BUREAU OF RECLAMATION

Improvements to Temperature Modeling Workflows

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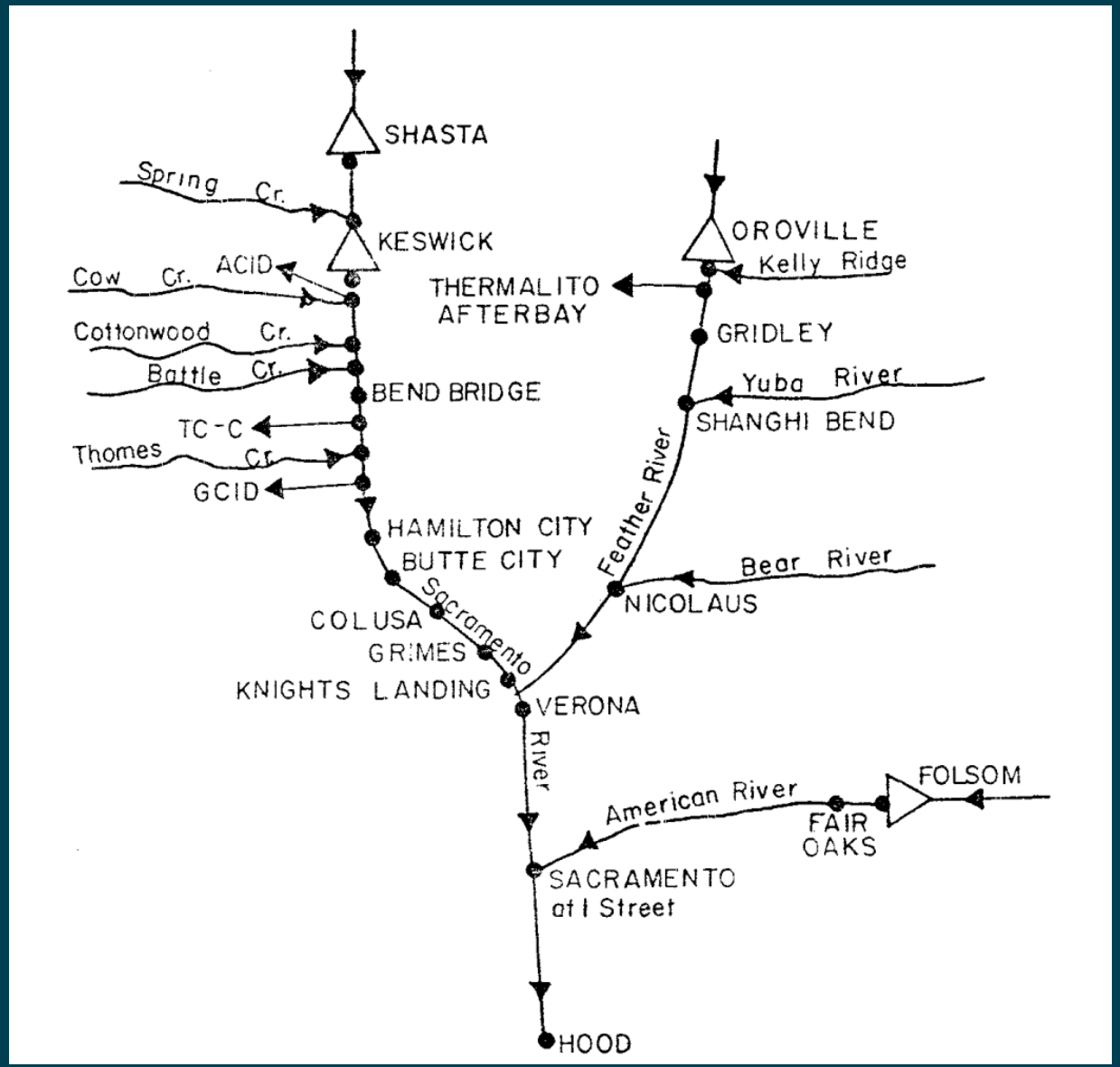
Overview

- HEC5Q
- Temperature questions
- Workflows
- Beyond Shasta
- Temperature dependent mortality
- Meteorology extension

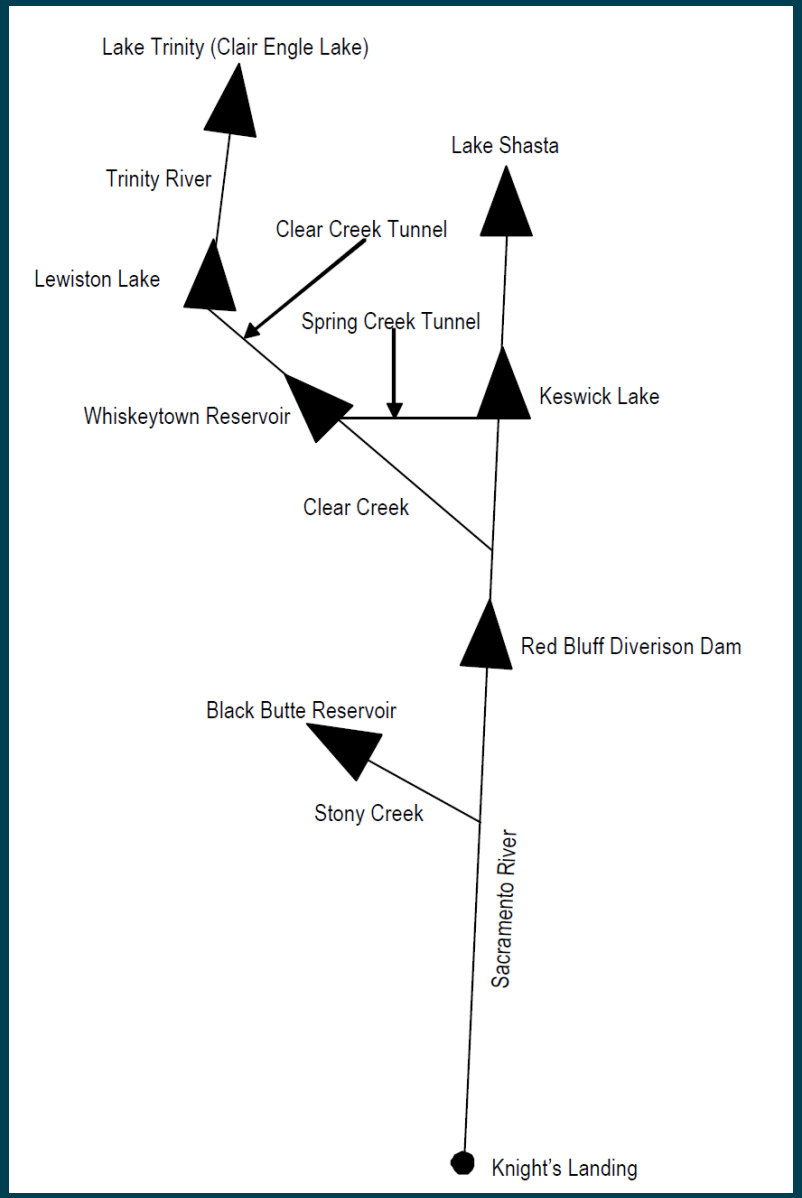


HEC-5Q: System Water Quality Modeling, USACE 1986.

HEC5Q

- USACE reservoir model began in 1973
- Initial water temperature logic added in 1979
  - Revised in 1997 to allow for multiple reservoirs and streams
- Additional water quality parameters added over time

- Initial CVP implementations date to early 1986
- Continuously updated with new data and logic improvements



Upper Sacramento River Water Quality Modeling with HEC-5Q: Model Calibration and Validation, RMA. 2003

Shasta Temperature Questions

What do we ask from our temperature models?

- Compliance location temperatures
- Cold water pool evolution
- Approximate shutter changes
- Seasonal management temperatures

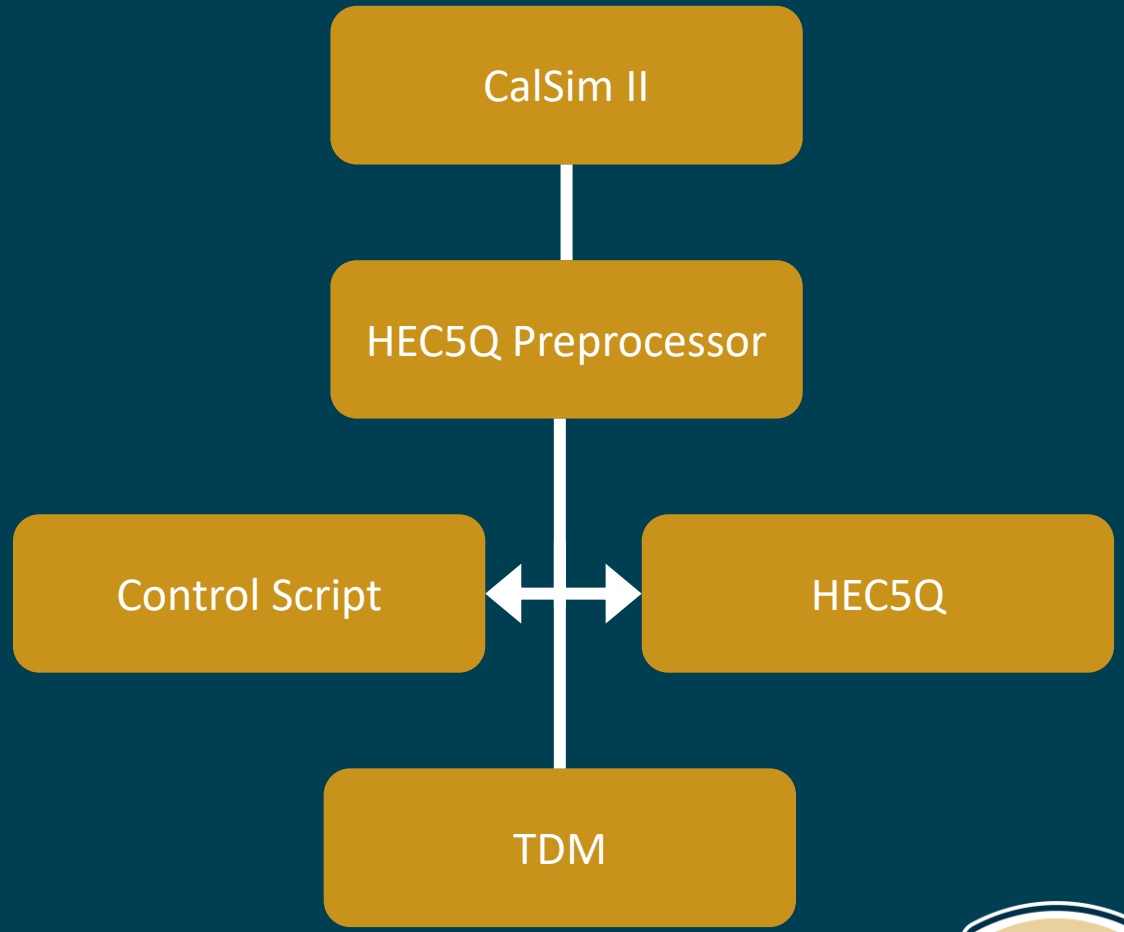
- Temperature dependent mortality

HEC5Q Workflow

- Preprocessors

- Position Analysis
- Carryover Analysis
- Continuous Analysis

- Temperature Dependent Mortality

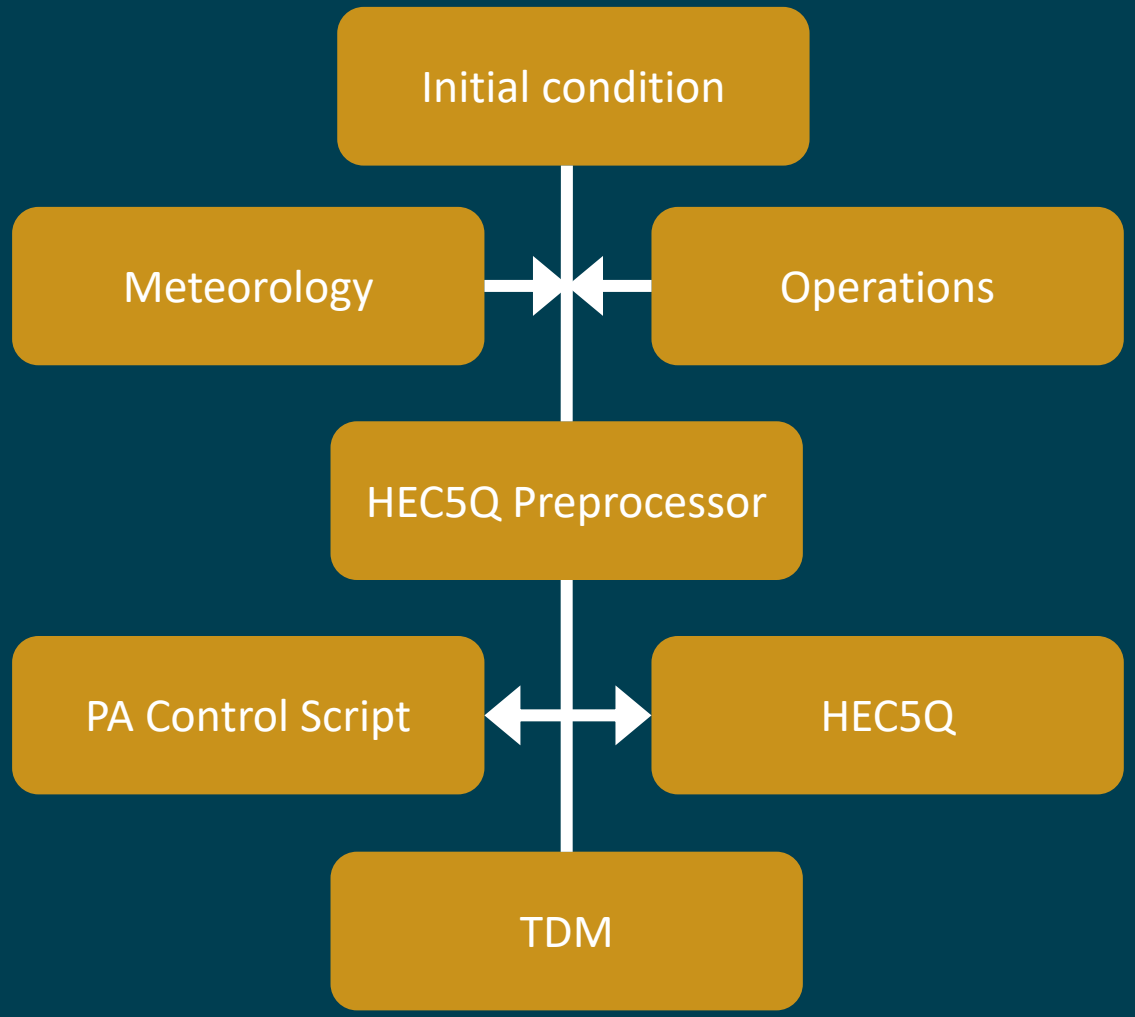


Preprocessors

- Hard coded to CalSim II inputs and period of record

- Rewrote from Fortran into Python
- Target HEC5Q template file directly to formulate inputs
- Allow selection of specific series by full name as well as DSS F part

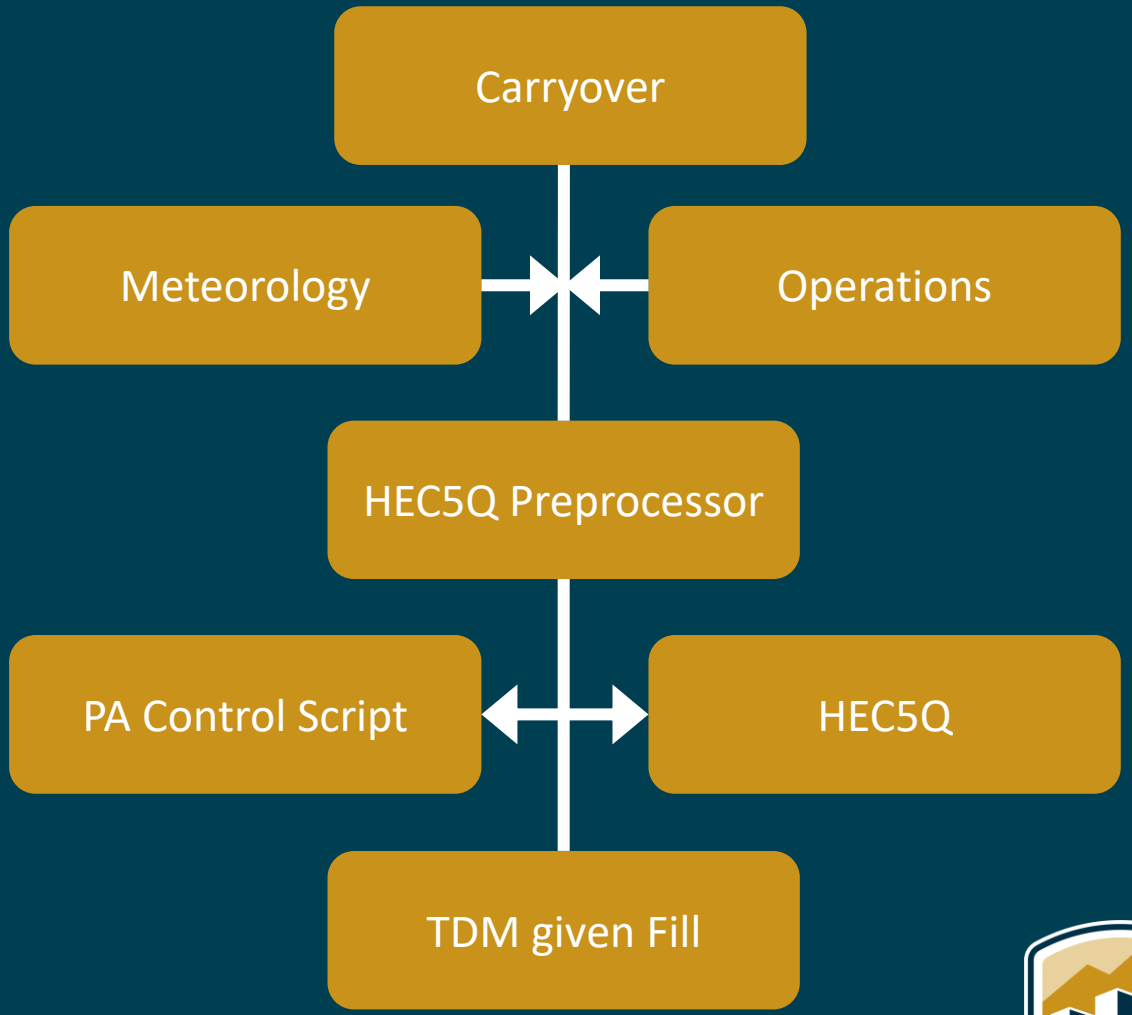
Position Analysis



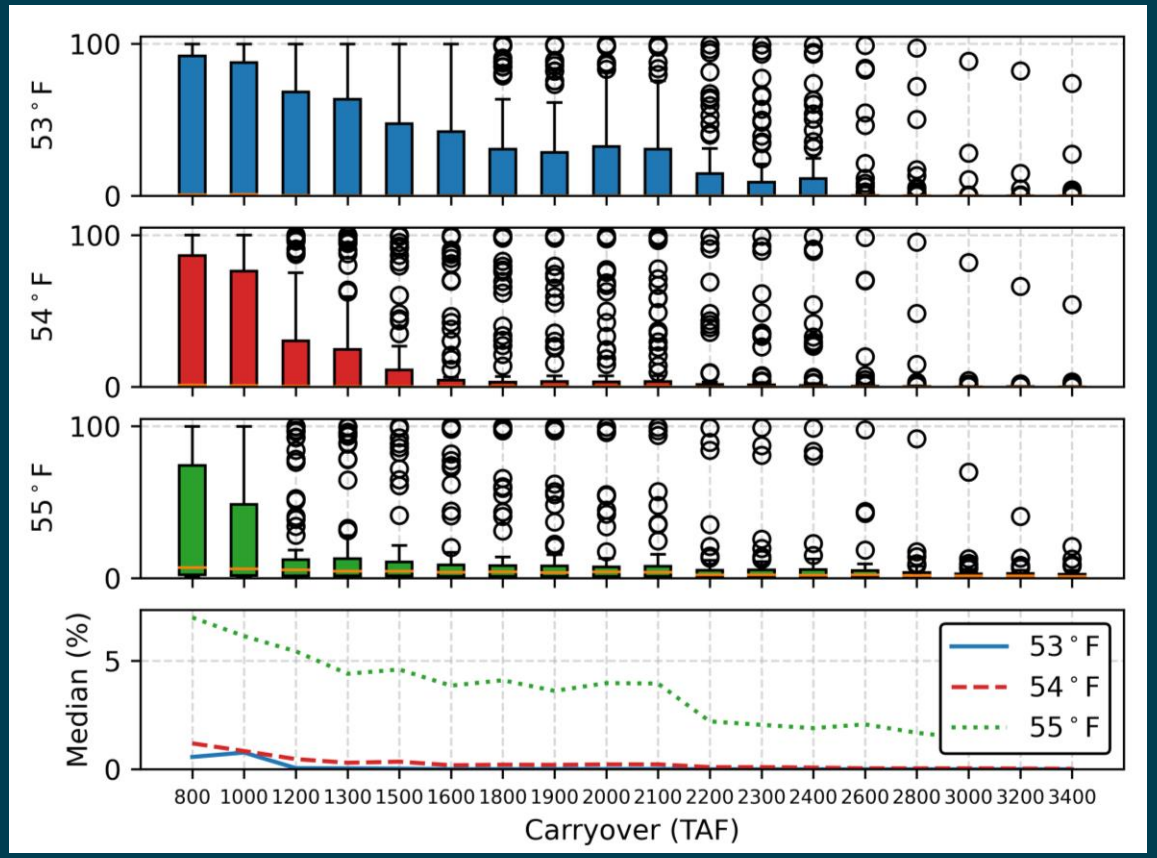
- Identify the range of future outcomes based on the same initial state
- Combine meteorologic conditions with projected operations
  - Meteorologic year by operations year
  - Meteorologic years across all operations years

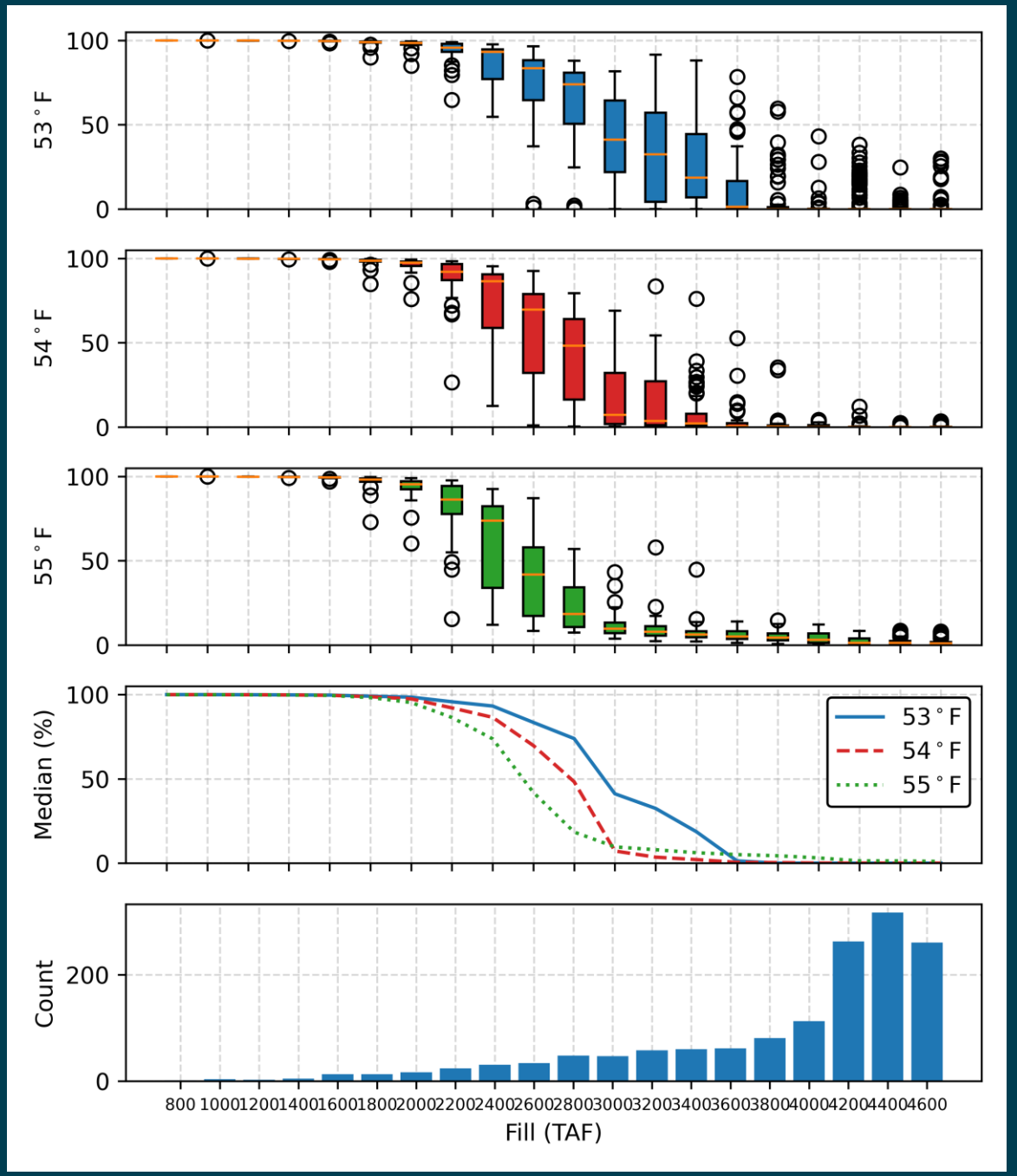
Carryover Analysis

- Identify the range of potential outcomes based on carryover
- Combine meteorologic conditions with projected operations
- Post process to obtain TDM by fill and carryover



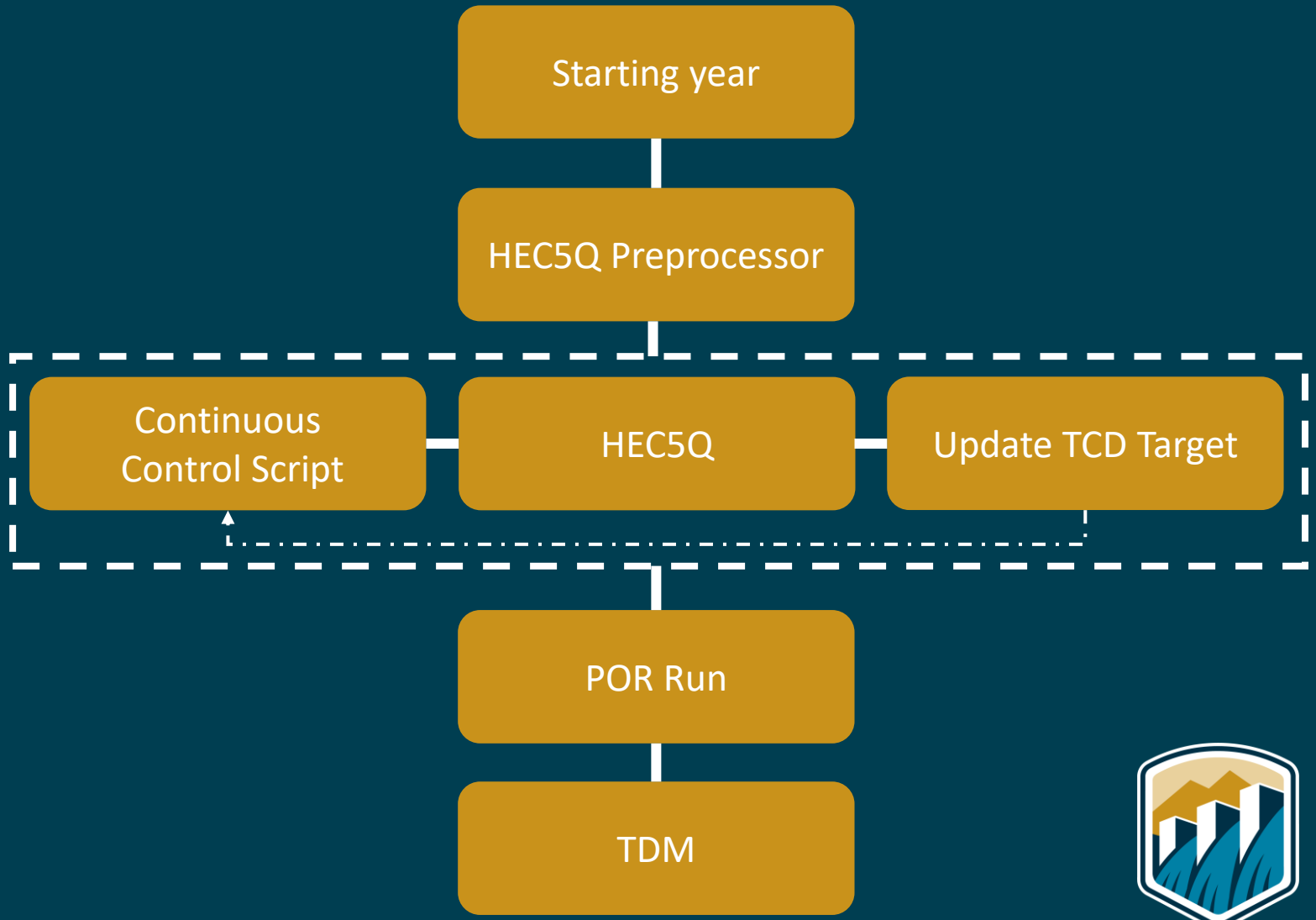
Carryover Analysis





Continuous Analysis

- Break period of record into separate annual periods
- Converge TCD operations by year to maximize cold water use
- Combine annual TCD target for period of record run



Beyond Shasta

- All HEC5Q workflows apply across all temperature managed basins
  - Able to use the logic by changing paths and temperature targets
- Preprocessor applies across all basins
  - Update template and meteorology, as necessary

- Standardizes and accelerates workflow
  - ~24 LTO carryover models @ 1 week per analysis
  - >50 LTO continuous models @ 1 day per analysis

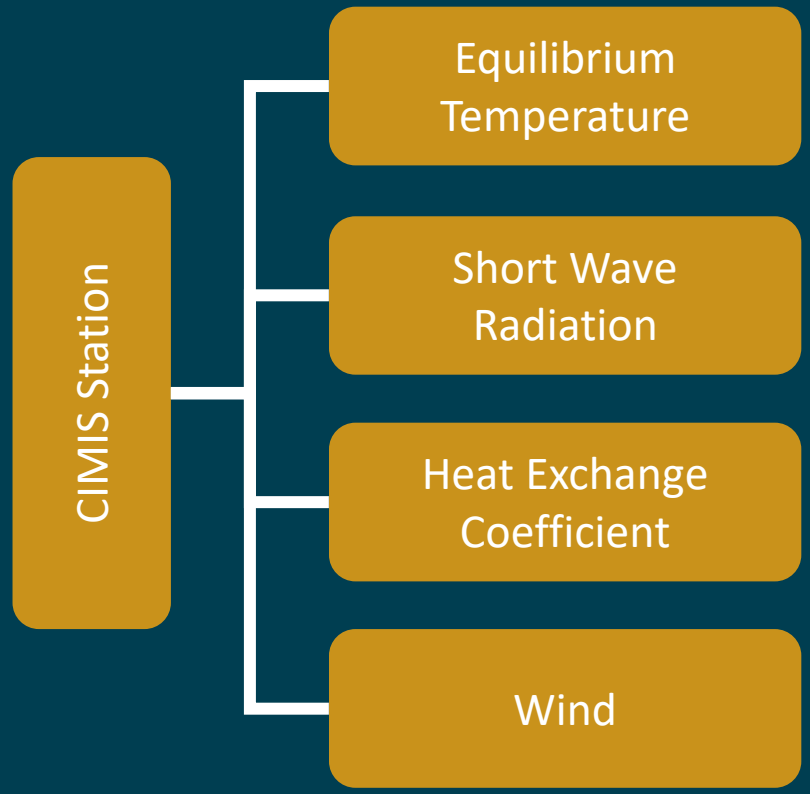
Temperature Dependent Mortality

- Brought TDM calculation back in house
- Wrote Python script to replicate Martin and Anderson SacPas

- Enabling capabilities
  - Run TDM in real time with temperature models
  - Explore uncertainty space of TDM parameterization
    - 8 million TDM runs to explore changing outcomes
  - Use as a temperature management objective

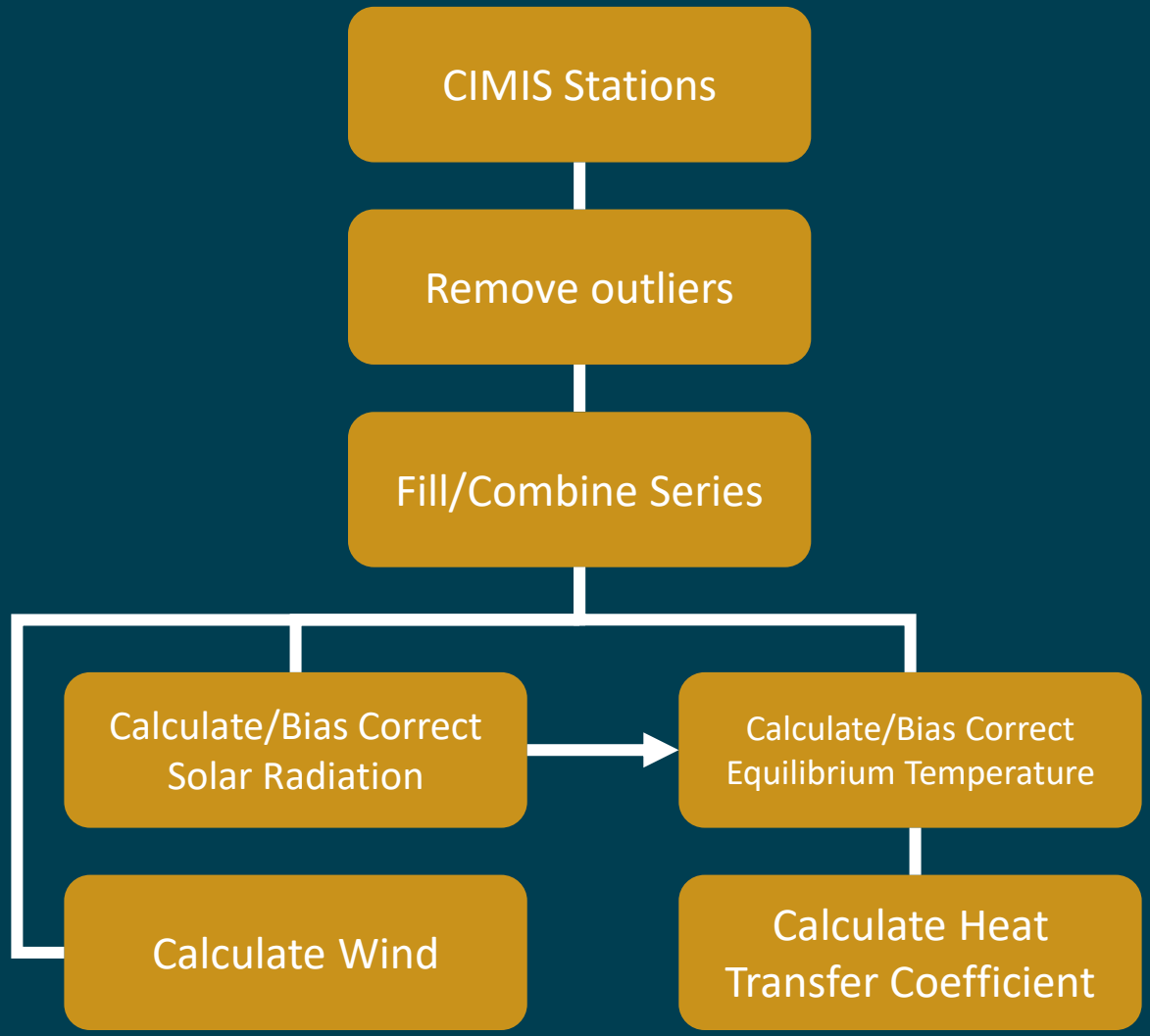
Meteorology Extension

- HEC5Q CalSim II meteorologic inputs cover 1921-2010
- HEC5Q CalSim 3 meteorologic inputs cover 1921-2015
  - Needed to extend HEC5Q inputs through 2021 to match new period
  - Initial extension done by DCR effort
- Revisit input development process to document and verify



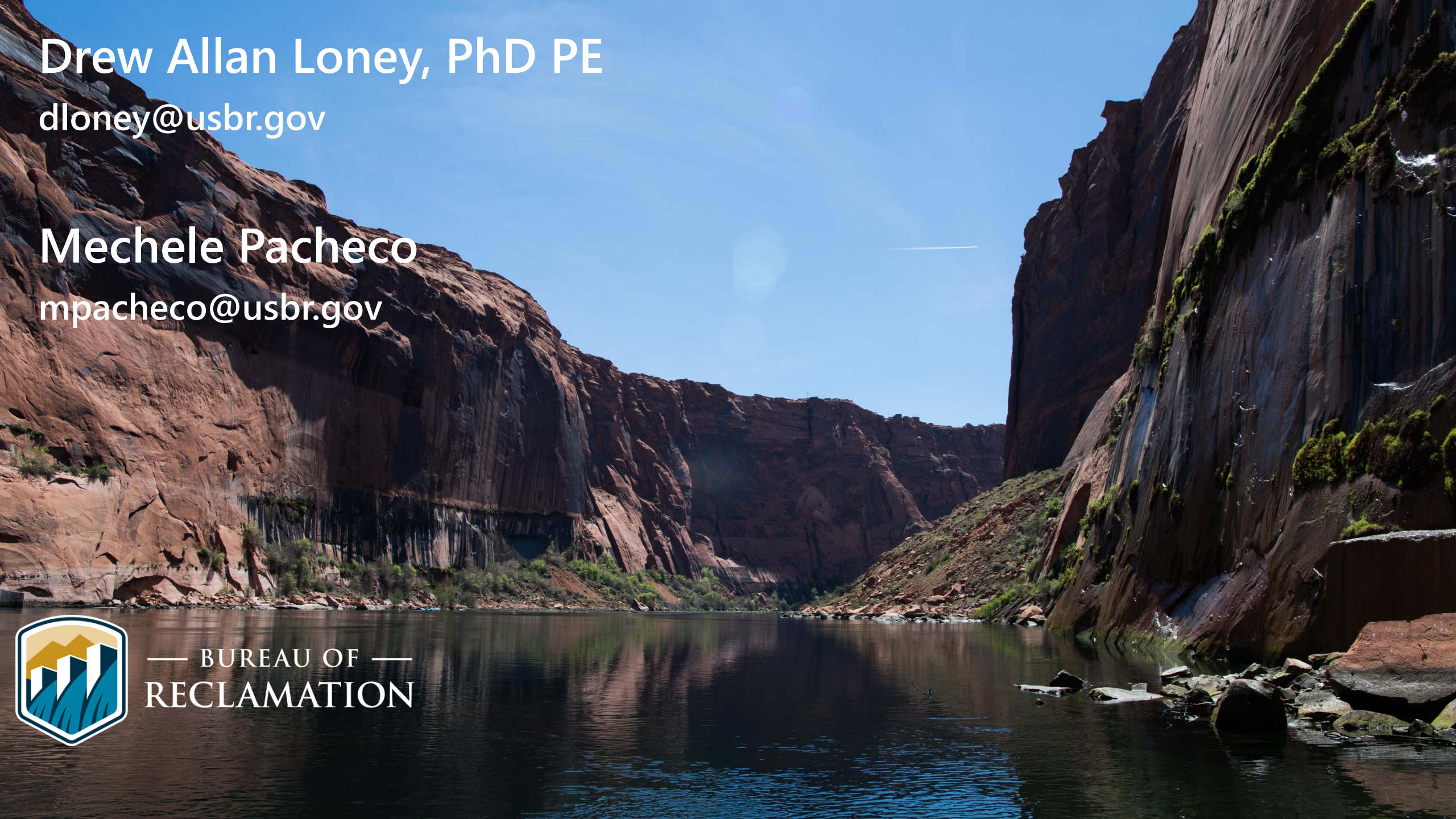
Meteorology Extension

- Gerber/Nicolaus stations end mid 2010's
- Combine multiple stations to form a single record
- Unable to verify some of the assumptions in the solar radiation formulation
  - Changes carry through to equilibrium temperature and heat transfer coefficient
- Use DCR extension as verification



Next Steps: WTMP

- Next generation temperature modeling framework for the CVP
- Uses HEC ResSim and CE-QUAL-W2 implemented in HEC-WAT
- Data management and reporting build into the framework
  - Accelerates modeling
  - Improves data quality
  - Standardizes reports
- A Reclamation instance is anticipated September 2023
- Some overlap period between HEC5Q and WTMP, but anticipating a rapid transition



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