



Photo credit: John Hannon, Reclamation

# WTMP Implementation: Forecasting and Long-Term Planning

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# Peer Review Panel Questions #9

- Are the models, in **forecast mode**, adequate for the intended real-time and seasonal planning purposes (i.e., forecast period ranges from 3- to 5-days to six months into the future), based on performance measures, uncertainty, and the fidelity with which the models represent physical processes?



# Feedback

- Evaluate Monte-Carlo methods using a distribution of flow and reservoir-storage scenarios to evaluate ensemble forecasts based on past and potential future modeling scenarios
- Use model to identify additional recourses that improve model forecasts
- Several items about data development
  - WTMP is forecast boundary condition agnostic
  - Meteorologic/climate uncertainty compounds the WTMP uncertainty







# WTMP as Building Blocks

- WTMP is a modeling system
- Component combination is defined by the question being answered
- Flexibility is inherent
- Maintain components once, use multiple times



Source: Microsoft



# WTMP Modeling Framework User Interface

Menus and  
Toolbar Buttons

Study Tree

Study Element  
Details

The screenshot displays the WTMP Modeling Framework User Interface. The main window shows a map of the Shasta2RedBluff area with a blue river network and various simulation points. A 'Model Calibration-Validation Action' dialog box is open, showing simulation details for the '2014' group. The dialog includes a table of simulations and a legend for their status.

Simulation	Selected	Map	Report
ResSim_T_Mix-2014	<input checked="" type="checkbox"/>	Display In Map	View
Keswick 12-16-2014	<input type="checkbox"/>	Display In Map	View
S14-KesW2-River-2014	<input type="checkbox"/>	Display In Map	View

Legend:   
■ Not Computed   
■ Out of Date   
■ Computed   
■ Compute Error

Buttons: Run Simulation, Create Report..., Save Results, Delete Results

Georeferenced  
Schematic

WTMP Actions  
Window





# Shared Interface (Part I)

- HEC-WAT plugin interface built for the WTMP
- Study types are defined as pathways through a common interface
- Select studies, initial conditions, boundary conditions
- Post process model results

Simulation	Selected	Map	Report
ResSim_T_Mix-2014	<input checked="" type="checkbox"/>	Display In M...	View
Keswick 12-16-2014	<input type="checkbox"/>	Display In M...	View
S14-KesW2-River-2014	<input type="checkbox"/>	Display In M...	View

Legend: ■ Not Computed ■ Out of Date ■ Computed ■ Compute Error

Buttons: Run Simulation, Create Report..., Save Results, Delete Results



# Shared Interface (II)

WTMP Actions Window

Validation Forecast

Simulation Group: sample Edit... New... Delete... Get/Update Models

Description:

Initial Conditions Operations Meteorology Boundary Condition Sets Temperature Target Sets

Shasta	
Select	Date
<input type="checkbox"/>	2016-01-20
<input type="checkbox"/>	2016-02-09
<input checked="" type="checkbox"/>	2016-03-08
<input type="checkbox"/>	2016-03-15
<input type="checkbox"/>	2016-04-07
<input type="checkbox"/>	2016-04-04

Keswick	
Select	Date
<input type="checkbox"/>	2010-01-21
<input checked="" type="checkbox"/>	2010-03-30
<input type="checkbox"/>	2010-04-14
<input type="checkbox"/>	2010-05-18

Get/Update Data Review Data

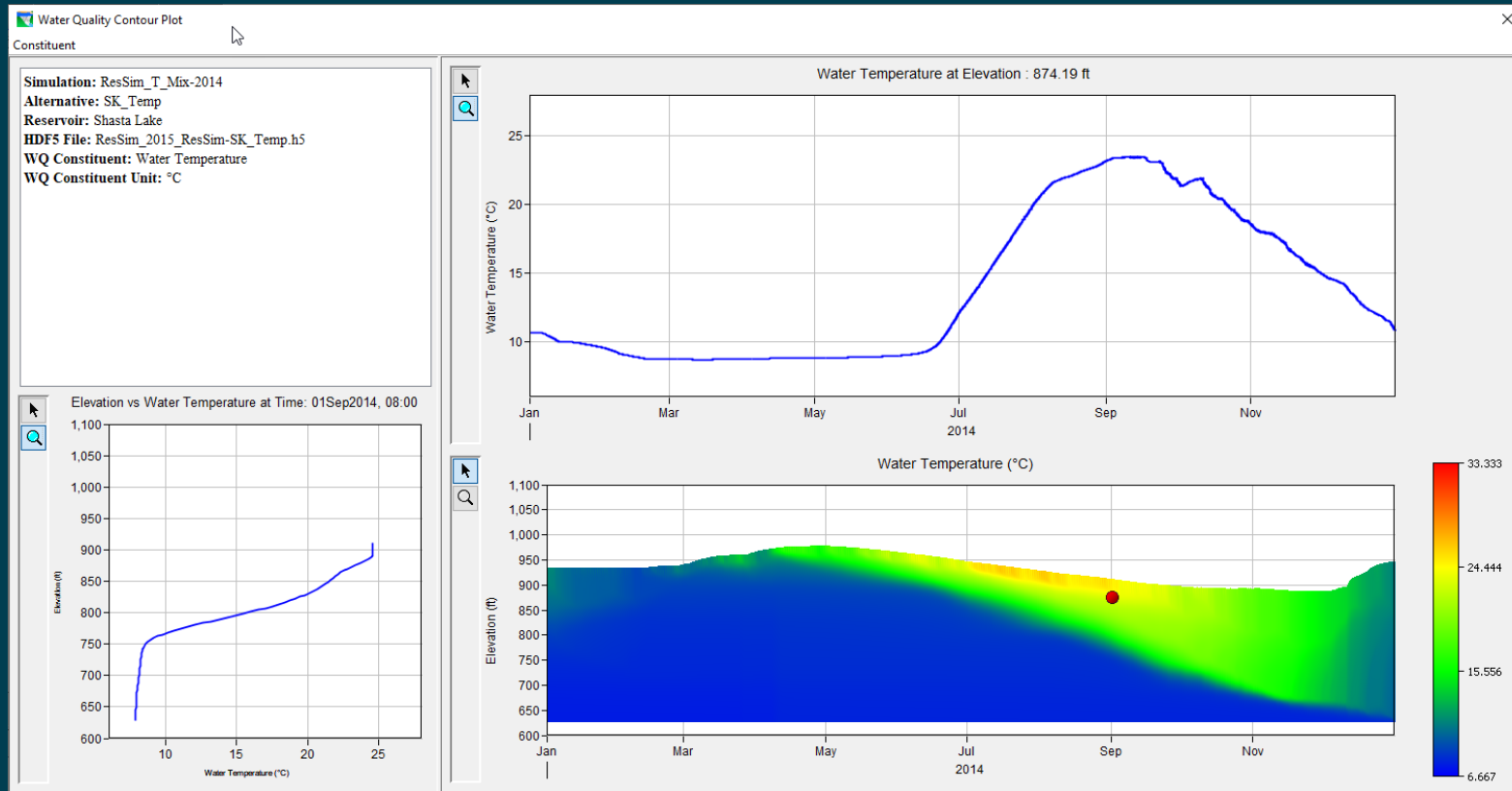
depth temp

depth temp

- Users are stepped iteratively through the model setup in dedicated validation/forecast windows
- Select combinations of the input conditions
- WTMP handles data operations
- Rapidly generate combinatoric runs



# Shared Interface (III)

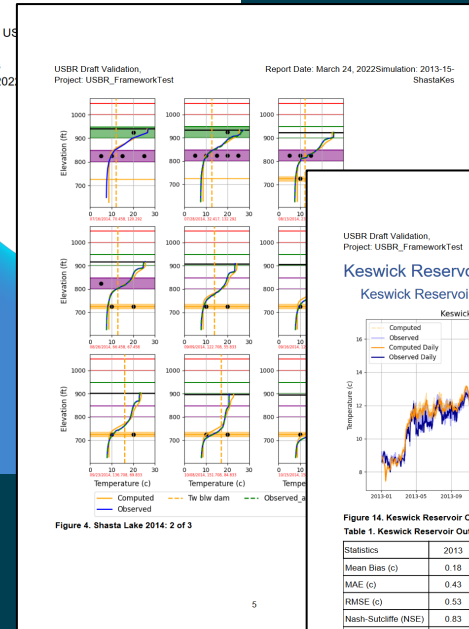
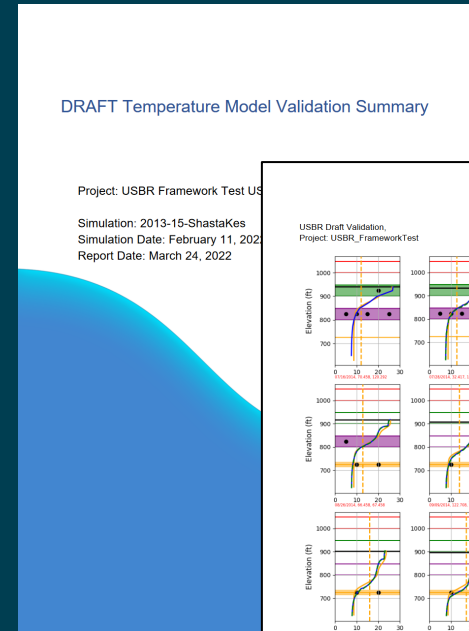


- Enables operator cross-training
- Rapidly explore simulation results
- Accelerates solution iteration
- Generate similar reports across study types



# WTMP Automated Reporting

- Overview of design concept
- Configuration of reports
- Plotting options
- Tabulation options
- Graphic options
- Metadata



# Creating Reports

comparison report (CSV)

*Model type, Model Alternative, Chapter Template*

```
ResSim, WQ_dsTrib3, Shasta_ResSim.XML  
ResSim, WQ_dsTrib3, Keswick_ResSim.XML  
ResSim, WQ_dsTrib3, UpperSac_ResSim.XML
```

Model Calibration-Validation Action

Create Simulation Group...  
Select Simulation Group...  
Edit Simulation Group...  
Delete Simulation Group  
Get/Update Models  
Get/Update Data  
Review Data  
Edit Compute Settings...  
Post Results

Simulation Group: 2014  
Description: W2 and ResSim examples  
Analysis Period: 2014  
Start Time: 1 January 2014, 00:00  
End Time: 31 December 2014, 24:00

Simulation	Selected
ResSim_T_Mix-2014	<input checked="" type="checkbox"/>
Keswick 12-16-2014	<input checked="" type="checkbox"/>
S14-KesW2-River-2014	<input type="checkbox"/>

Not Computed Out of Date Computed

Run Simulation Create Report... Save Results

About...

Create Report displays the report creation dialog for the selected Simulations

Select Reports to Create

ResSim\_T\_Mix-2014  
 Comparison Report  
 Simulation Report

Keswick 12-16-2014  
 Comparison Report  
 Simulation Report

File Type: PDF

Print Headers and Footers

Create Reports Close

Comparison Reports will contain results from multiple Simulations

File Types include PDF, HTML, and MS Word



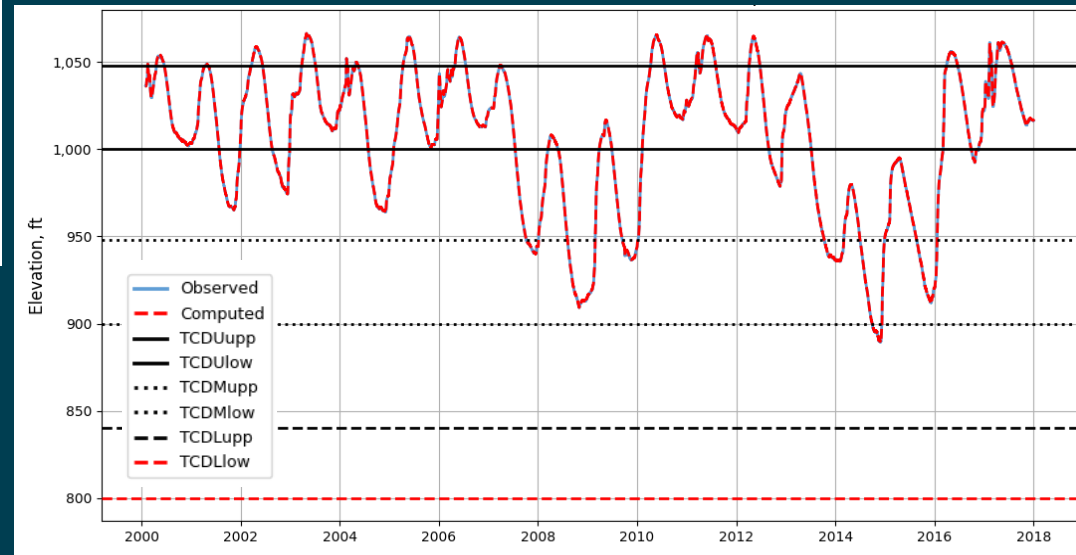
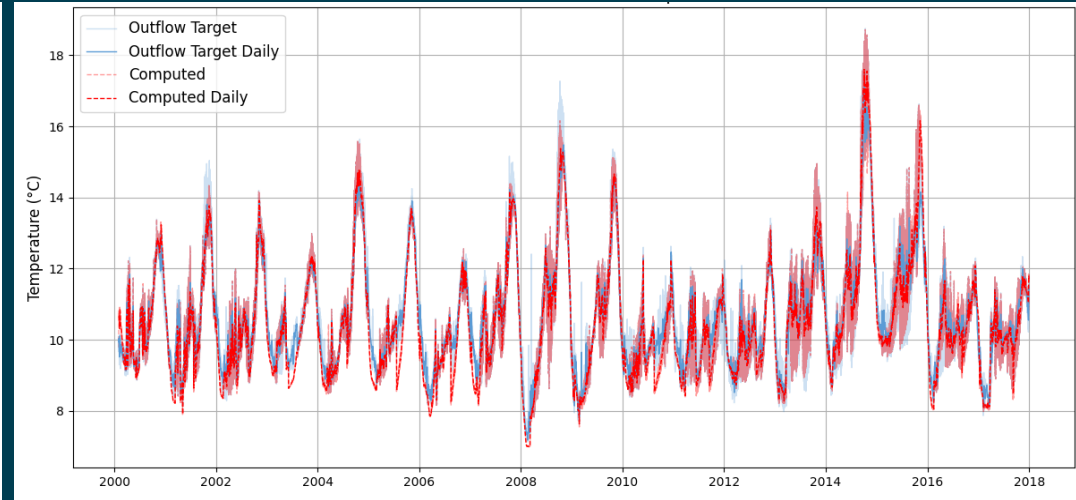
# Example Time Series Plot Objects

## Shasta Reservoir Outflow Temperature

Shasta, Simulation: Shasta-Keswick W2 14-val2014

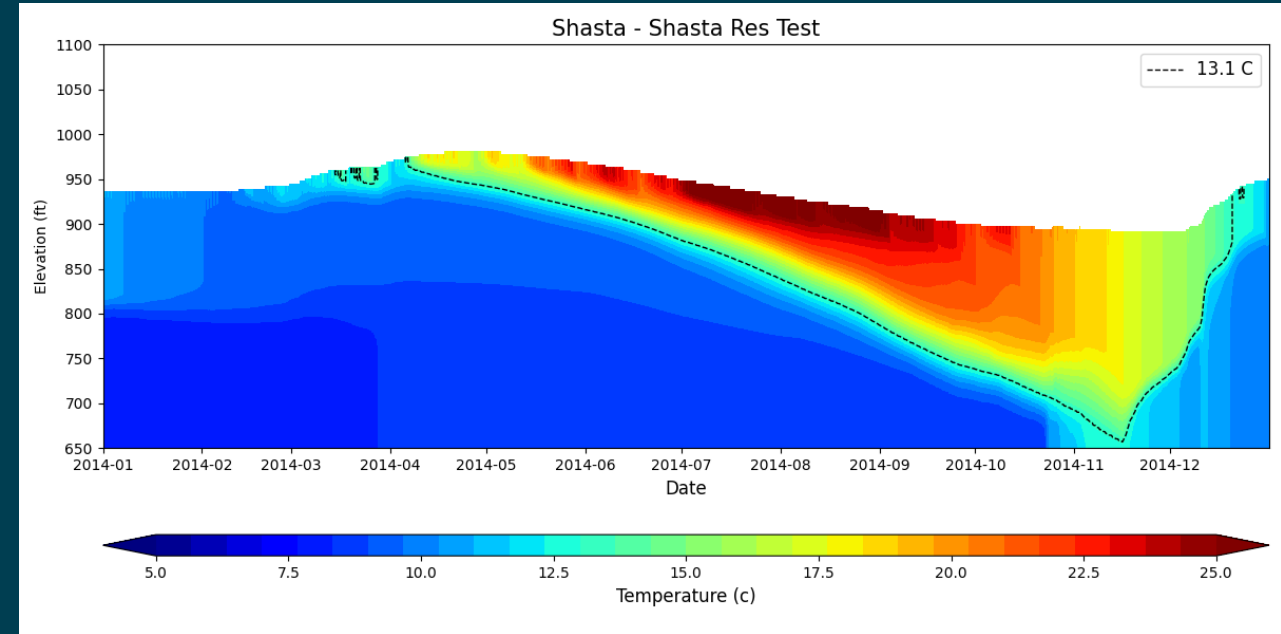
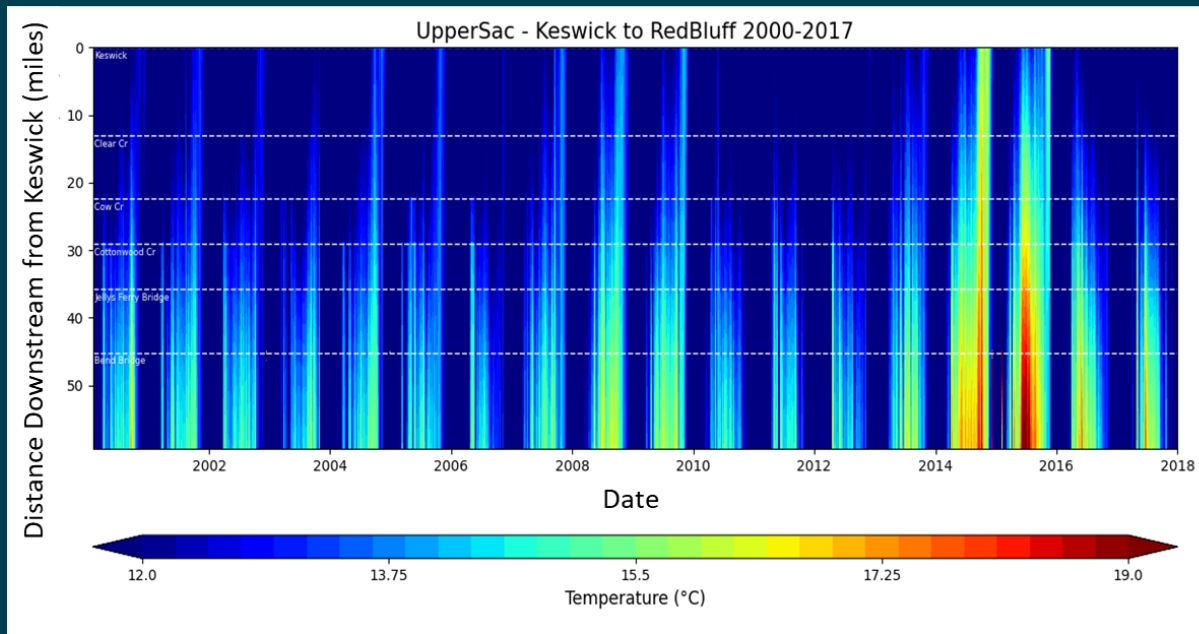


Figure 4. Shasta Outflow





# Example Contour Plot Objects



# Example Table Objects

- Shasta Outflow Error Statistics Table

Statistics	2014	All Years
Mean Bias (deg C)	0.23	0.23
MEA (deg C)	0.37	0.37
RMSE (deg C)	0.47	0.47
Nash-Sutcliffe (NSE)	0.95	0.95
COUNT	365	365

- Shasta Outflow Temperature NSE, invalid under .65 Statistics Table

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	0.97	0.27	0.13	0.57	0.86	-	-	0.98	0.98	0.97	0.89	0.80
2014	0.92	0.49	0.56	0.72	0.91	0.96	0.98	0.97	0.96	0.92	0.53	0.28
2015	-0.02	-0.30	0.48	0.83	0.95	0.96	0.98	0.97	0.96	0.86	0.33	0.54
All	0.86	0.22	0.50	0.79	0.93	0.96	0.98	0.97	0.97	0.91	0.67	0.66

- Shasta Outflow Mean Monthly Statistics Table

Month	Comp. Mean 2014	Obs. Mean 2014
Jan	9.71	9.77
Feb	9.00	9.03
Mar	9.92	9.91
Apr	10.46	9.99
May	11.98	11.13

- Shasta Lake with Tributaries in 2013 Profile Statistics Table

Statistics	08Jan2013	05Feb2013	12Mar2013	03Apr2013	08May2013	20May2013
Mean Bias (deg C)	0.56	0.59	0.76	0.80	0.89	0.82
MEA (deg C)	0.76	1.08	0.97	0.87	1.01	0.94
RMSE (deg C)	0.92	1.21	1.10	1.04	1.16	1.14
Nash-Sutcliffe (NSE)	0.22	-0.26	0.29	0.67	0.85	0.92



# Types of Studies



- **Calibration**
  - Updates parameterization of a model
- **Validation/Hindcast**
  - Confirm model accuracy
  - Conduct a retrospective model
- **Iterative**
  - Ensemble/position analysis for variable conditions
- **Seasonal**
  - Multiple hydrology/meteorologic conditions
- **Long-term Planning**
  - Long term changes to the CVP operations and hydrology

Source: US Navy

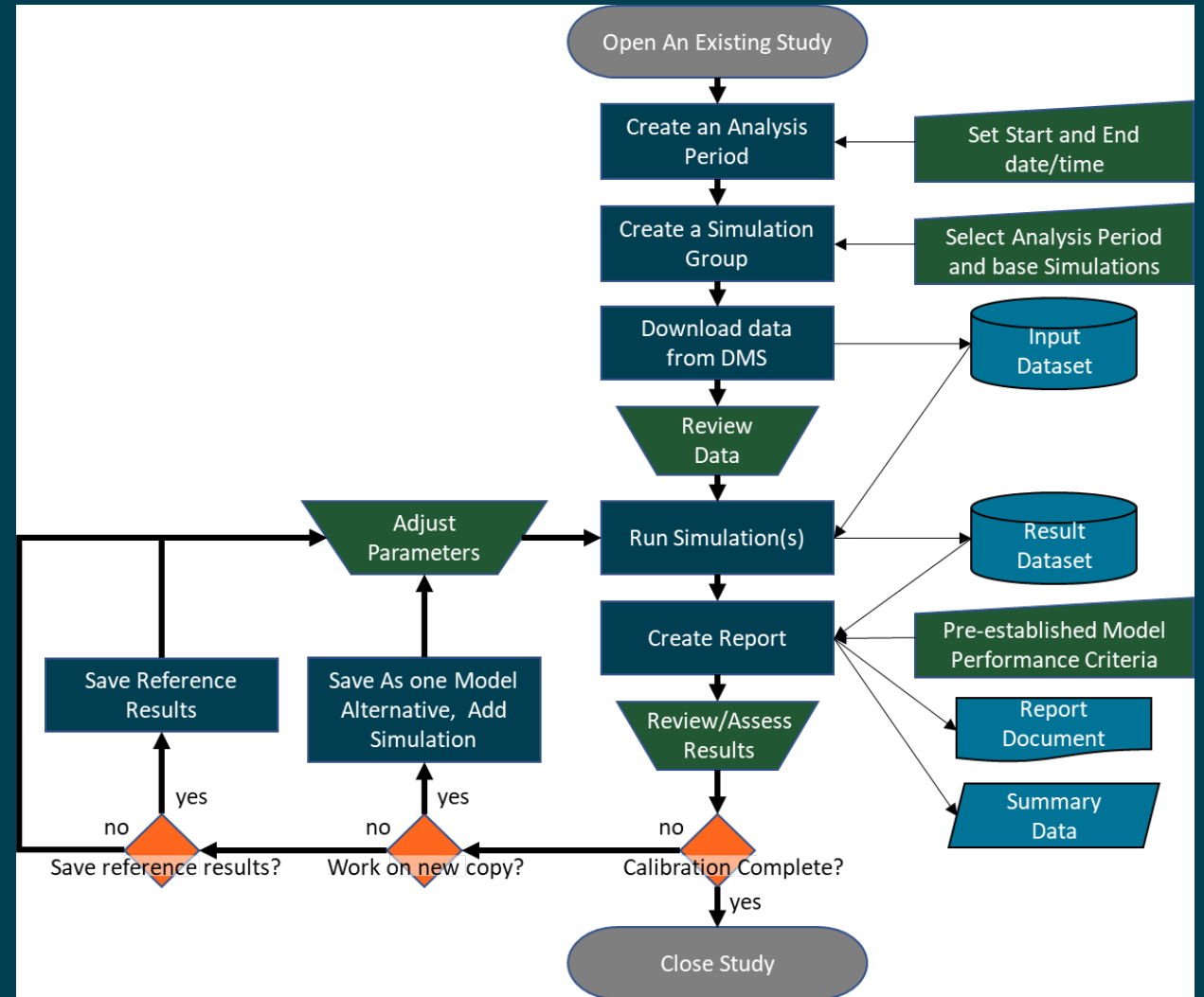




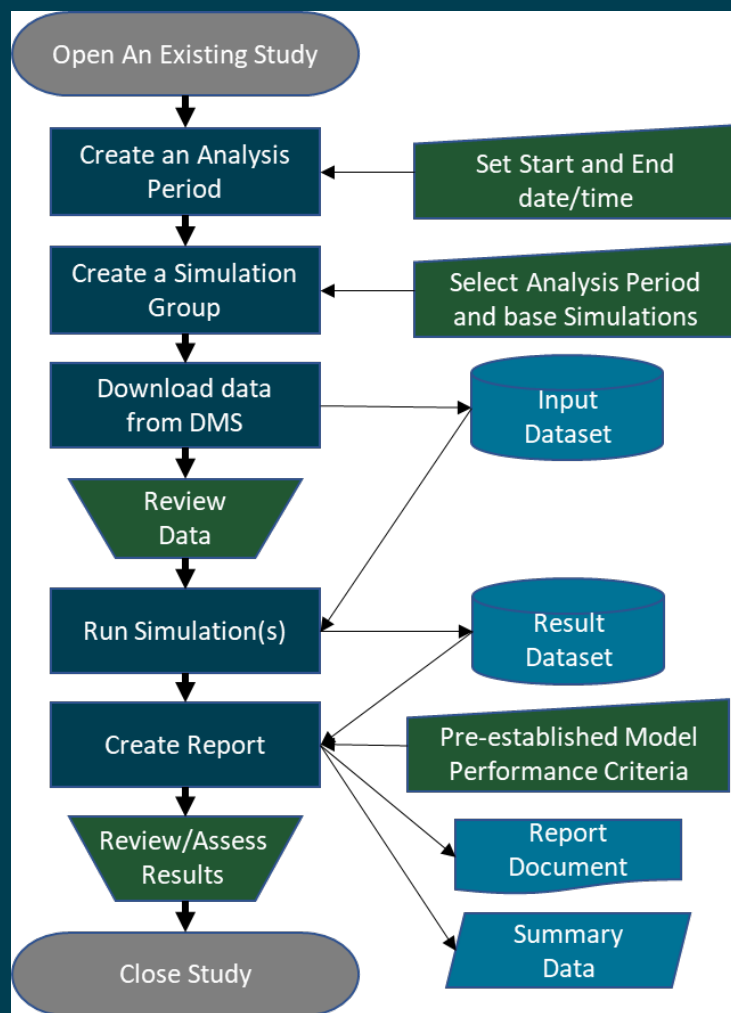


# Calibration

- Updates parameterization of a model
- Focuses on parameter adjustment, report creating, and review
- Builds multiple simulations until calibration is complete



# Hindcast



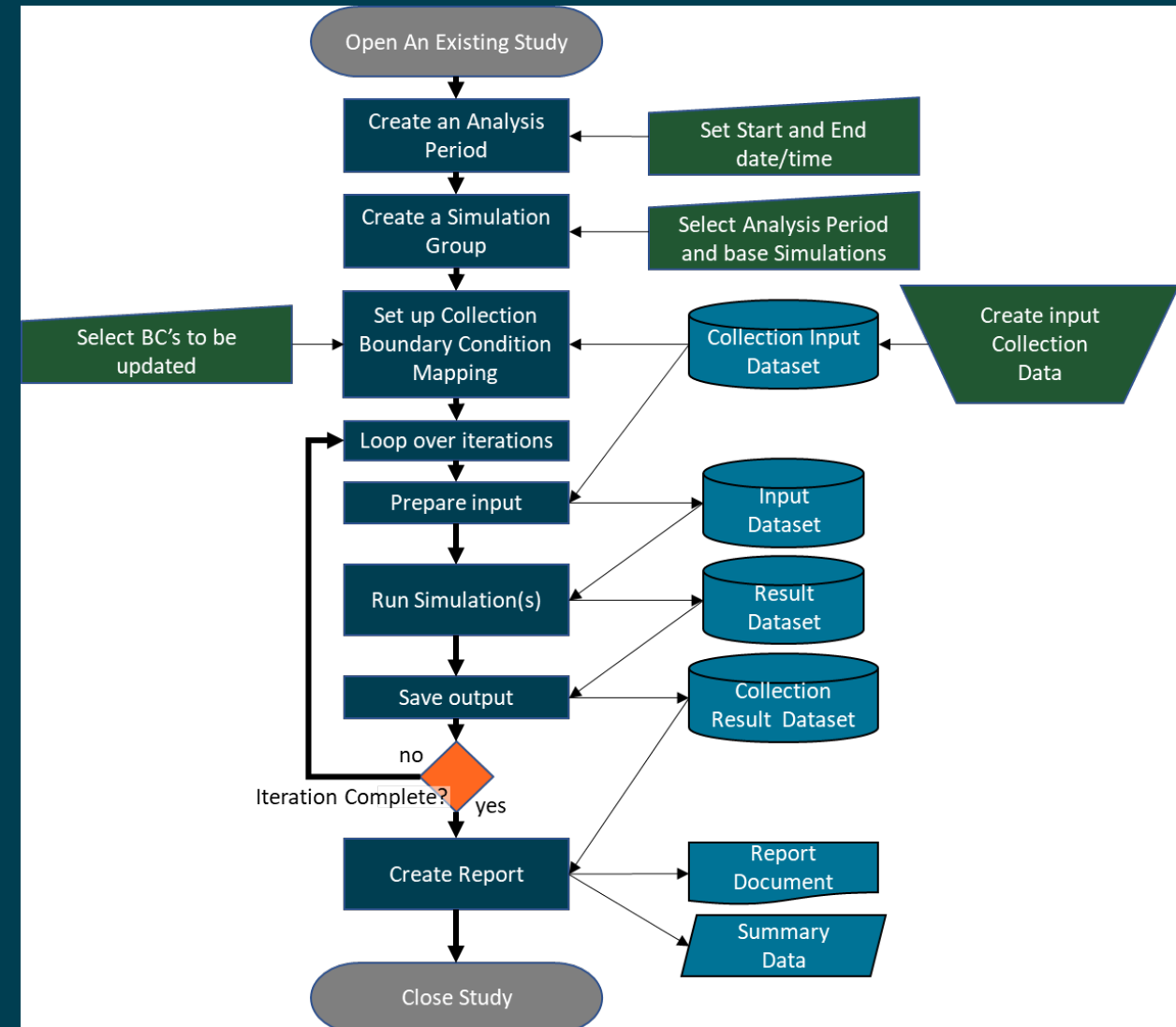
- Confirm model accuracy
- Conduct a retrospective model
- Generate inputs from observed input data
- Single simulation with the potential for a specialized report





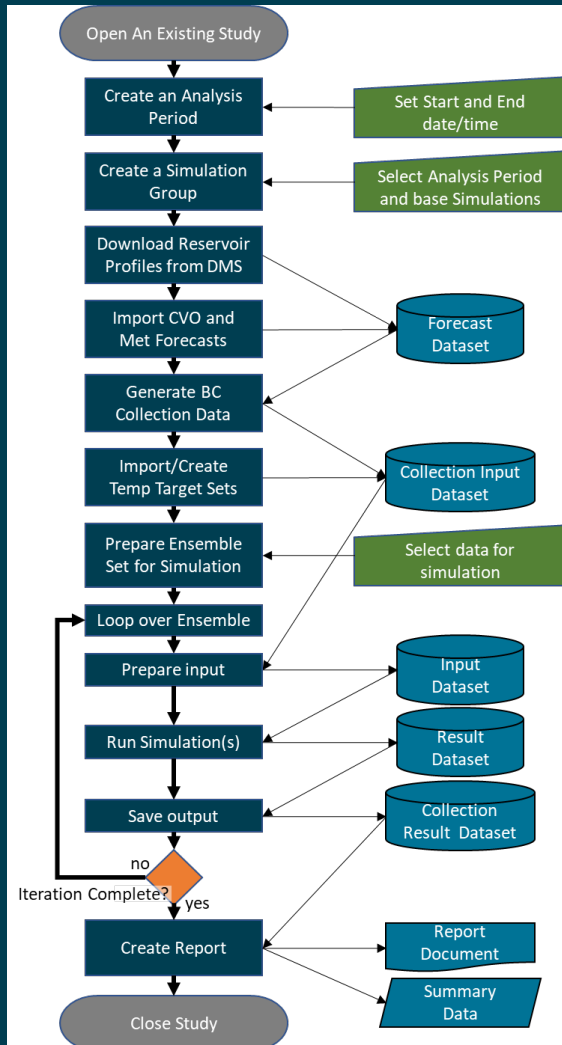
# Iterative

- Ensemble/position analysis for variable conditions
- Includes ensemble simulation, position analysis, and sensitivity analyses
- Varying conditions until some condition is met in the model
- Report across multiple simulations





# Seasonal Temperature Operations



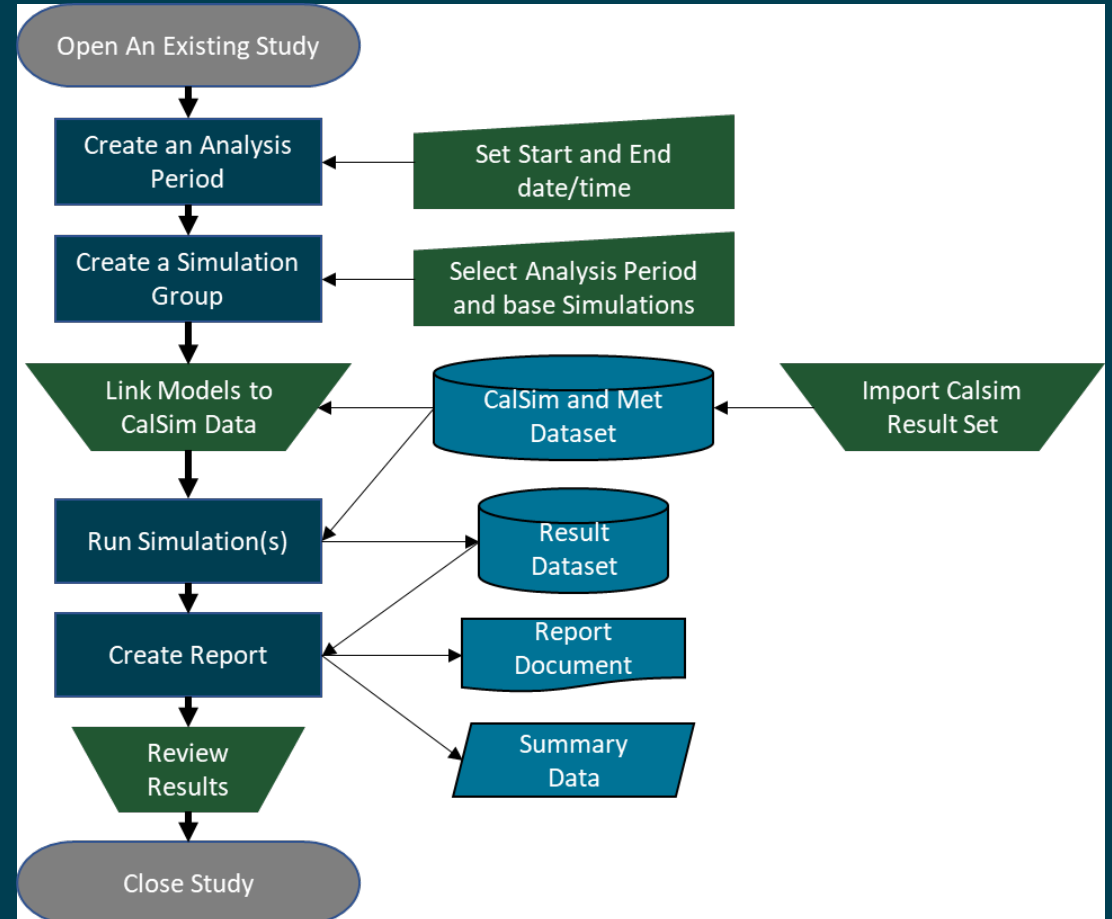
- Multiple hydrology/meteorologic conditions for estimating operations
- Similar to iterative but with differing inputs available on the seasonal scale
- TCD logic may be determined by automated targets
- Meteorologic inputs
  - Forecast spreadsheets
  - Local Three-Month Temperature Outlook
  - Position Analyses



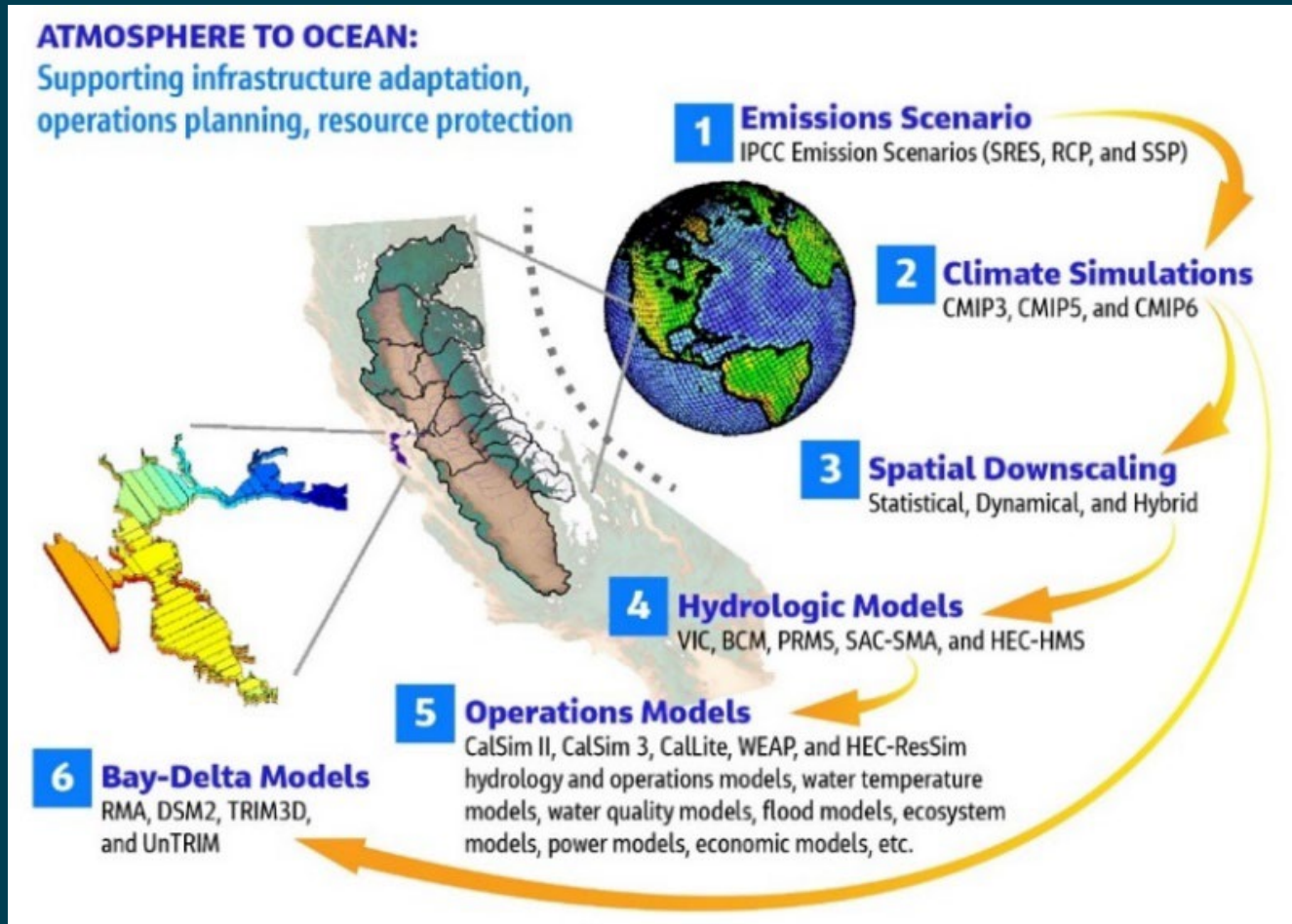


# Long-term Planning (Part I)

- Long-term changes to the CVP operations and hydrology
- Requires linkage to the CalSim operations model
  - Determines releases across the CVP
- Must share a consistent meteorology/hydrology with CalSim and CalSim Hydro



# Long-term Planning (II)



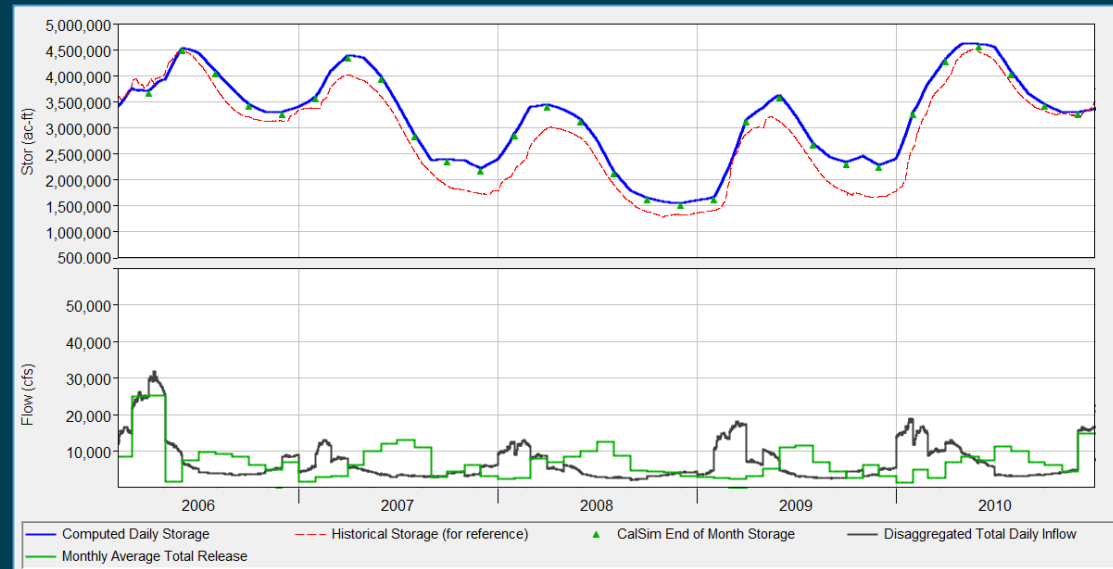
- Climate change adaptation
- WTMP is part of a broader CalSim workflow
- Executes as part of a model sequence
- Needs to link to and provide output within the modeling workflow
- Replaces HEC5Q integration





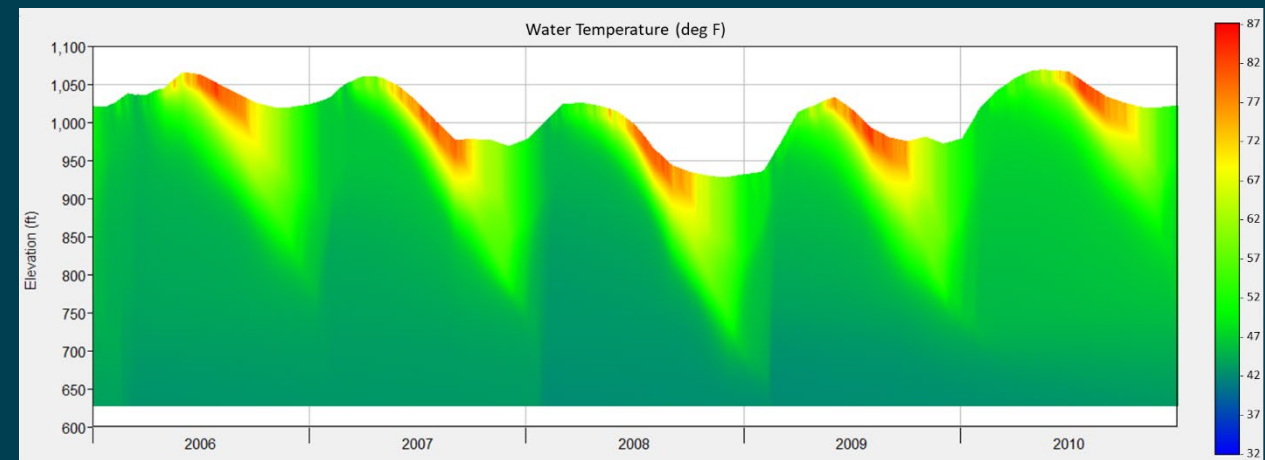
# Long-term Planning Application

- Demonstration of WTMP integration into the workflow
- Calsim 3 flows are mapped to WTMP initial/boundary conditions
- Meteorologic condition development



ResSim  
Shasta Storage

ResSim  
Shasta  
Temperatures



# Implementation Summary

- **Accomplishments:**
  - Calibration, hindcast, and iterative workflows
  - Forecast/seasonal temperature management plan
  - Demonstrated long-term planning capability
- **Assessment:**
  - Addresses WTMP project modeling needs
  - Flexible platform for future enhancements







Photo credit: John Hannon, Reclamation

# Morning Break

