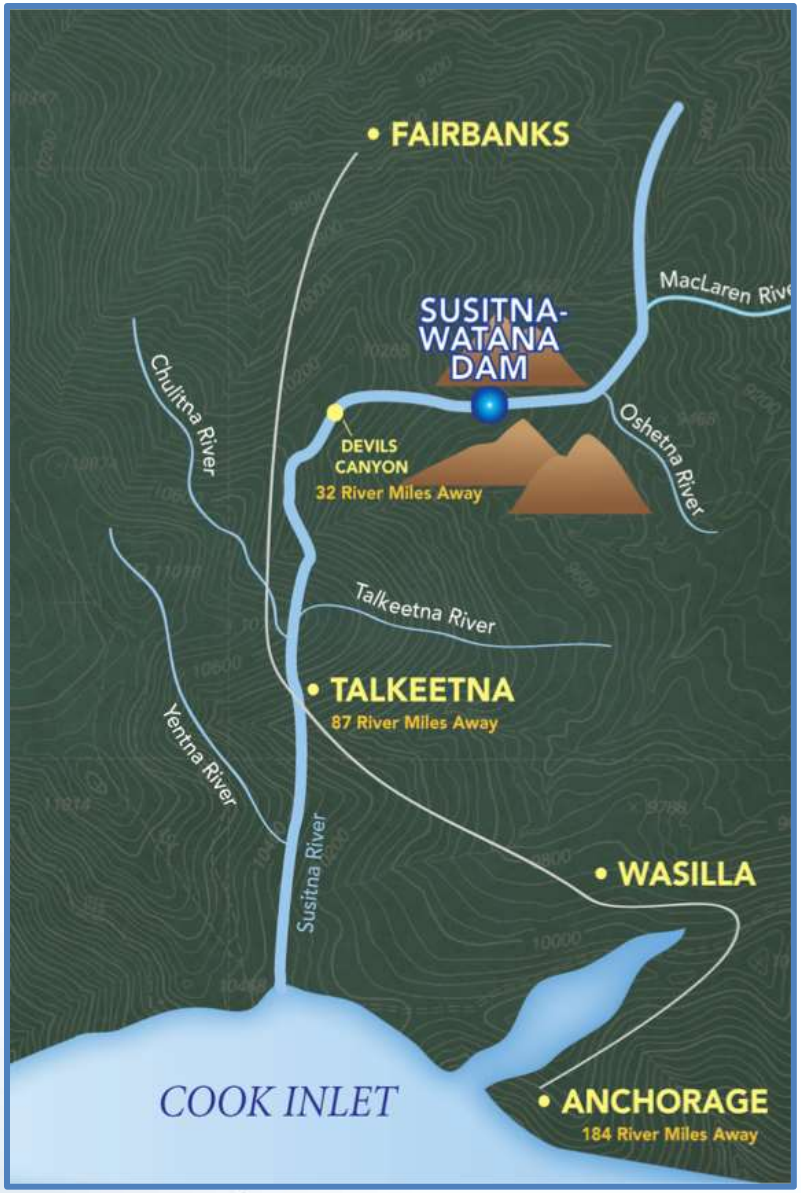

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Technical Team Meeting

Riverine Modeling Proof of Concept

Reservoir Water Quality Modeling

April 15-17, 2014

Prepared by Tetra Tech

Water Quality Modeling

- *Objectives*
  - *Predict temperature and nutrient and mercury cycling in the reservoir*
  - *Predict temperature, nutrients and mercury cycling in the downstream river for preexisting and post reservoir conditions*
  - *Predict fate and transport for organic contaminants and metals in the reservoir and riverine portion of the study area as required*
- *EFDC modeling framework*
  - *Hydrodynamic model*
  - *Temperature model*
  - *Nutrient cycling model*
  - *Solids and sorptive contaminant and/or metals transport and fate model*
  - *Mercury cycling model*

Hydrodynamic Model

- *Provides physical transport*
  - *Temperature and dissolved and suspended water quality constituents*
  - *Also fines suspended solids, mercury and potentially toxic organic and inorganic materials*
- *Three-dimensional reservoir hydrodynamics*
  - *The only hydrodynamic model of the reservoir*
  - *Generalized vertical coordinate formulation*
  - *Historical inflows and projected outflows*
  - *Consistent inflows and outflows from reservoir operations model*

Temperature Model

- *Temperature is equally important as transport for water quality processes*
  - *Reactions have significant temperature dependence*
- *Reservoir temperature model*
  - *The only reservoir temperature model*
  - *Full thermal balance including ground coupling*
  - *Includes ice dynamics with a range of complexity levels*
  - *Model capable of representing outflow from multiple levels*
- *Forcing functions*
  - *Synthesized annual time scale inflow temperature*
  - *Historical and synthesized atmospheric thermal forcing*

Nutrient Cycling Model

- *Consistent state variables between reservoir and river*
- *Available State Variables*
  - *DO, POC, DOC*
  - *NH3, NOX, PON, DON*
  - *PO4d, PO4p, POP, DOP*
  - *Optional labile and refractory organic class splits*
  - *Multiple algae species*
- *Optional sediment diagenesis model*
  - *Sediment oxygen demand and nutrient fluxes*
- *Ice related effects accounted for*
  - *Re-aeration*
  - *Light attenuation*

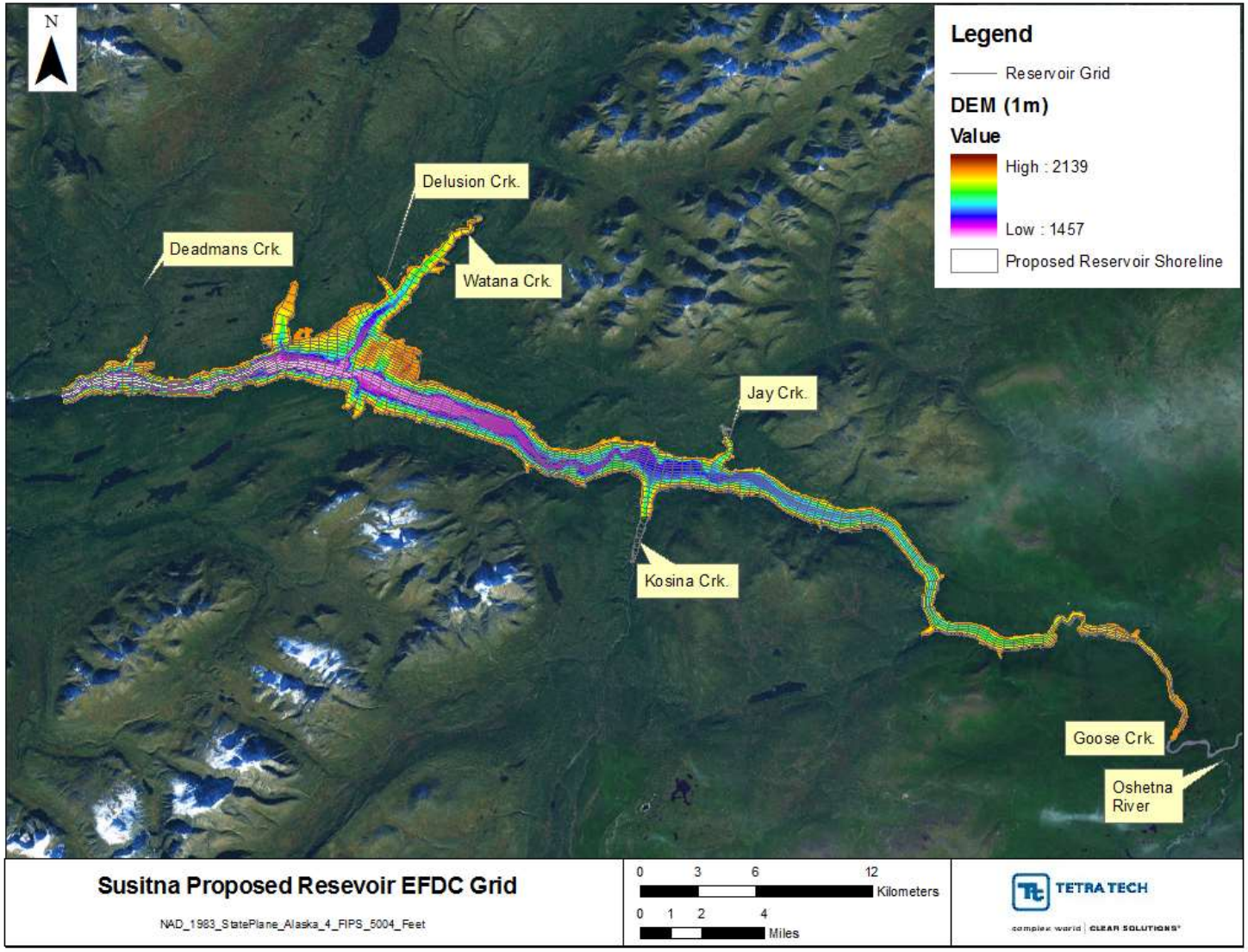
Solids and Sorptive Contaminant Transport and Fate Model

- *Solids Transport*
  - *Two solids classes representing fine silt and clay*
  - *One or more classes of organic solids from nutrient cycling model or externally specified*
- *Reservoir solids transport*
  - *Only model of fine sediment trapping in reservoir*
  - *Critical for representing light attenuation for water quality processes*
- *Contaminant transport and fate*
  - *Arbitrary number of sorptive (organics and metals) contaminants*
  - *Three phase equilibrium partitioning including DOC complexated*
- *Provides framework for to reservoir mercury model*

Model Spatial Resolution

- *Spatial resolution of reservoir model optimized for multi-year time to decadal time scales simulations*
- *Reservoir modeling challenged by up to 60 m pool level fluctuations with drying of shallow areas*
- *Reservoir model domain and resolution*
  - *75 to 150 m lateral resolution*
  - *400 to 800 m longitudinal resolution*
  - *On the order of 1400 horizontal grid cells*
  - *2.5 to 25 m vertical resolution (subject to change)*
  - *Current version has 20 vertical layers in deepest region*

Reservoir Model Horizontal Grid



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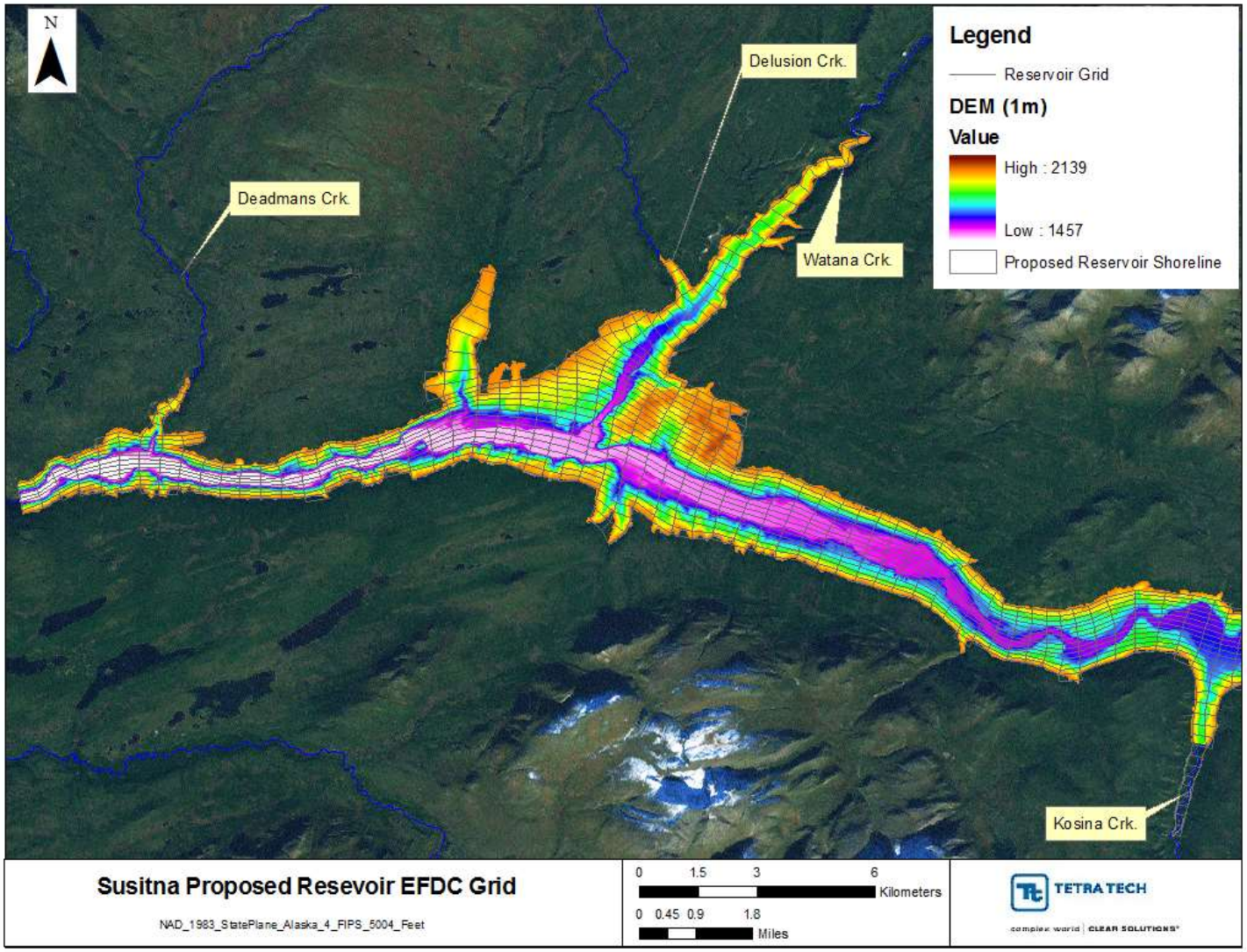
Reservoir Model Horizontal Grid



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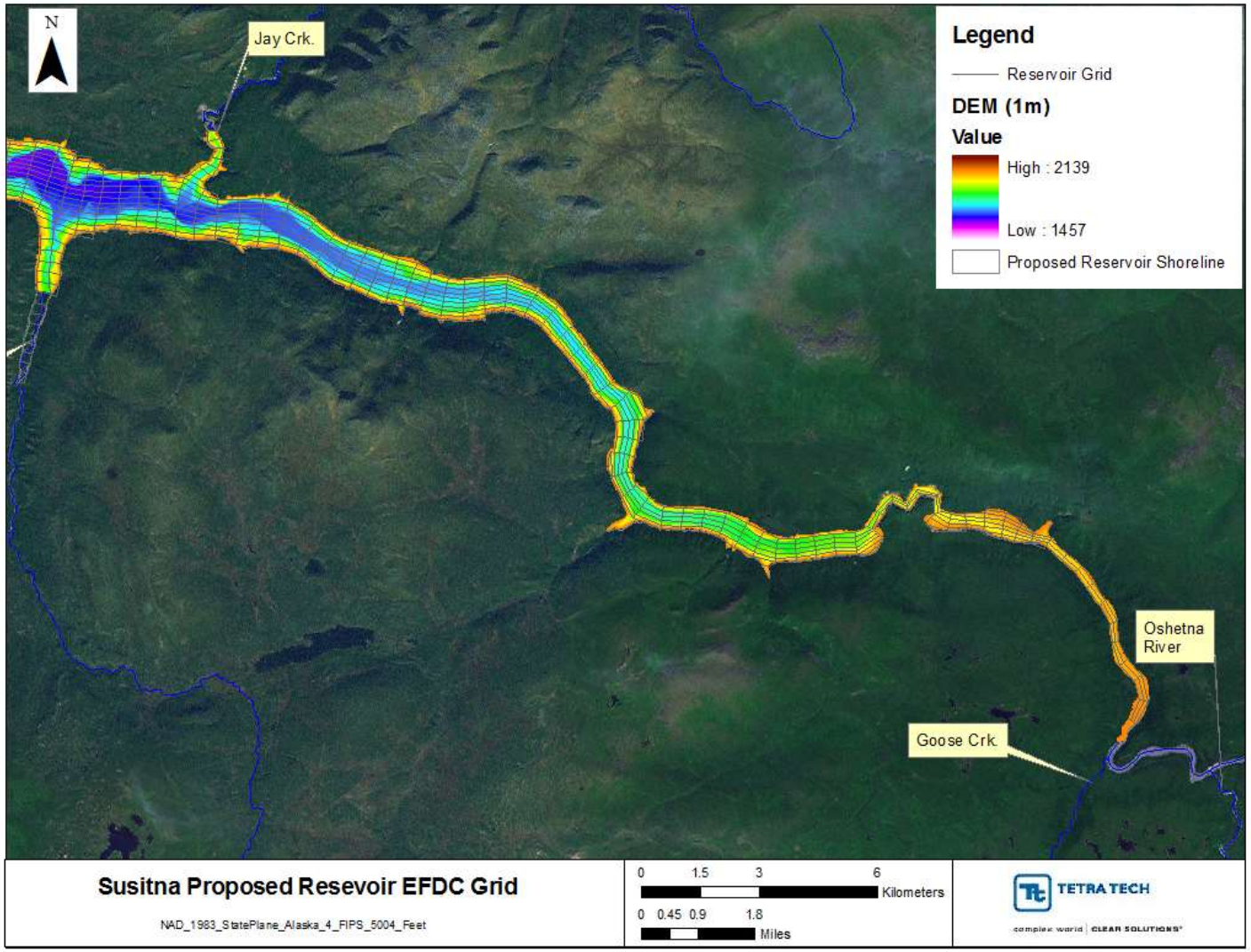
Reservoir Model Horizontal Grid



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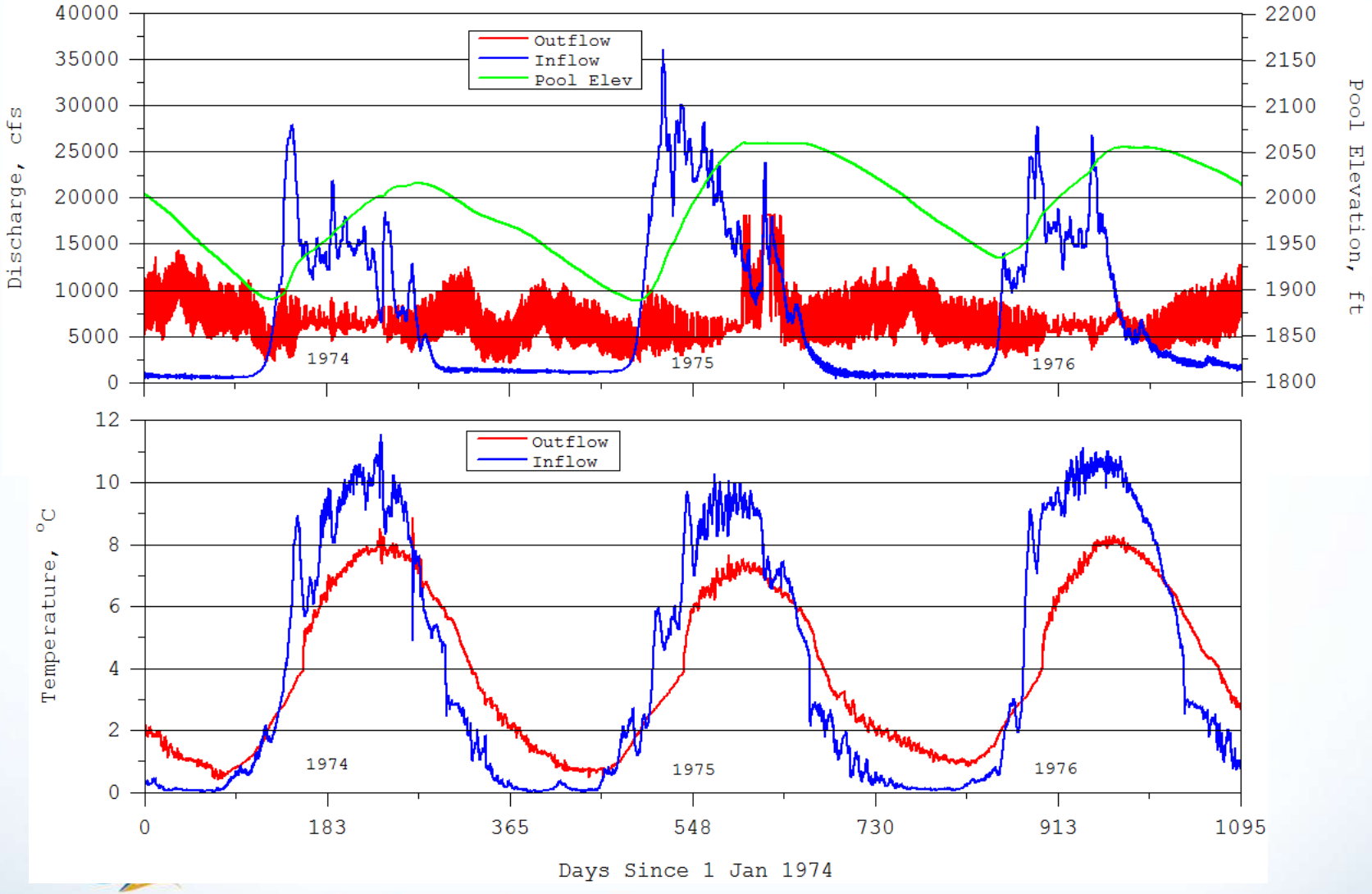
Proof of Concept Simulations

- *Focus on temperature simulation*
- *Two multiple year simulation periods*
  - *1974-1976 Dryer with large pool draw down*
  - *1979-1981 Wetter with small pool draw down*
  - *Longer simulations needed for dynamic temperature equilibrium*
- *Synthesized inflow temperature and historical atmospheric thermal forcing*
- *Currently reservoir outflow is from 1800 ft to surface, with multiple level outflow possible when design information becomes available*
- *Out flow and out flowing temperature provided to river water quality*

1974-76 Simulation



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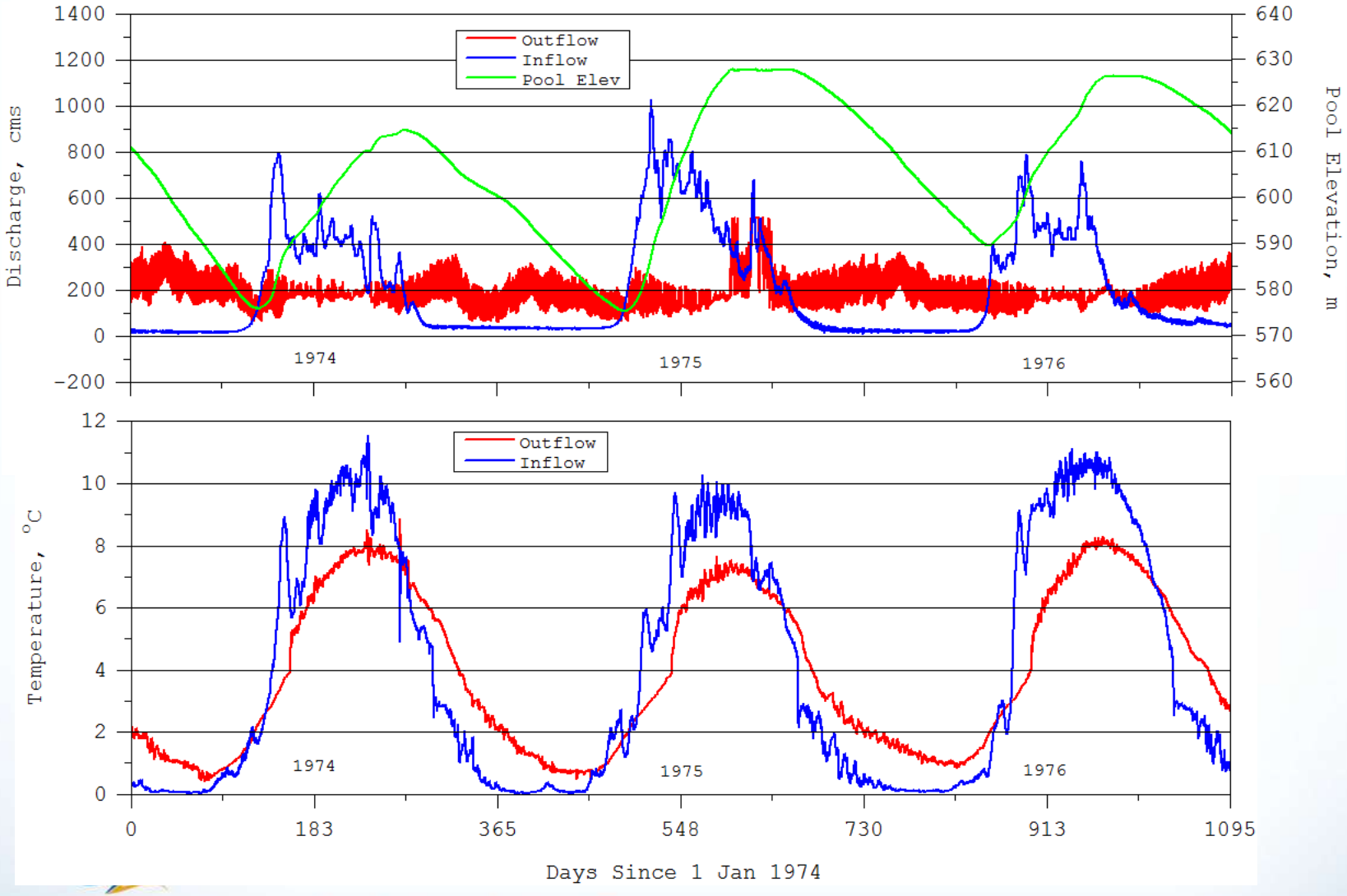
1974-76 Simulation (metric)



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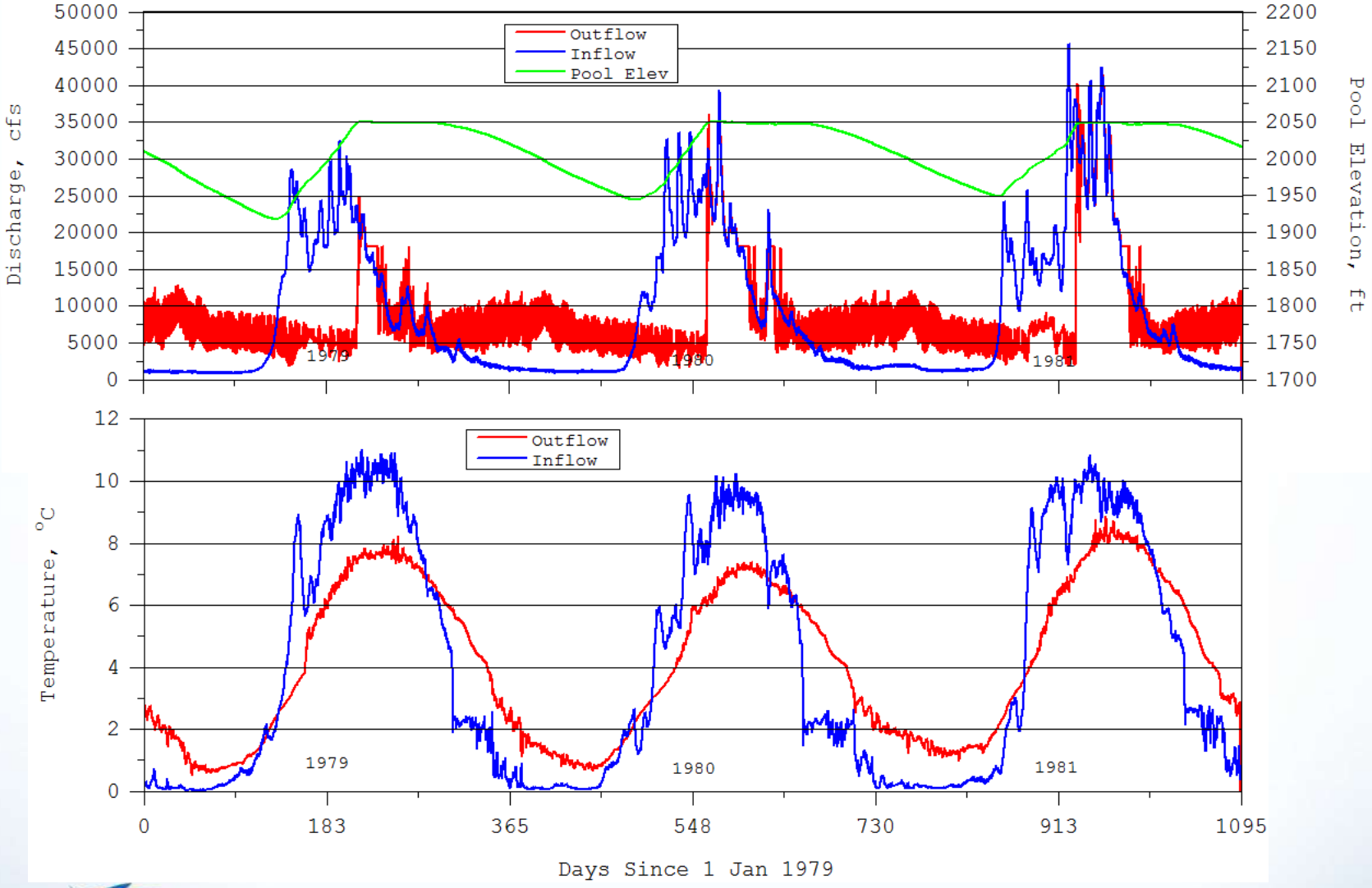
1979-81 Simulation



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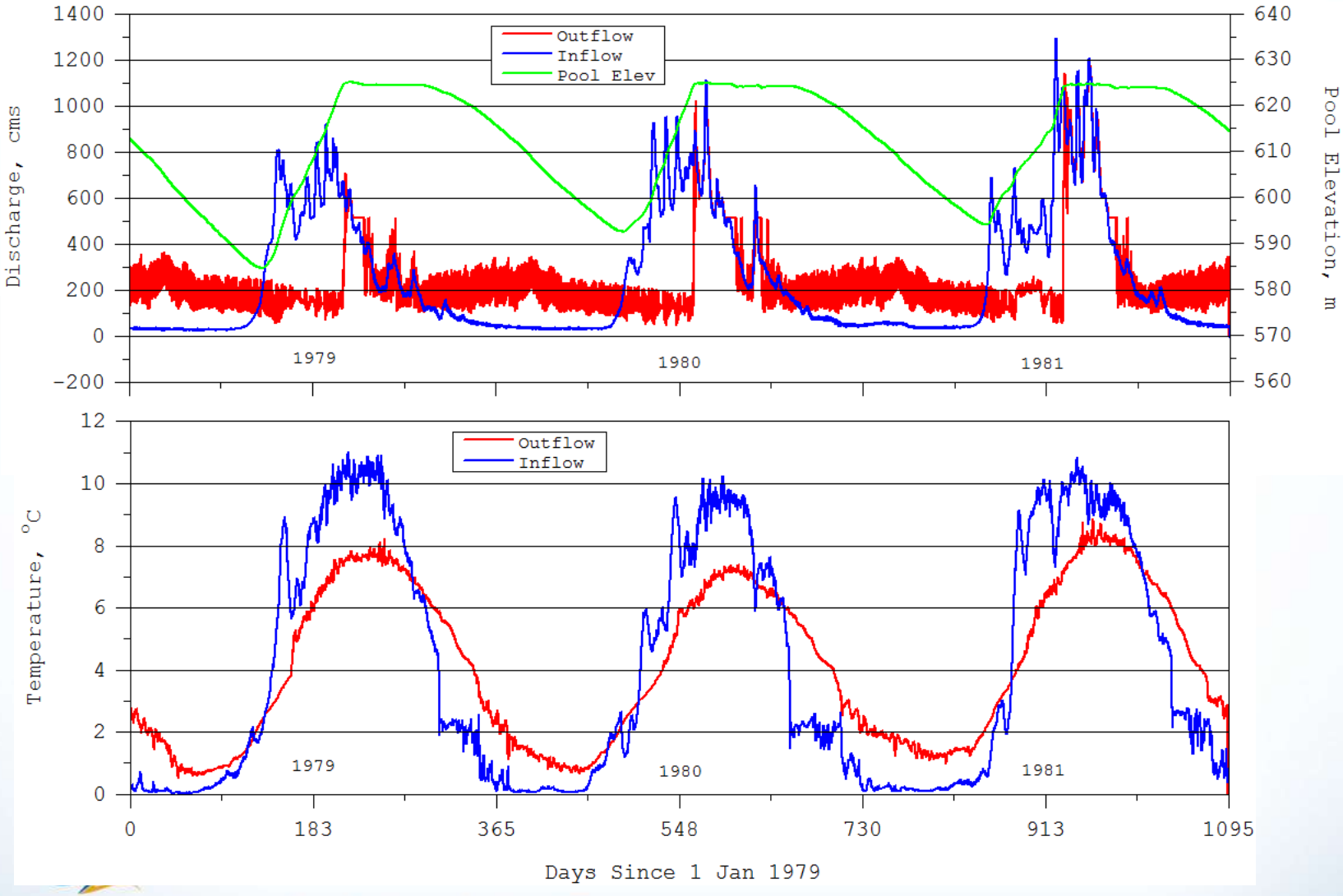
1979-81 Simulation (metric)



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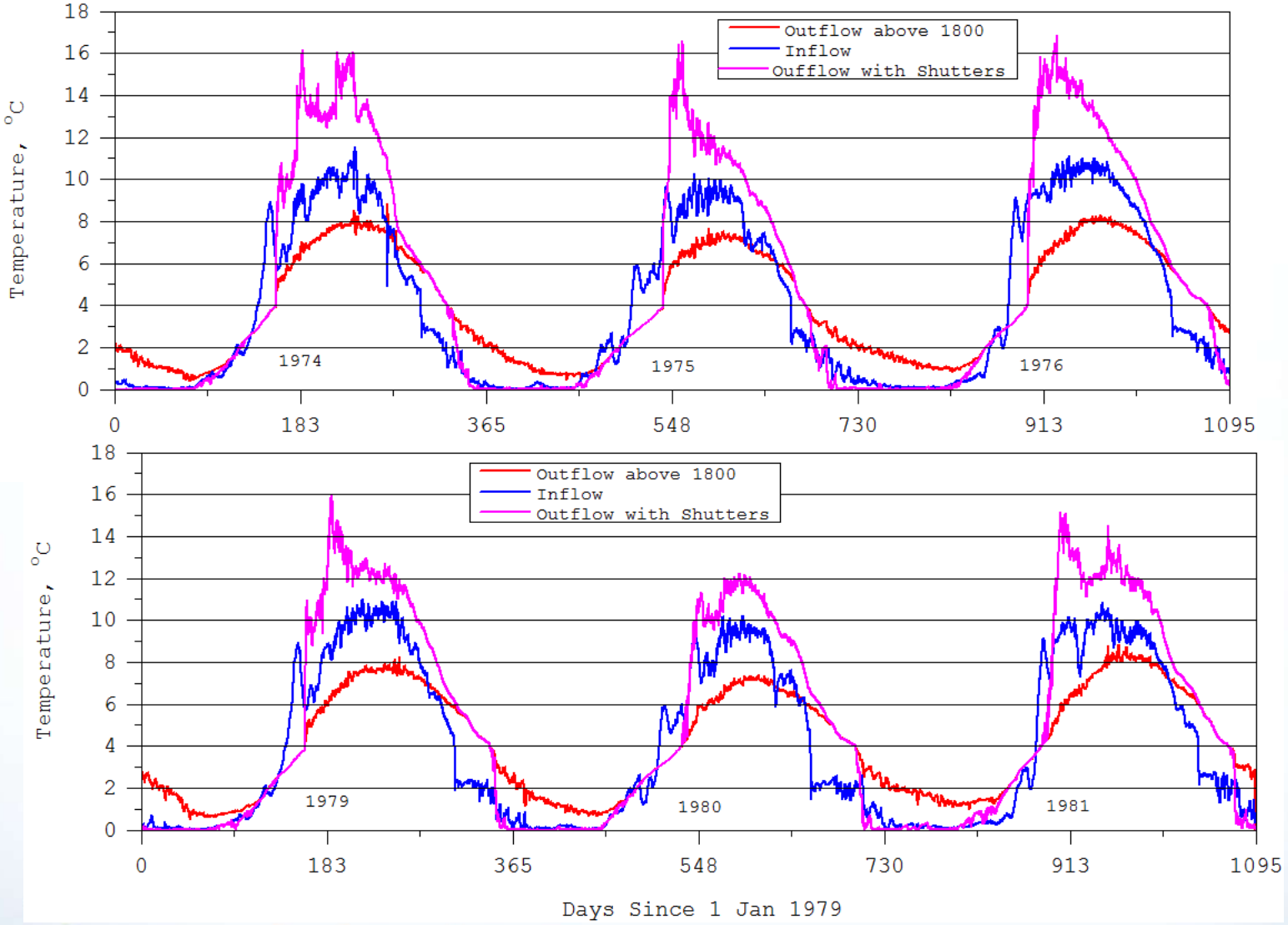
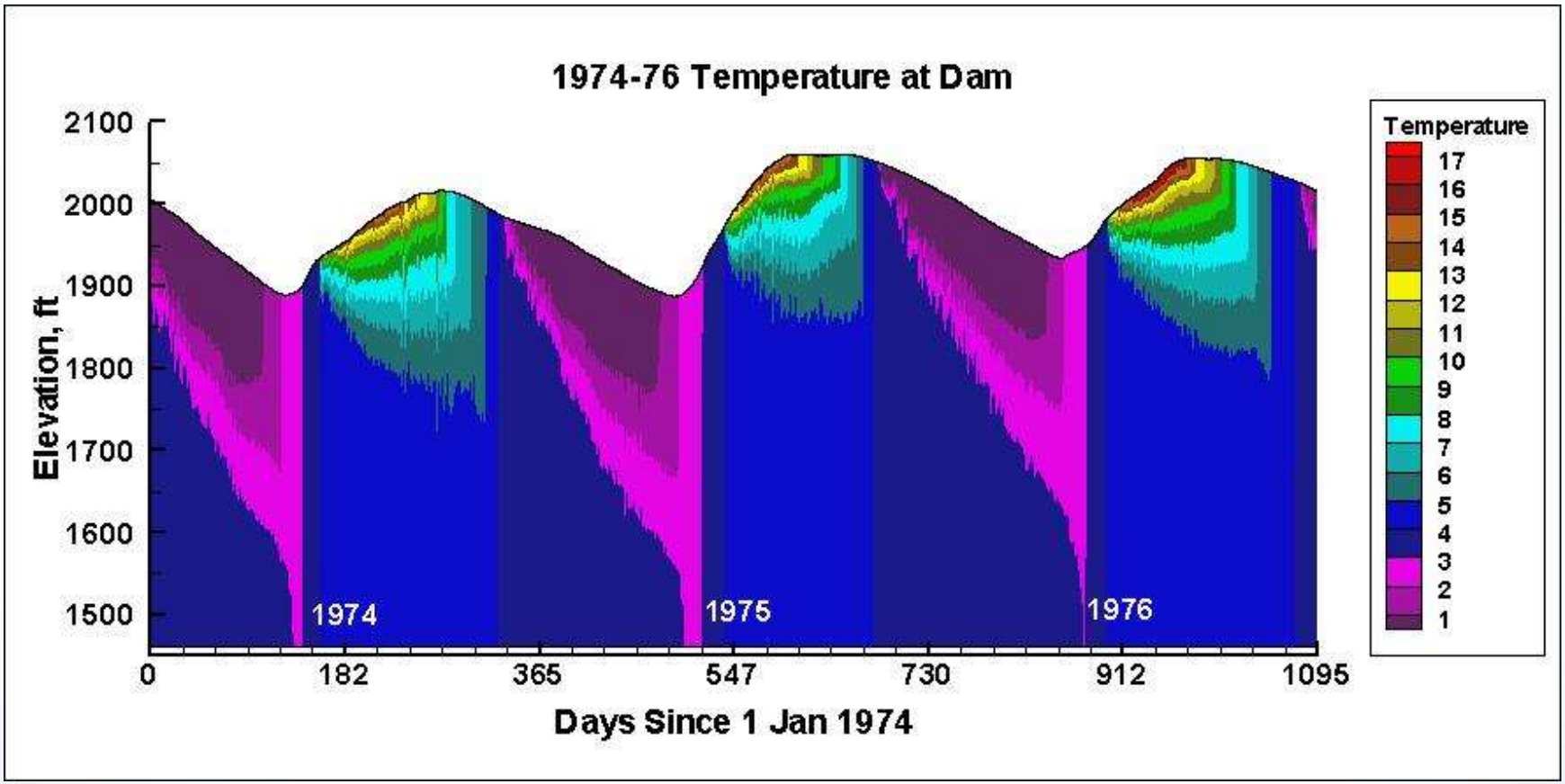
Outflow Temperature



1974-76 Simulation



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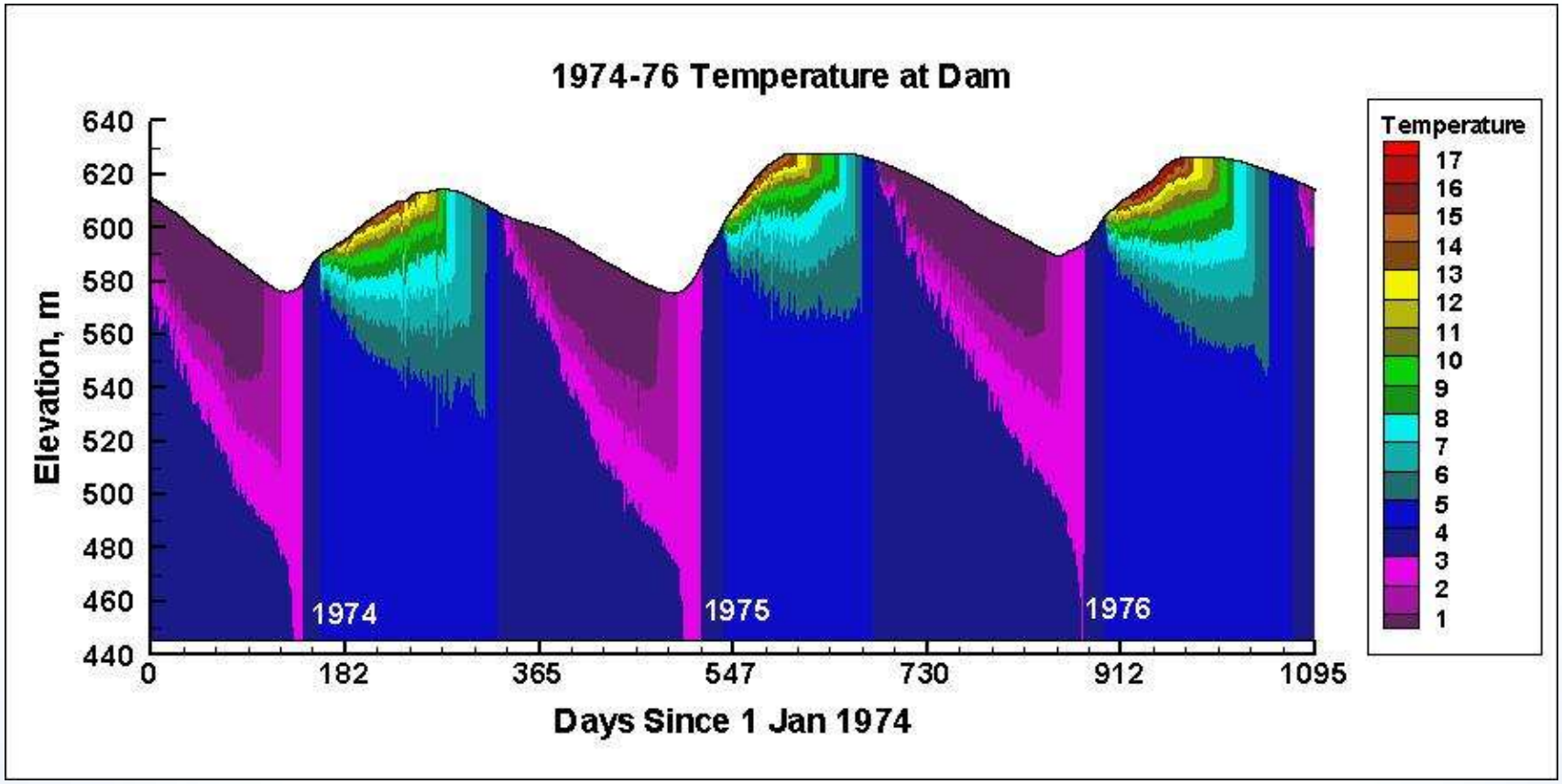
1974-76 Simulation (metric)



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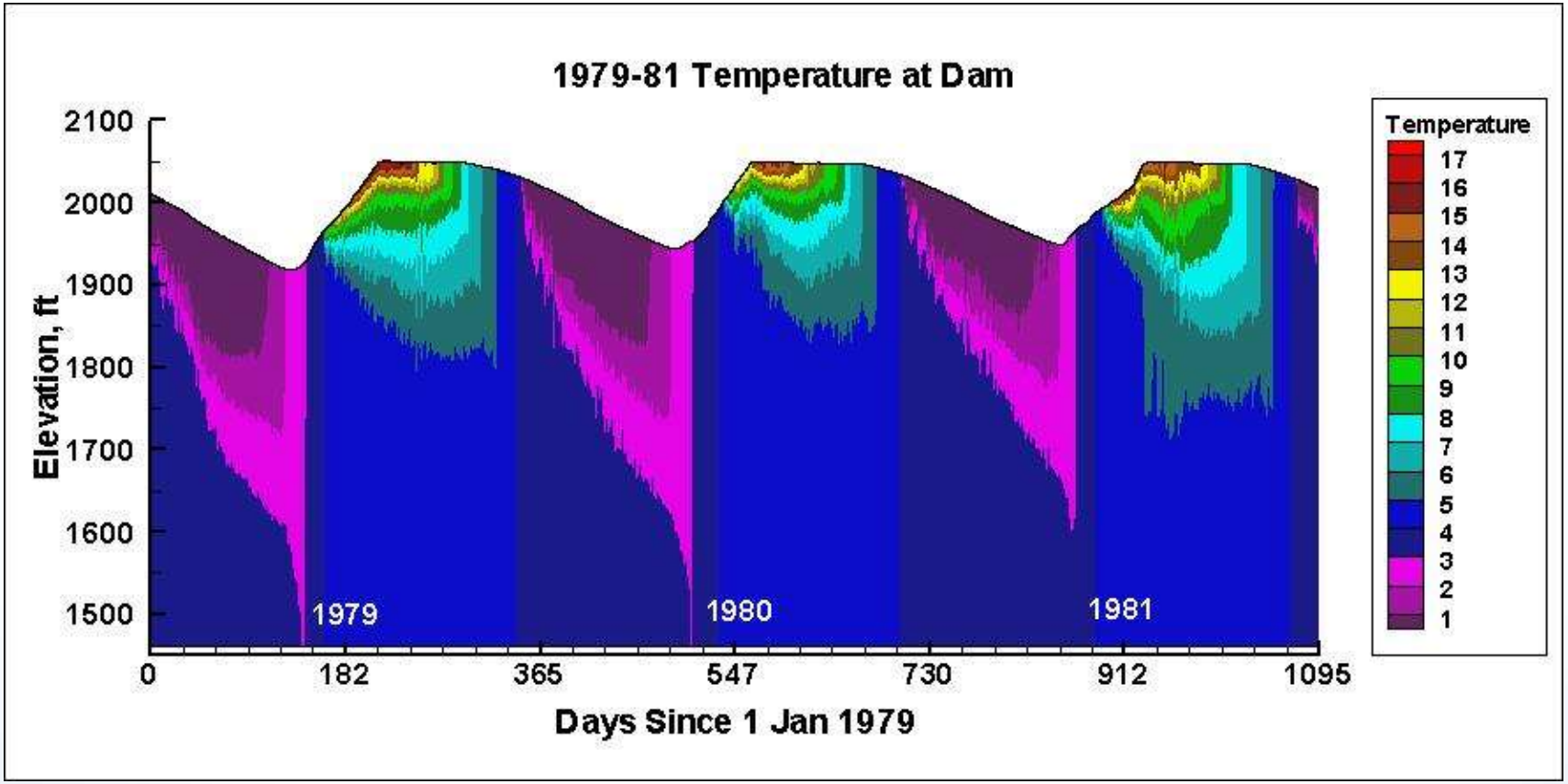
1979-81 Simulation



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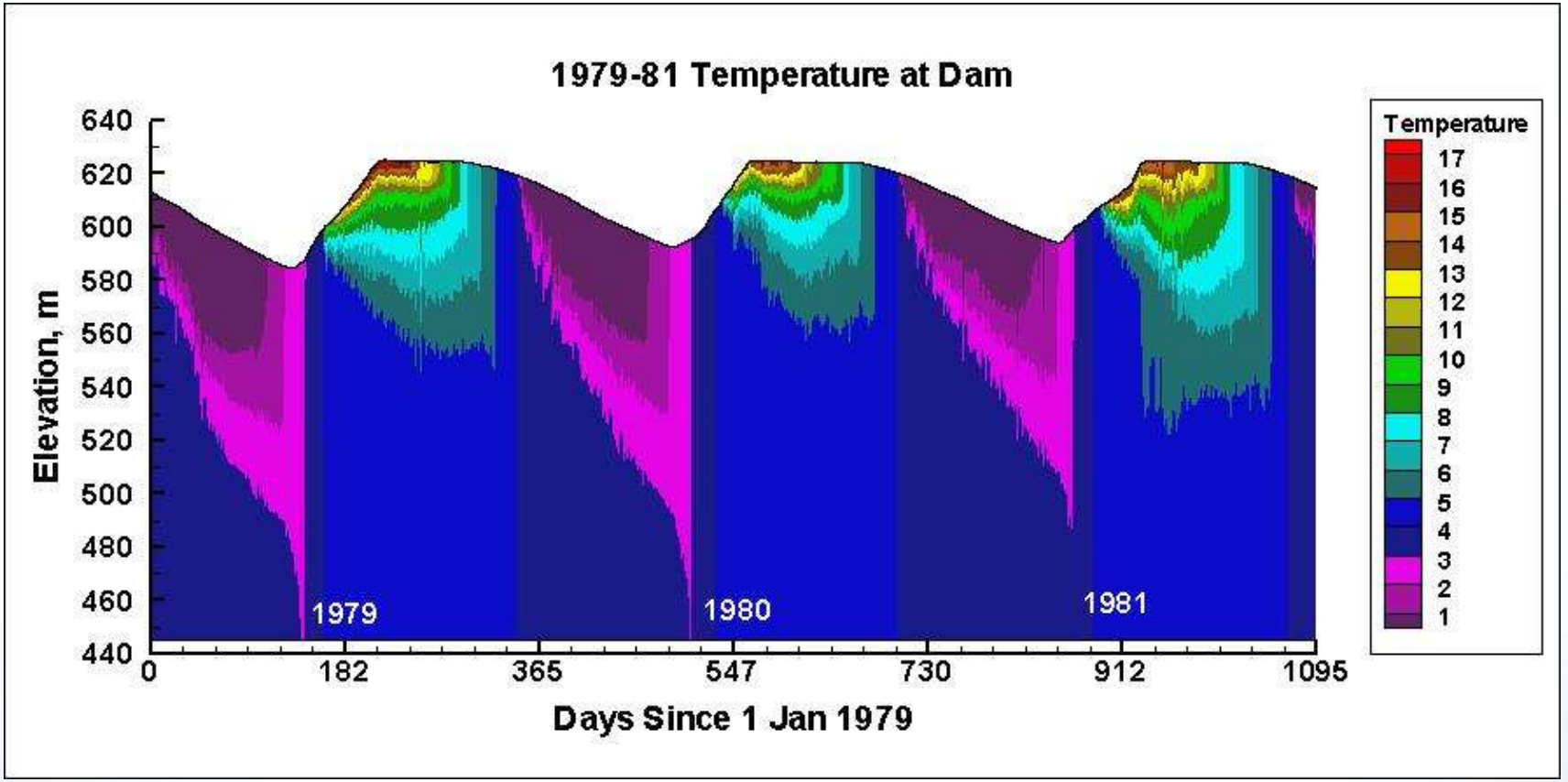
1979-81 Simulation (metric)



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Status of the Reservoir Model

- *Model configured for 61 year historical-operational scenario with temperature and fine suspended solids*
- *Simulated 1974-76 and 1979-81 operational scenarios*
  - *Demonstrates multi-year temperature simulation with large pool level fluctuations*
  - *Demonstrates that vertical resolution captures thermal stratification and mixing processes*
- *In progress*
  - *Sensitivity analysis of temperature simulations*
  - *Completing suspended solids transport to evaluate reservoir trapping and provide downstream river loading*
  - *Further evaluation of reservoir ice sub-model*
  - *Completing configuration of nutrient cycling and mercury models*