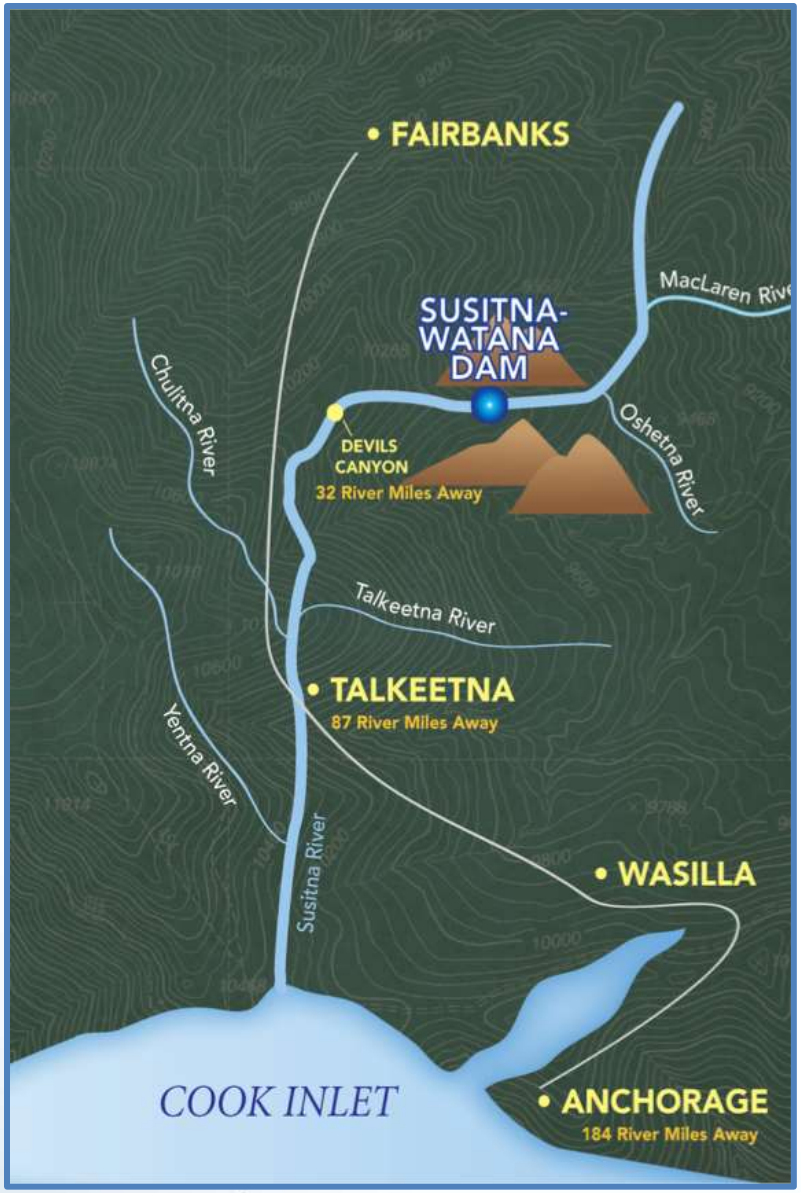

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Technical Team Meeting

Riverine Modeling Proof of Concept

Riverine Water Quality Modeling

April 15-17, 2014

Prepared by Tetra Tech

Riverine TT Meeting – Issues/Questions Raised

- Enhanced resolution in the Focus Areas (100m longitudinally and 30m laterally).
- How will groundwater be used in the Focus Area models?
- Model Integration; reduce duplication of modeled parameters.
- Sediment accretion behind the dam; will be included in the Reservoir Model.

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

- *Two-dimensional river hydrodynamics*
  - *One of five river hydrodynamic models including three 1-D models and two limited area 2-D modeling*
  - *Coarser 2-D model of the entire river*
  - *Finer 2-D models of focus areas*
  - *Dedicated river hydrodynamic model for water quality ensures consistent space and time scale resolution between hydrodynamics and water quality transport*
  - *Eliminates cumbersome model linkages*

Temperature Model

- *Temperature is equally important as transport for water quality processes*
  - *Reactions have significant temperature dependence*
- *River temperature model*
  - *One of two river temperature models*
  - *Primarily focused on open water conditions*
  - *Can import ice cover information from Ice Routing Model or use observation based space and time varying ice cover*

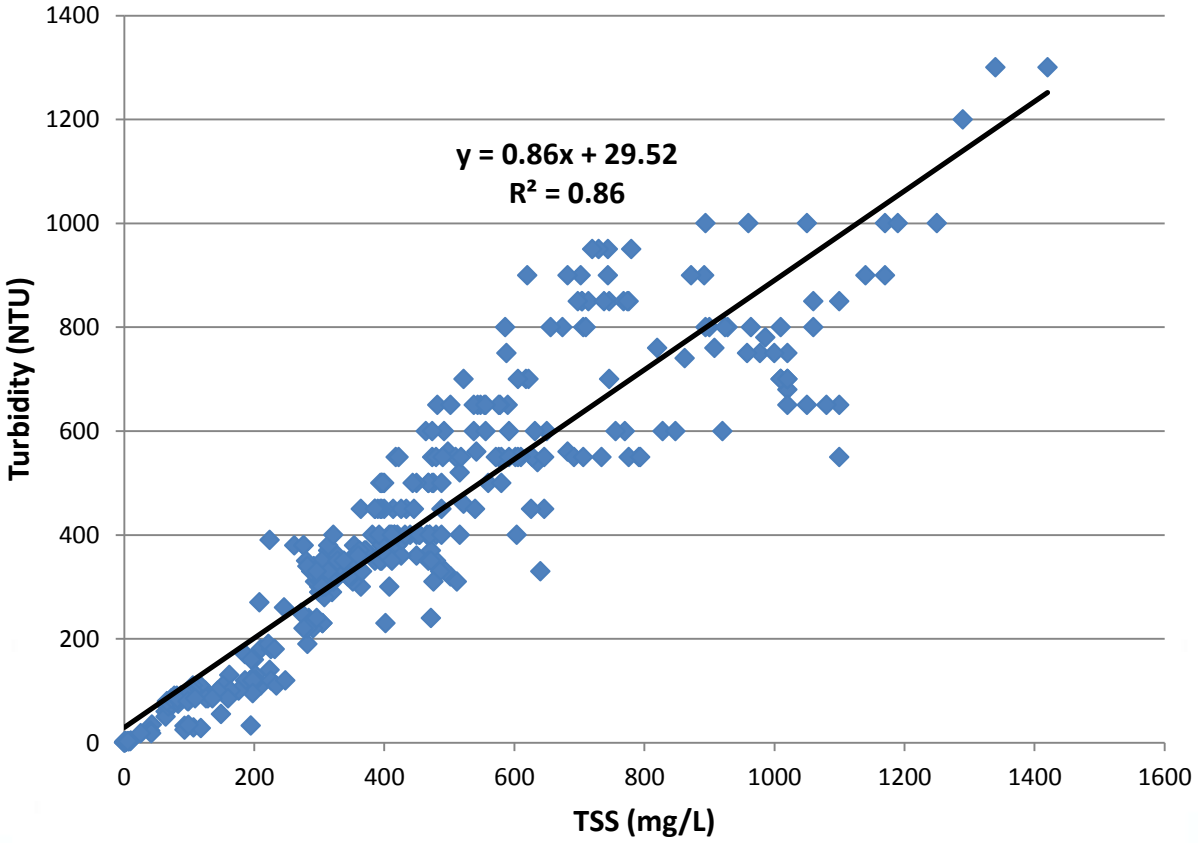
Nutrient Cycling Models

- *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*
- *Riverine solids transport*
  - *Compliments riverine sediment transport modeling*
  - *Suspended solids concentrations 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 river mercury model*

Predicting Turbidity from TSS



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Model Domain and Spatial Resolution

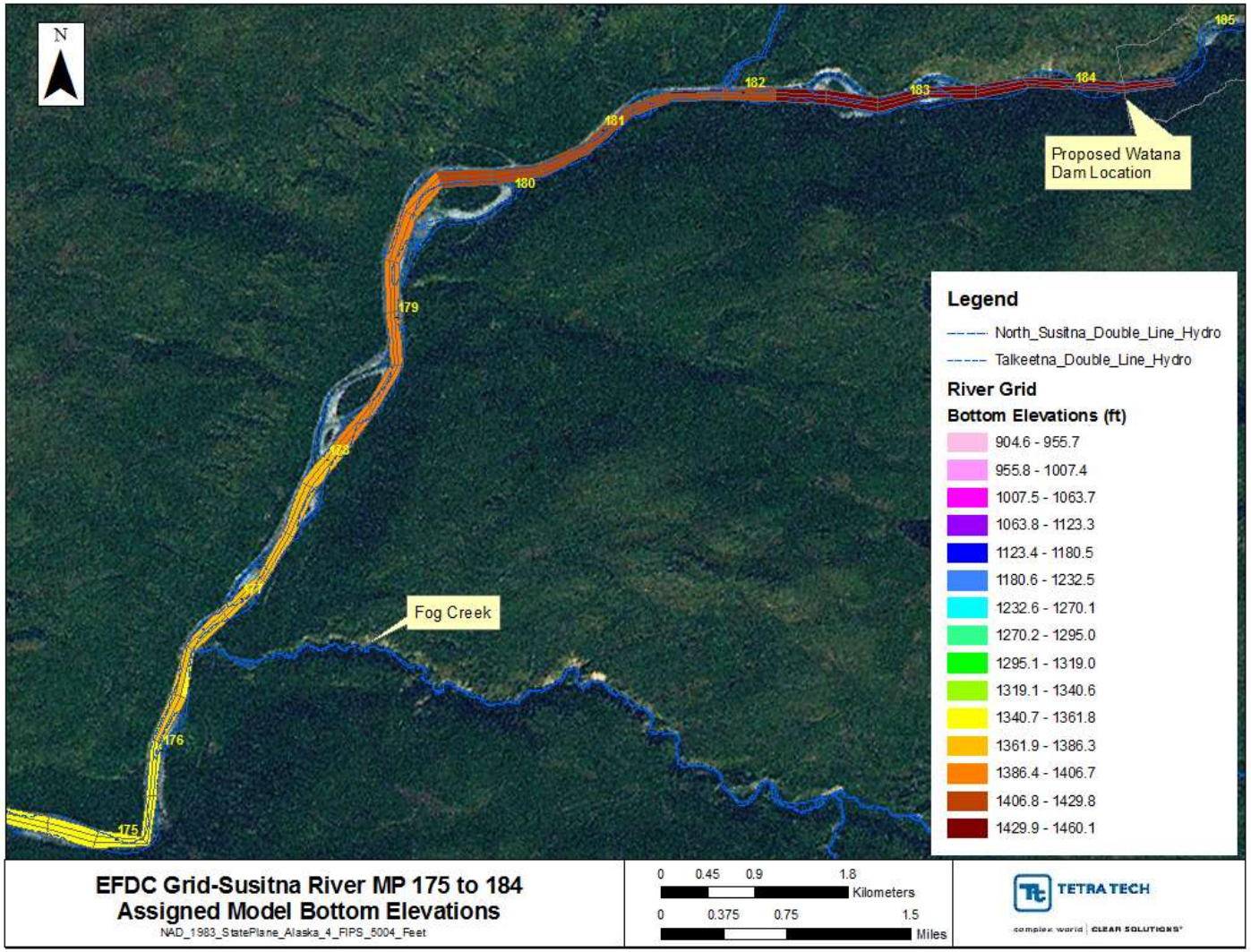
- *Model domain*
  - *Consistent with other river models*
  - *Dam site to approximately river mile 30*
- *Spatial resolution of river model optimized for multi-year to decadal time scales simulations*
- *Multiple spatial resolution versions of the river model*
  - *Coarser resolution for entire river*
  - *Finer resolution for focus areas*

Model Domain and Spatial Resolution

- *Middle River resolution*
  - *3 to 7 cells laterally in bank in Middle River with transition to and from higher resolution in Focus Areas*
  - *800 to 3000 ft (250 to 1000 m) longitudinal resolution with higher resolution in Focus Areas*
- *Lower River resolution*
  - *Lower River will not attempt to distinguish multiple numerous channels but will use EFDC wetting and drying capabilities*
- *Estuary*
  - *Optional 3-D estuary model tidal region*
- *Focus Areas*
  - *Approximately 300 ft (100 m) longitudinally and 100 ft (30 m) laterally*
  - *Final resolution will be based on sensitivity to water quality constituent gradients in focus areas*

River Model Coarse Horizontal Grid

(secondary channels not shown)



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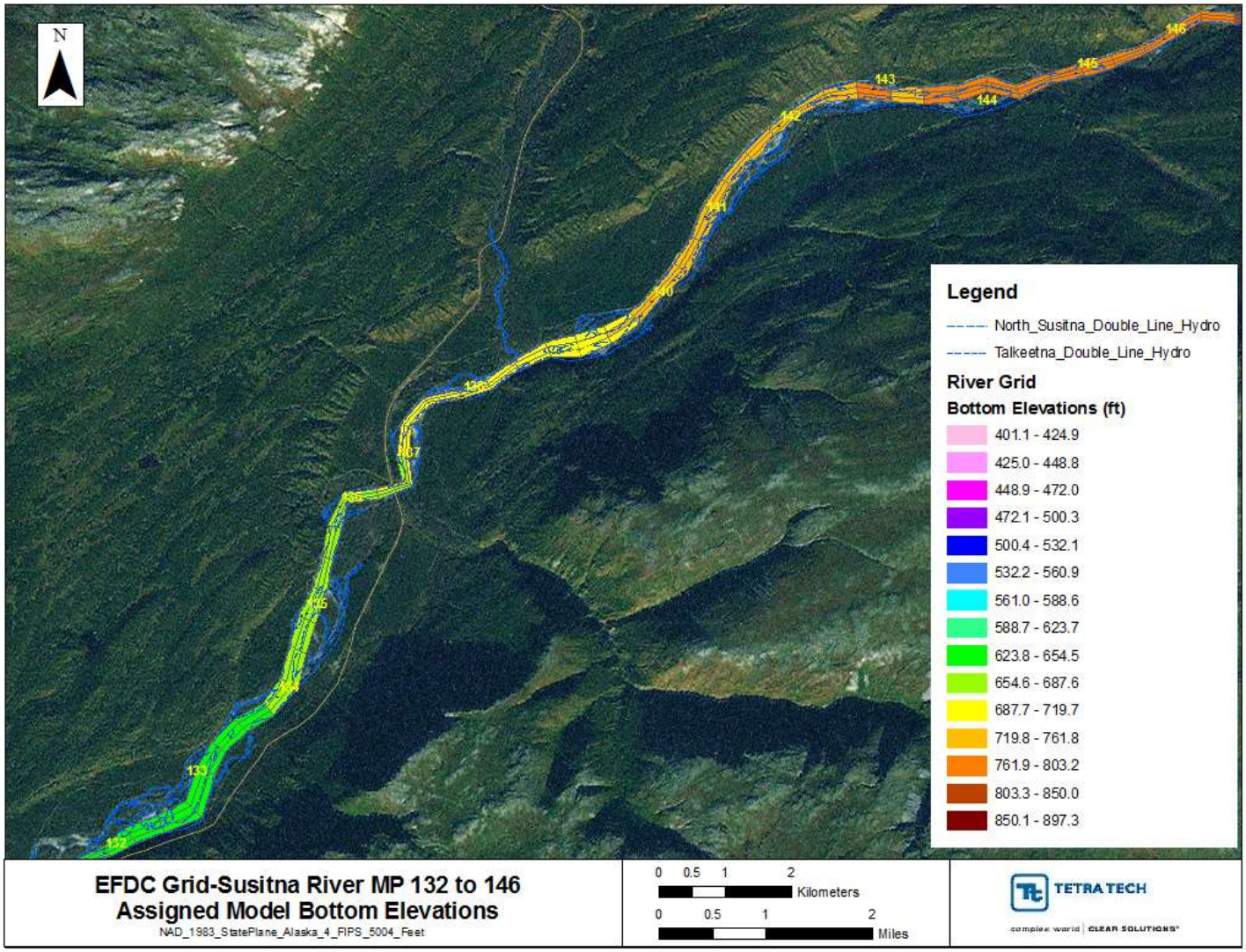
River Model Coarse Horizontal Grid

(secondary channels not shown)



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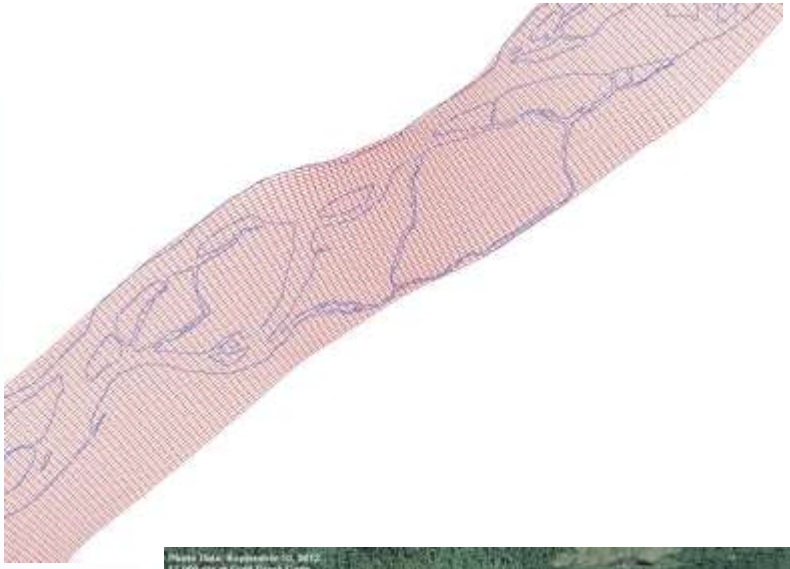
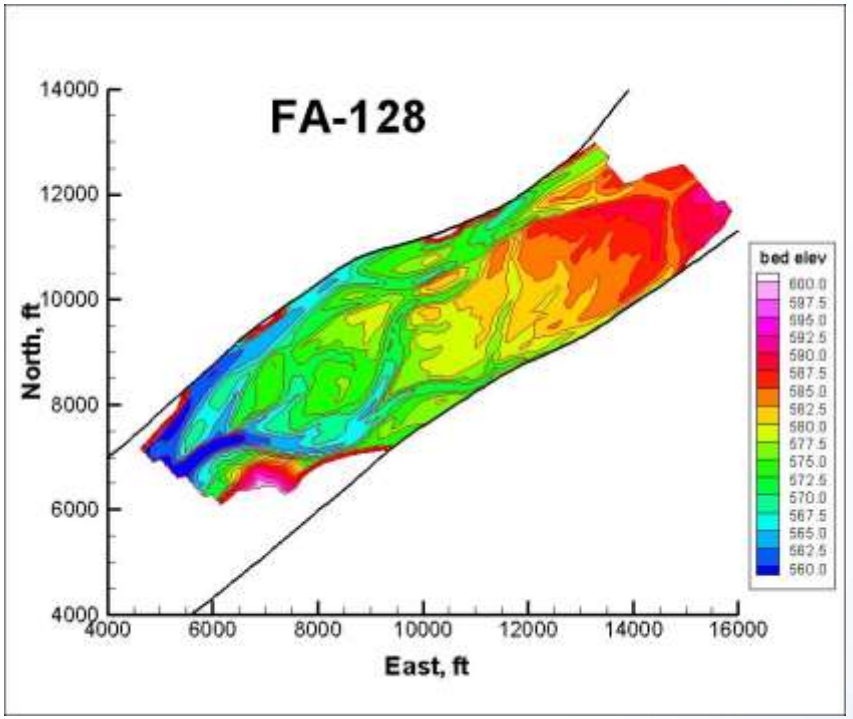
Finer Grid in FA-128





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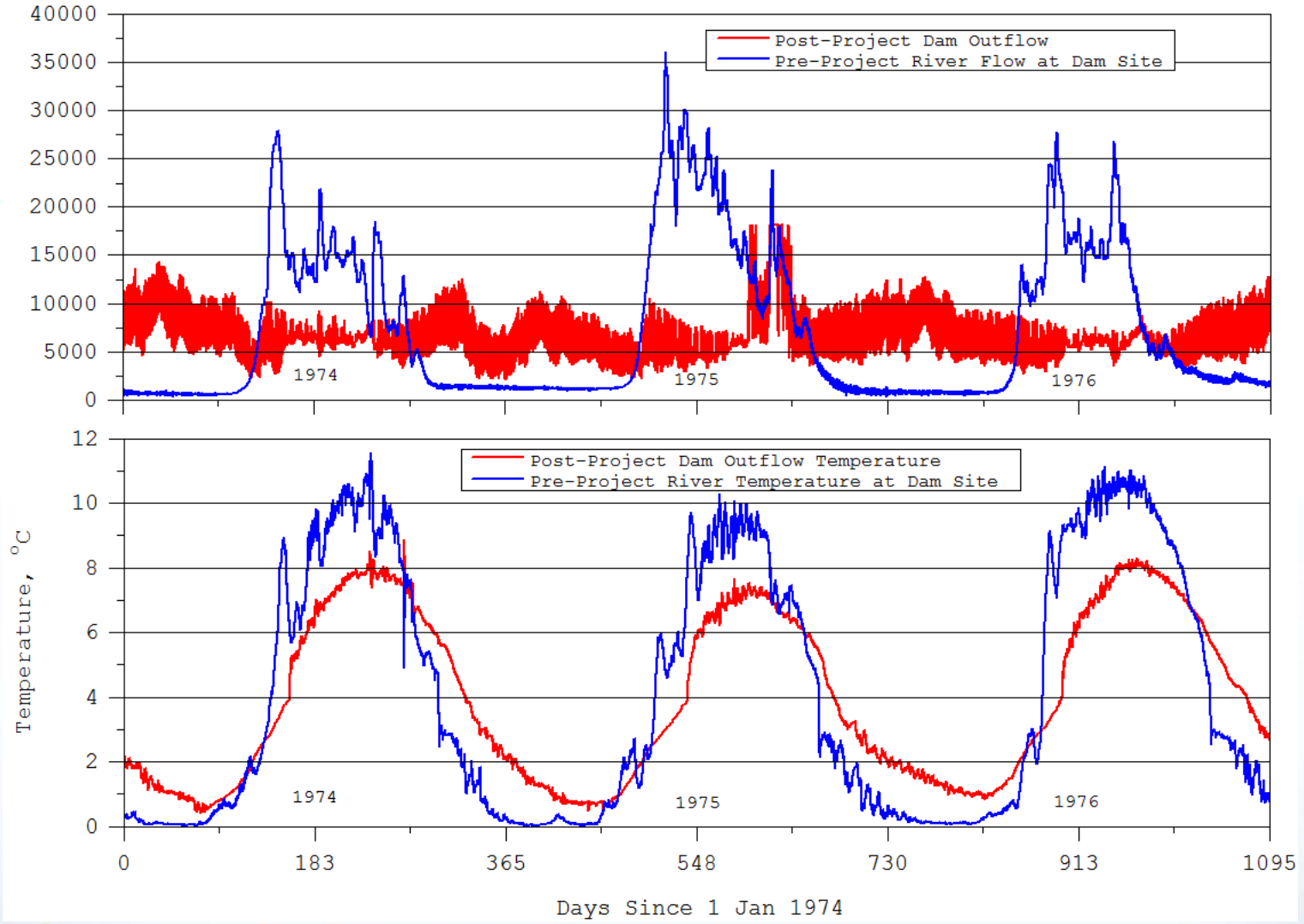
Proof of Concept Simulations

- *Focus on temperature simulation*
- *Compare pre- and post-project temperature*
- *Multiple year simulation periods*
  - *1974-1976 Dryer with large pool draw down*
  - *1979-1981 Wetter with small pool draw down*
- *Pre-project uses historical river flow and synthesized annual inflowing temperature*
- *Post-project used reservoir outflow and out flowing temperature at upstream river boundary*
- *All simulations use historical atmospheric thermal forcing*

1974-76 Simulation Boundary Conditions



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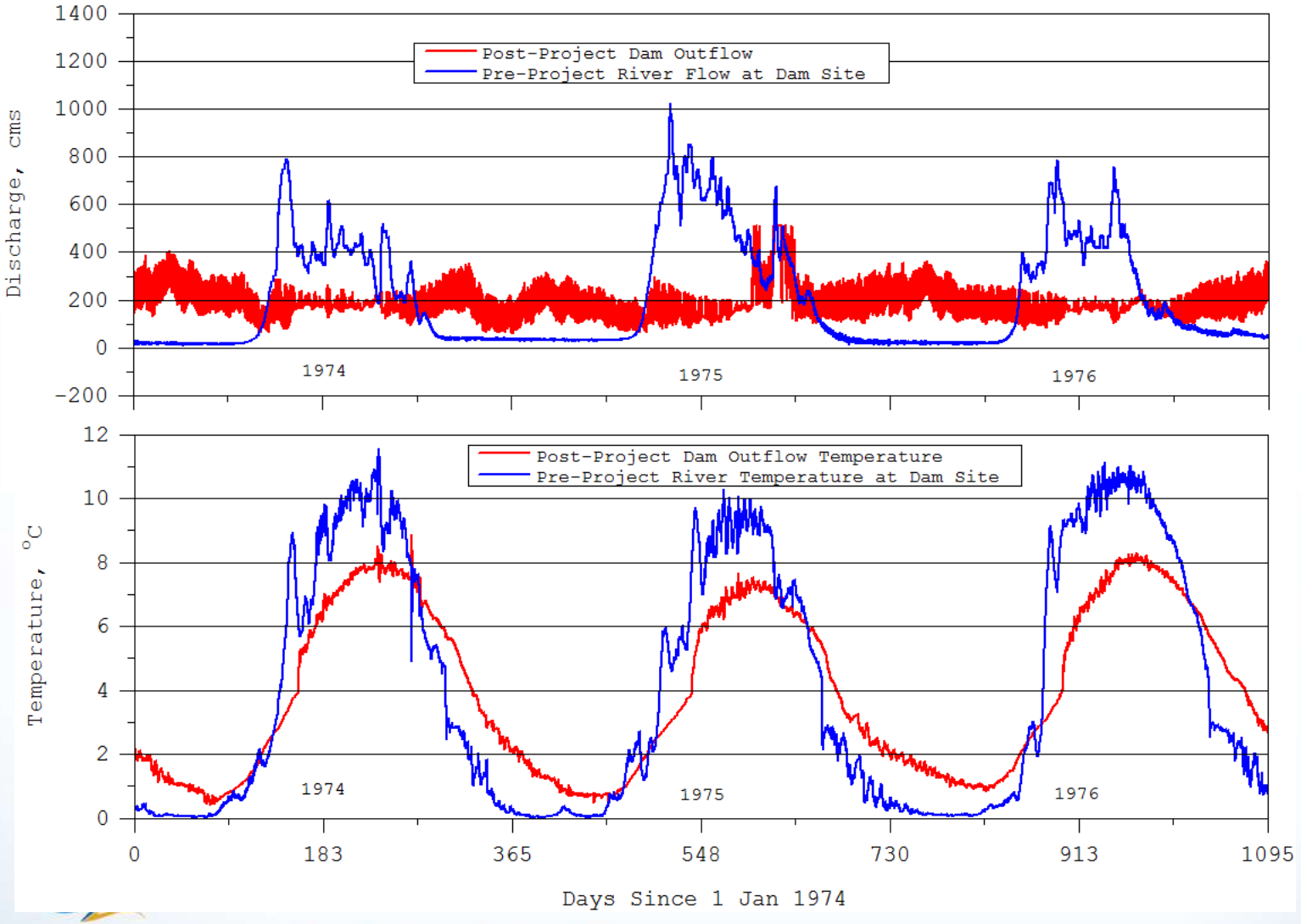
1974-76 Simulation Boundary Conditions (metric)



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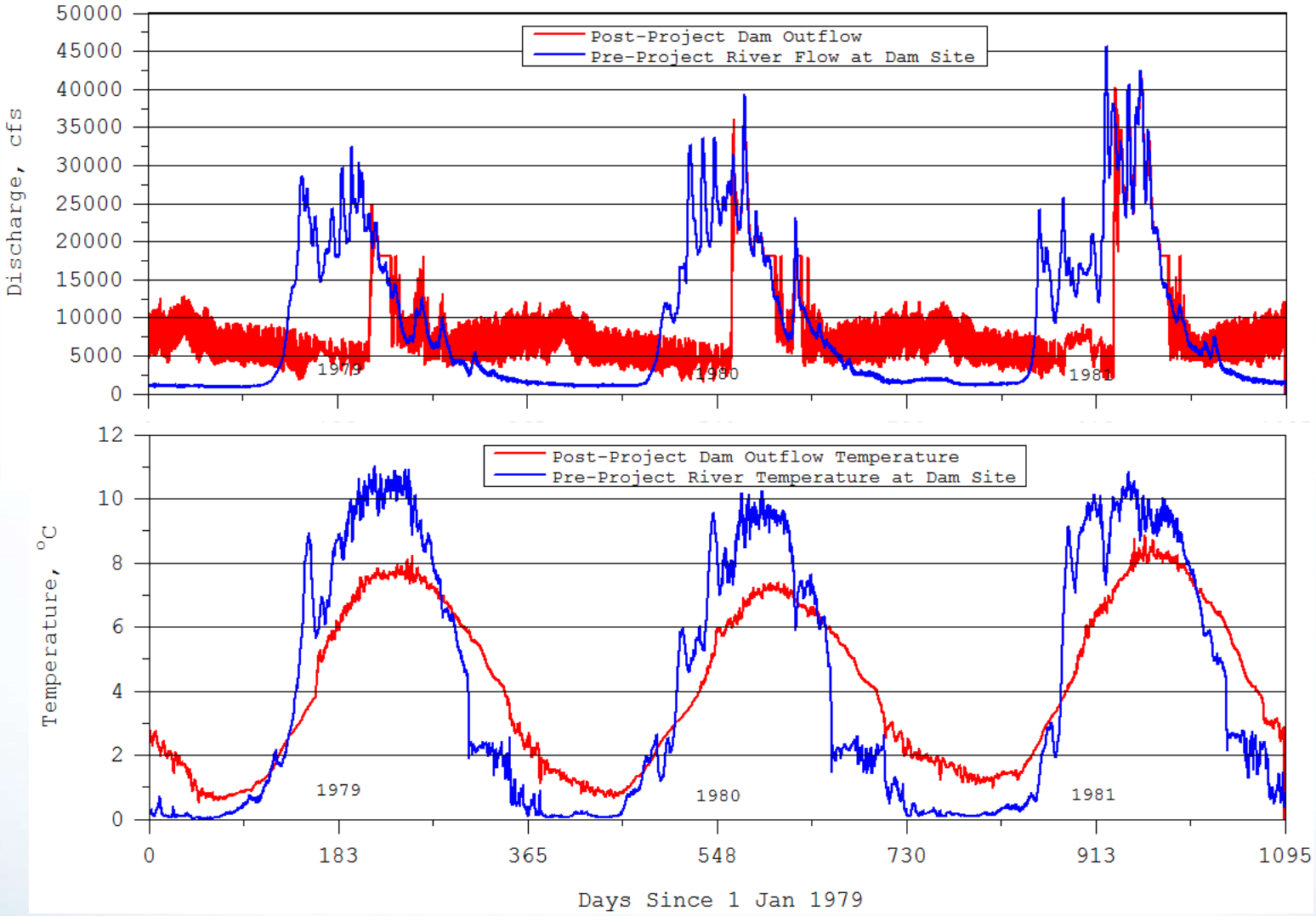
1979-81 Simulation Boundary Conditions



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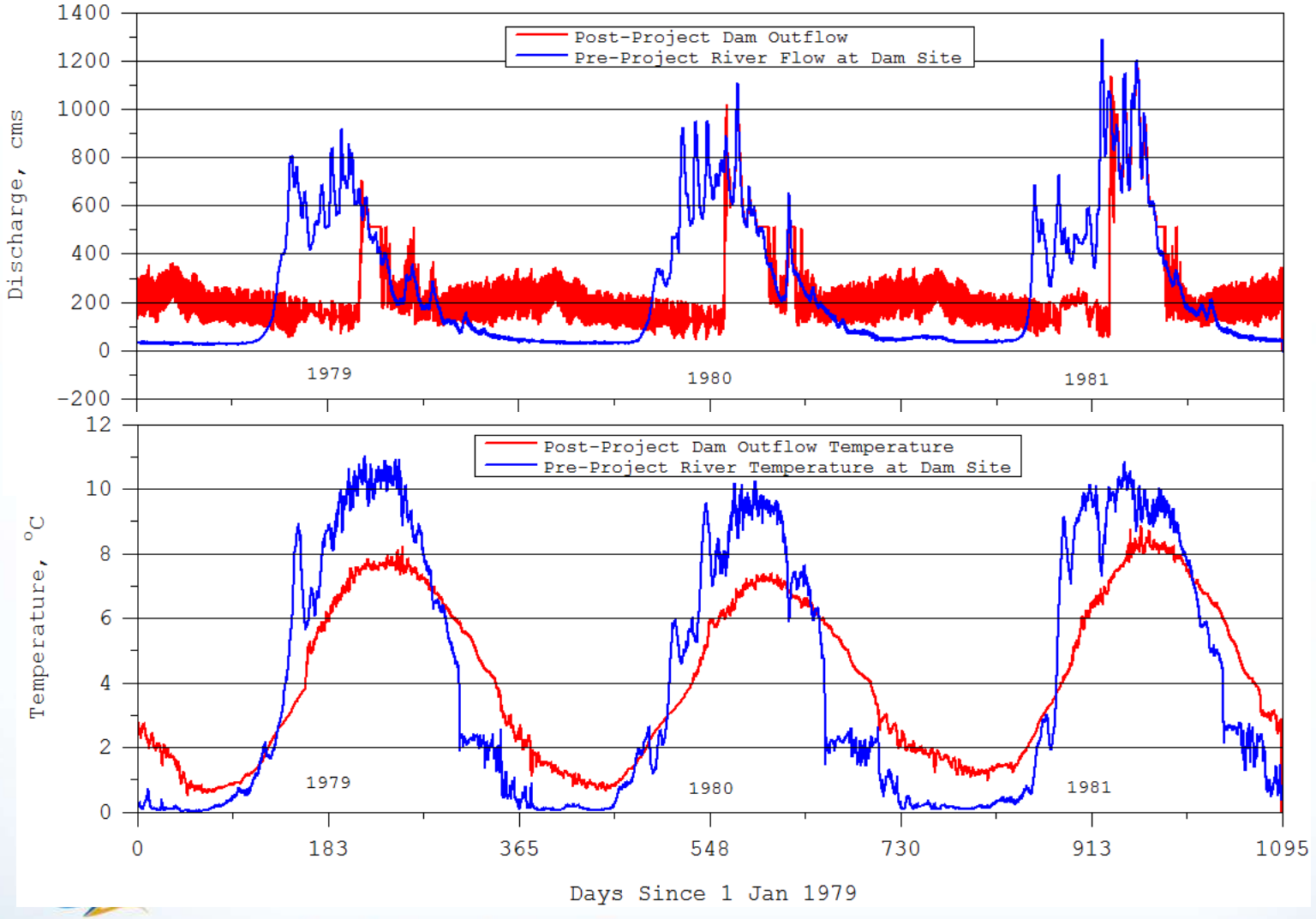
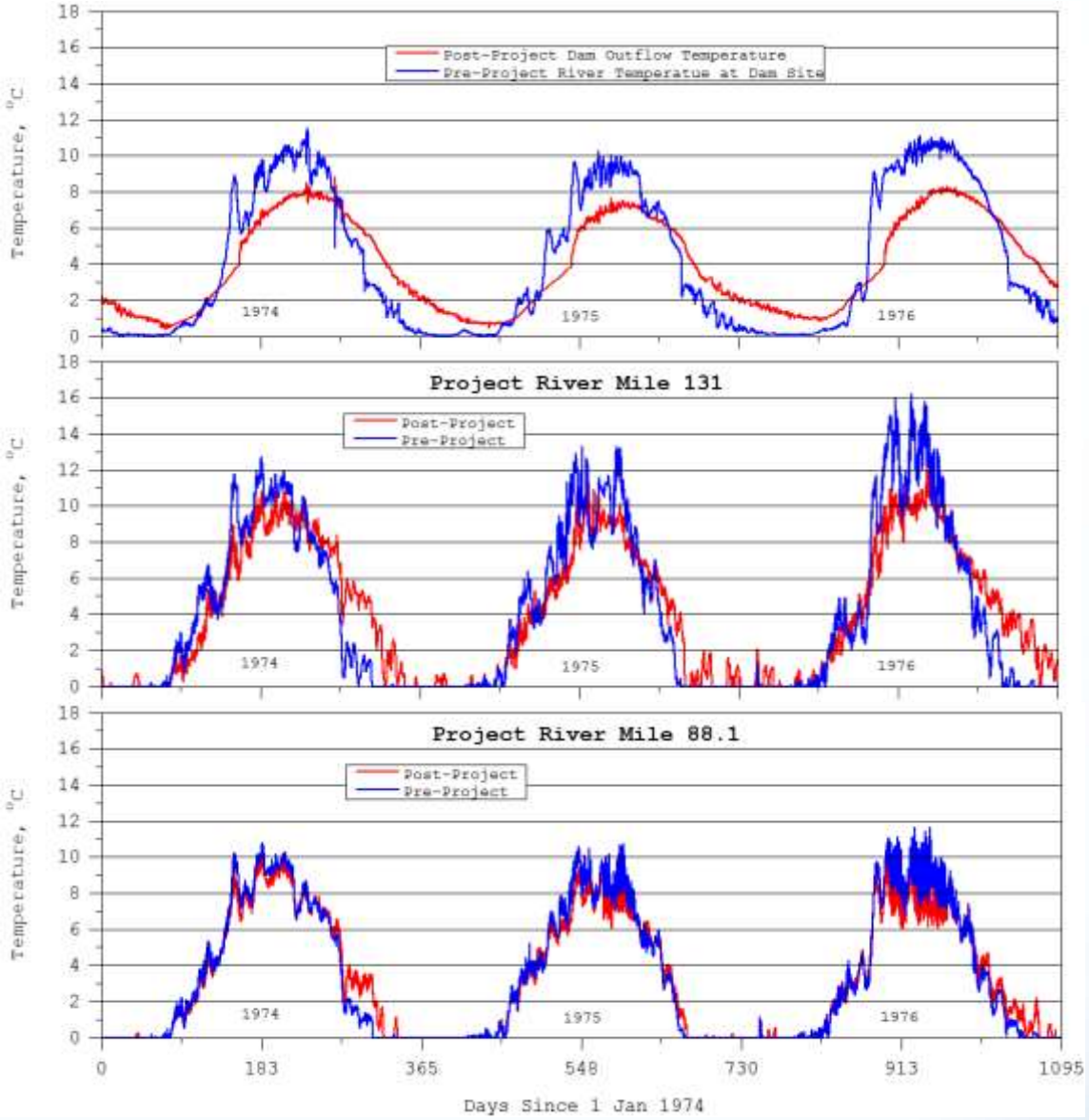
1979-81 Simulation Boundary Conditions (metric)



1974-76 Along River Temperature in Main Channel



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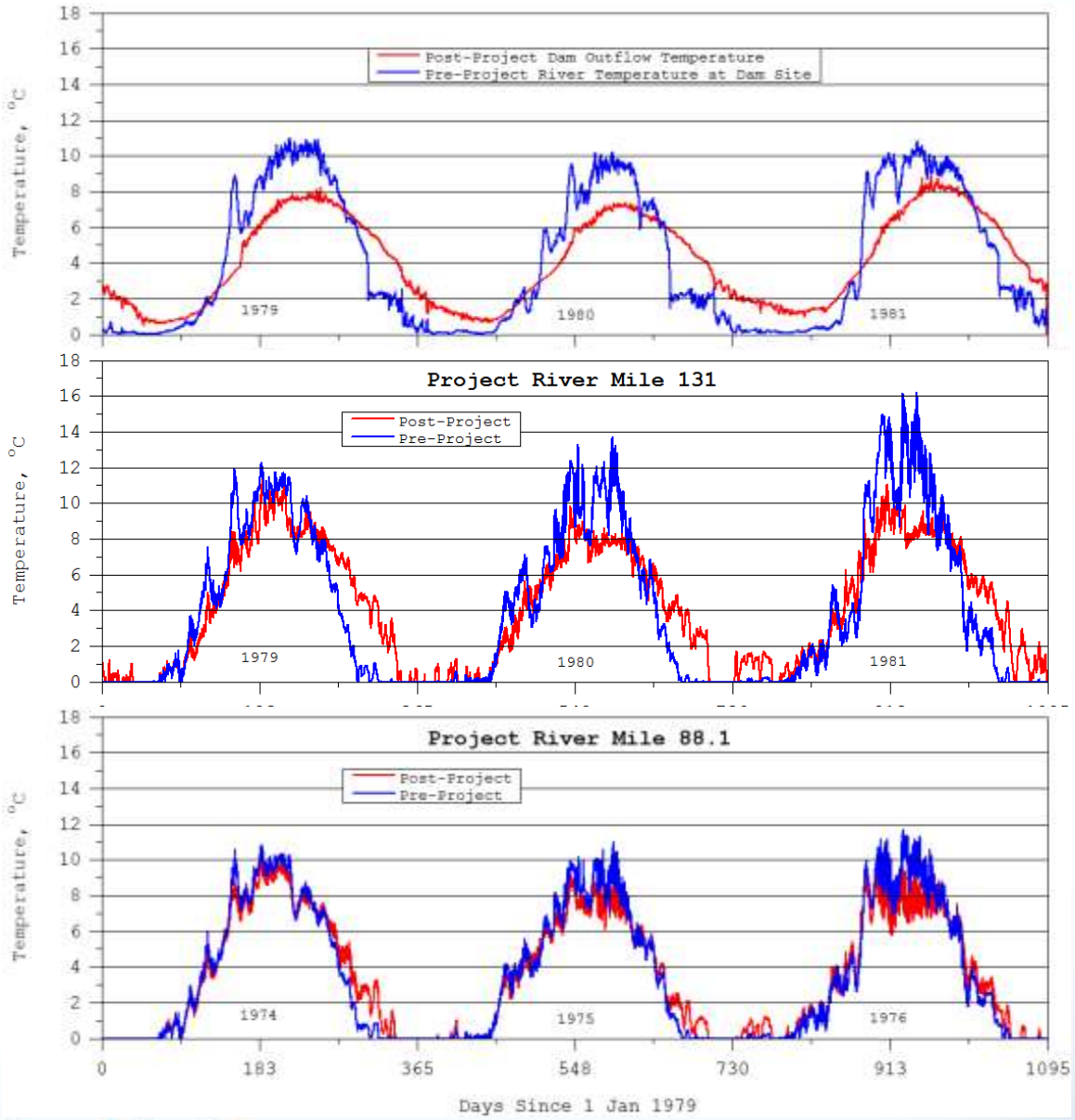
1979-81 Along River Temperature in Main Channel



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Comparison of Pre- and Post-Project Main Channel River Temperatures in FA-128

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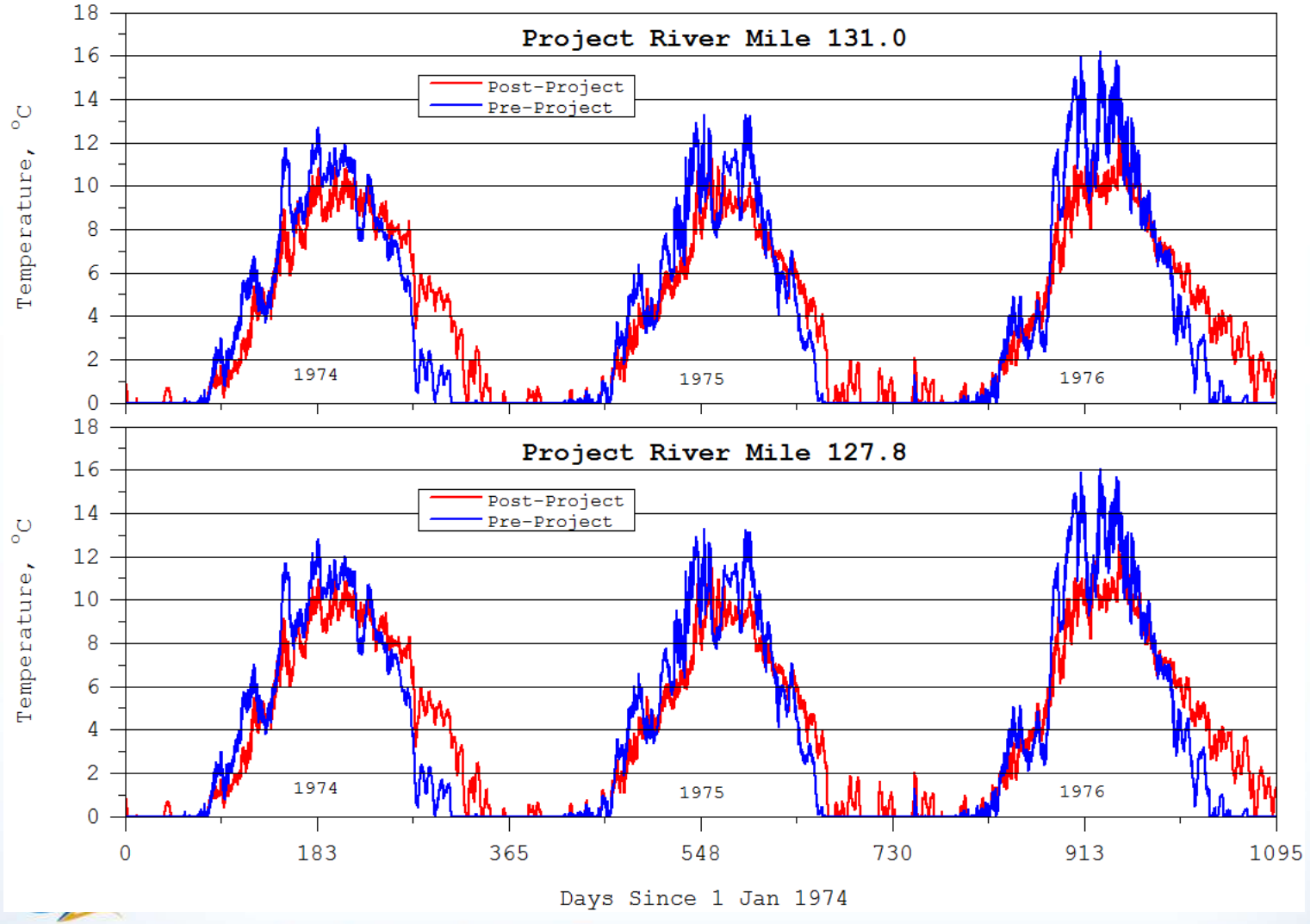
1974-76 River Temperature Comparison



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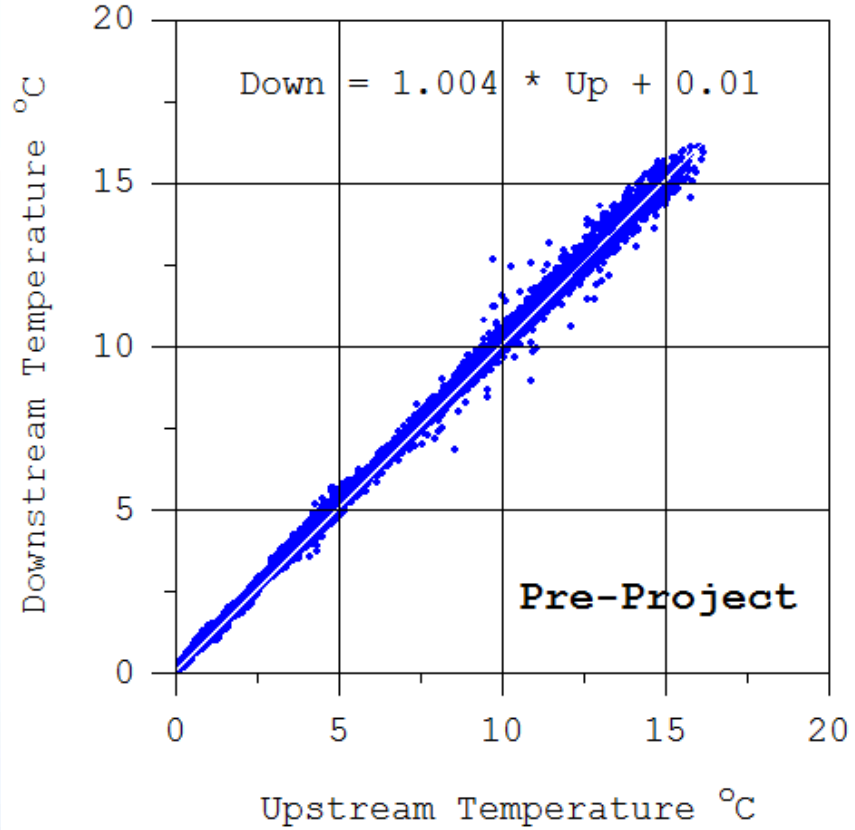
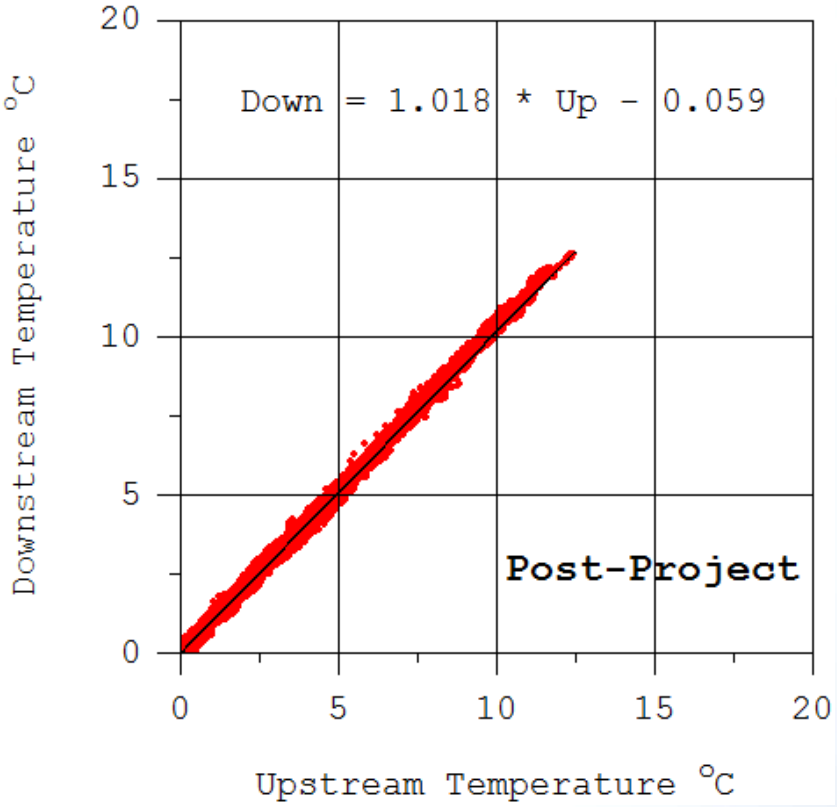
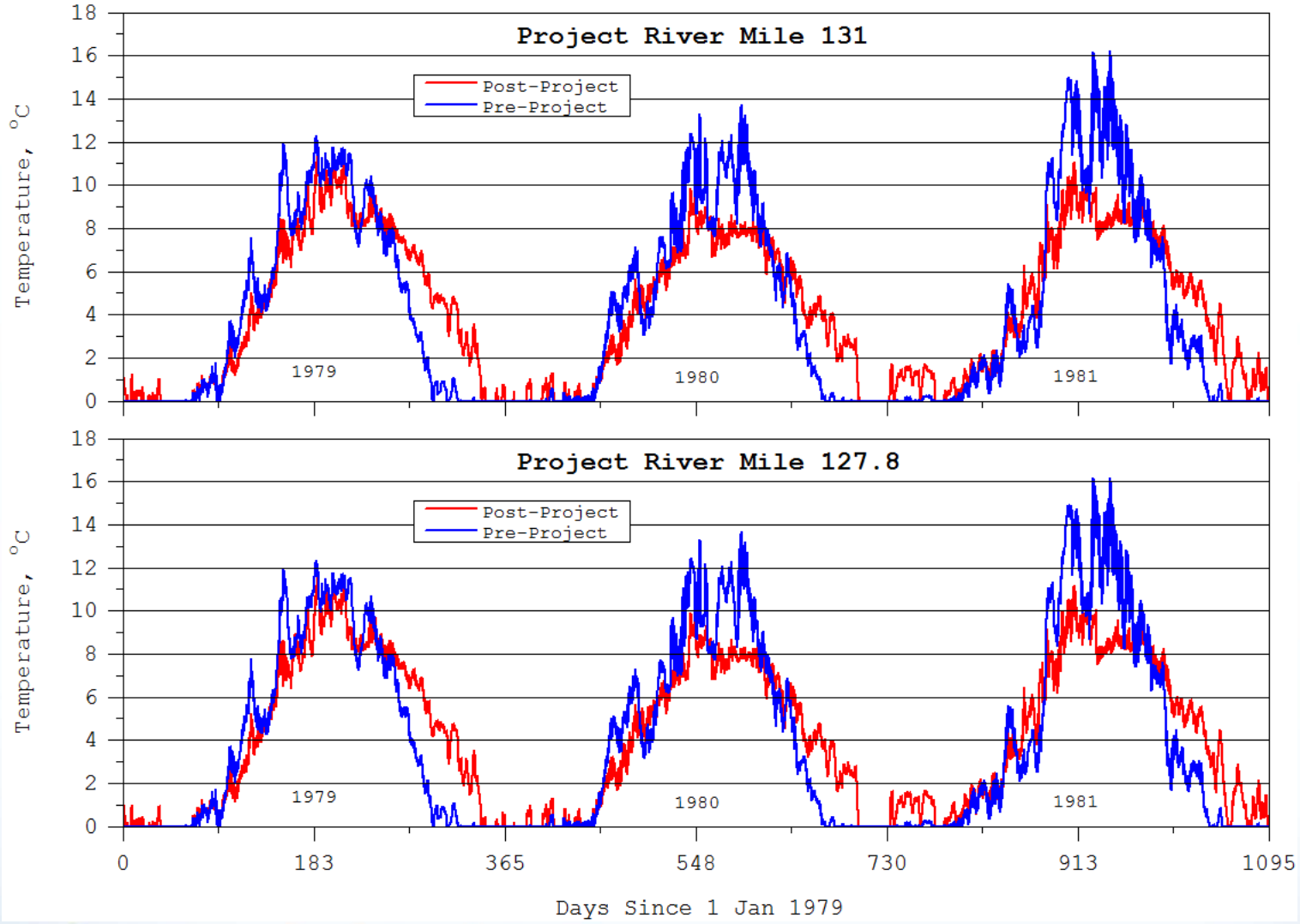
1974-76 River Temperature Comparison

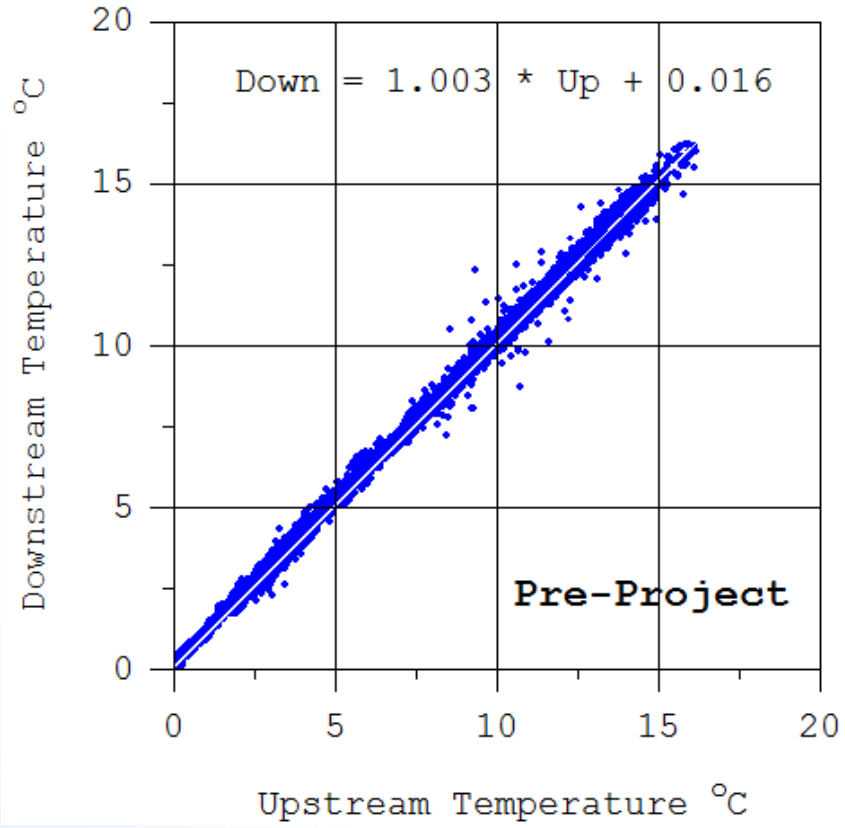


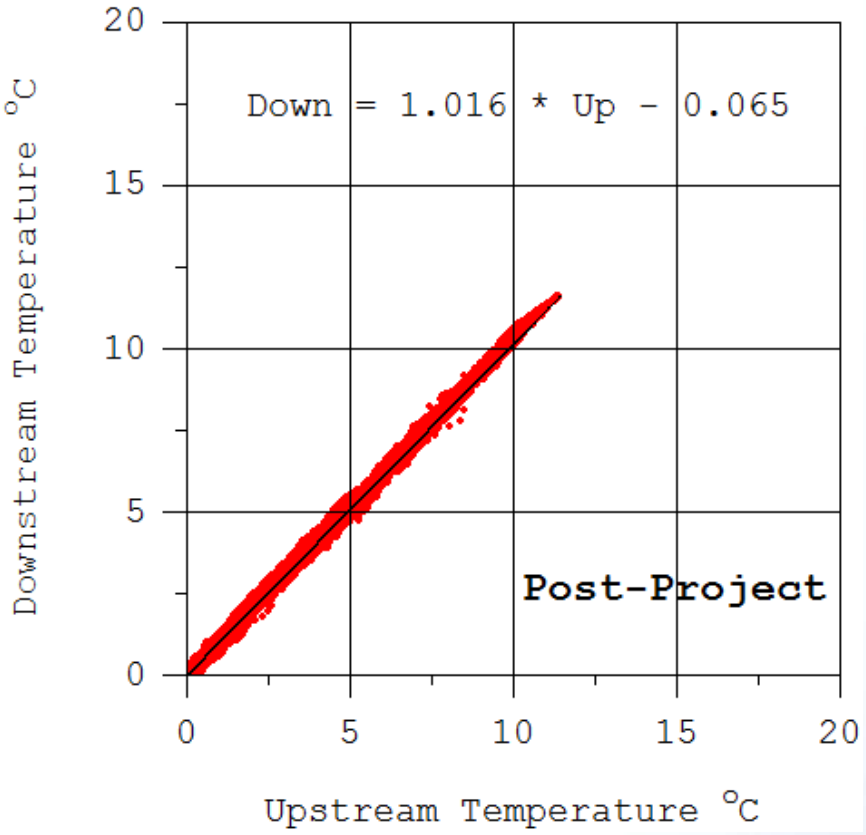


1979-81 River Temperature Comparison



1979-81 River Temperature Comparison





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Lateral Variation In Focus Areas

- *Preliminary simulations in this presentation do not show significant temperature variations laterally across focus areas*
- *Limited observational data indicates that sloughs and creeks have 0.5 to 2 ^{o}C higher temperatures than main channel in July and August*
- *Thermal imagery indicates that sloughs and creeks have 1 to 3 ^{o}C higher temperatures than main channel in later October*
- *Mechanisms for temperature variability differ between these two time periods*
  - *Longer water residence time and net warming from atmospheric heat exchange in summer*
  - *Groundwater upwelling at 3 to 4 ^{o}C in late fall and winter*
- *Continued riverine WQ model development to represent these mechanisms and improver predictions of lateral variability*

Main Channel and Slough Temperature Comparison

Date	Observed Skull Creek Transect Temperature	Observed Gold Creek Continuous Temperature	Model Main Channel Temperature
July 25	14.50 (+/- 0.4)	12.45	13.90 (+/- 0.6)
August 8	13.45 (+/-0.8)	12.20	11.75 (+/- 1.0)
August 25	9.15 (+/-0.4)	9.55	9.10 (+/-0.35)

Status of the River Model

- *Entire river model configured for pre-project hydrodynamic and temperature simulation of 2012-13 calibration period and 1950-2010, 61 year historical period*
- *Entire river model configured for post-project hydrodynamic and temperature simulation of 1974-76 and 1979-81 post-project reservoir operation periods*
- *Multi-year temperature simulations of 1974-76 and 1979-81 periods under pre- and post-project conditions completed*
- *Configuration of corresponding fine solids simulation completed*

Status of the River Model

- *In progress*
  - *Continued refinement to represent mechanisms responsible of lateral variability in Focus Areas*
  - *Continued configuration of selected Focus Areas*
  - *Sensitivity studies of Focus Area temperature and solids response*
  - *Continuing configuration of nutrient cycling model*