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Improving the Lake Powell CE-QUAL-W2 Water Quality Model

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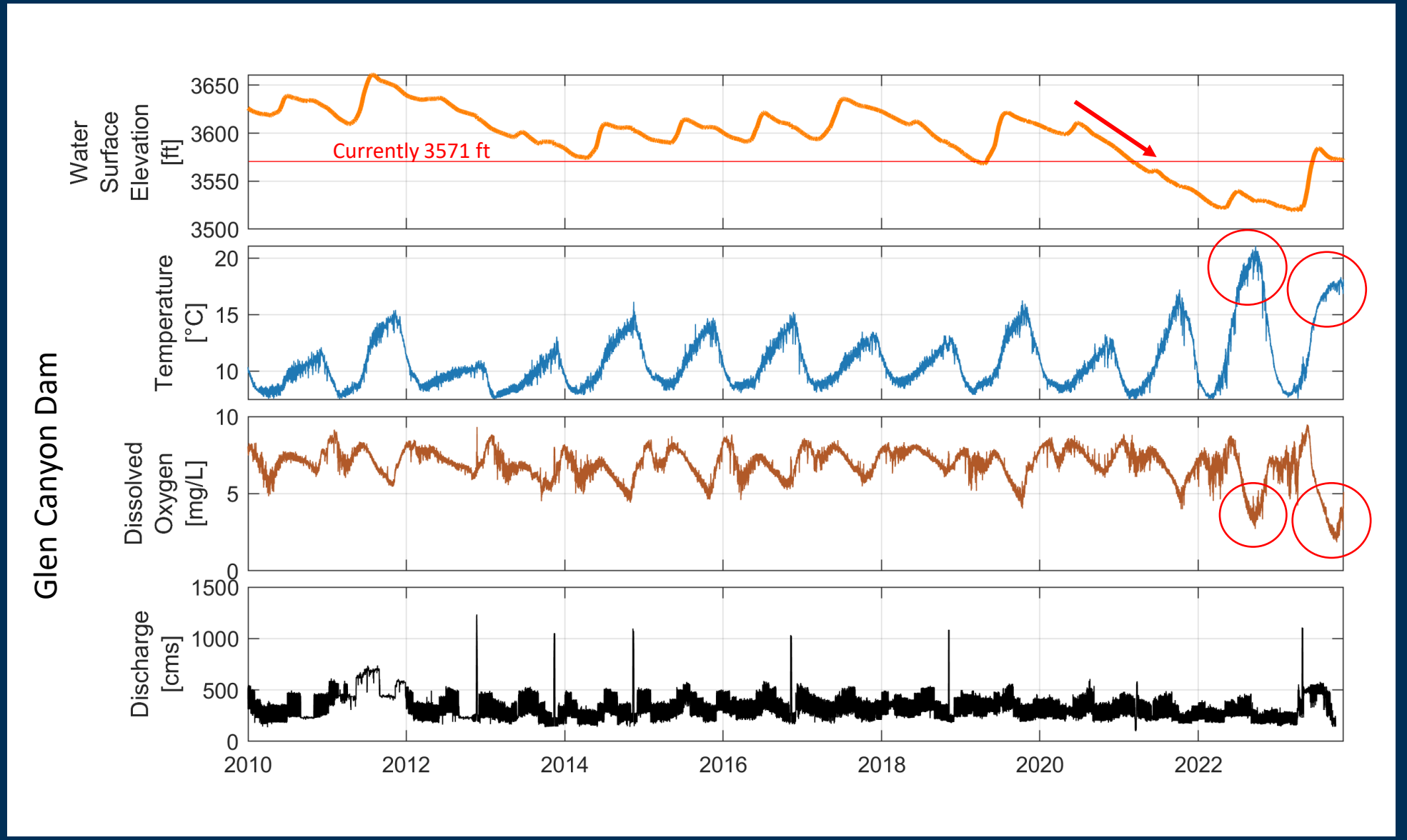
Recent Water Quality Trends



"Preliminary Information-Subject to Revision. Not for Citation or Distribution."

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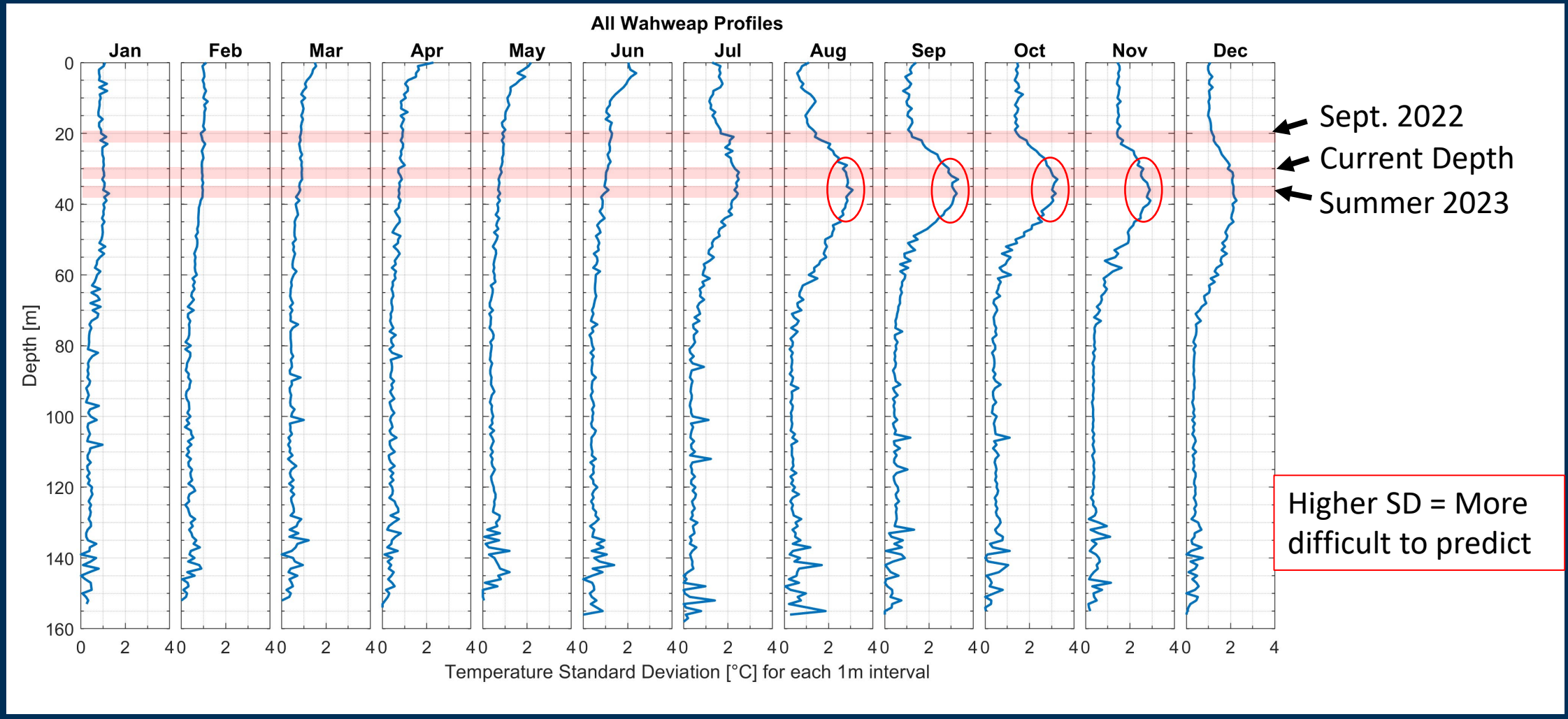
Wahweap Temperature Variability



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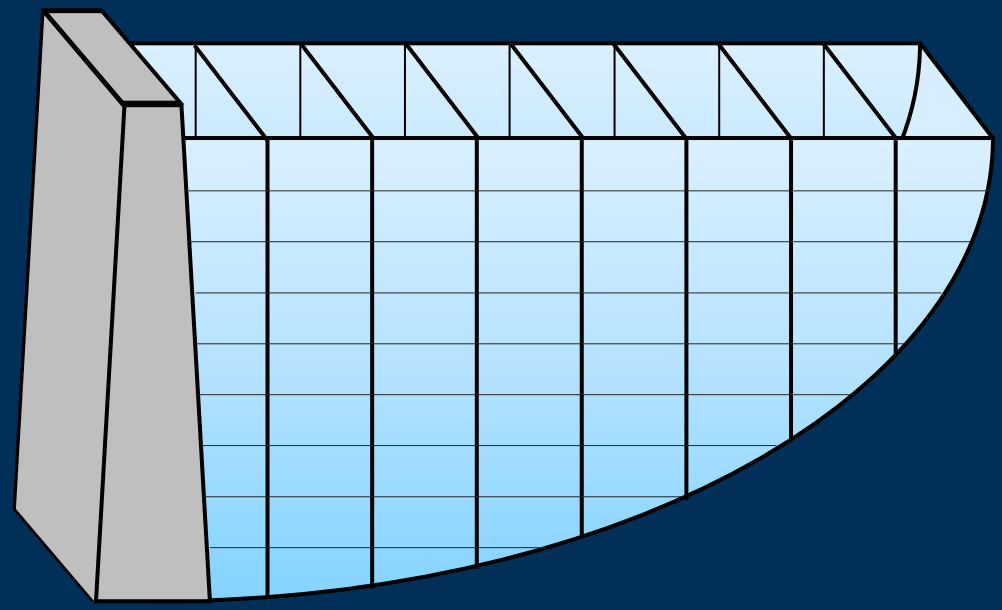
What is CE-QUAL-W2?

- 2D (laterally averaged) hydrodynamic model
- Individual heat and constituent fluxes
- Simulates stratification and seasonal turnover
- Ability to specify GCD characteristics
  - Penstock and Bypass elevations



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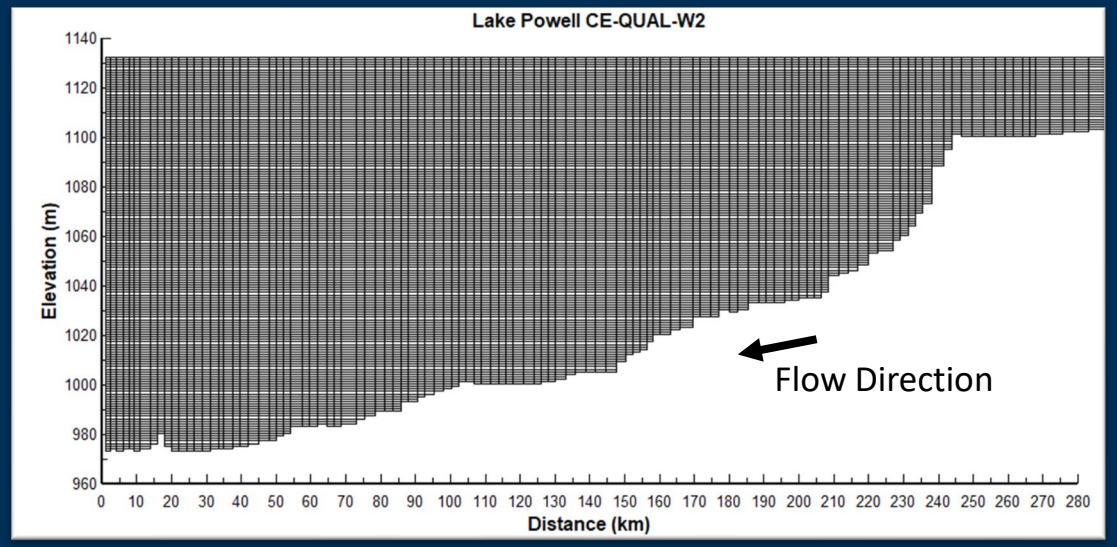
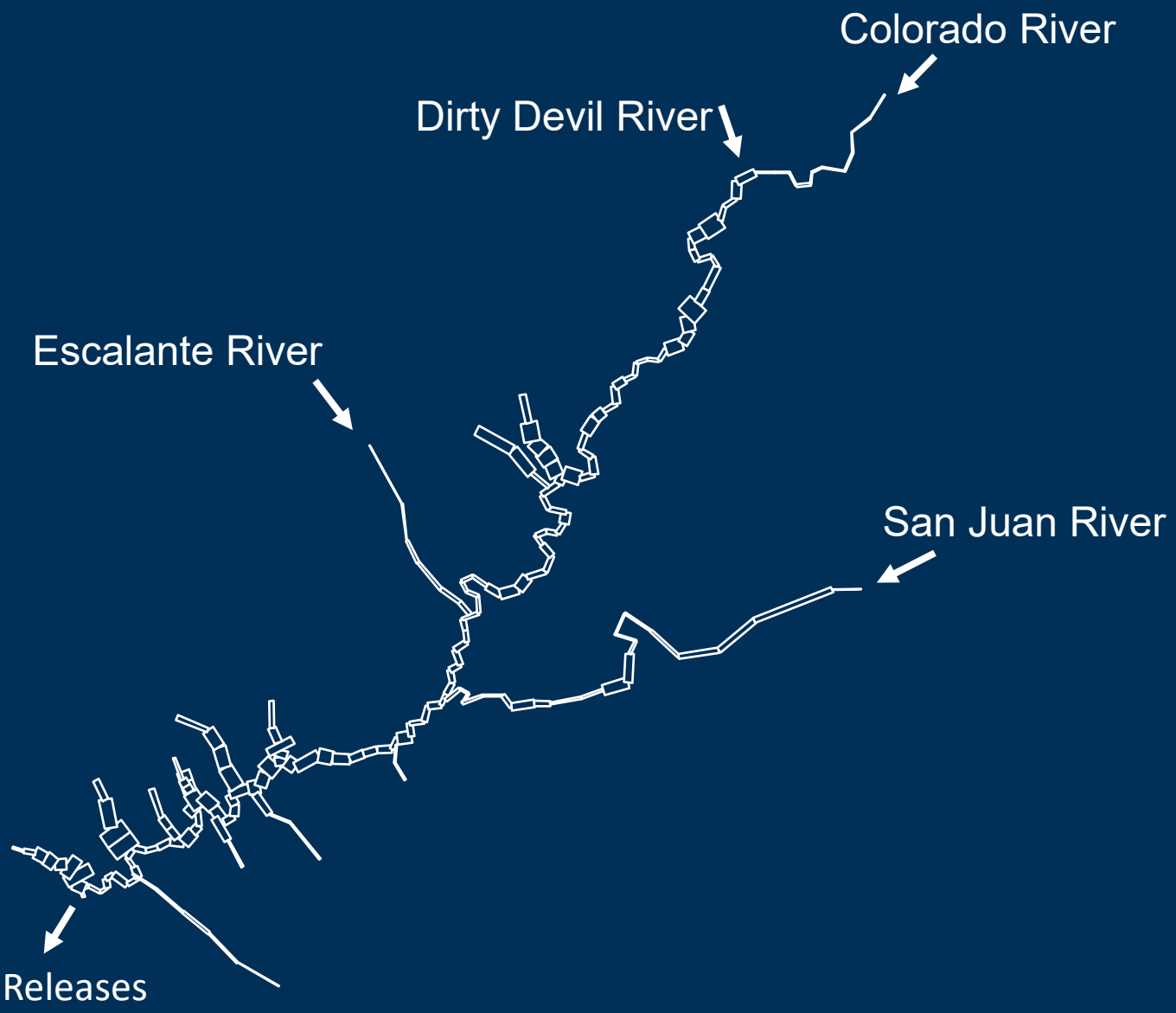
Updates from last year

- **New bathymetric data**
- **Finer model grid**
- **More branches/tributaries**





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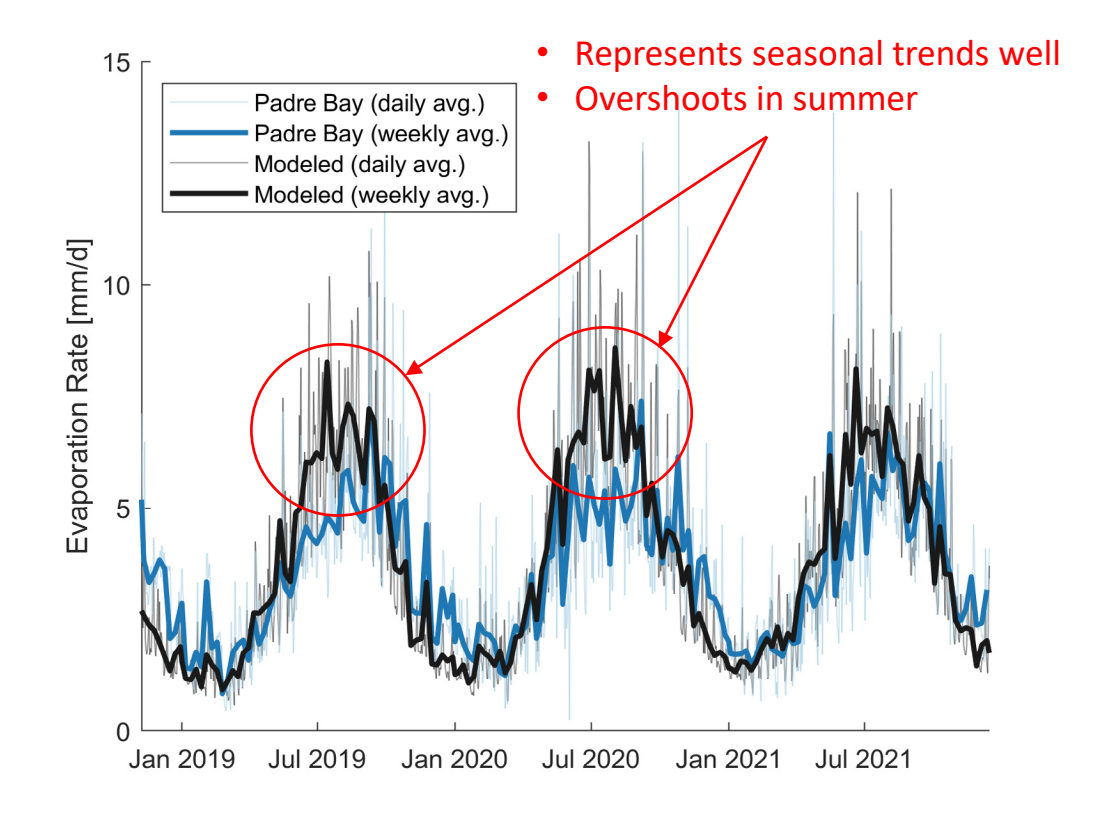
Model Evaporation Rates

- Updated coefficients based on USBR study
- Impacts surface heating and mixing



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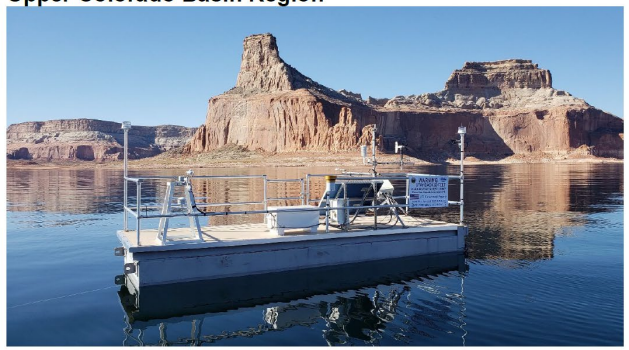
Evaporation from Lake Powell: In-situ Monitoring between 2018 and 2021

Technical Memorandum No. ENV-2023-007
Upper Colorado Basin Region



(Padre Bay)

U.S. Department of the Interior **September 2022**

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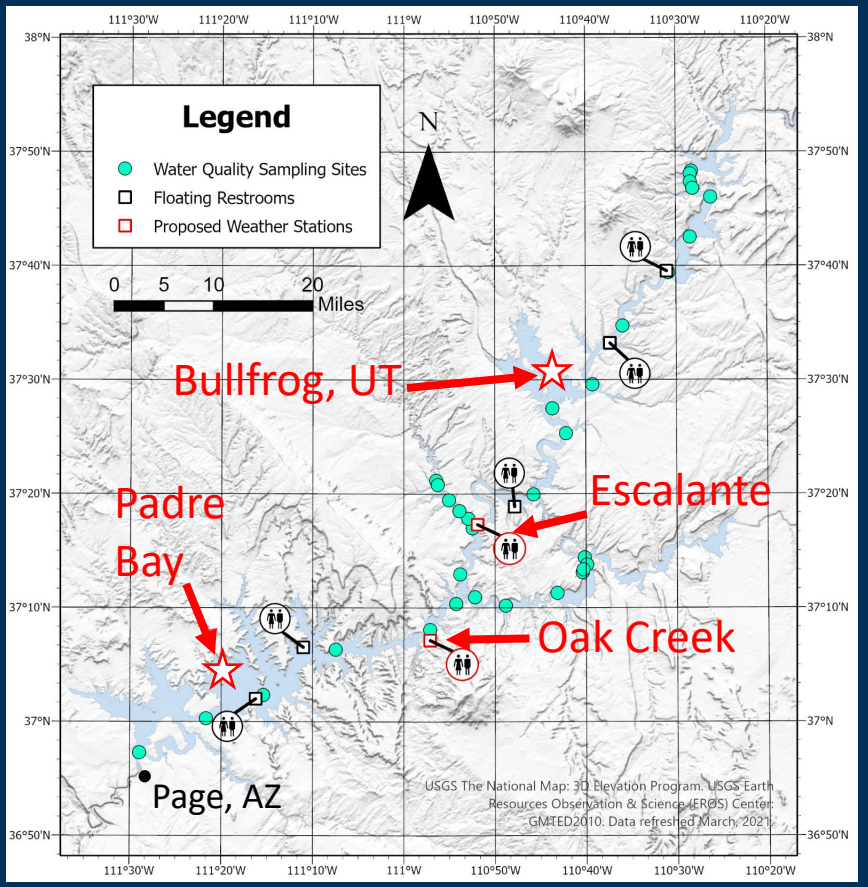
New Weather Stations

- Better understand over-water conditions
- Fill in spatial gaps in data
- Installed in May 2023



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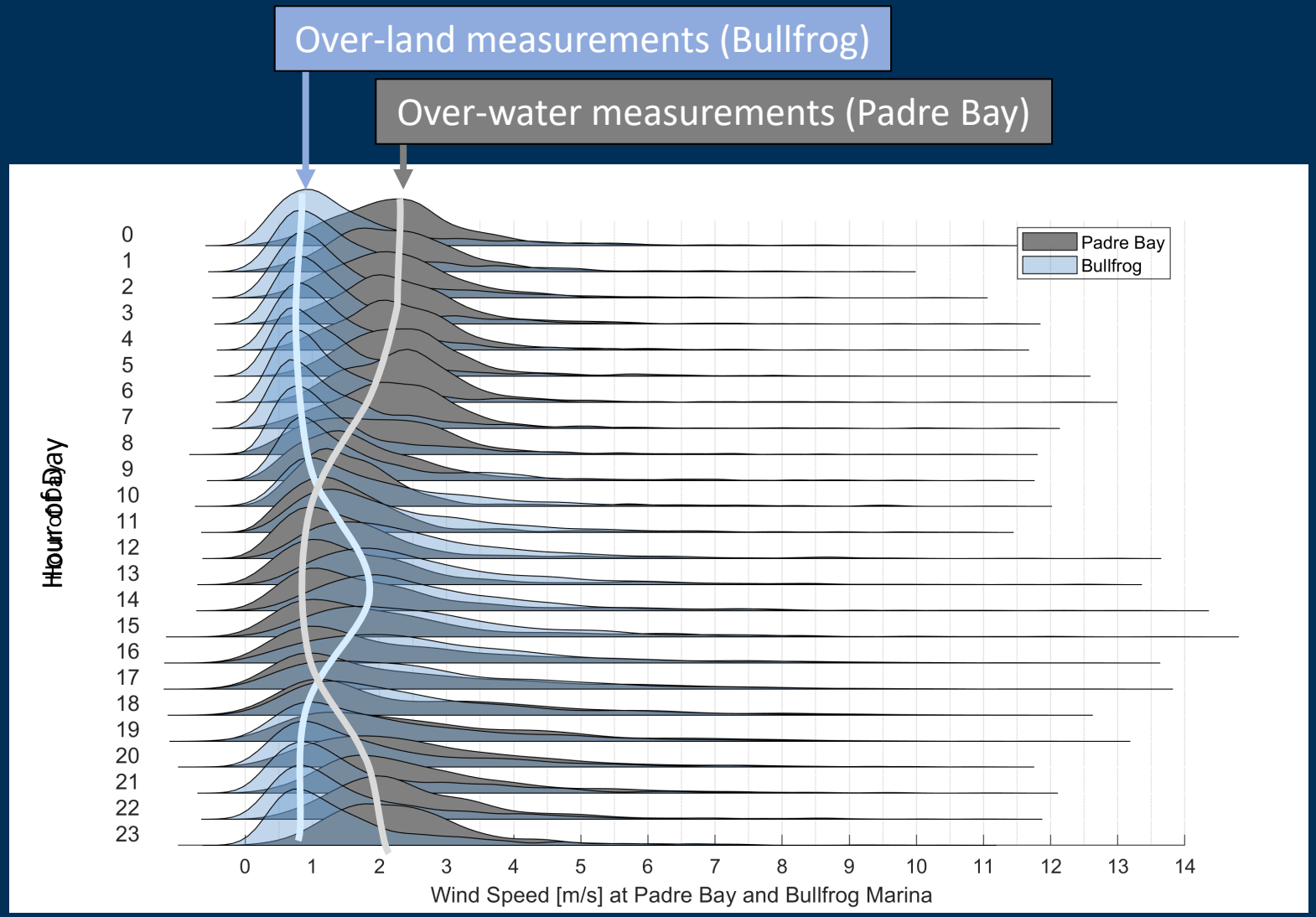
Understanding Wind Speed

- Over-land vs over-water
  - Different within-day patterns
  - Different magnitudes
- Model currently uses over-land weather inputs
  - Need to correct for timing and magnitude
- Important b/c controls:
  - Surface evaporation rates
  - Convective mixing
  - Internal seiche



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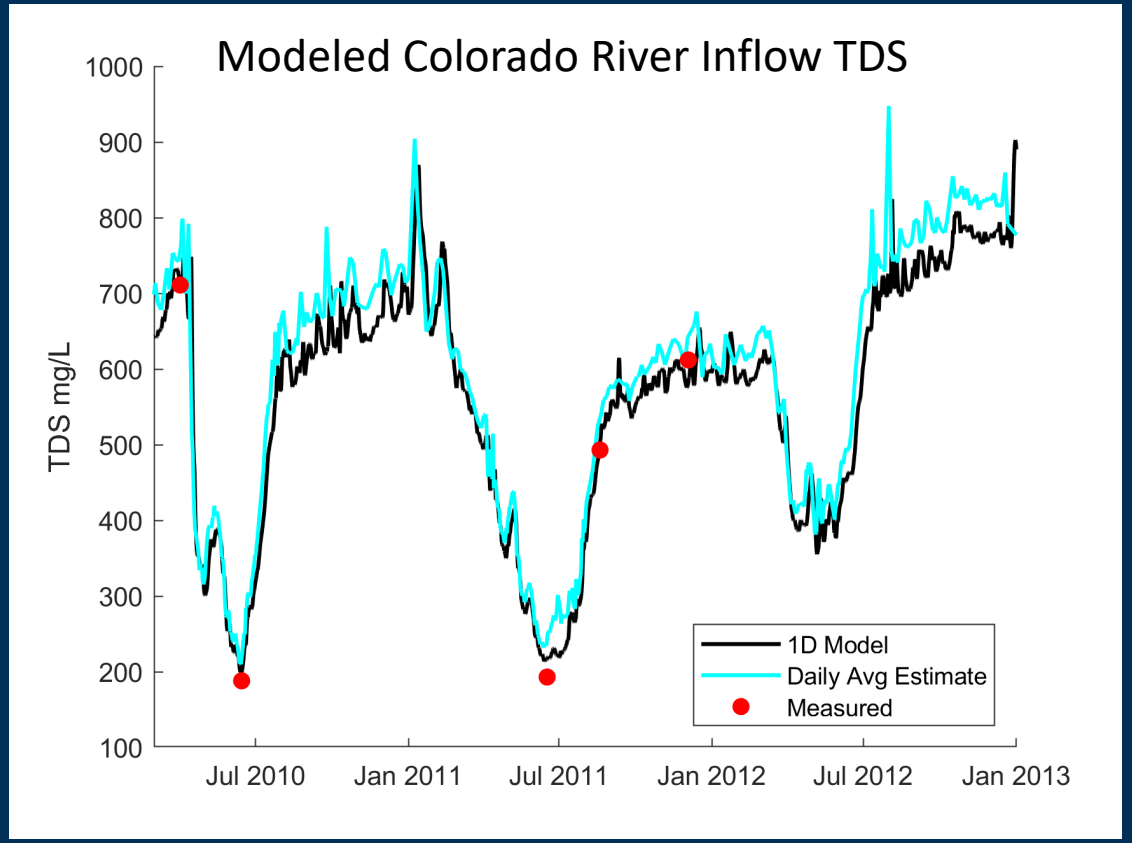
Ongoing model development: River Inputs

- Modeled Colorado River inputs
  - 1D wave routing
  - Discharge, Temperature, TDS
  - Colorado River @ Cisco UT
  + Green River @ Green River UT
  + San Rafael River
    - ~225 km of river

  - No data gaps in model inputs
  - Higher temporal resolution
    - Within day variability



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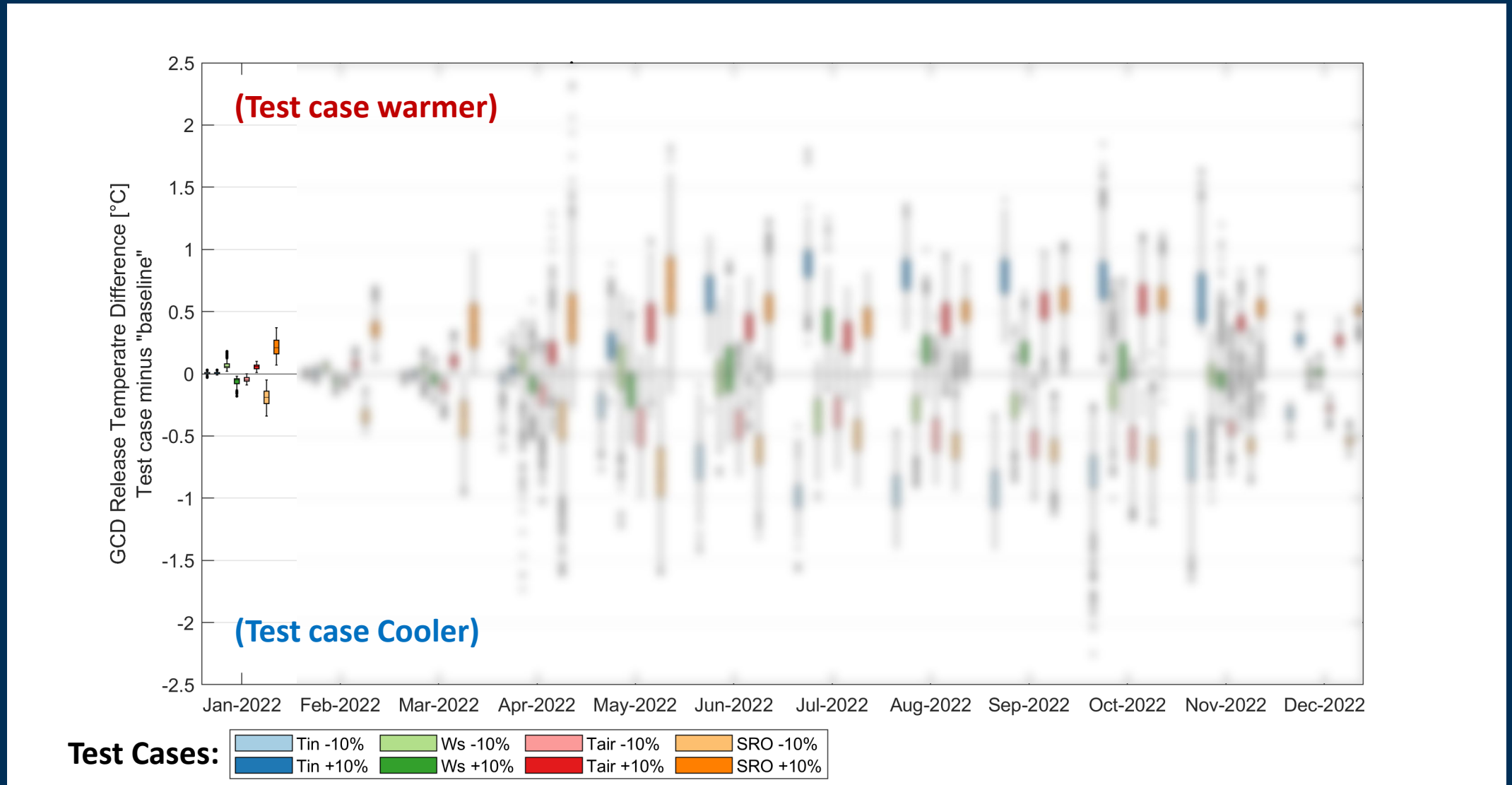
Sensitivity Analysis (2022)



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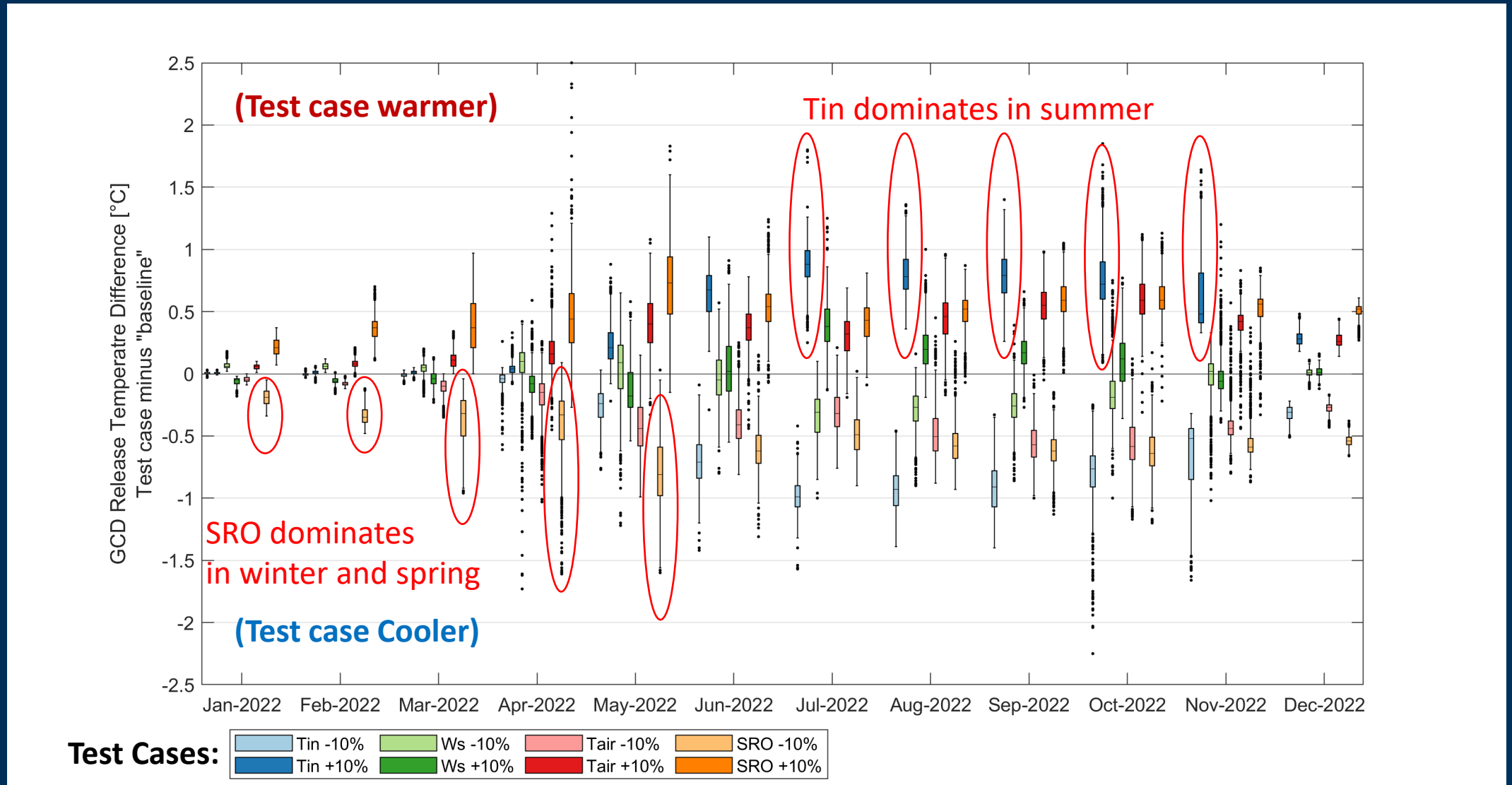
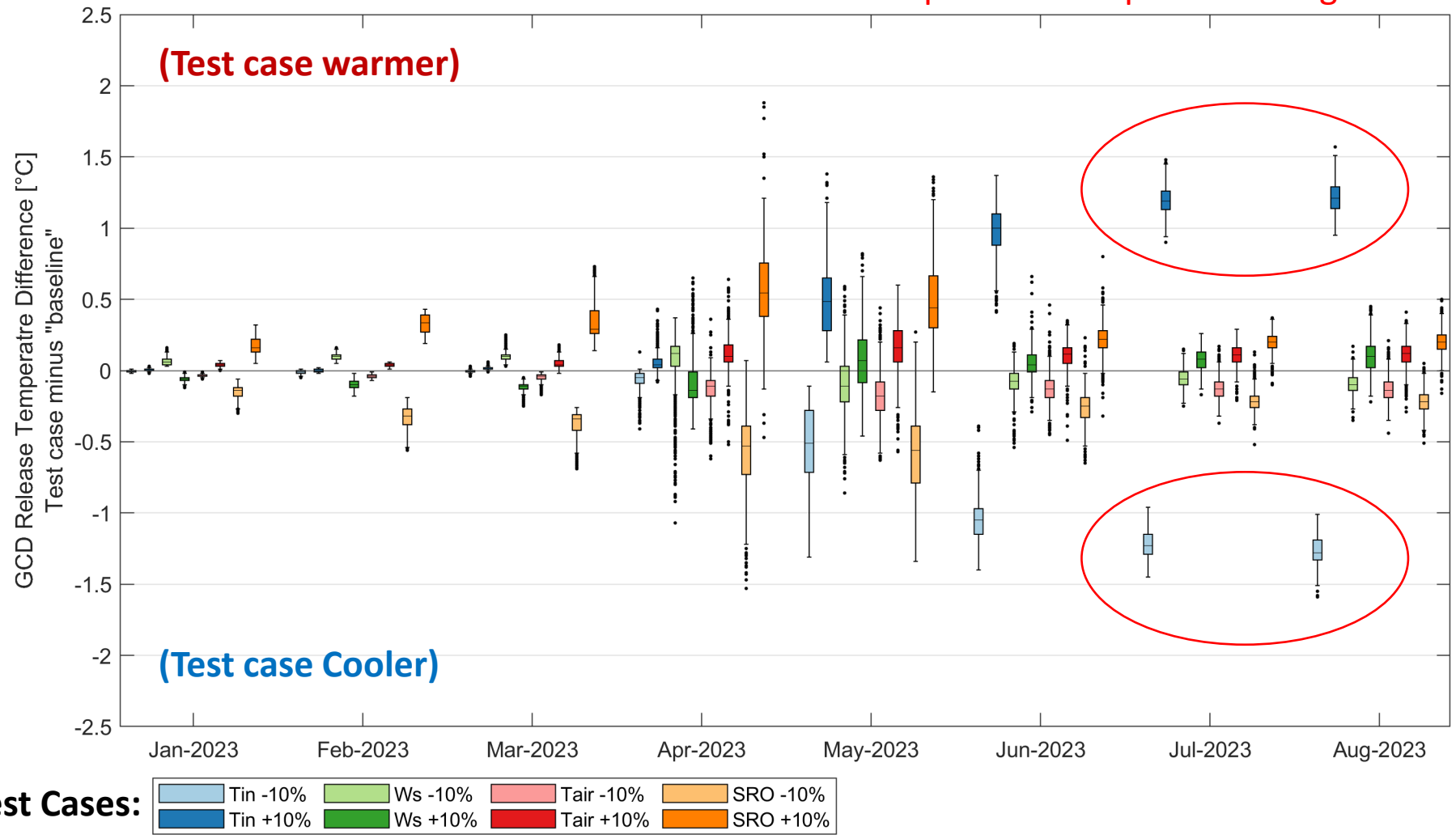
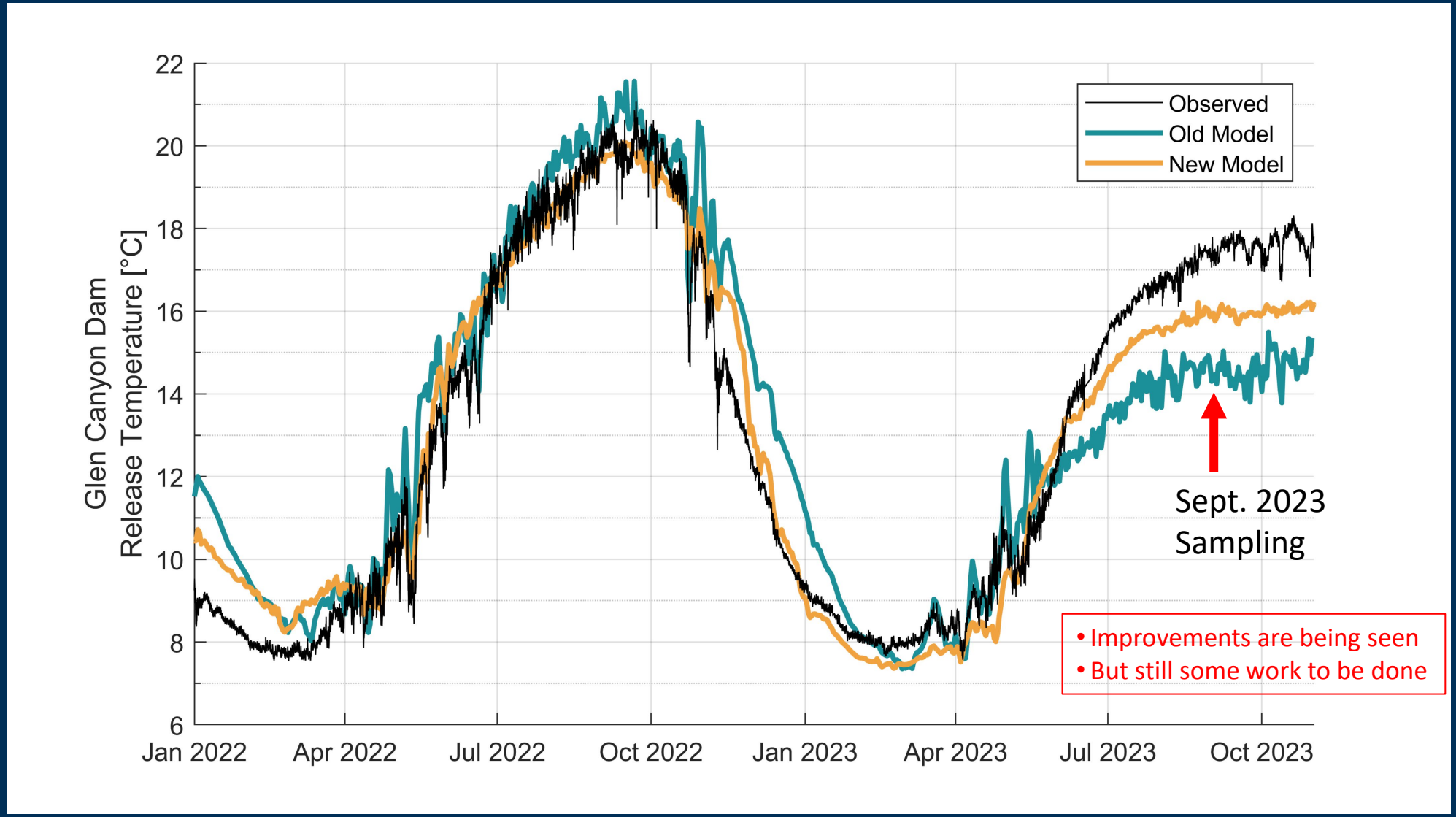


Sensitivity Analysis (2023)

Inflow temperatures important in high inflow year

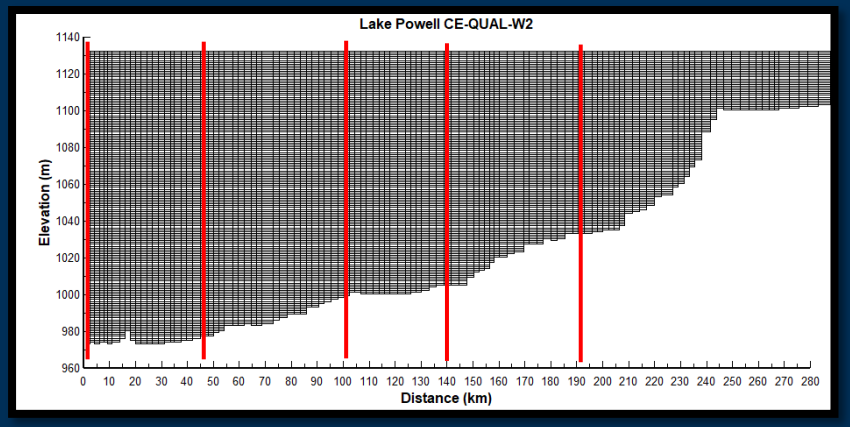


How are model predictions looking?



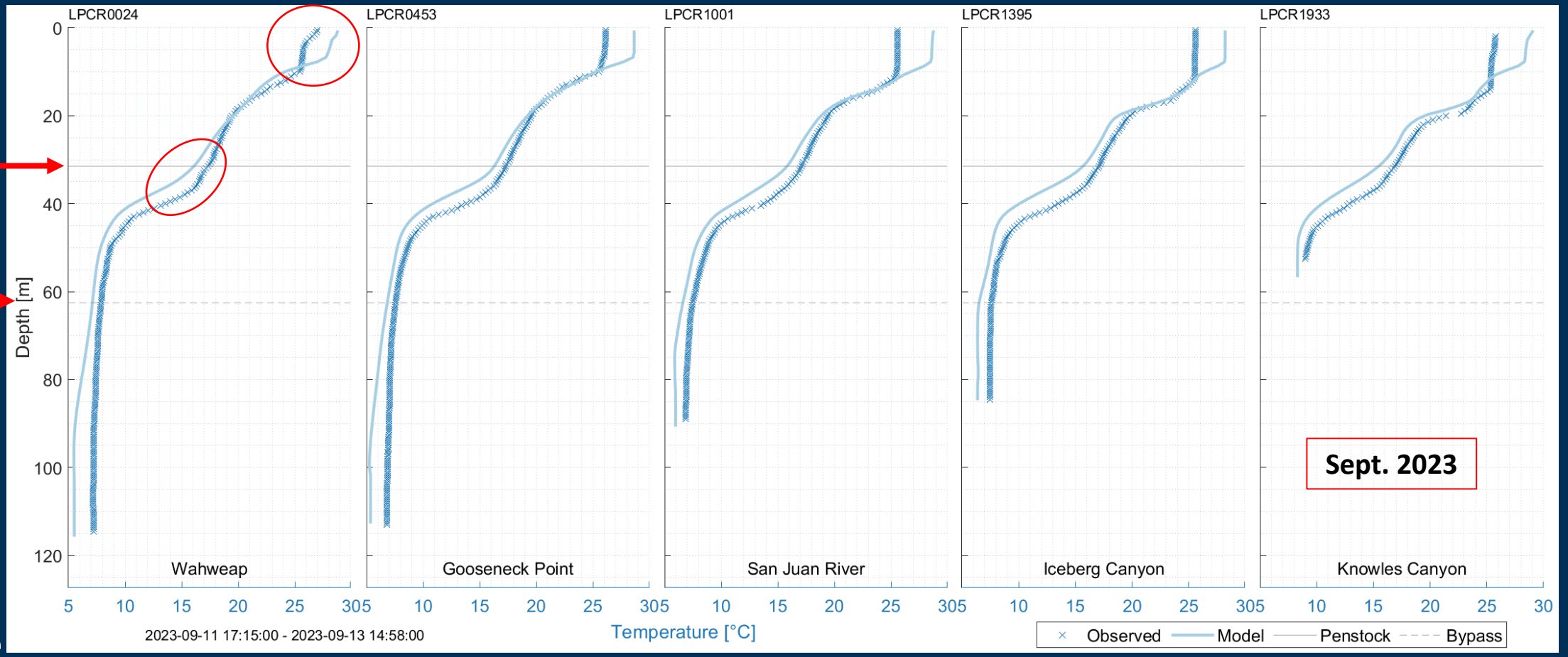
Model Profiles

- Surface too warm – not enough wind mixing or evaporation
- Meta/hypolimnion too cool – more internal mixing needed



Penstock

Bypass



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2023 Applications and Presentations

- Modeling
  - Spring HFE
  - Near-term operations sEIS
  - LTEMP sEIS
  - Evaluating “Thermal Curtain” idea
- Community of Practice Working Group
  - Received feed back from CE-QUAL-W2 experts
  - Most frequent comments/suggestions:
    - Wind speed might be too low
    - Check evaporation rates

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Additional Modeling Options

- SMB Temperature Model (Yackulic and Eppehimer)
  - Predicts release temperatures (RMSE = 1.28 °C @ Lees Ferry)
  - Based on statistical regressions (inflow volume, elevation, time of year)
  - Pros
    - Very fast to run
    - Has been making good predictions
  - Cons
    - Does not model constituents (like total dissolved solids)
    - Will need updates to capture future mixing dynamics

- Work to compare SMB to CE-QUAL-W2
  - If they both agree – more confidence in forecasting
  - If not – learning opportunity to improve one/both

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Next Steps

- Continued model calibration
- Include more constituents
  - Dissolved oxygen, pH, nutrients (P, N)
- Develop best forecasting practices
- Transfer updated version to USBR
- Predictions under mgmt. alternatives (sEIS)

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Acknowledgments

- Many contributors to the long-term water quality monitoring program including Robert Radtke, Nick Voichick, Tom Sabol, Caitlin Andrews, Alex Walker, and Dean Sedgwick.
- Mentors that have provided model guidance including Scott Wells and Bethany Nielsen

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