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

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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 le Edit Set View	Rules"	_		ß
LT Model Rules		RPL Set L	oaded	1
Policy & Utility Groups	Report Groups			
Name		Priority	On	
> Ocoee1 Operating	Rules	319-334	 Image: A second s	
> Ocoee3 Operating	Rules	335-351	1	
> P BlueRidge Operation	ng Rules	352-369	1	
> 🕑 Apalachia Operatir	ng Rules	370-383	~	
> P Hiwassee Operatin	g Rules	384-399	1	
> Nottely Operating	Rules	400-415	1	
P Chatuge Operating) Rules	416-431	~	
> P MeltonHill Operation	ng Rules	432-444	1	
P Norris Operating F	tules	445-462	 Image: A second s	
P Brookfield Operati	ng Rules	463-468	1	
P Fontana Operating	Rules	469-484	 Image: A second s	
> P Douglas Operating	Rules	485-501	~	
P Cherokee Operating	g Rules	502-518	1	
> P Tie Back Upper Ho	lston	519-523	~	
FtPatH Operating I	Rules	524-538	1	
> P Boone Operating F	Rules	539-562	 Image: A second s	
> P Wilbur Operating I	Rules	563-576	 Image: A second s	
> P Watauga Operating	g Rules	577-593	1	
> P SoHolston Operati	ng Rules	594-609	1	
> P Limiting Flows and	Flood Control Triggers	610-617	1	
> P Within the Week L	oad Leveling Allocation	618-644	 Image: A second s	
> P Cumberland Week	ly and Daily Volume Targets	645-667	1	
P Cumberland Daily	and Weekly Min and Max Volumes	668-681	~	
> P TVA Daily Volume	Targets	682-704	 Image: A second s	
> P TVA Weekly Volur	ne Targets and Balancing Logic Rul.	705-764	 Image: A second s	
> P TVA Weekly Min a	nd Max Volumes	765-819	~	
P TimsFord, Great F	alls Weekly Volumes	820-822	 Image: A second s	
P ROS Flow Require	ment	823-825	~	
Adjusted Guide Cu	irves	826-826	 Image: A second s	
Preserve Weekly F	orecasts	827-828	1	
> P Spillway Blockage	and Gate Failure	829-830	1	

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



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

K MRM Configuration - Hydrologic T	races from Historical Inflo	ws — 🗆 X
Configuration		
Name: rologic Traces from Historical In Mode: Concurrent	Folicy flows None Rules Optimization	Input Input DMIs Traces Index Seq. Select Years
Description Output Run Parame	sters Policy Input	Distributed Runs Concurrent Runs
Input DMIs	Edit Selection	
Repeat DMI 32 x Import Historical Inflo Append DMI	Number of Traces: 3: Year Range: 19 Selected Years 1937 1940 1948 1949 1963 1965 1966 1967 1969	2 First Year: 1923 ◆ 9 Last Year: 2021 ◆ 9 Last Year: 2021 ◆ Select: ○ All Years ● Individual Years Number of Traces: 32 ■ Select / Deselect All ✓ 1965 ✓ 1966 ✓ 1967 1968 ✓ 1969 ✓ 1970 1971 1972 1972
HDB Input Ensembles		✓ 1974 ✓ 1974 ★ 1977
Index Sequential / DMI Mode: Com 	binations 🔘 Pairs	View: All Years Selected Years
OK A	pply	OK Cancel

Ensemble Data Analysis Via Scripts



Import MRM trace results to

Monthly Trace Data ensemble data set

🔾 Object Viewer			
File Edit View Slot Group Object Tabs			1
Monthly Trace Data 🔀			-
Object: Monthly Trace Data			
Save with Model Open Ensemble Data Tool			
Slots Methods Accounts Accounting Methods Attributes	Desc	ription	
24:00 March 15, 2022			
Slot Name Value	Units		
✓ G System Data Object Total Net Energy Monthly			
System Data Object Total Net Energy Monthly 1981	MWH	C C	
M System Data Object Total Net Energy Monthly 1983	MWH	C	
M System Data Object Total Net Energy Monthly 1984	MWH	C	
M System Data Object Total Net Energy Monthly 1986	MWH		
🗛 System Data Object Total Net Energy Monthly 1987	MWH	C	
K System Data Object Total Net Energy Monthly 1990	MWH	C	
M System Data Object Total Net Energy Monthly 1993	MWH	C) C	
System Data Object Total Net Energy Monthly 1995	MWH	C	
System Data Object Total Net Energy Monthly 1996	MWH	C	
System Data Object Total Net Energy Monthly 1998	MWH	C	
System Data Object Total Net Energy Monthly 2000	MWH	C	
M System Data Object Total Net Energy Monthly 2003	MWH	C	
M System Data Object Total Net Energy Monthly 2004	MWH	C	
M System Data Object Total Net Energy Monthly 2006	MWH	C	
🔣 System Data Object Total Net Energy Monthly 2007	MWH	C	
🔣 System Data Object Total Net Energy Monthly 2008	MWH	L) C	
K System Data Object Total Net Energy Monthly 2011	MWH	C. C	
K System Data Object Total Net Energy Monthly 2013	MWH	C C	
K System Data Object Total Net Energy Monthly 2014	MWH	C	
K System Data Object Total Net Energy Monthly 2016	MWH	C	
> G System Data Object TVA Energy Monthly			
Order: Default			



3000000

Monthly Energy

1-01-2023

80

60

4-01-2023

100

Filtering Ensemble Data Analysis: Timesteps and Traces

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

Script Editor: Long-term Ru	in for RPS — 🗆 🗙	
File Edit		p
ript Settings		K Select Traces
Setting Value		First Trans. 1002
Name Long-term Run for R	RPS	Filst frace: 1905
Description		Last Trace: 2017 ≑
ctions		Select: 🔿 All Traces 🧿 Individual Traces
dd Action Analyze Ensemble Da	ata Set 🗸 🗣 ? Move Selected Action: 👔 🌗	Number of Traces: 32
Text	Туре	Select / Deselect All
<u> </u>	Divider	1995
Compute Monthly Medians fo	or Near-term Analyze Ensemble Data Set	1997
~	Divider	1998
Compute Monthly Medians for	or Long-term Analyze Ensemble Data Set	1999
elected Action Settings (Analyze	Ensemble Data Set)	2000
Setting	Value	2001
Vhich Data Set To Analyze	Specified By Name	2002
nalysis Data Set Name	Monthly Trace Data	2003
low To Filter Slots	Include Specific Slots	2005
lots To Include	Slot Set: MonthlyOutputsForRPS	2006
low To Filter Dates	Include Dates In A Specific Range	2007
tart Date	StartTimestepRoundedToMonthly()	2008
nd Date	EndNearTerm()	2009
llow Start Date Editing	No	
Now End Date Edition	No	View: 🔾 All Traces 🔘 Selected Traces
) Search		
kecution		OK Cancel
tatus: script not executing	Current Script: this script is not executing Current Action: this script is not executing	
	OK Cancel Apply	VALLEY AUTHOR

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

 Reservoir Data Power Dam Plots Non-power Dam Plots Power Dam Tables Non-power Dam Tables Main River Storage Data Prep Spill Program Inflows RiverWare Import COP Generate RiverWare/RAS Inflows Generate RiverWare Inflow Scenarios Calculate Hourty MFL MSI 	
 Reservoir Data Power Dam Plots Non-power Dam Plots Power Dam Tables Non-power Dam Tables Main River Storage Data Prep Spill Program Inflows RiverWare Import COP Generate RiverWare/RAS Inflows Generate RiverWare Inflow Scenarios Calculate Hourdy MEL MSI 	 Reservoir Data Power Dam Plots Non-power Dam Plots Power Dam Tables Non-power Dam Tables Main River Storage Data Prep Spill Program Inflows RiverWare Import COP Generate RiverWare/RAS Inflows Generate RiverWare Inflow Scenarios Calculate Hourly MEL MSL NonPower Ocoee Hourly 6-Hour Model LT Model Base LT Model 35/120 Day Headless
	NonPower NonPower Ocoee Hourly G-Hour Model EngTerm Model ITModel Base LT Model 35/120 Day Headless



