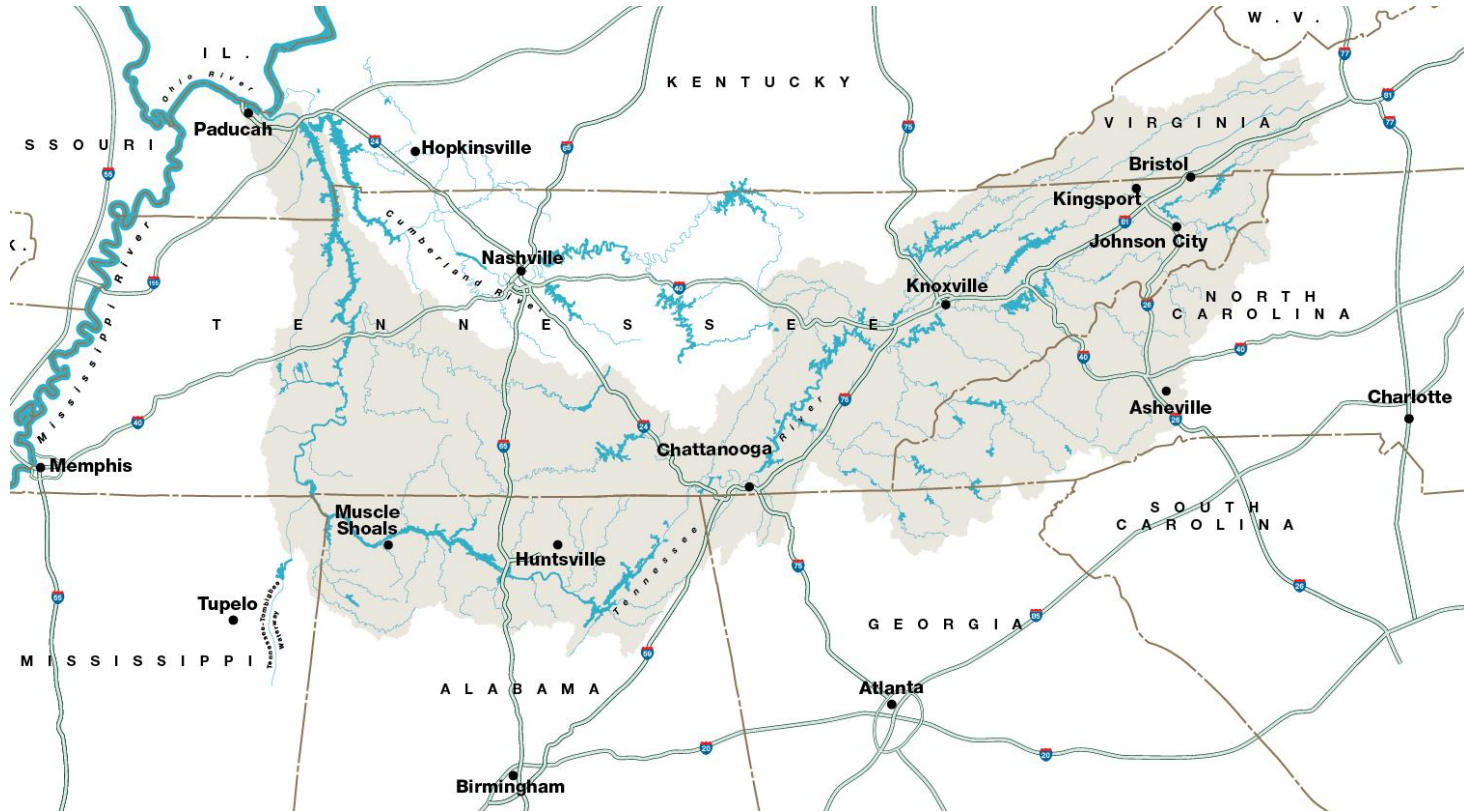

Replacing TVA's Weekly Scheduling Model with a RiverWare Long-term Model Using MRM

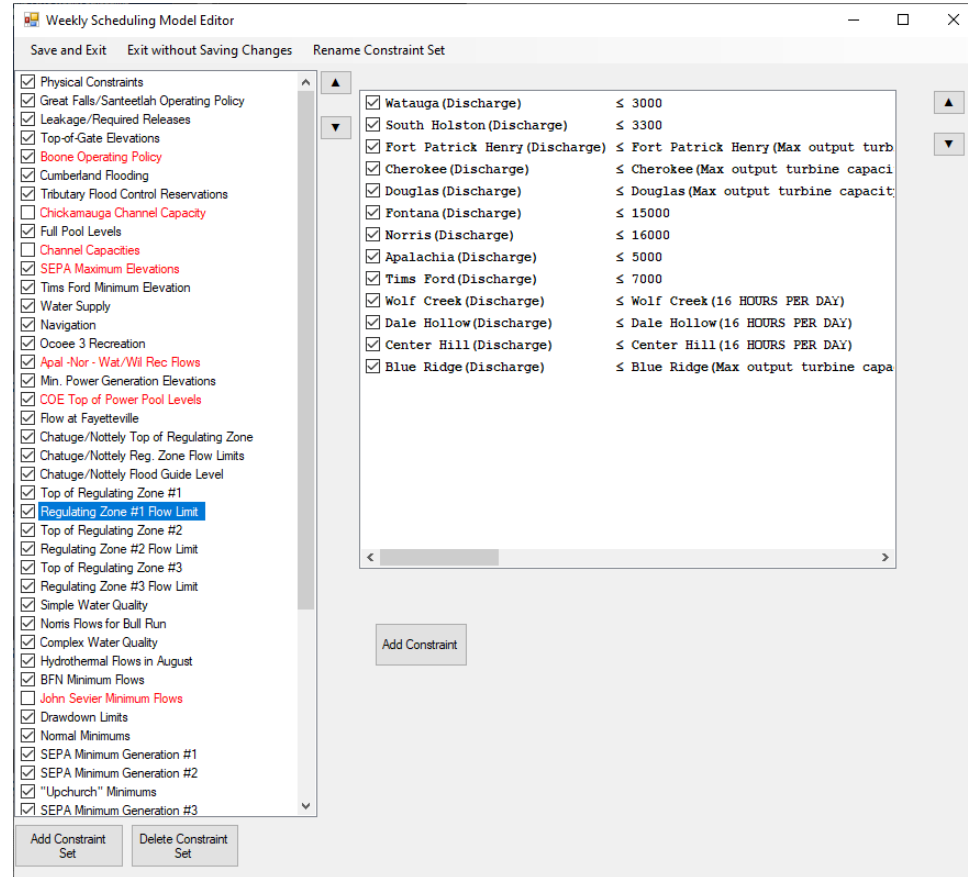
Gabriel Miller, P.E.

Tennessee Valley Watershed



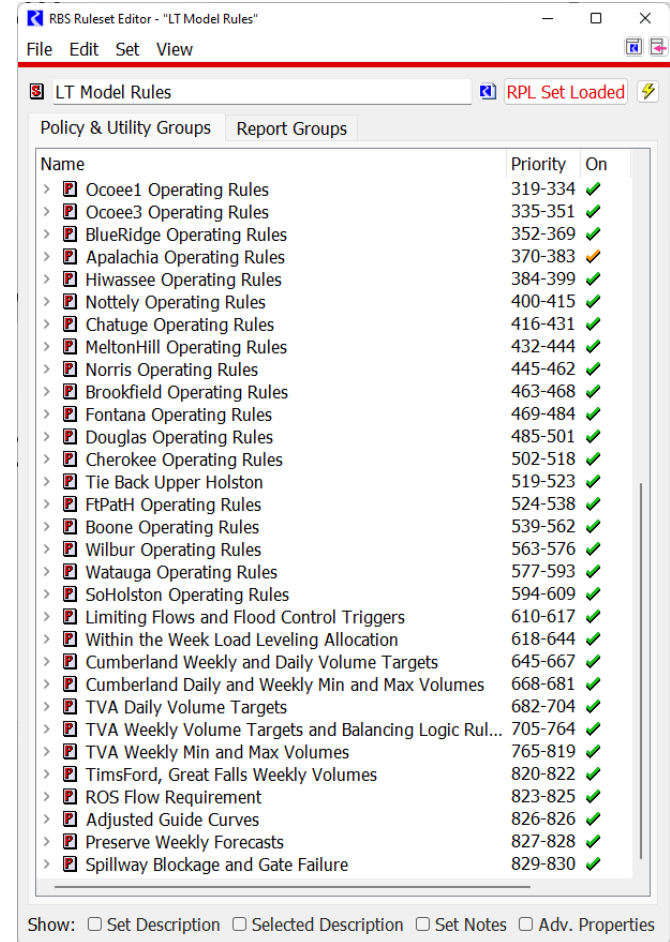
Background and Motivation

- Legacy VB/fortran long-term model built on a weekly timestep.
- Only one, mostly retired person, could maintain the old model.
- Riverware model would allow for more flexible, accurate runs



General Rule Structure

- 830 Rules!
- Weekly “pseudo-simulation” → weekly volumes
- Allocate to hourly releases to “level load”
- Aggregate to 6-hour target releases
- Apply target at each reservoir and check against high-priority requirements
- Post-process outputs specific to use case



RBS Ruleset Editor - "LT Model Rules"

File Edit Set View

LT Model Rules RPL Set Loaded

Policy & Utility Groups Report Groups

Name	Priority	On
> Ocoee1 Operating Rules	319-334	✓
> Ocoee3 Operating Rules	335-351	✓
> BlueRidge Operating Rules	352-369	✓
> Apalachia Operating Rules	370-383	✓
> Hiwassee Operating Rules	384-399	✓
> Nottely Operating Rules	400-415	✓
> Chatuge Operating Rules	416-431	✓
> MeltonHill Operating Rules	432-444	✓
> Norris Operating Rules	445-462	✓
> Brookfield Operating Rules	463-468	✓
> Fontana Operating Rules	469-484	✓
> Douglas Operating Rules	485-501	✓
> Cherokee Operating Rules	502-518	✓
> Tie Back Upper Holston	519-523	✓
> FtPatH Operating Rules	524-538	✓
> Boone Operating Rules	539-562	✓
> Wilbur Operating Rules	563-576	✓
> Watauga Operating Rules	577-593	✓
> SoHolston Operating Rules	594-609	✓
> Limiting Flows and Flood Control Triggers	610-617	✓
> Within the Week Load Leveling Allocation	618-644	✓
> Cumberland Weekly and Daily Volume Targets	645-667	✓
> Cumberland Daily and Weekly Min and Max Volumes	668-681	✓
> TVA Daily Volume Targets	682-704	✓
> TVA Weekly Volume Targets and Balancing Logic Rul...	705-764	✓
> TVA Weekly Min and Max Volumes	765-819	✓
> TimsFord, Great Falls Weekly Volumes	820-822	✓
> ROS Flow Requirement	823-825	✓
> Adjusted Guide Curves	826-826	✓
> Preserve Weekly Forecasts	827-828	✓
> Spillway Blockage and Gate Failure	829-830	✓

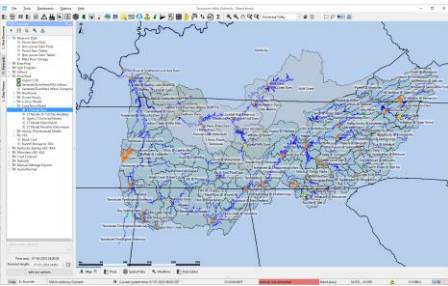
Show: Set Description Selected Description Set Notes Adv. Properties

Use Cases

- Inputs for power system models
 - Long-term: 20-30 years; 2x/year
 - Near-term: 1-2 years; every month
 - **Outputs:** monthly energy and capacity
- 120-day forecast
 - Run daily
 - **Outputs:** daily elevations, flows, energy, capacity
- Outage analysis
 - Compare alternative outage schedules
 - **Outputs:** energy value delta relative to baseline
- Plant modification analysis
 - Compare alternative plant power characteristics (upgrades)
 - **Outputs:** energy and value delta relative to baseline

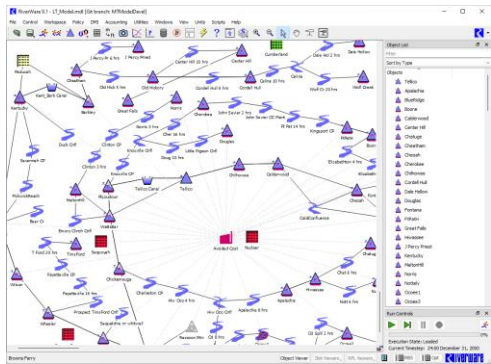
LT Model Workflow

Initialize model
from FEWS

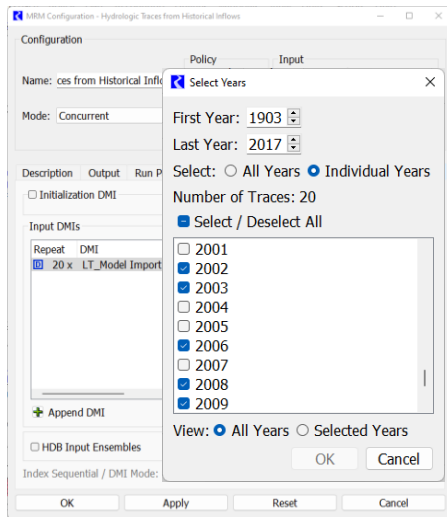


Sets
Run
Range

Inputs
common
to all runs

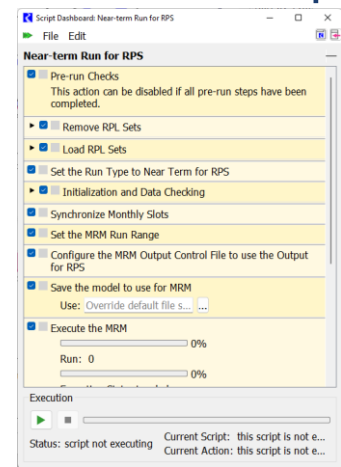


Configure MRM inputs

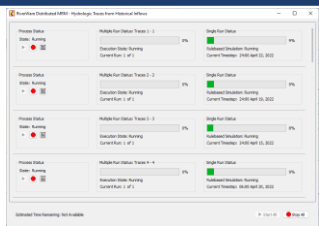


Select
historical
years as
traces

Execute script specific to use case



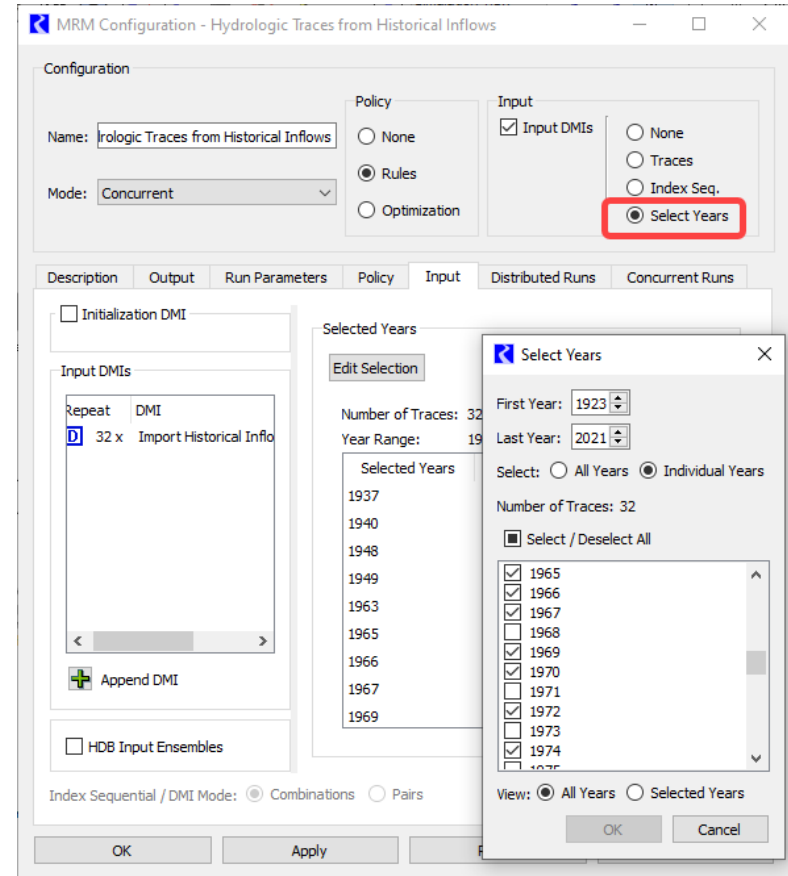
- Initialization
- Distributed MRM
- Post-process MRM results – ensemble data analysis, example: medians across traces



Series Slots	Day	Total Net Energy MWh	Total Net Max Capacity MW	Total Net Min Capacity MW	Total Net Peaking Capa MW
2/28/22	Mon				
3/31/22	Thu	1,939,093.18	2,922.50	1,914.70	2,997.31
4/30/22	Sat	1,093,830.23	2,329.51	521.26	2,486.72
5/31/22	Tue	723,365.53	1,869.82	313.09	2,024.80
6/30/22	Thu	890,759.79	2,321.62	275.77	2,465.80
7/31/22	Sun	897,953.50	2,550.19	238.36	2,780.19
8/31/22	Wed	1,240,131.72	3,020.52	596.03	3,118.04
9/30/22	Fri	1,096,377.15	2,710.13	400.95	2,965.53
10/31/22	Mon	991,238.55	2,559.41	289.52	2,721.50
11/30/22	Wed	1,214,187.57	2,563.01	408.46	2,711.23
12/31/22	Sat	1,794,328.73	3,098.80	887.38	3,172.66
1/31/23	Tue	2,111,509.25	3,426.38	1,278.36	3,473.94
2/28/23	Fri	1,696,968.64	3,205.78	1,134.79	3,274.65
3/31/23	Tue	1,799,861.99	2,961.90	1,145.11	3,057.48

Select Hydrologic Years for Traces

- Select hydrologic years similar to current conditions
 - New MRM Select Years Input Mode
 - Single input timeseries for each location
 - Maps to simulation years
 - Traces labeled with selected years



Ensemble Data Analysis Via Scripts



Import MRM trace results to
ensemble data set

Monthly Trace Data

Object Viewer

File Edit View Slot Group Object Tabs

Monthly Trace Data

Object: Monthly Trace Data

Save With Model Open Ensemble Data Tool

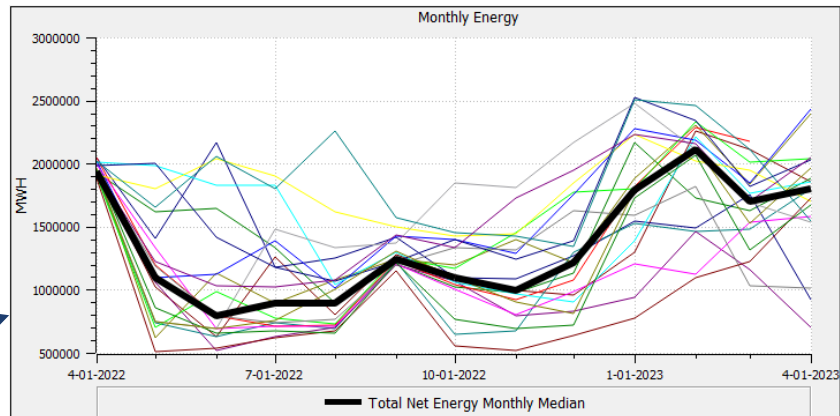
Slots Methods Accounts Accounting Methods Attributes Description

24:00 March 15, 2022

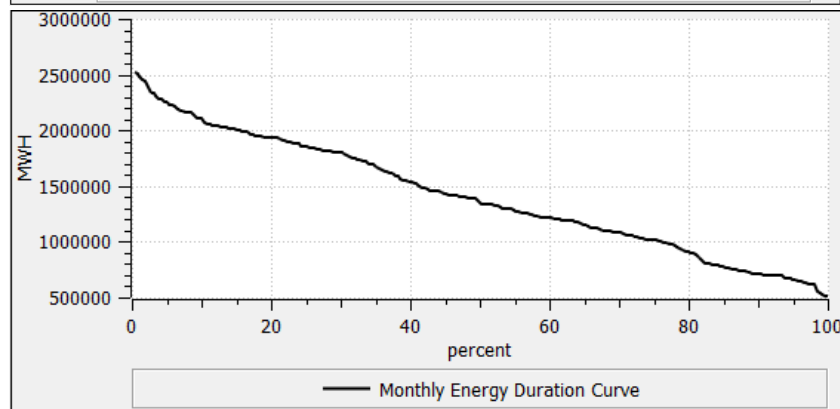
Slot Name	Value	Units
System Data Object Total Net Energy Monthly		
System Data Object Total Net Energy Monthly 1981		MWH
System Data Object Total Net Energy Monthly 1983		MWH
System Data Object Total Net Energy Monthly 1984		MWH
System Data Object Total Net Energy Monthly 1986		MWH
System Data Object Total Net Energy Monthly 1987		MWH
System Data Object Total Net Energy Monthly 1990		MWH
System Data Object Total Net Energy Monthly 1993		MWH
System Data Object Total Net Energy Monthly 1995		MWH
System Data Object Total Net Energy Monthly 1996		MWH
System Data Object Total Net Energy Monthly 1998		MWH
System Data Object Total Net Energy Monthly 2000		MWH
System Data Object Total Net Energy Monthly 2003		MWH
System Data Object Total Net Energy Monthly 2004		MWH
System Data Object Total Net Energy Monthly 2006		MWH
System Data Object Total Net Energy Monthly 2007		MWH
System Data Object Total Net Energy Monthly 2008		MWH
System Data Object Total Net Energy Monthly 2011		MWH
System Data Object Total Net Energy Monthly 2013		MWH
System Data Object Total Net Energy Monthly 2014		MWH
System Data Object Total Net Energy Monthly 2016		MWH
System Data Object TVA Energy Monthly		

Order: Default

Compute median
across traces
Example: Median
Monthly Energy

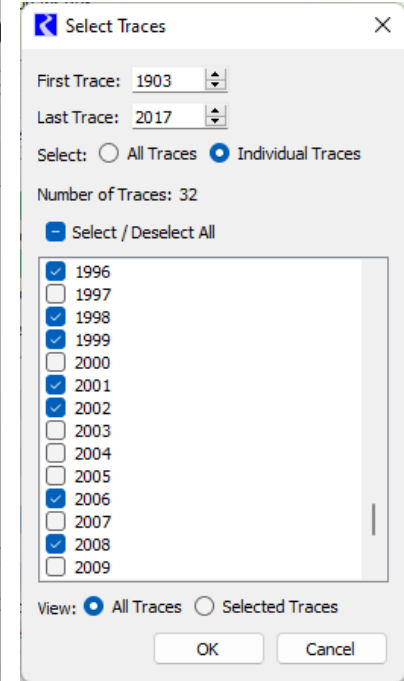
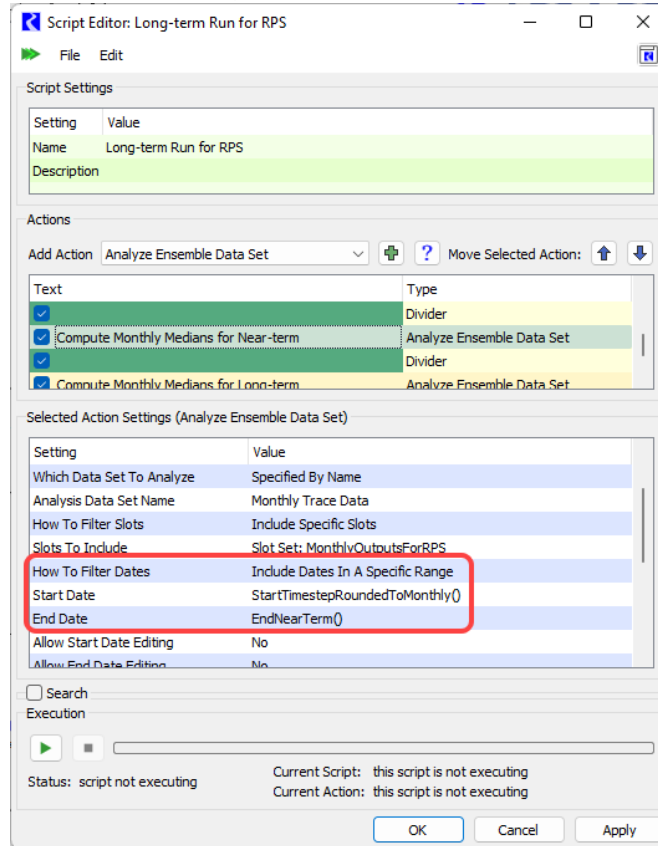


Compute duration
curve across traces
and timesteps



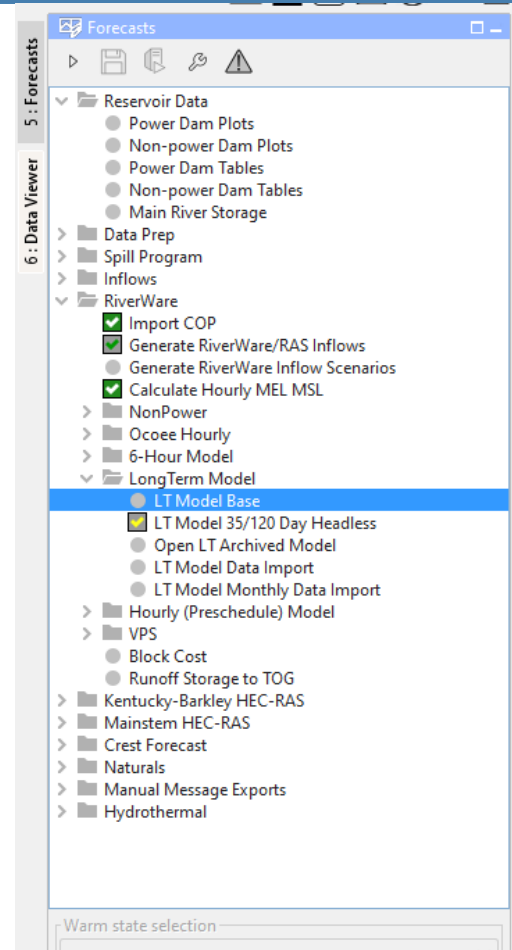
Filtering Ensemble Data Analysis: Timesteps and Traces

- Include only select traces in near-term analysis – similar years
- Include all traces in long-term analysis



Benefits of New LT Model

- Improved model results because 6-hour timestep and better policy representation
- Common platform that our modelers and forecasters understand
- More flexibility to run special studies and modifier policy
- Better integration with FEWS/existing software.
- Can be supported



TVA

**TENNESSEE
VALLEY
AUTHORITY**