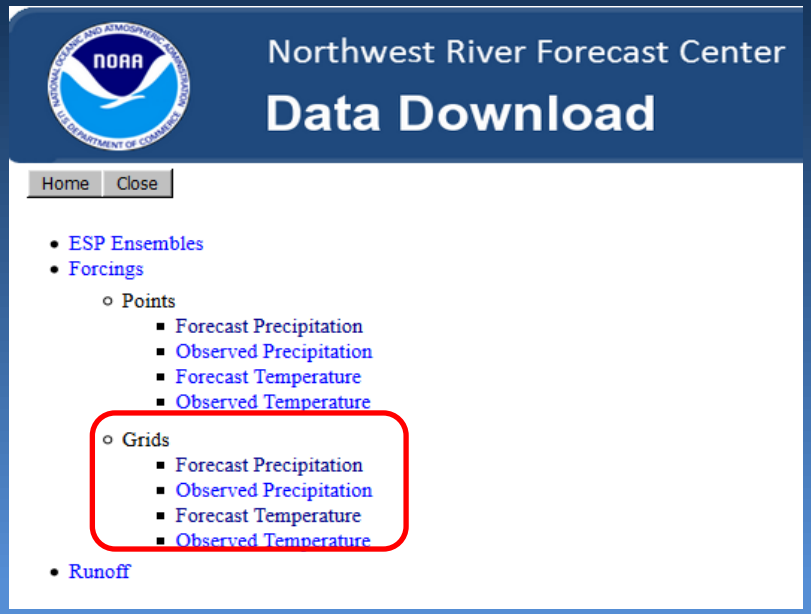
ENSO – Runoff Plots

- *Phase 1 (WY 2016):*
  - *OCT-DEC ONI vs Runoff*
- *Phase 2 (WY 2017):*
  - *User Selection for Climate Index and Period*

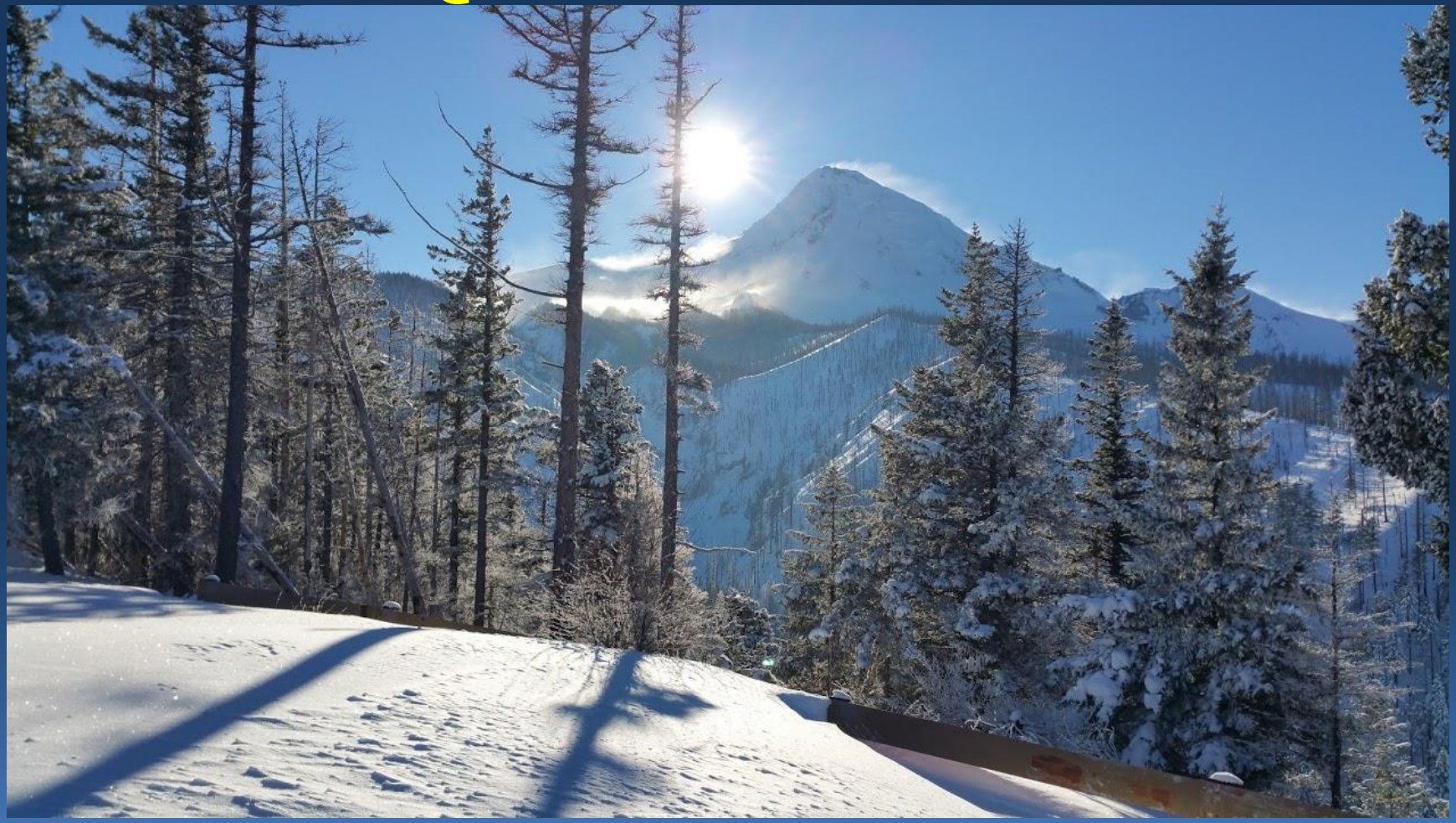


Data Download Service

- *Late WY 2015:*
  - *ESP Ensembles*
  - *Model Forcings*
  - *Runoff*
- *Q3 of WY 2016:*
  - *Gridded Forcings (netcdf format)*



Questions?



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