

RECLAMATION

Managing Water in the West

Temperature Workshop - 4/1/08

**Temperature Modeling Tools
Used on the Upper Sacramento
River**



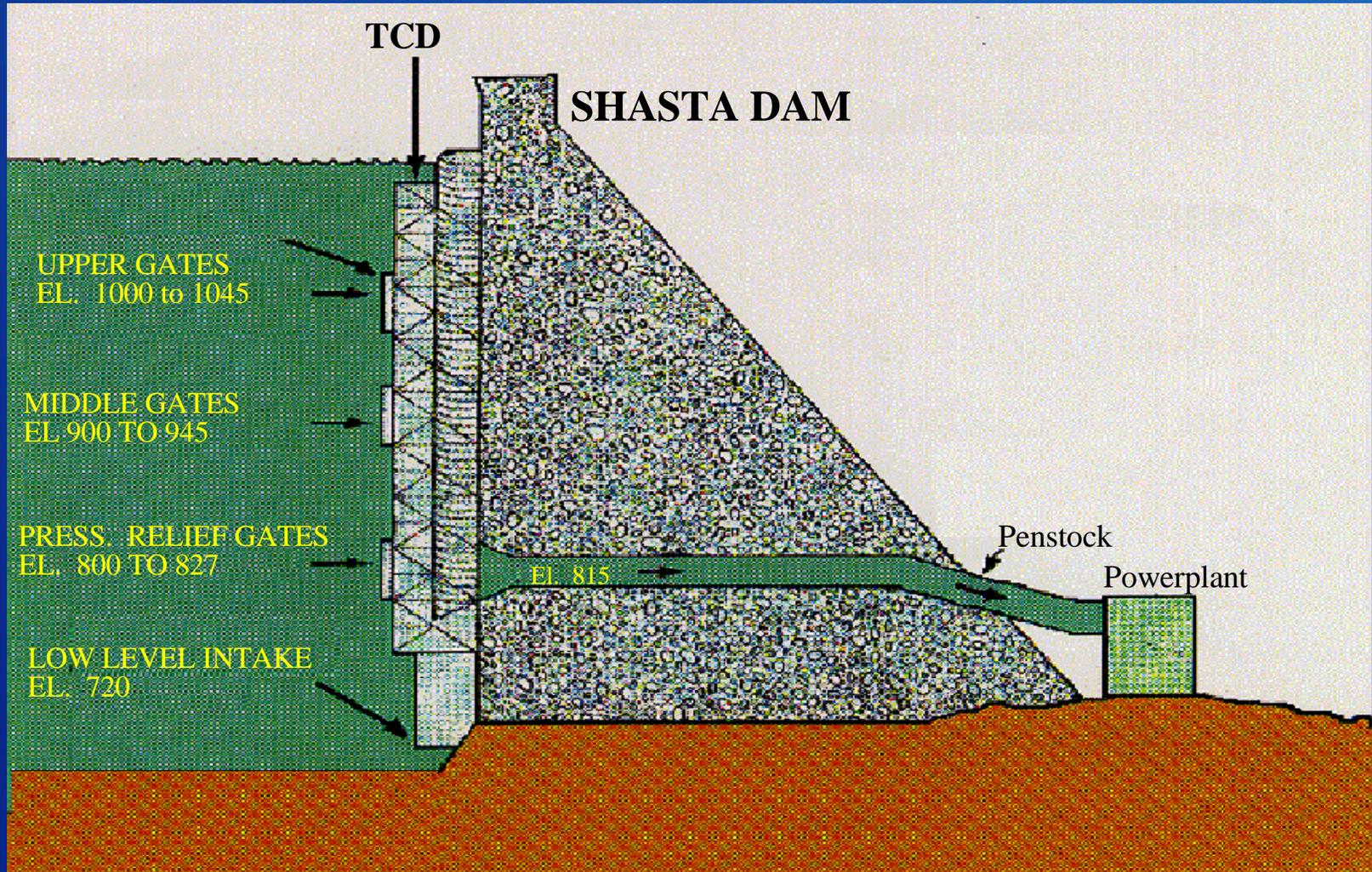
U.S. Department of the Interior
Bureau of Reclamation

Temperature Modeling Tools

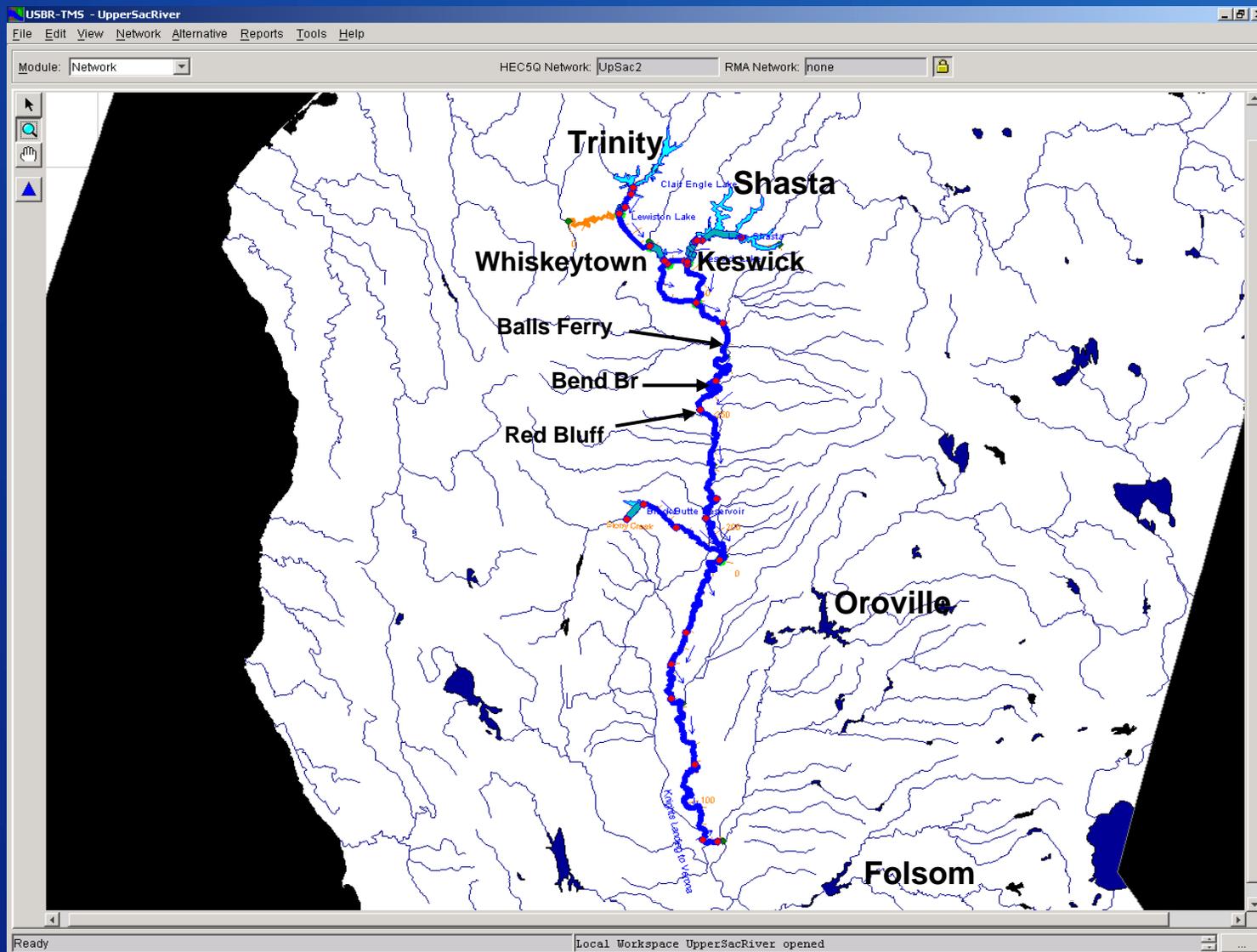
- Upper Sacramento River -

- Long-term planning study applications
 - Use of CALSIM II water resource model and associated temperature models of the CVP/SWP for analyzing study alternatives
 - Alternative operations of the existing CVP/SWP
 - New storage projects (enlarged Shasta Dam, Sites Reservoir, etc.)
- Real-time operations
 - Overall day-to-day project operations (*temperature*) and operation of the Shasta temperature control device (TCD)

Shasta Dam TCD



Upper Sacramento River



Long-term Planning Studies

- Suite of Reclamation temperature models intended as a tool for evaluating the effects of proposed project operations on mean monthly temperature in the basin
- Extends from Shasta and Trinity Lakes to Freeport
- Uses CALSIM II water resources model output (Oct 1921–Sep 2003 study period)
- Consists of Reservoir & River Components
 - One-dimensional model
 - Monthly time-step
- Shasta TCD operation - Uses a set of seasonal Shasta Dam tail-bay temperature targets to simulate temperature operations
- Useful tool for comparative analysis of proposed alternatives

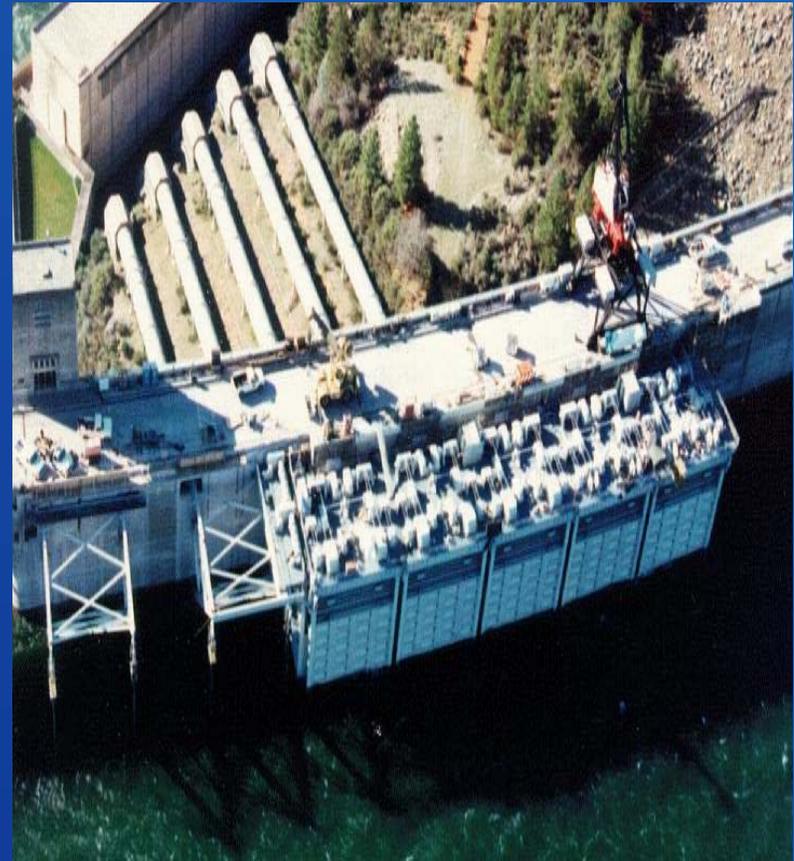


Model Limitations

- **General operation rules and constraints applied in CALSIM II**
- **Monthly time-step**
 - **Unable to define daily variation due to flow dynamics and meteorological conditions**
 - **Unable to accurately simulate operation strategies to meet temperature objectives**
- **Model operates to a rigid set of seasonal Shasta Dam tail-bay temperature targets**

Model Limitations (cont'd)

- Shasta TCD operation
 - Simplistic representation of the existing TCD
 - TCD operation limited to once per month



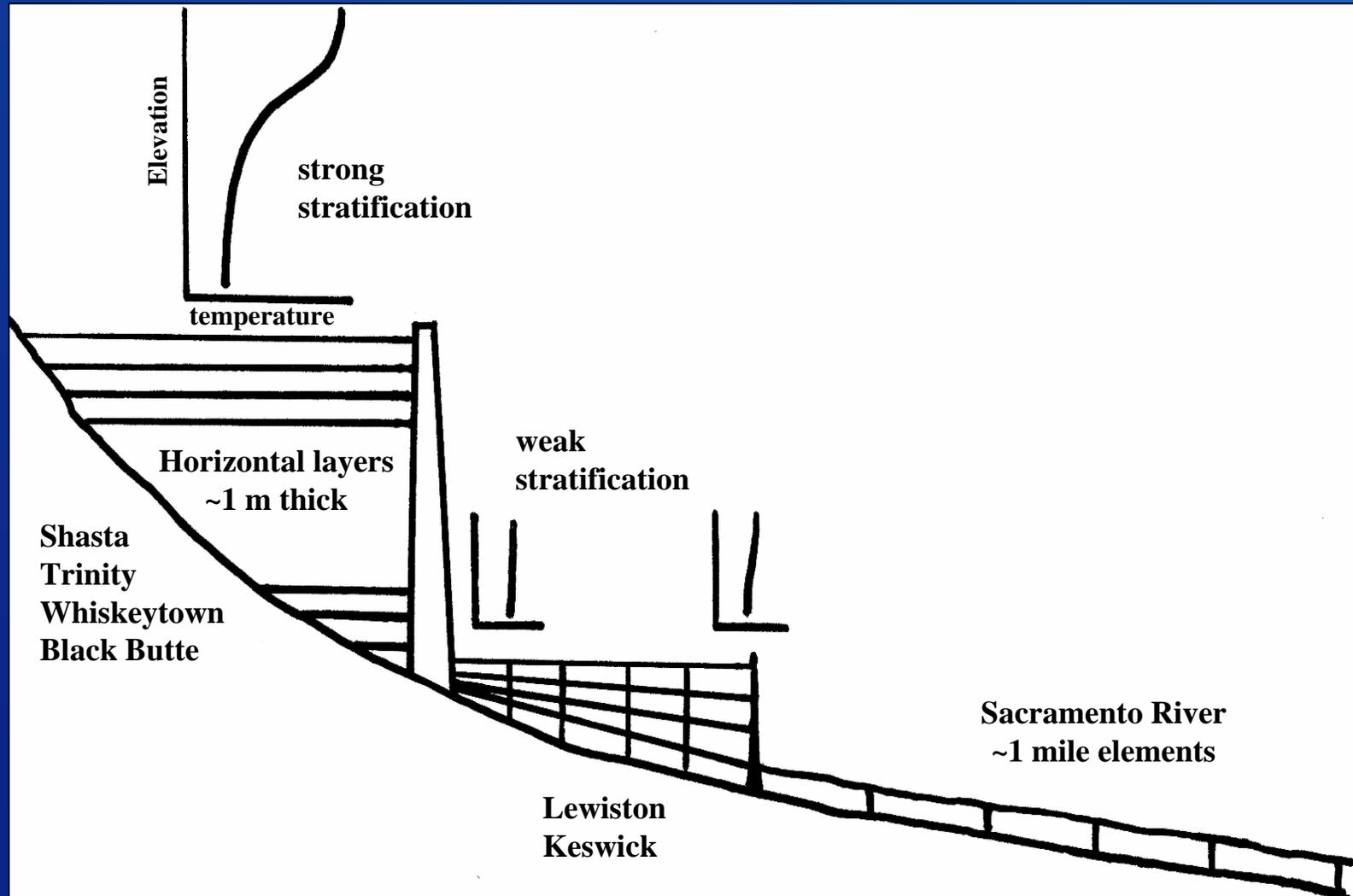
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Sacramento River Water Quality Model (SRWQM)

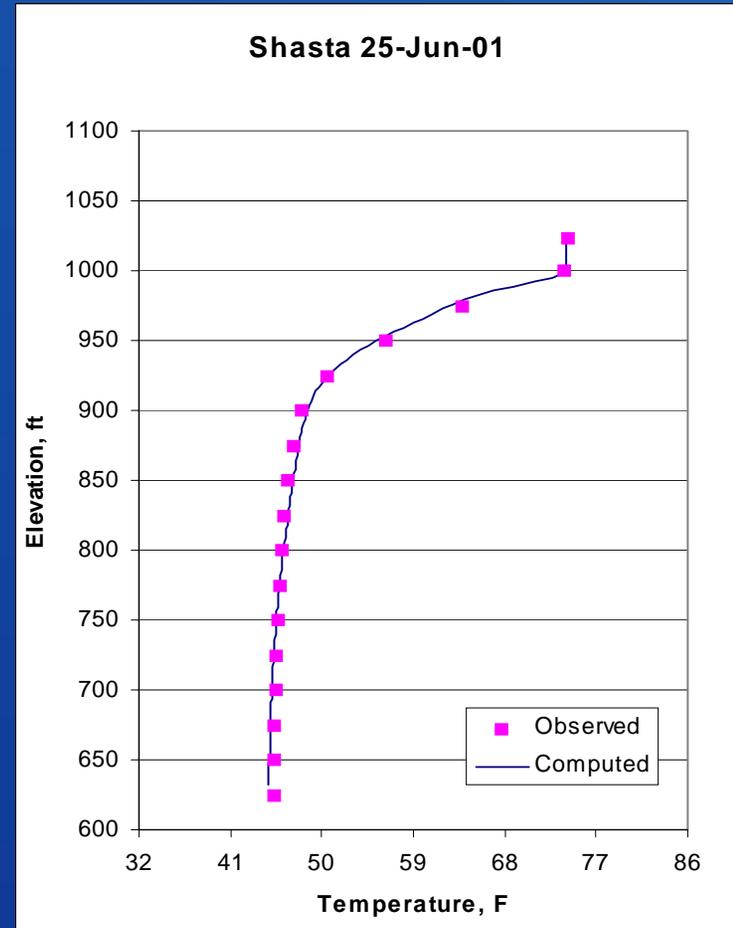
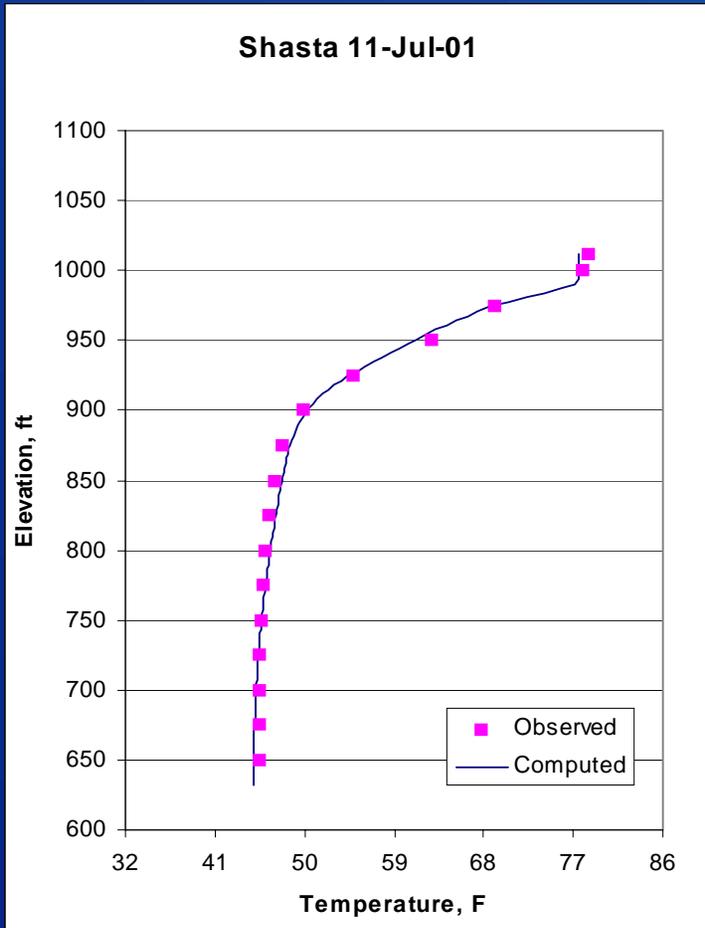
- Beginning in 2005, SRWQM was implemented (HEC-5Q water quality model) for use in long-term planning studies
- Extends from Shasta and Trinity Lakes to Knights Landing
- 6-hour computation interval
- Daily flow model
- Uses monthly CALSIM II flows (82-year study period) that are “disaggregated” into mean daily flows based on historical patterns
- Shasta TCD operation - Uses 4 sets of seasonal Shasta Dam tail-bay temperature targets to simulate temperature operation, based on maximum spring storage in Shasta
- More realistic representation of the physical system
- More accurate representation of the Shasta TCD
 - TCD withdrawal algorithm is embedded in the model
- Calibrated for 1998-2002 period



HEC-5Q Model Representation of Reservoirs and Stream Reaches

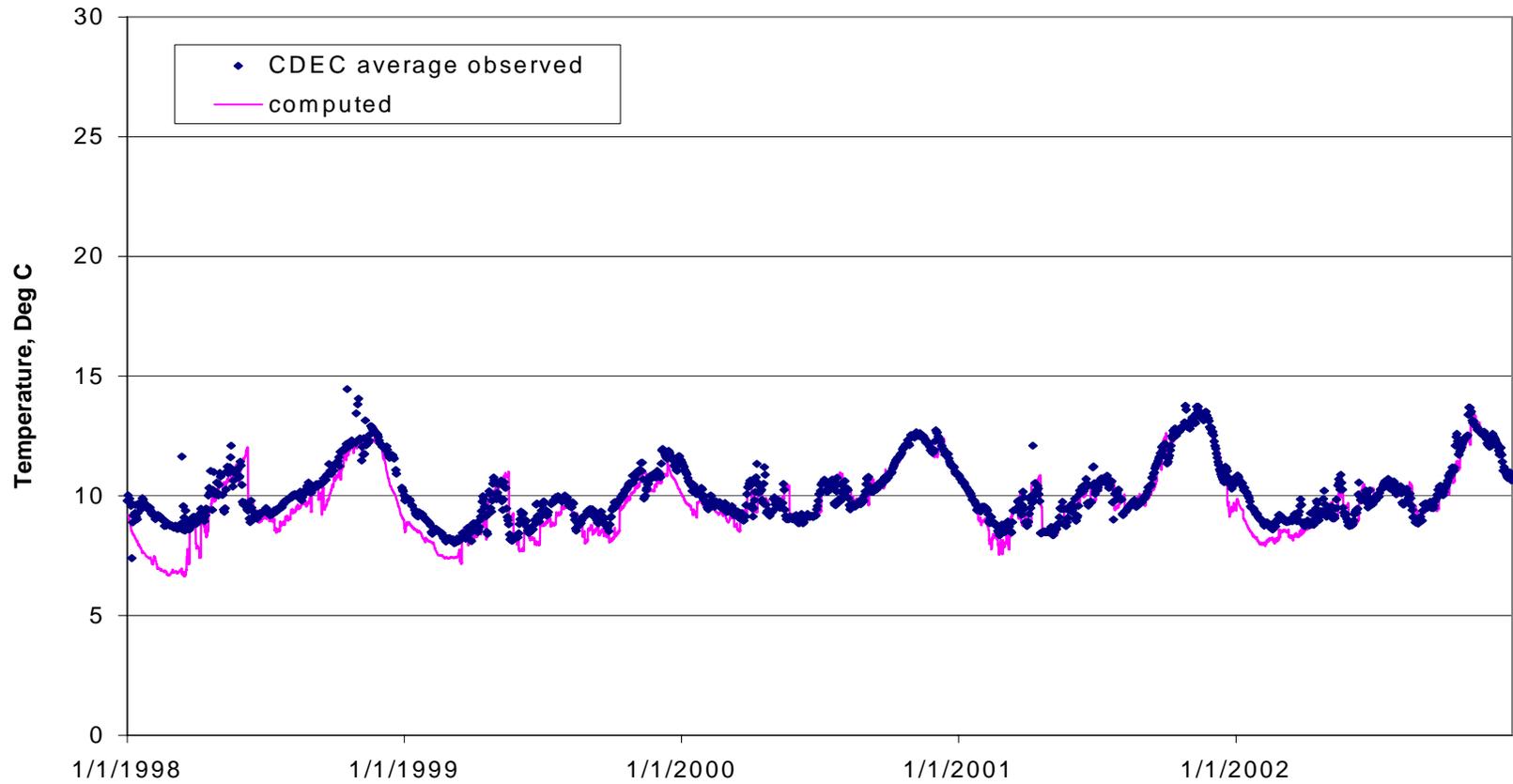


Lake Shasta Sample Profiles



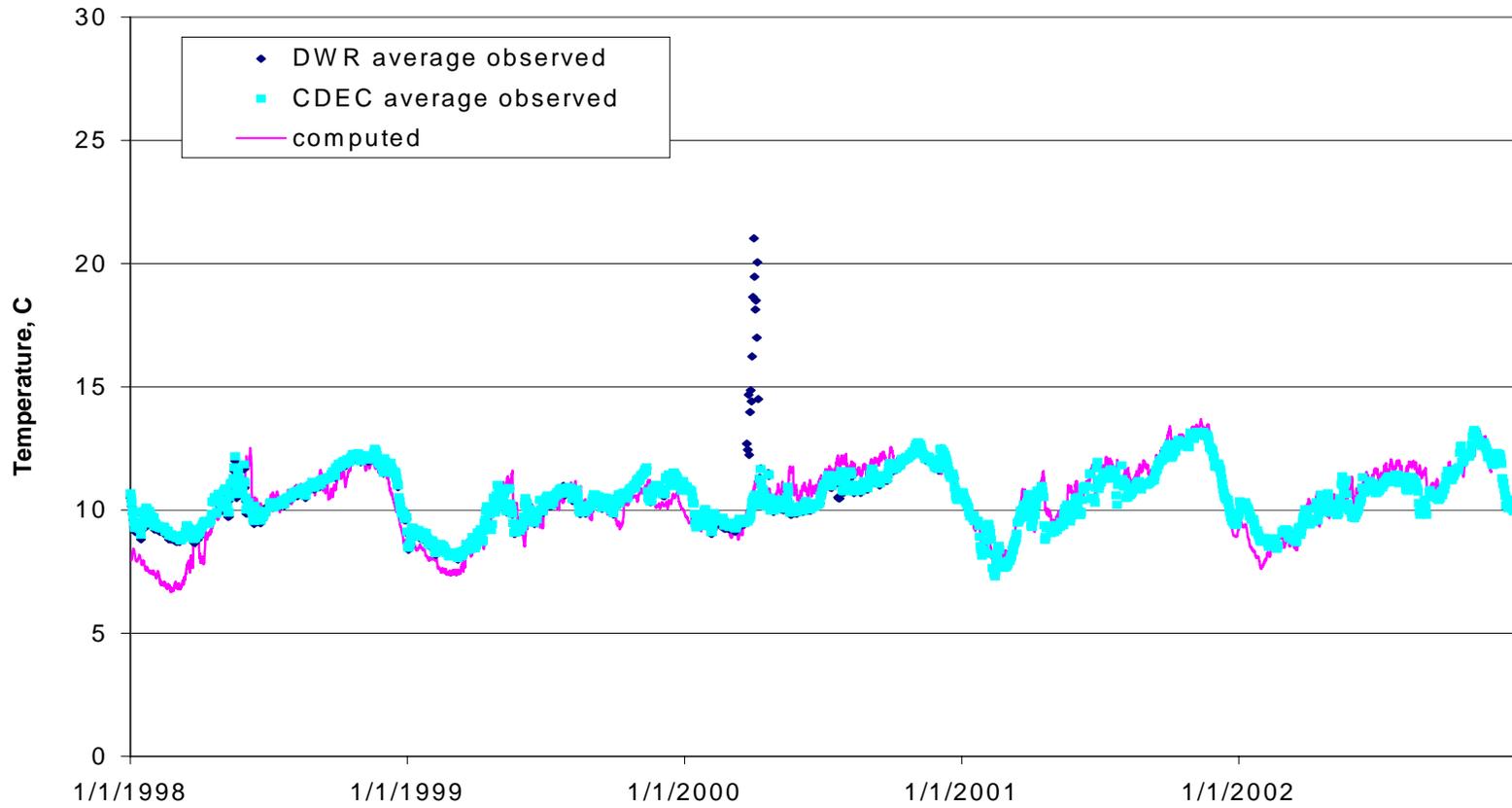
Calibration Results – Shasta Dam

Shasta Dam



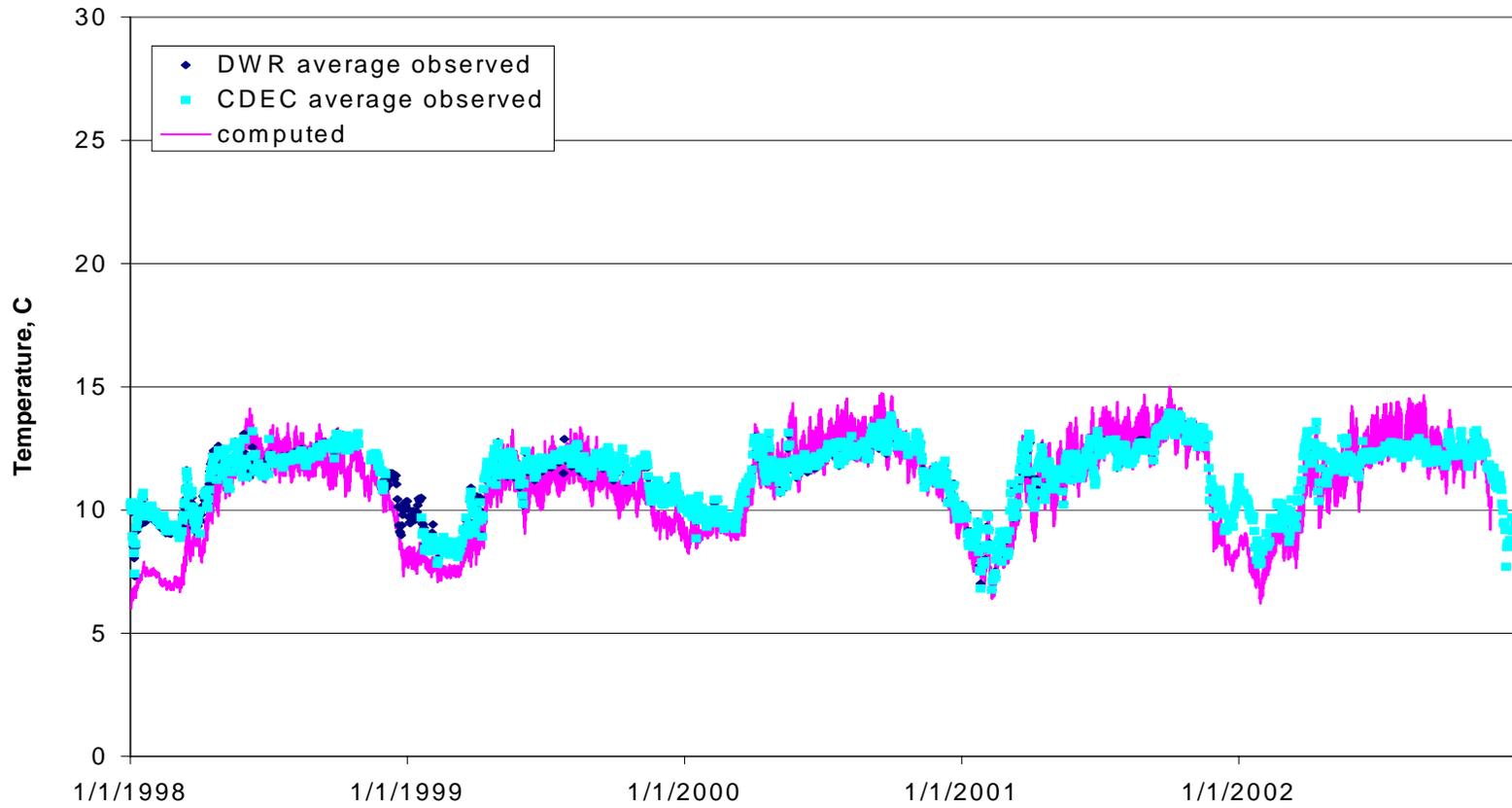
Calibration Results - Keswick

Sacramento River below Keswick



Calibration Results – Balls Ferry

Sacramento River @ Balls Ferry



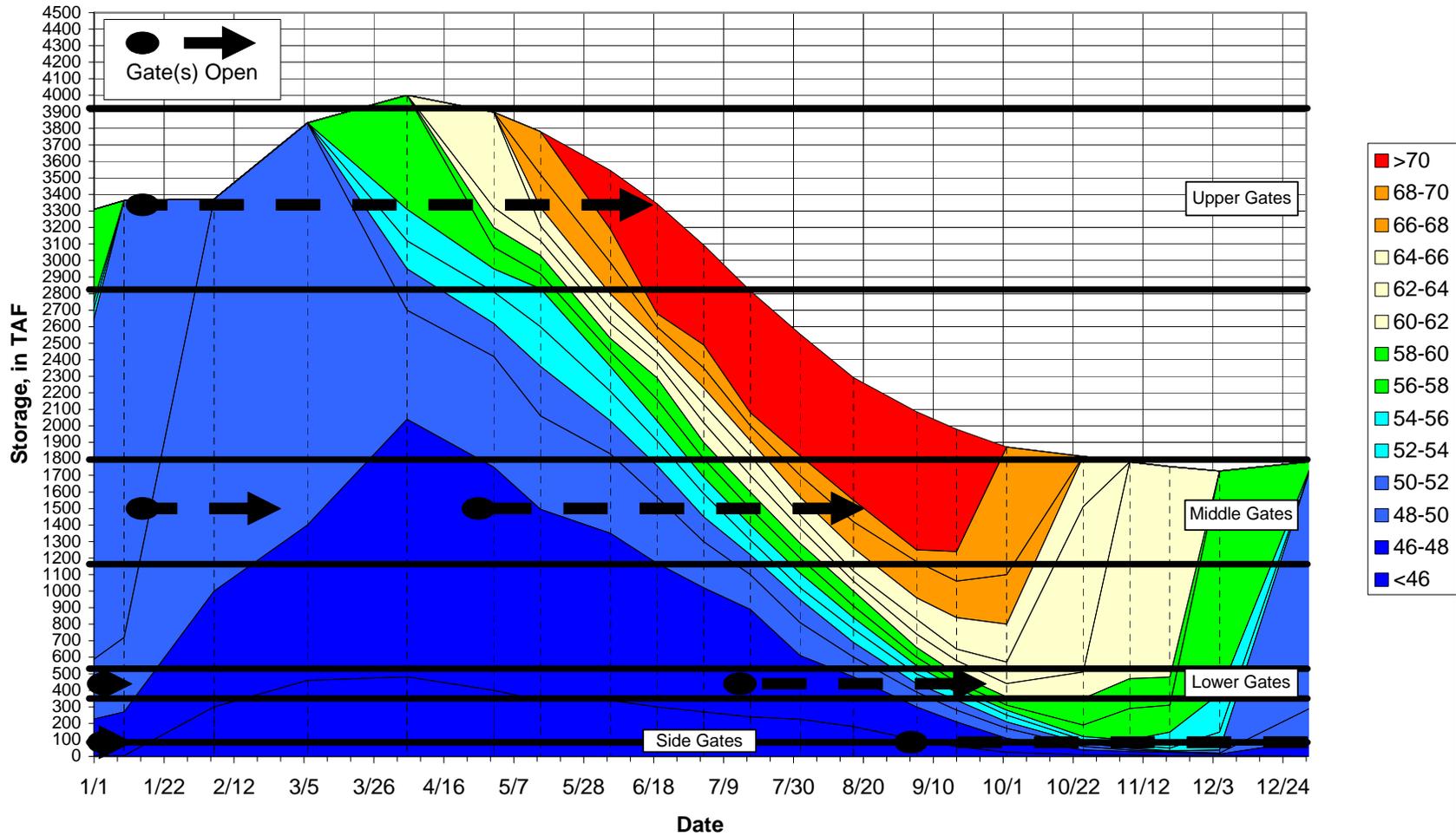
Model Limitations

- **General operation rules applied in CALSIM II**
- **Monthly flow “disaggregated” into mean daily flows**
- **Limited to 4 sets of seasonal Shasta Dam tail-bay temperature targets for temperature operations**
- **Unable to accurately simulate the day-to-day operation strategies to meet temperature objectives**

SRWQM Application in Real-time Operation

- A modified version of SRWQM has been in use since 2005
- Adapted to utilize the most current lake profiles
- The model is applied throughout the temperature operation season, primarily April through October
- Inputs are user specified (e.g., meteorology, inflow, outflow, lake profiles, starting pool elevations, and tail-water temperature targets)
 - *Ongoing study with the TSC evaluating use of NOAA Climate Prediction Center's Local Three-Month Temperature Outlook (L3MTO) products to develop forecast-based distributions of monthly climate outcomes*
- Useful decision tool in support of real-time operation, and the Sacramento River Temperature Task Group

Lake Shasta Isothermobaths - 2007 (Water Temperature, in ° F)



2007 Sacramento River Mean Daily Temperature

