BUREAU OF RECLAMATION

Trinity Temperature Operations

Drew Allan Loney, PhD PE
Mussie T. Beyene, PhD

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Overview

Reclamation, 2024

- Project features
- Temperature Processes
- Modeling Workflow
  - HEC5Q
  - RBM10
- Scenario Logic
- Climate Analysis

Trinity River Features

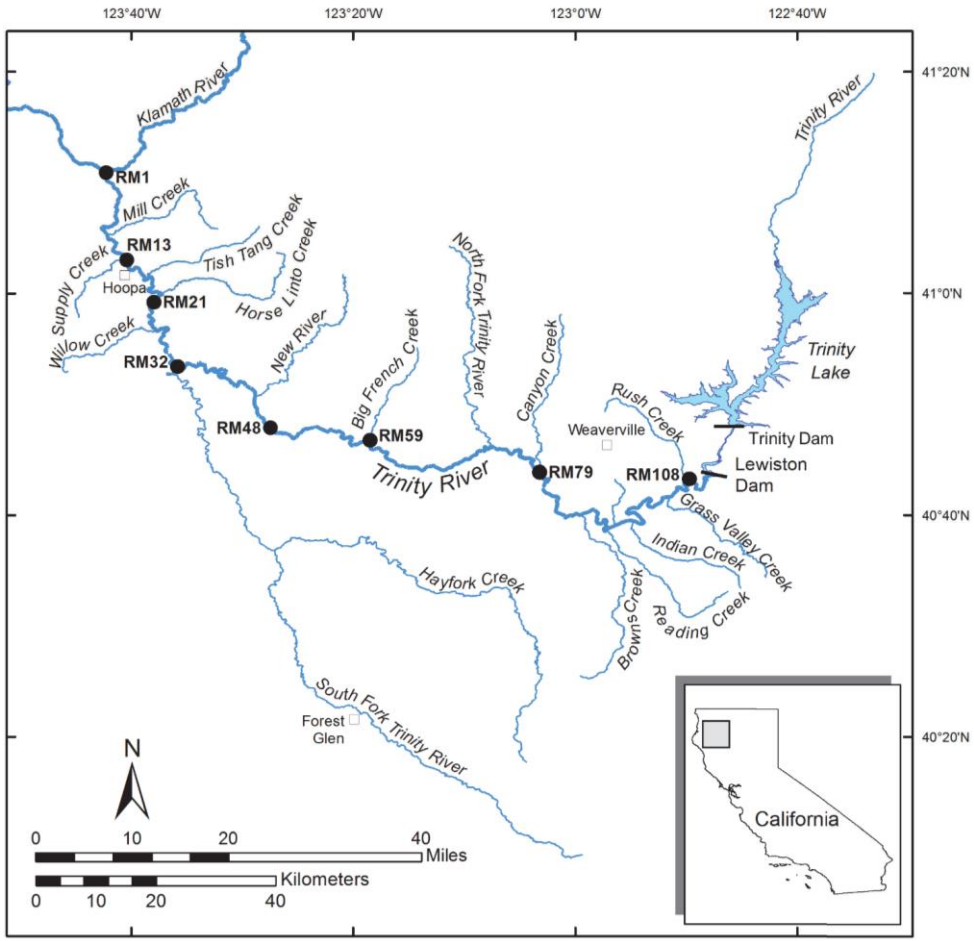


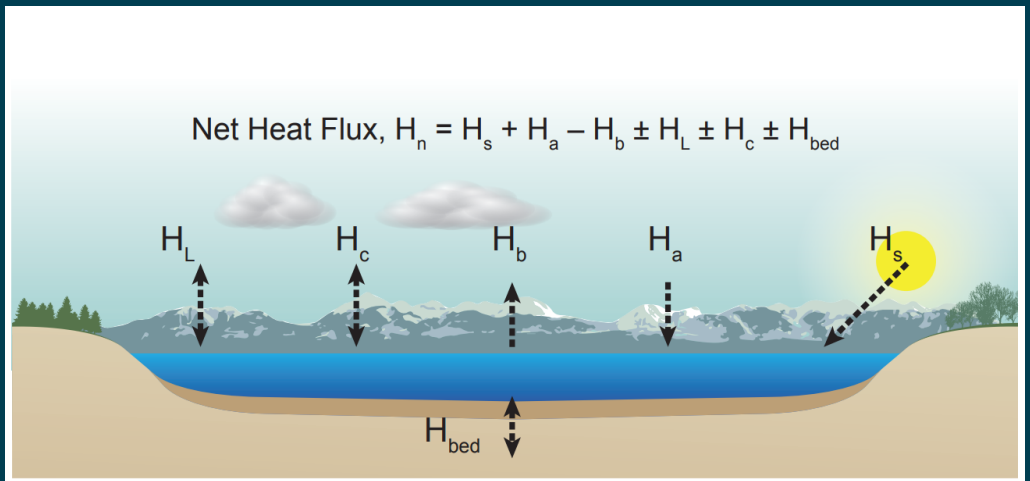
Figure 1. Map showing eight locations (circles) where observed water temperature data were measured and used to calibrate RBM10 at the downstream end of each meteorological reach of the Trinity River drainage basin, northern California.

USGS, 2016

- Reservoirs
  - Trinity
  - Lewiston
- Diversion
  - Clear Creek Tunnel to Whiskeytown Reservoir
- Downstream tributaries
- Temperature management important for salmonid habitat

Temperature Processes

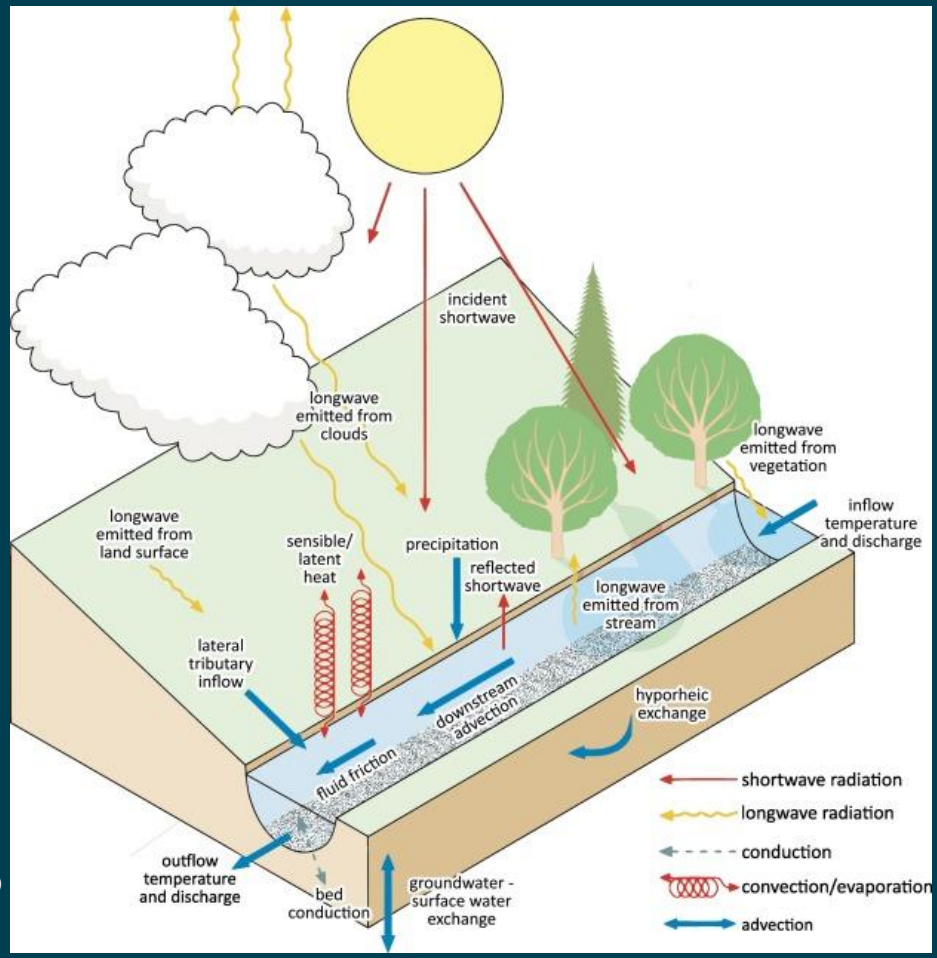
Reservoir Processes



Reclamation, 2017

Heat Flux		Influencing Factor(s)	Effects on the Water Body	
			Energy input resulting in an increase in temperature	Energy output resulting in an decrease in temperature
H_L	Latent or evaporative heat flux associated with a change in water phase	air temperature, water temperature, relative humidity, wind	when water condenses	when water evaporates
H_c	Sensible heat flux in response to conduction between the water body and the atmosphere	air temperature, water temperature	when water temperature is lower than air temperature	when water temperature is higher than air temperature
H_b	Long-wave radiation from the water body	water temperature	not applicable	always
H_a	Long-wave radiation from the atmosphere	air temperature	always	not applicable
H_s	Short-wave radiation from the sun	solar radiation	always	not applicable
H_{bed}	Ground or bed heat conduction between the water body and the bed	water temperature, bed temperature	when water temperature is lower than bed temperature	when water temperature is higher than bed temperature

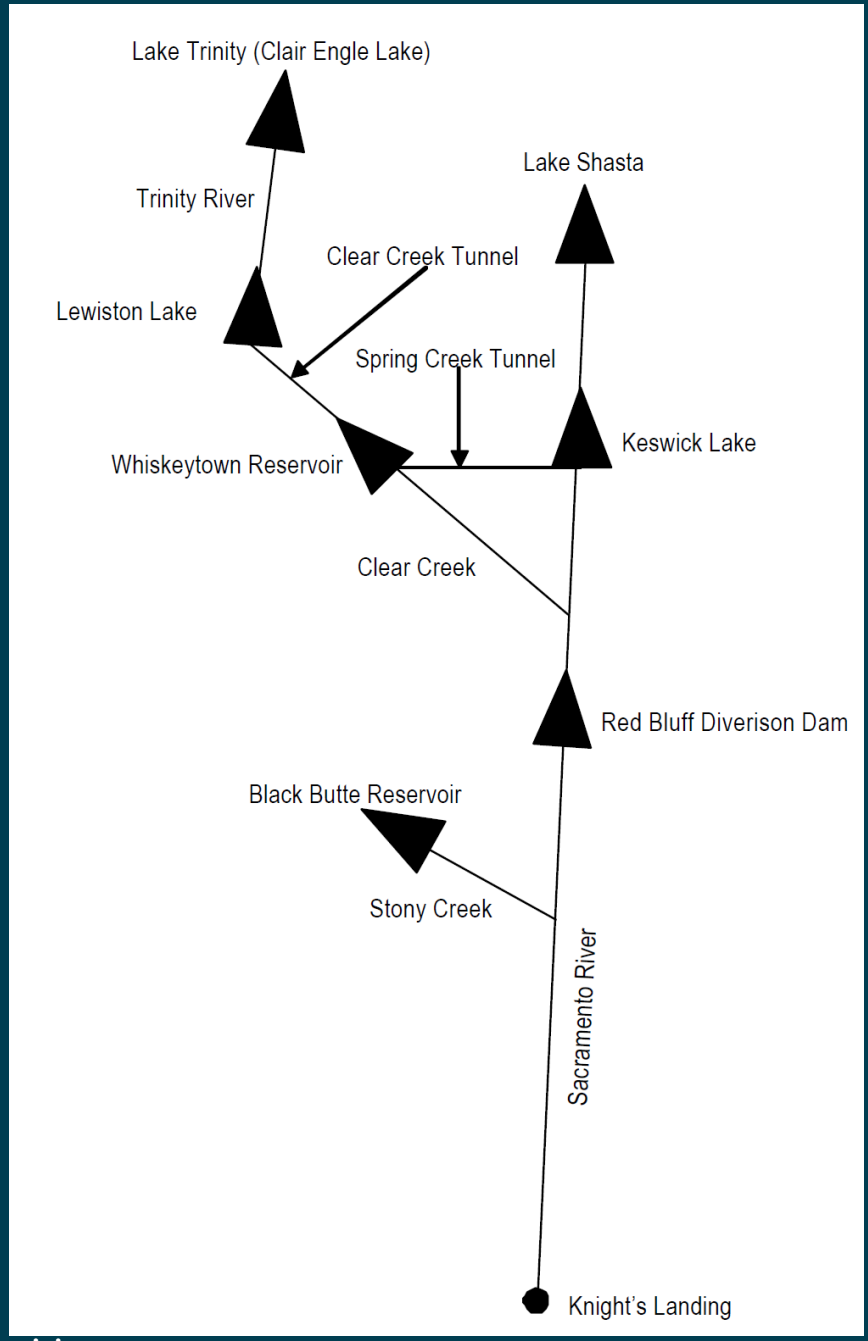
Riverine Processes



Dugdale et al., 2017

HEC5Q

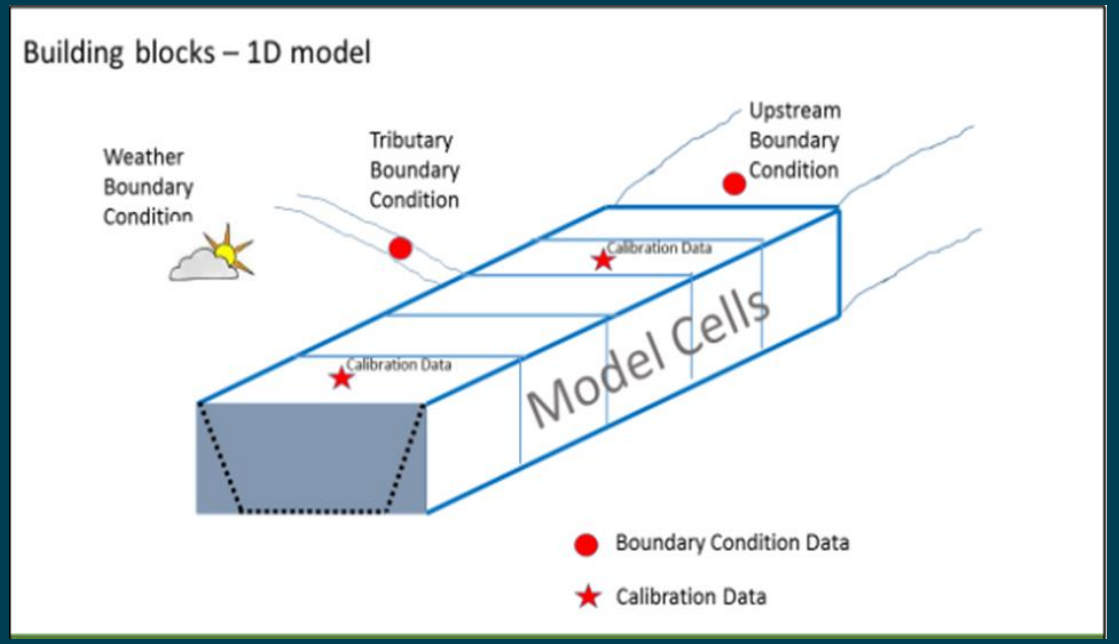
- Standard, accepted modeling toolkit used to model temperatures
- Period of record extended to match the CalSim 3 extension
  - Truncated by the RBM10 data availability
- Operations are fixed inputs from the CalSim 3 model
- Temperature compliance targets are set by alternative logic



RMA, 2003.

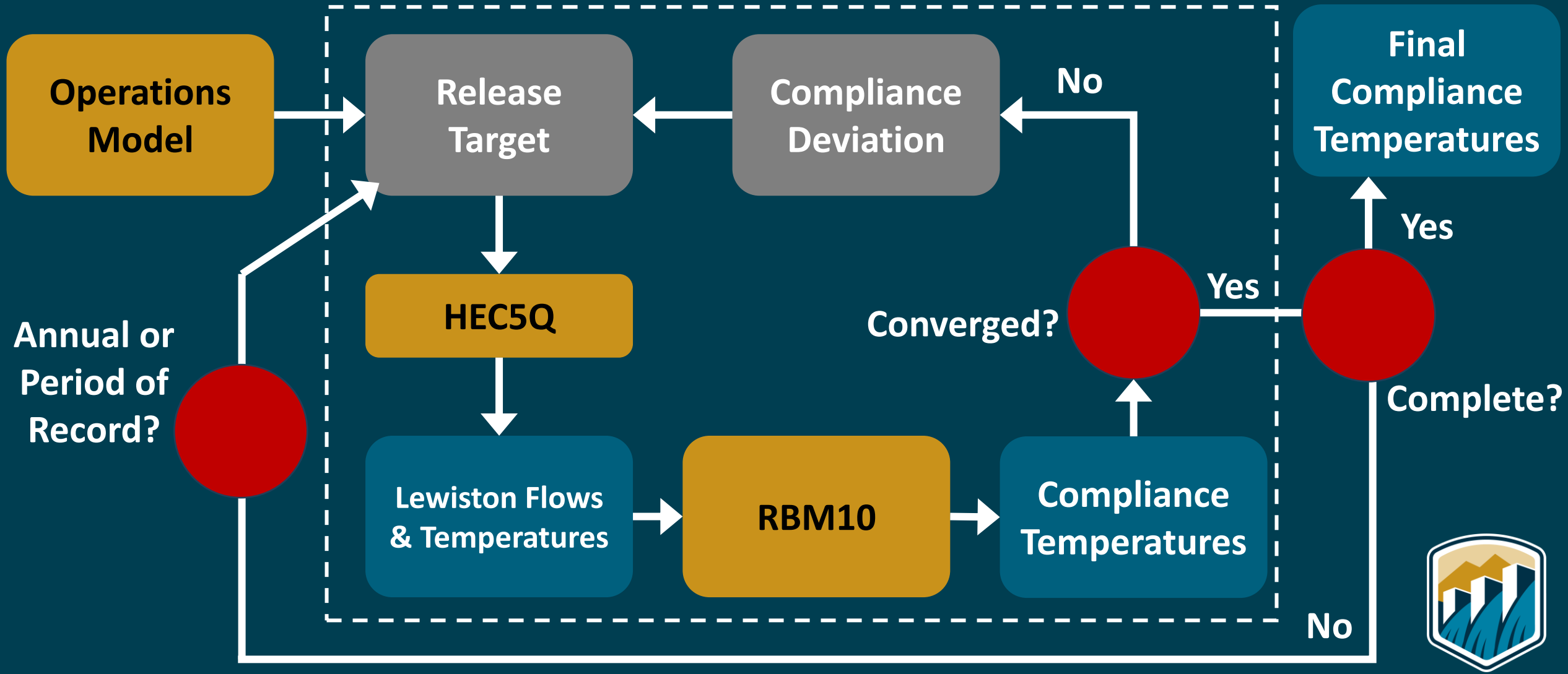
RBM10

- A one-dimensional water temperature model to simulate daily mean water temperature along the Trinity and lower Klamath Rivers.
- Model inputs: river geometry, boundary conditions, and meteorology.
- Sixteen meteorological reaches (Daymet) and 18 tributaries.
- Study period: 1980 - 2021
- Built by the USGS



EPA, 2018.

Modeling Workflow

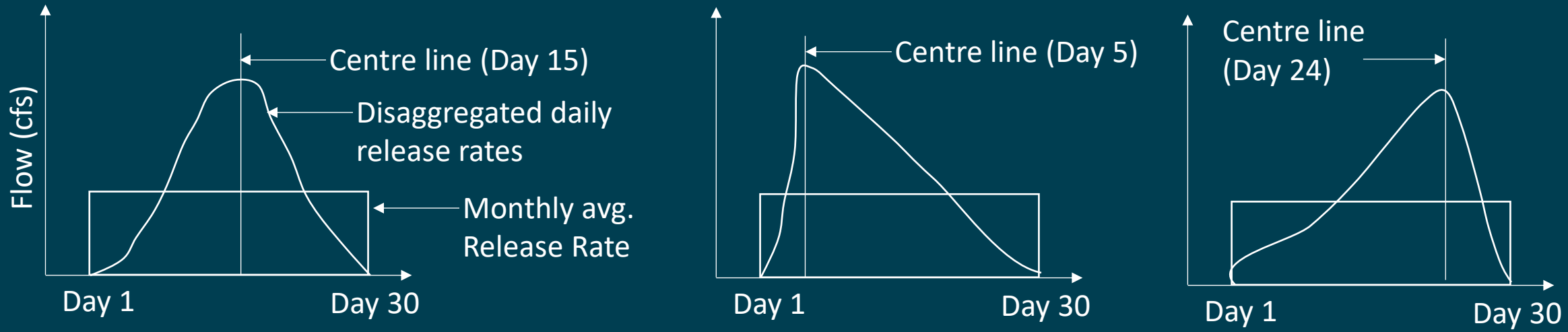


Workflow Validation

- Models not intend to run in coupled format
- Need to build unified workflow that moves data between models
- Must validate portions of the workflow

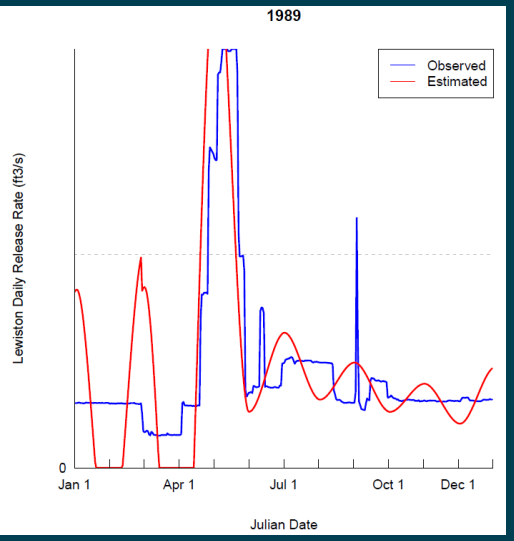
- Monthly CalSim to daily RBM10 inputs

RBM10 Release Disaggregation

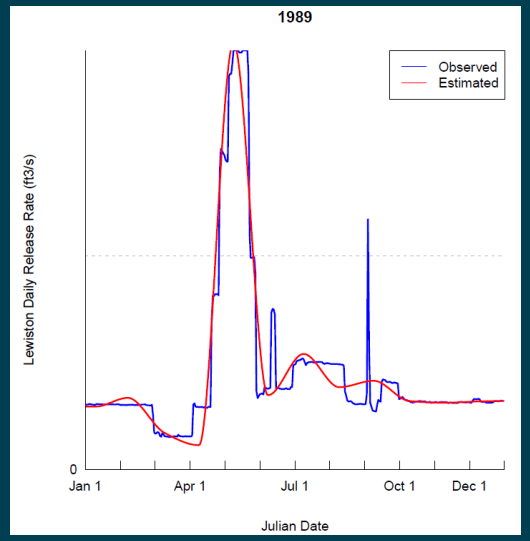


- Recorded daily release rates were averaged by month and disaggregated using SPLINE function
- 5 centre points were considered (1st, 7th, 14th, 21st, and 28th)

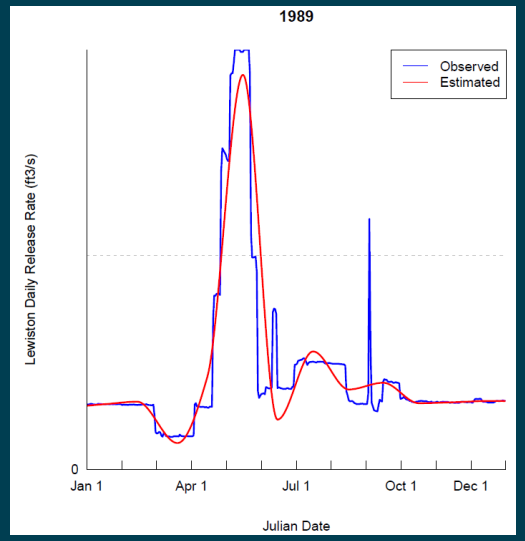
Disaggregated Lewiston Release Rates



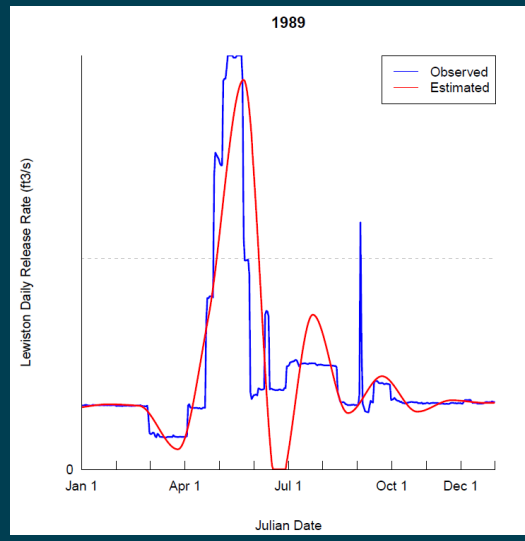
1st day



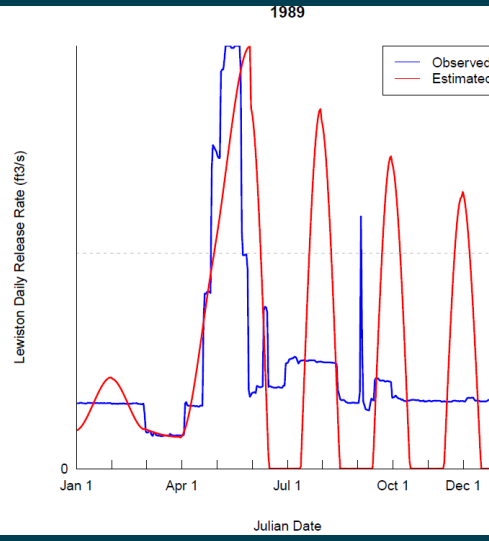
7th day



14th day



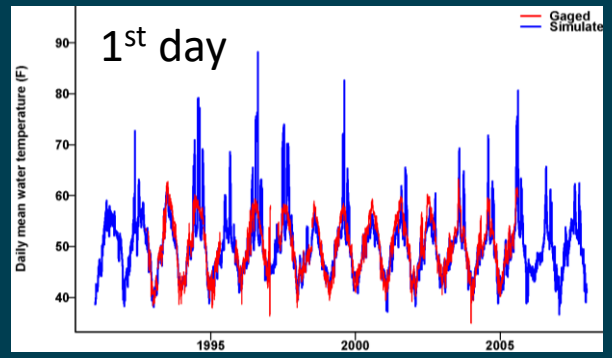
21st day

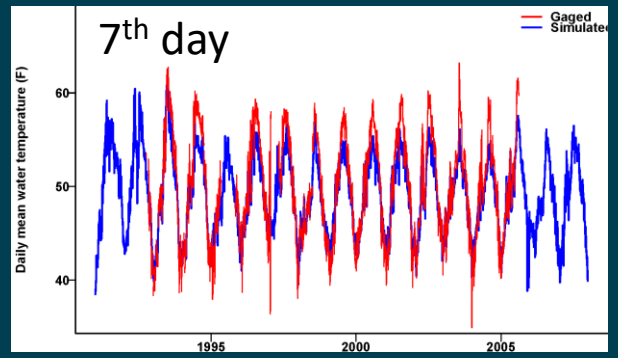


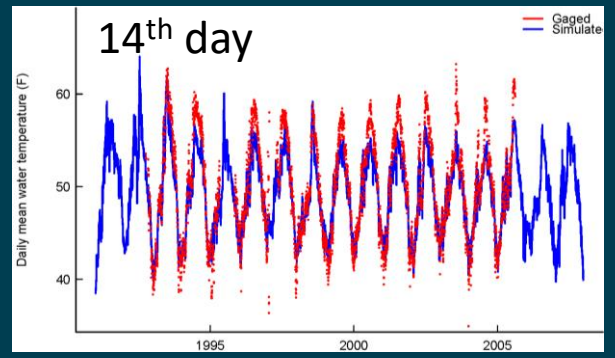
28th day

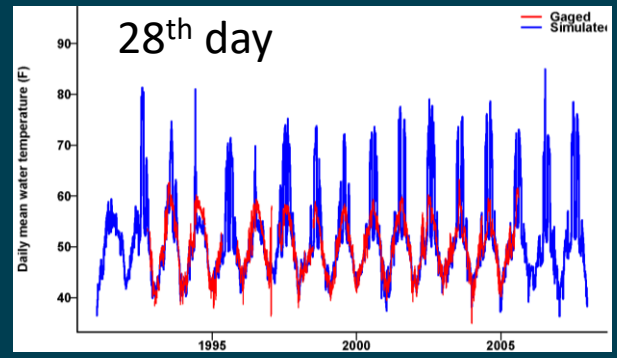
- Disaggregated daily release rates with center point at the 7th and 14th often matched recorded daily release rates.

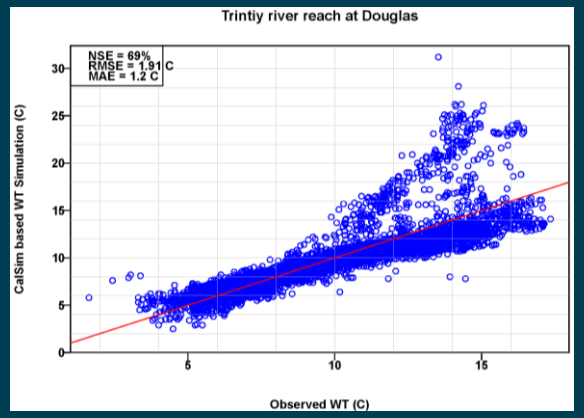
Temperature Comparison at Douglas City

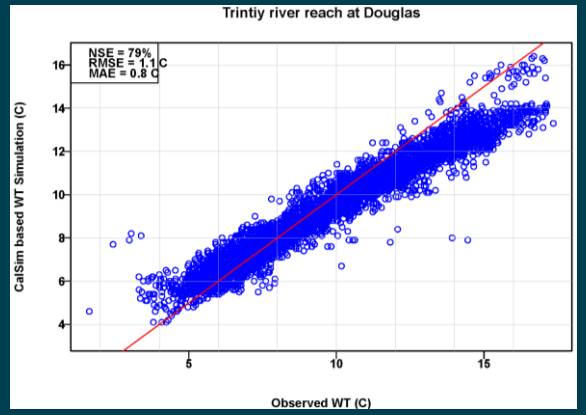


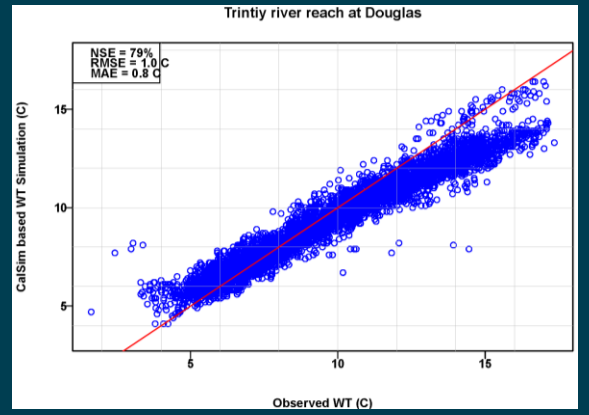


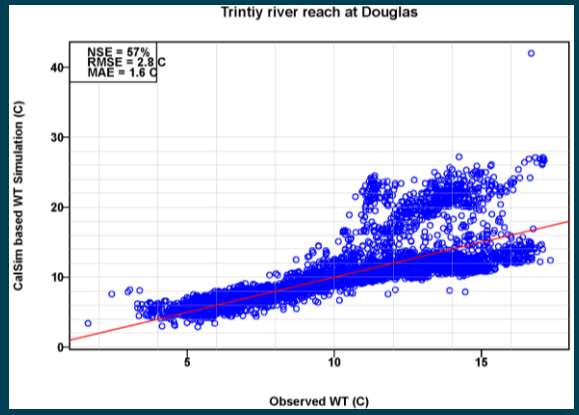












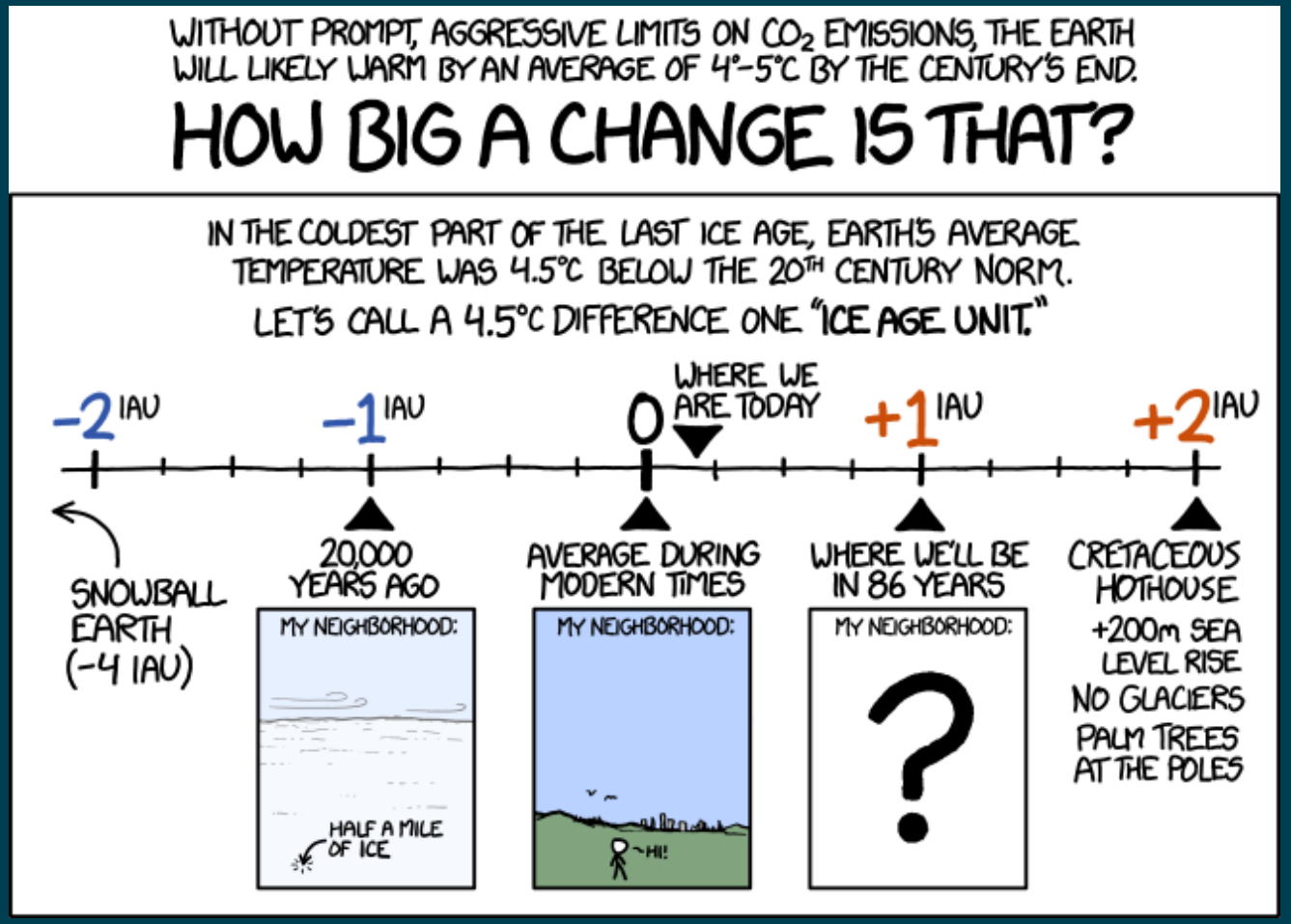
- Discrepancies between observed and modeled water temperatures were the least when the daily release flow rate was disaggregated using a SPLINE method centered on the 14th day.

Scenario Logic

- Nine CalSim operations logic
  - Different period of record
- Four temperature target logics
- Similar locations with different mixes of timing and temperatures

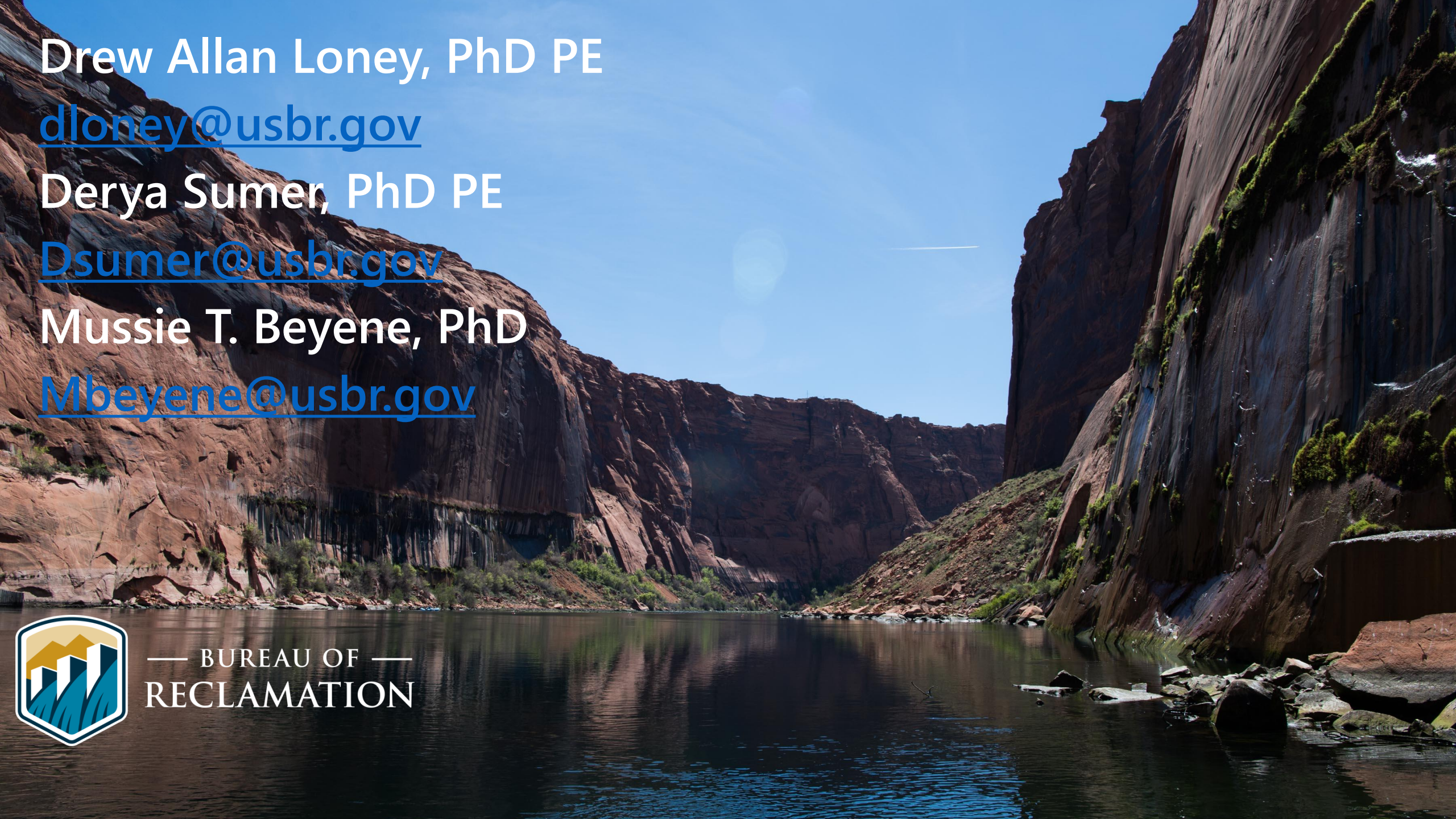
Scenario	Douglas City	NF Trinity River
1	July 15 – Sept 15 60F Sept 16 – Sept 30 56F Jan 1 – July 14 99F	Oct 1 – Dec 31 56F
2	July 15 – Sept 15 60F Sept 16 – Sept 30 56F Jan 1 – Mar 31 99F	Oct 1 – Dec 31 56F Apr 1 – July 14 58.5 7DADA
3	July 1 – Sept 14 60F Sept 15 – Sept 30 56F Jan 1 – June 30 99F	Oct 1 – Dec 31 56F
4	Sept 15 – Sept 30 56F Jan 1 – Sept 14 99F	Oct 1 – Dec 31 56F

Climate Analysis



xkcd

- Climate adjusted inputs are needed for temperature
  - CalSim does use NF Trinity inflow
- Tributary inflows/temperatures affect in river temperatures
- Climate is highly uncertain
- Input development is next step after workflow validation



Drew Allan Loney, PhD PE
dloney@usbr.gov
Derya Sumer, PhD PE
Dsumer@usbr.gov
Mussie T. Beyene, PhD
Mbeyene@usbr.gov

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