

Improving Stream Temperature Predictions for River Water Decision Support Systems

NOAA NMFS SWFSC

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Project Goals

Provide high resolution water temperature estimates for the Upper Sacramento River

- hindcasts, nowcasts, forecasts
- for each 1km reach
- sub-hourly time-step

Provide growth estimates based on temperature model results

Make results available to water and fisheries managers

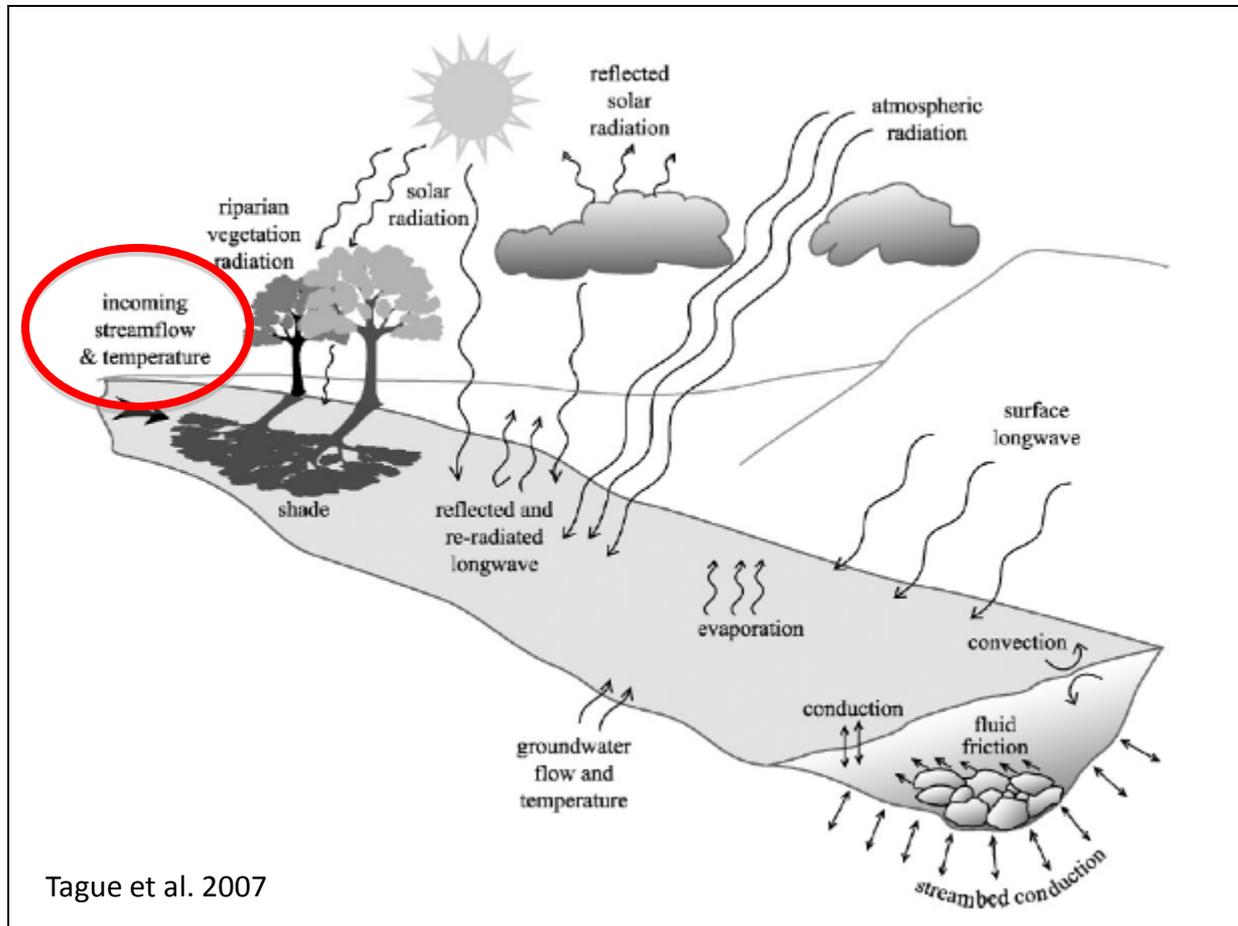
Heat Budget

Based on both atmospheric inputs and water temperature

$$H_n = \left(H_{s_e} + H_{h_l} + H_{t_a} \right) - \left(H_{nl_n} + H_{e_g} + H_{w_c} \right)$$

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atmospheric terms
water temperature terms



The model tracks each parcel of water...

1-Dimensional Advection-Diffusion (“bulk flow”) Equation

$$\frac{\partial T}{\partial t} + \mathbf{u}_x \frac{\partial T}{\partial x} = \left(\frac{1}{\rho_w C_s R} \right) H_n$$

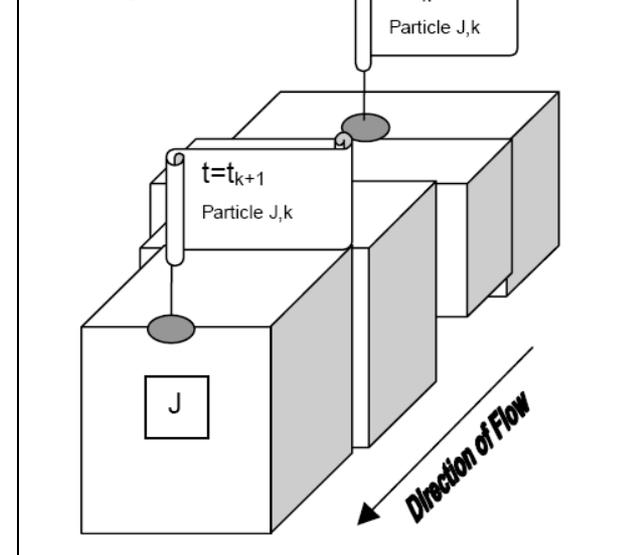
temperature change with time \rightarrow $\frac{\partial T}{\partial t}$
 velocity \rightarrow \mathbf{u}_x
 net heat flux \rightarrow H_n
 downstream temperature change \rightarrow $\frac{\partial T}{\partial x}$
 water density, heat capacity, depth \rightarrow $\rho_w C_s R$

Mixed Eulerian-Lagrangian Solution

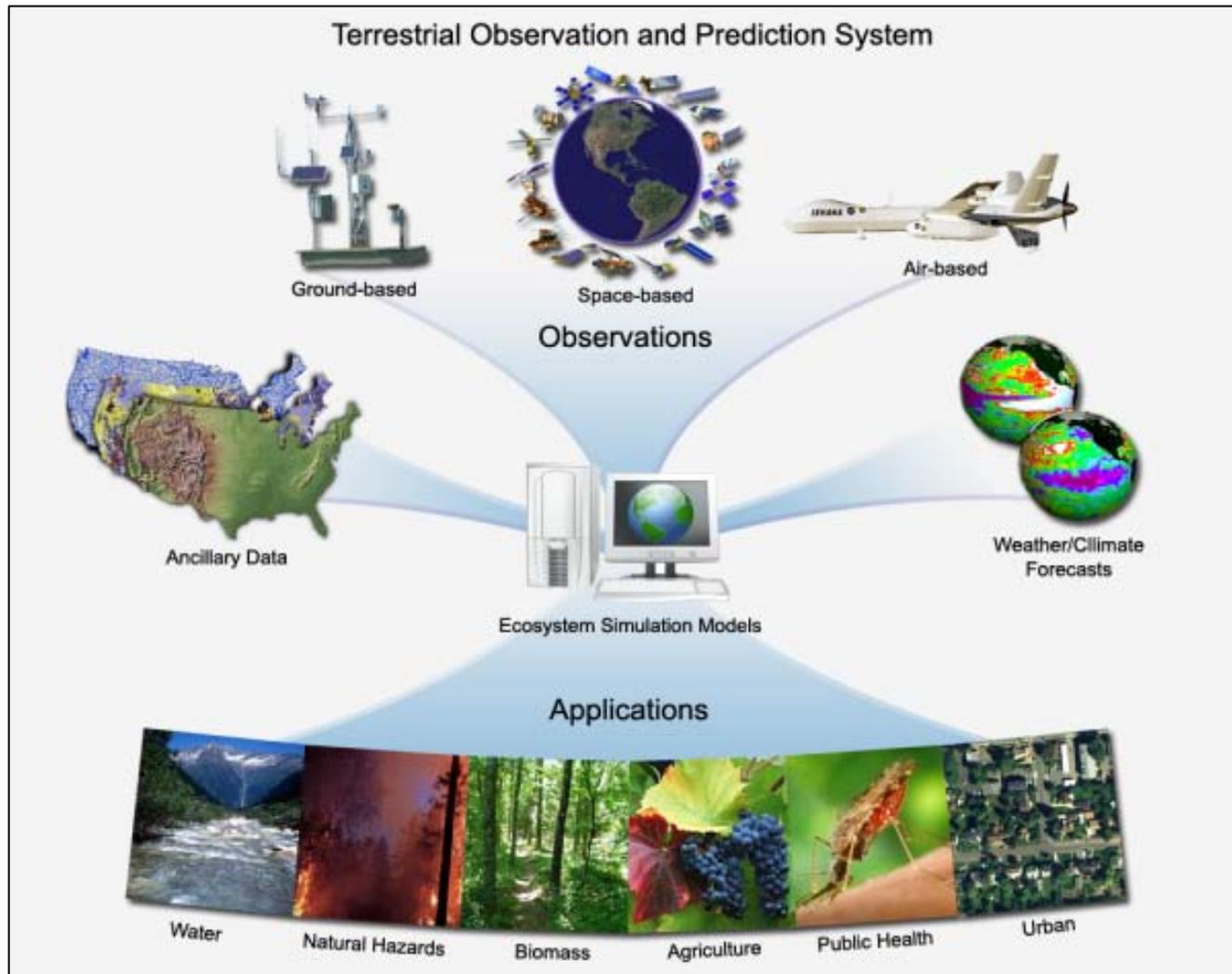
- Advection is treated in Lagrangian (‘moving reference’) framework
- Diffusion and dispersion are solved in Eulerian (‘fixed reference’) formulation

$$\mathbf{T}_{t=t_k} \approx \mathbf{T}_{t=t_{k-1}} + \Delta t \left(\frac{1}{\rho_w C_s R} \right) H_n$$

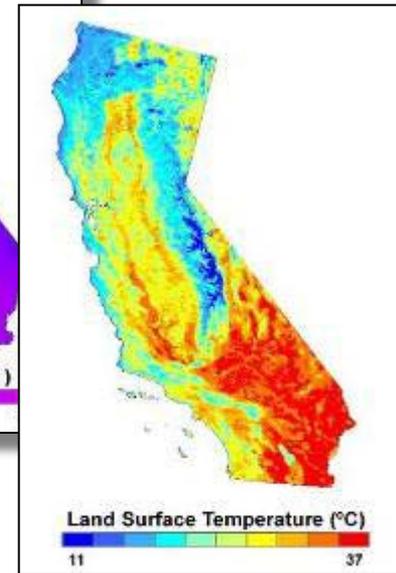
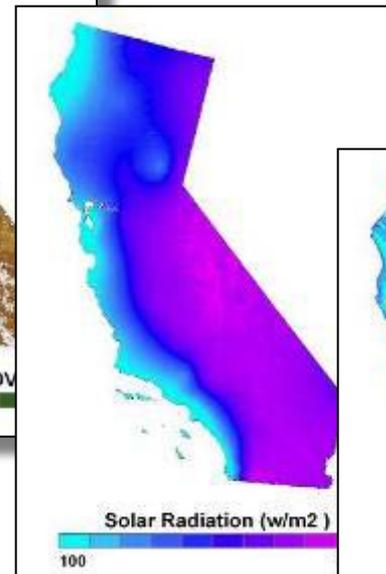
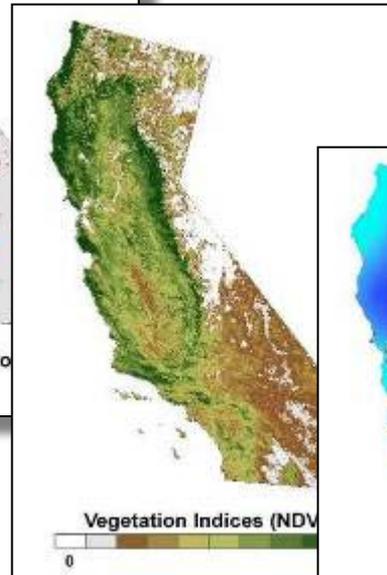
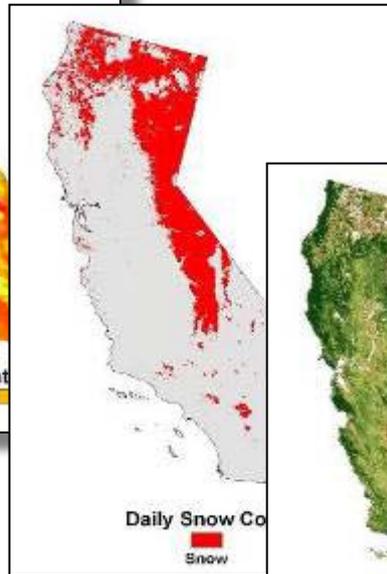
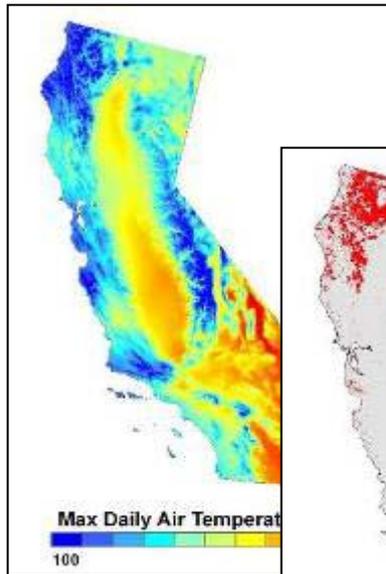
Reverse Particle Tracking (Yearsley et al. 2001)



NASA Ames Ecological Forecasting Lab



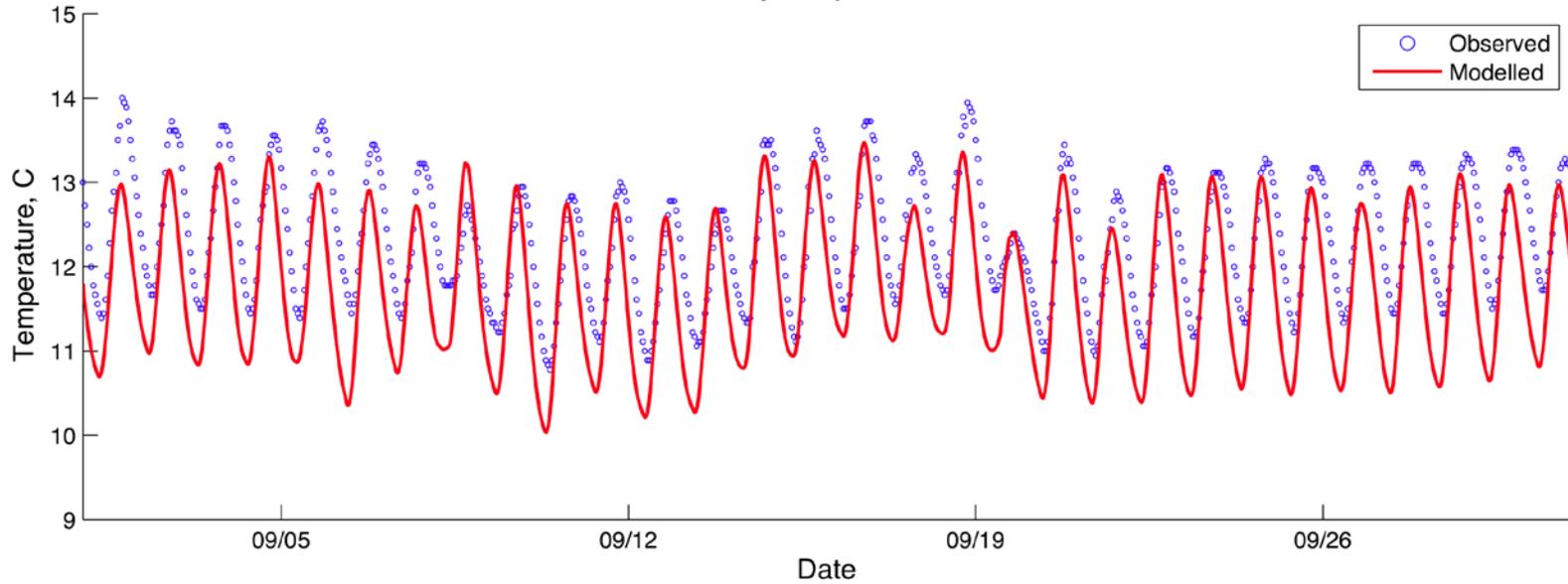
Integrate WRF model into
Terrestrial Observation and
Prediction System (TOPS)



Coupled TOPS-WRF system to generate
hindcasts and forecasts of weather
conditions every 15 minutes at a spatial
resolution of 1km²

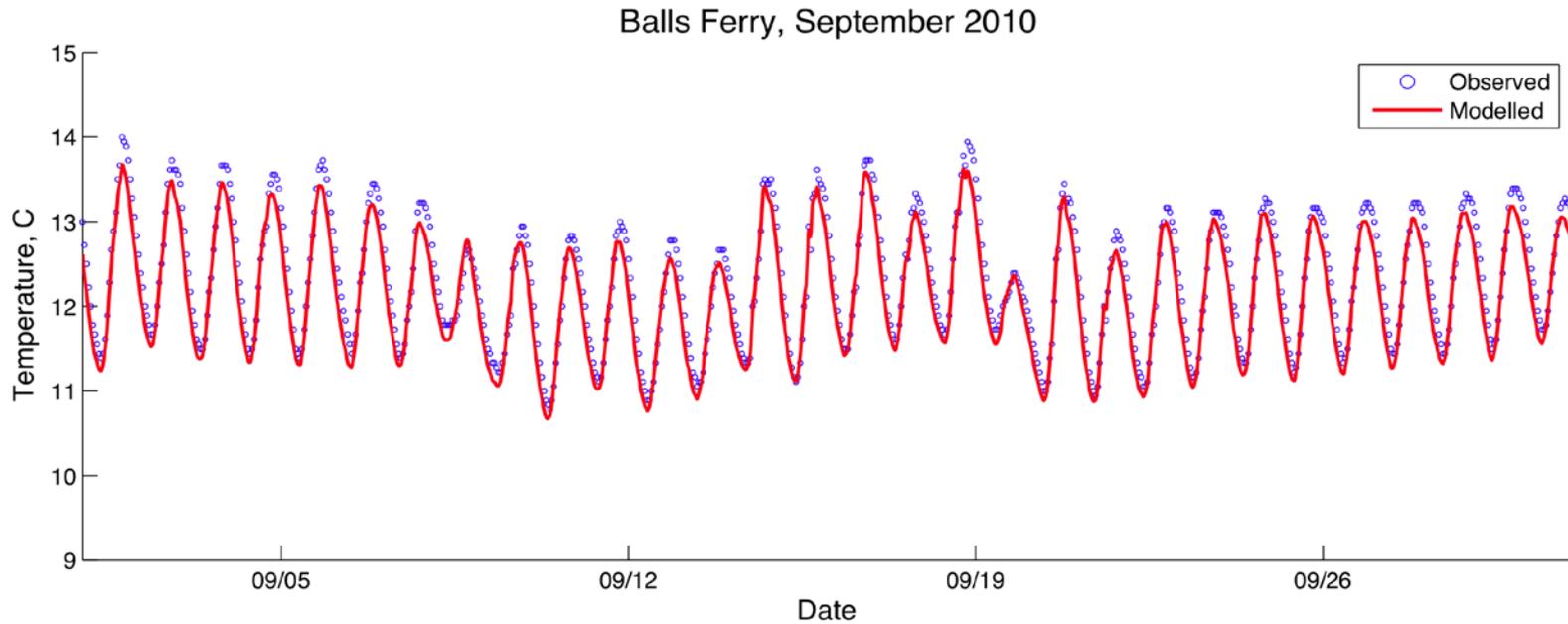
Model Results

Balls Ferry, September 2010



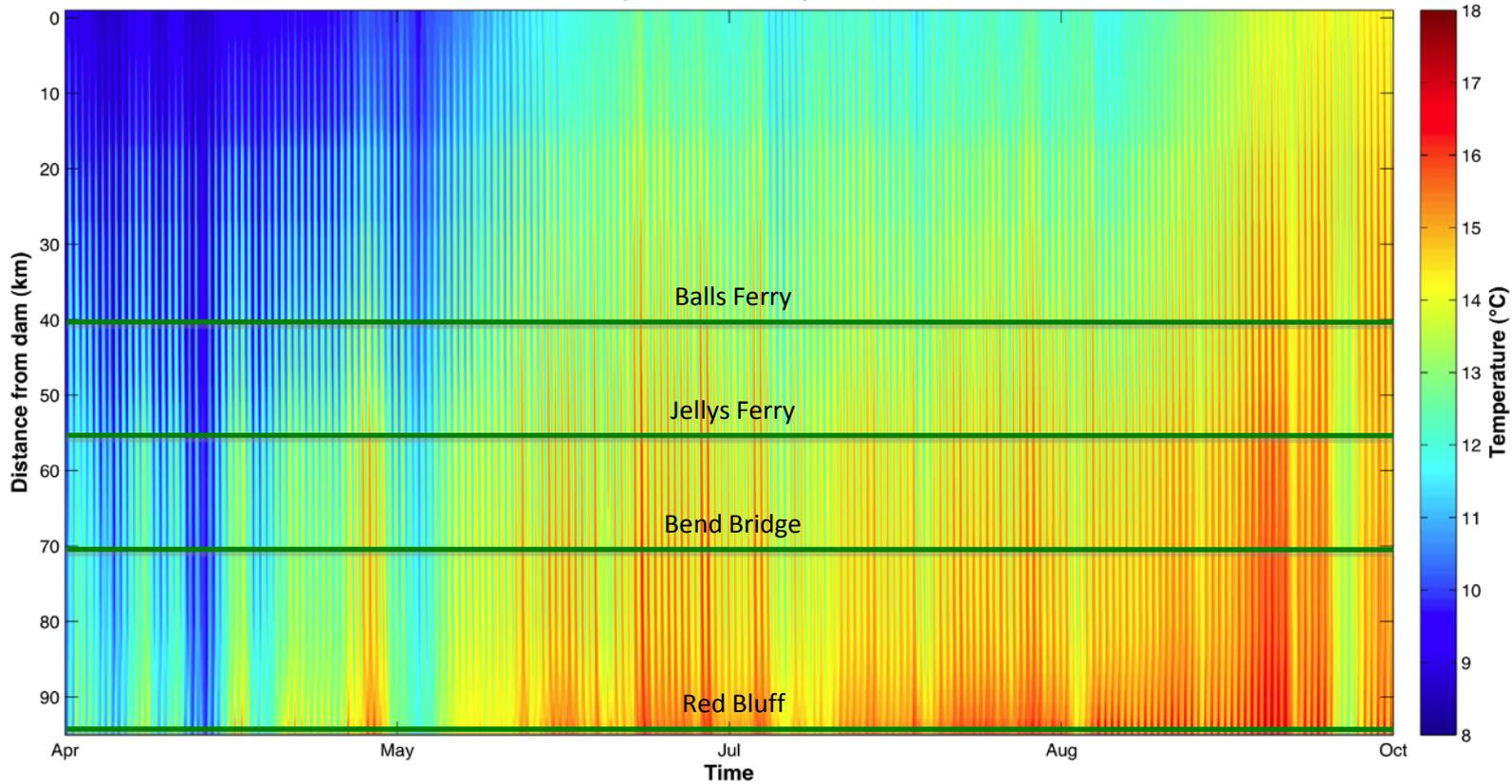
No data assimilation

Model Results

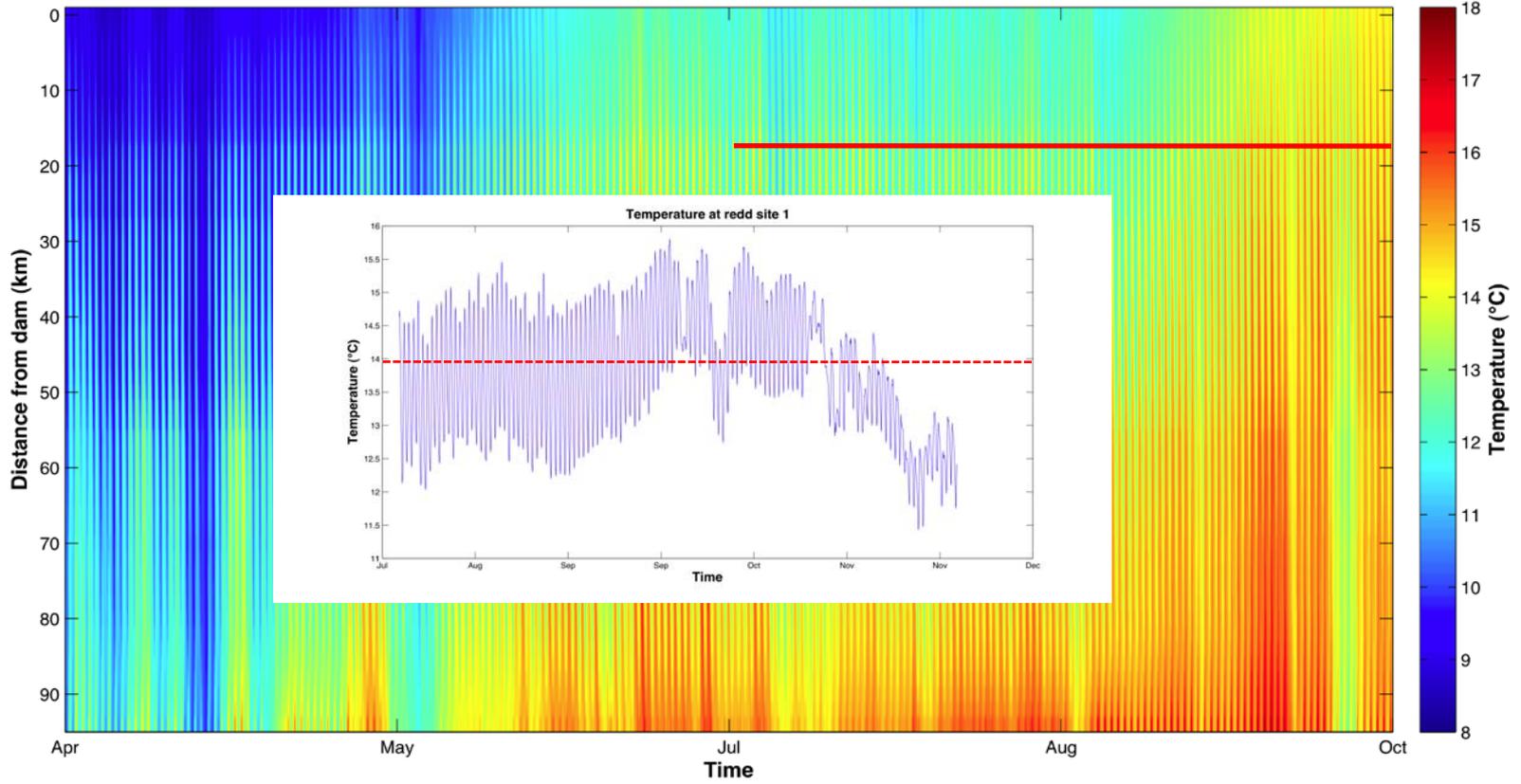


With data assimilation

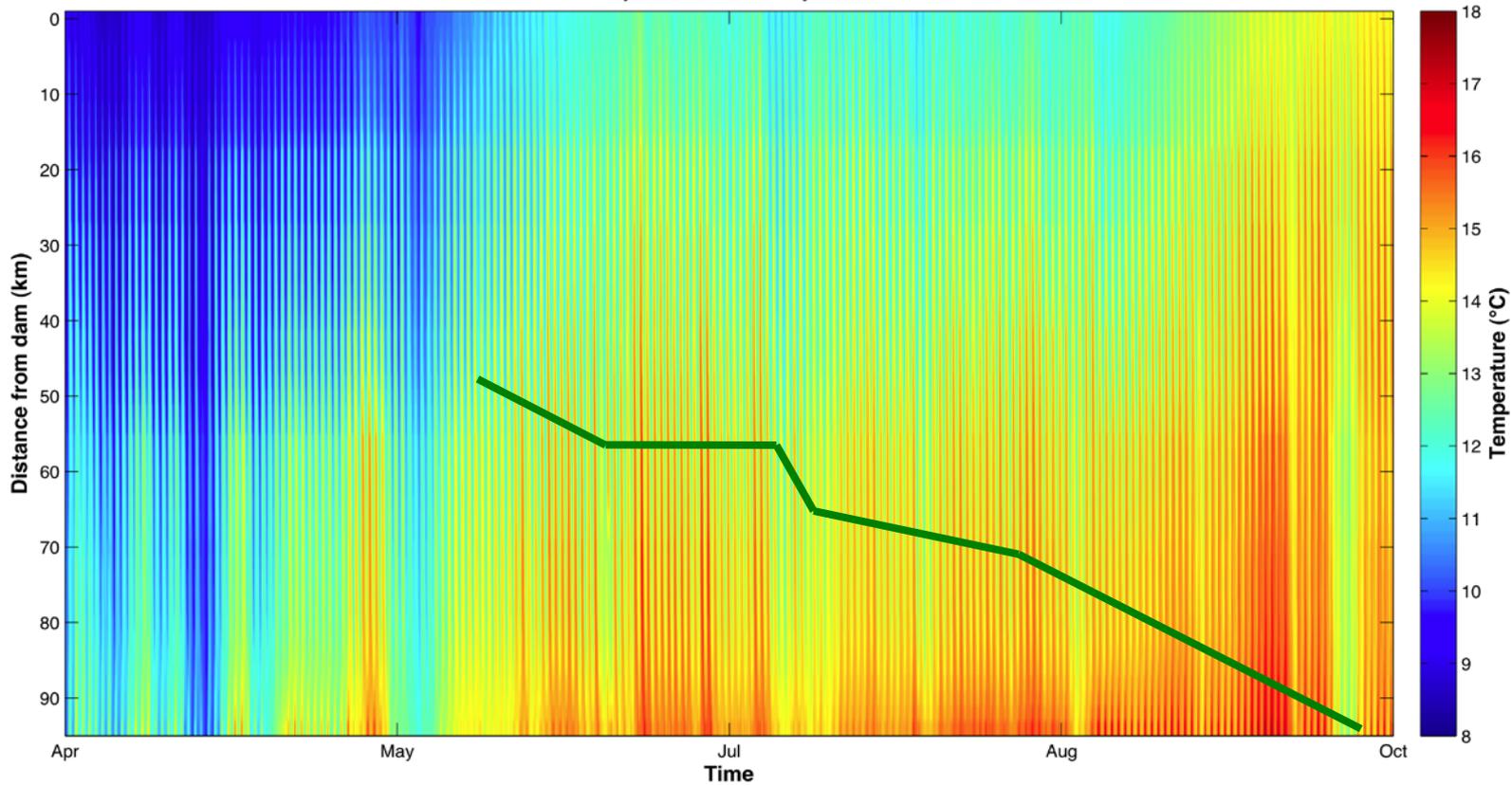
Temperature Landscape 2008



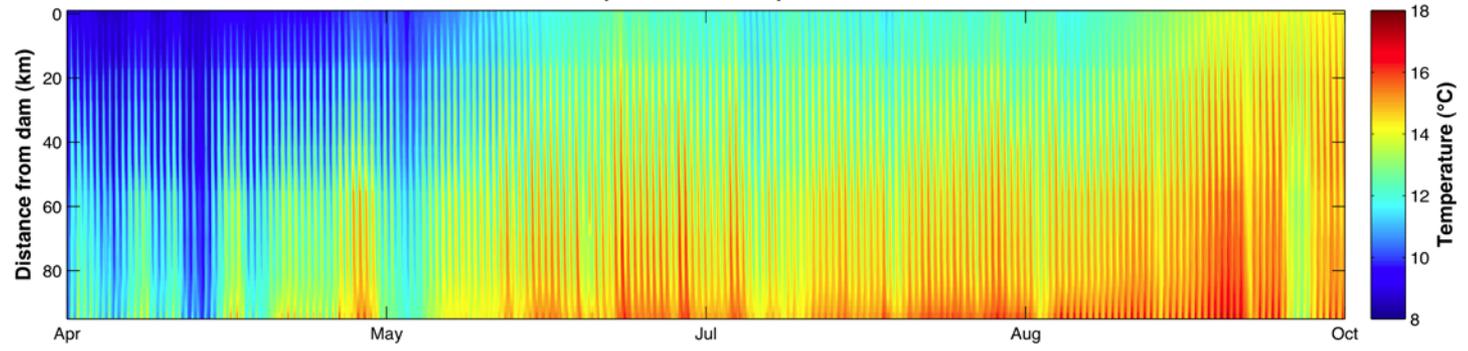
Temperature Landscape 2008



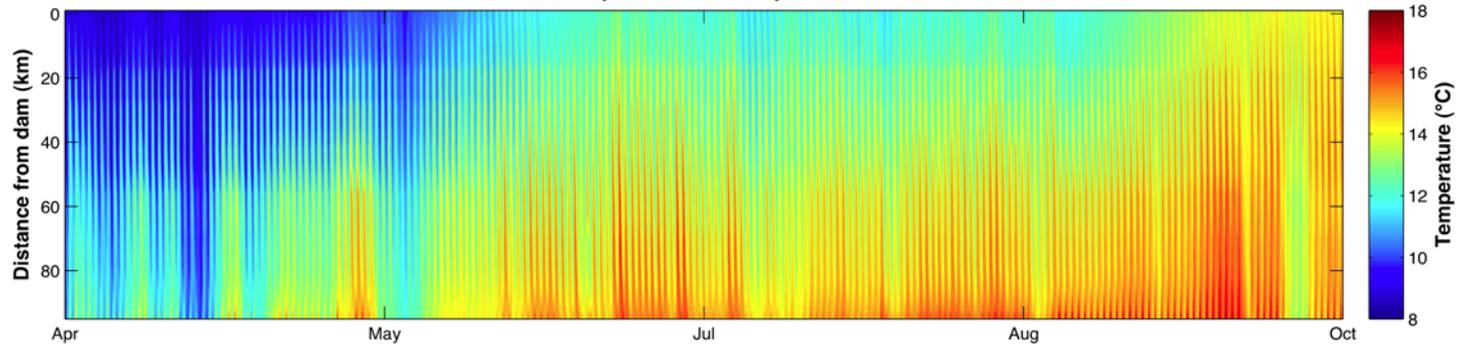
Temperature Landscape 2008



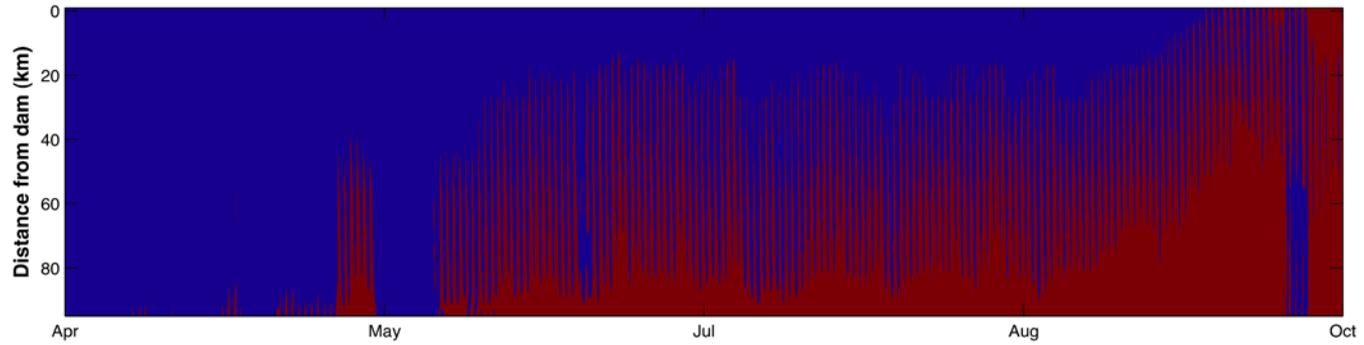
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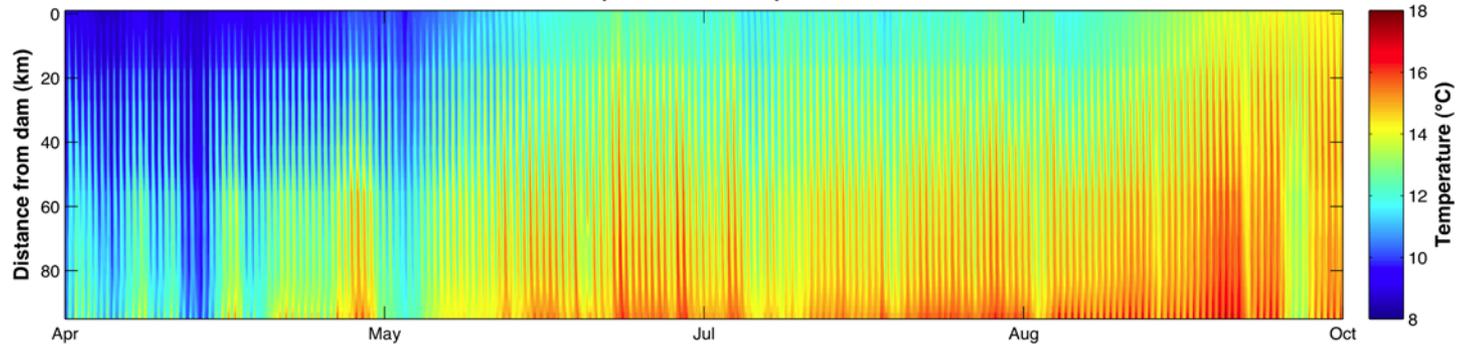
Temperature Landscape 2008



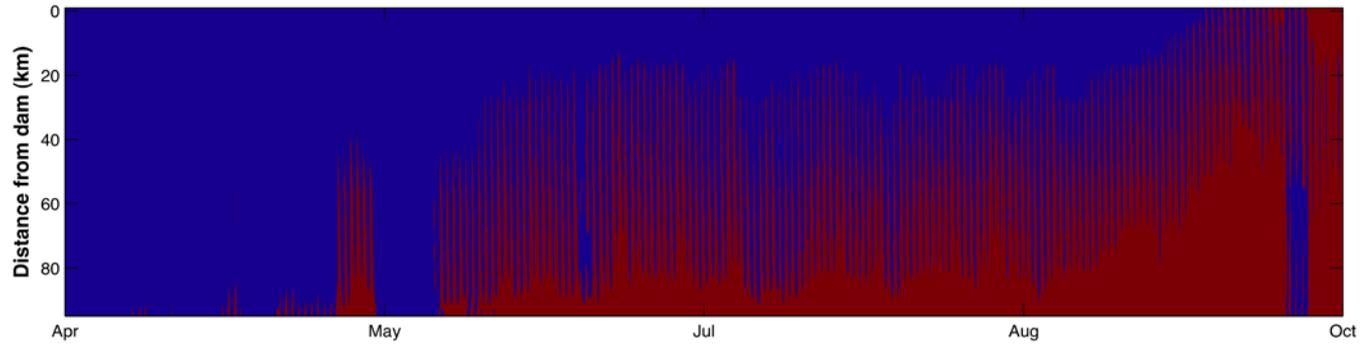
Exceedance 13.9°C



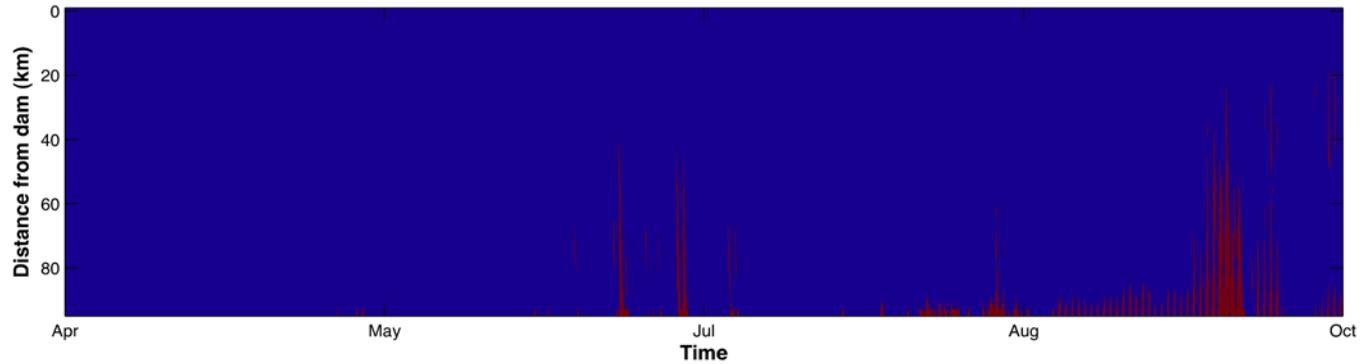
Temperature Landscape 2008



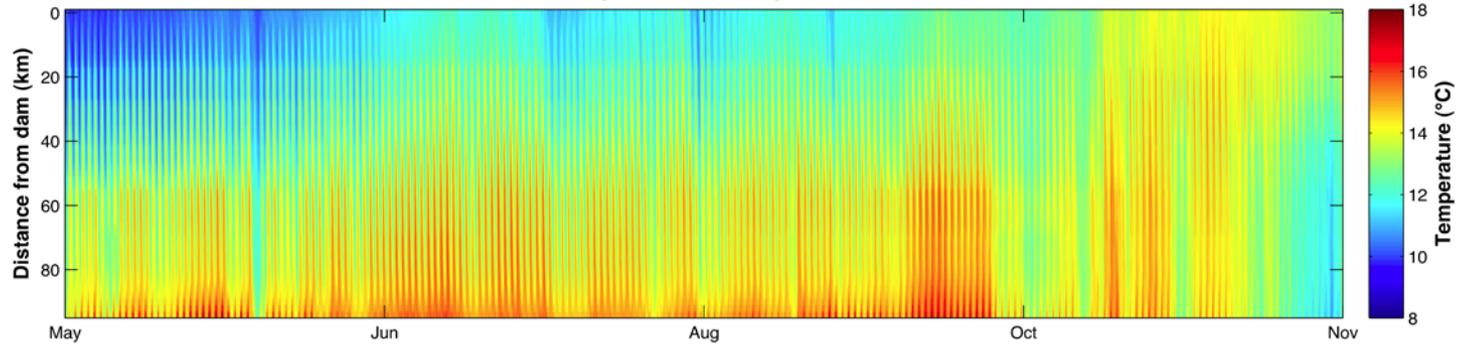
Exceedance 13.9°C



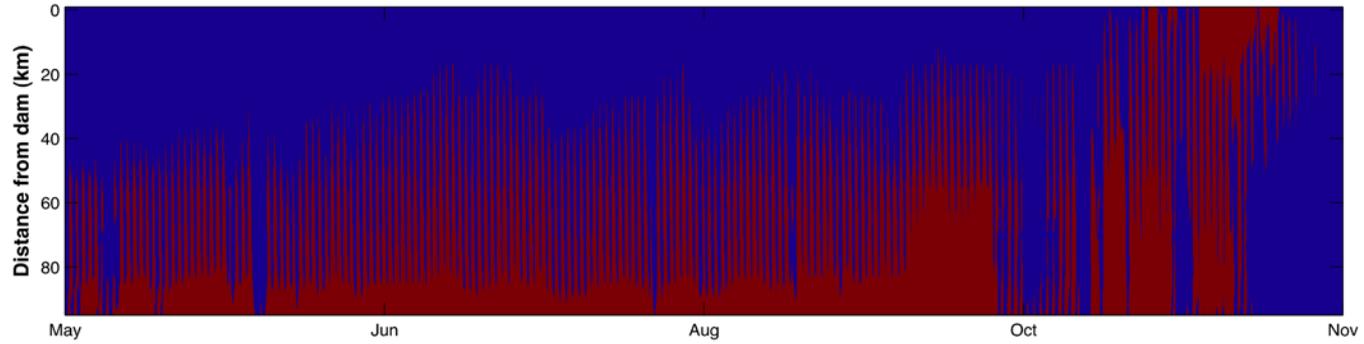
Exceedance 15.6°C



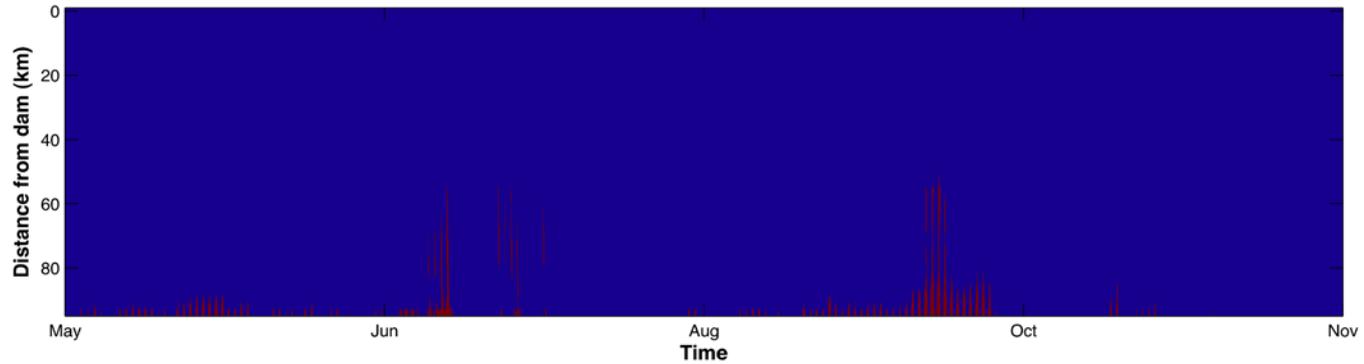
Temperature Landscape 2009



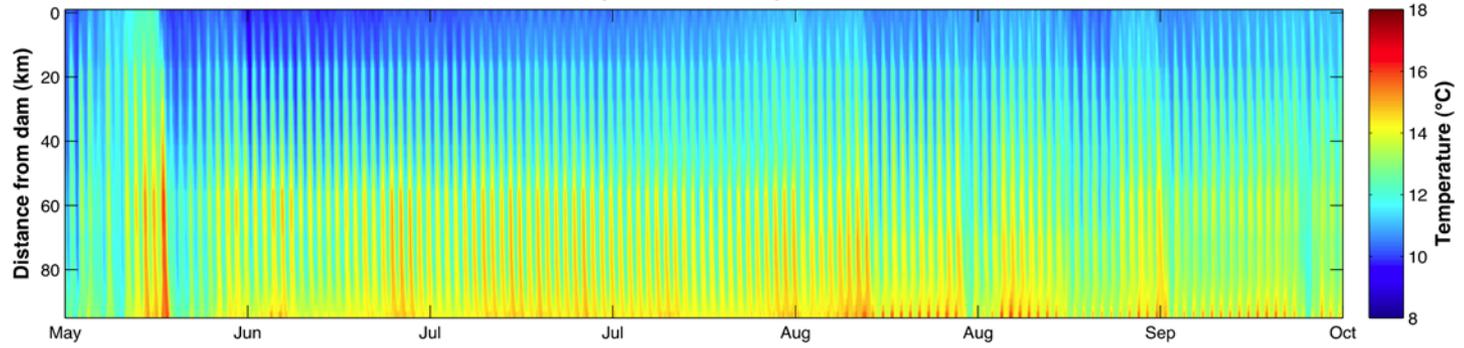
Exceedance 13.9°C



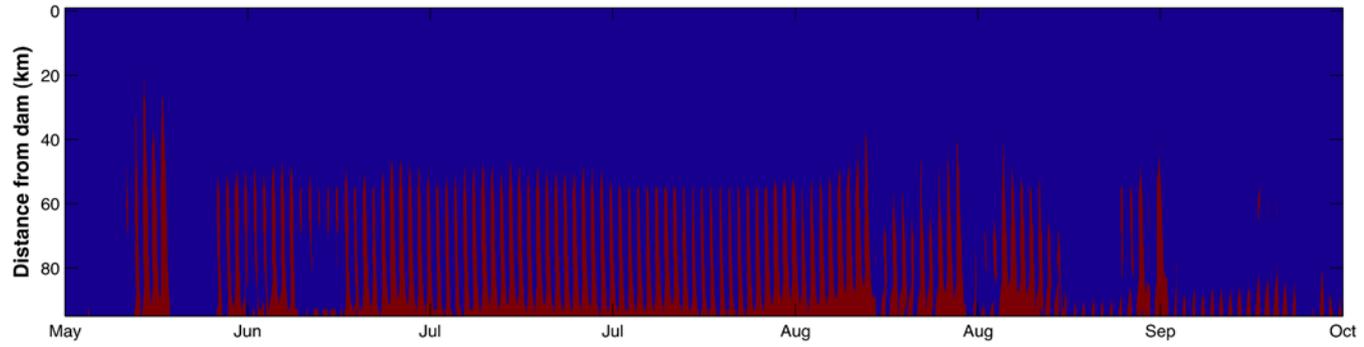
Exceedance 15.6°C



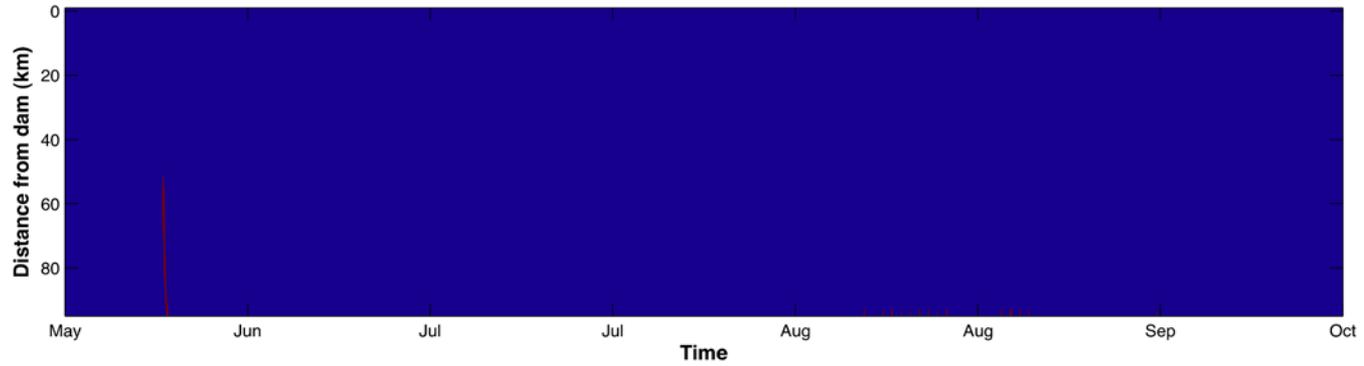
Temperature Landscape 2010



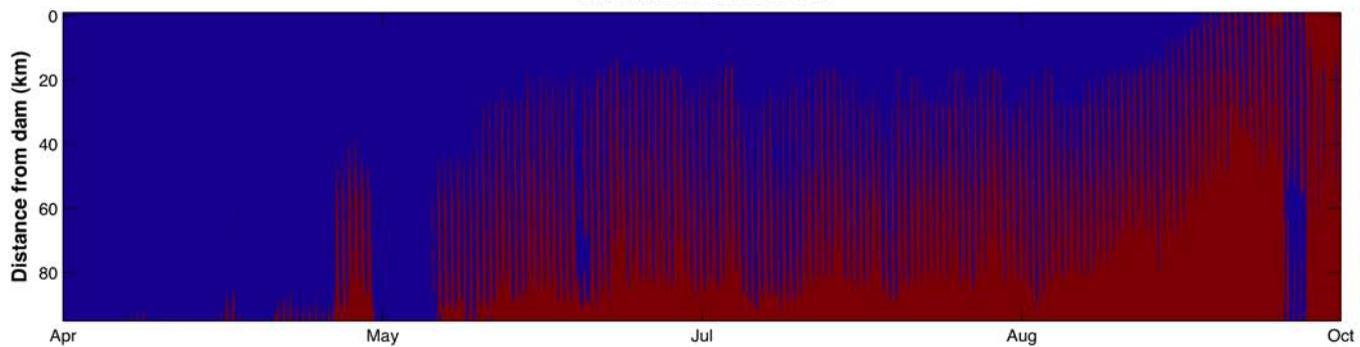
Exceedance 13.9°C



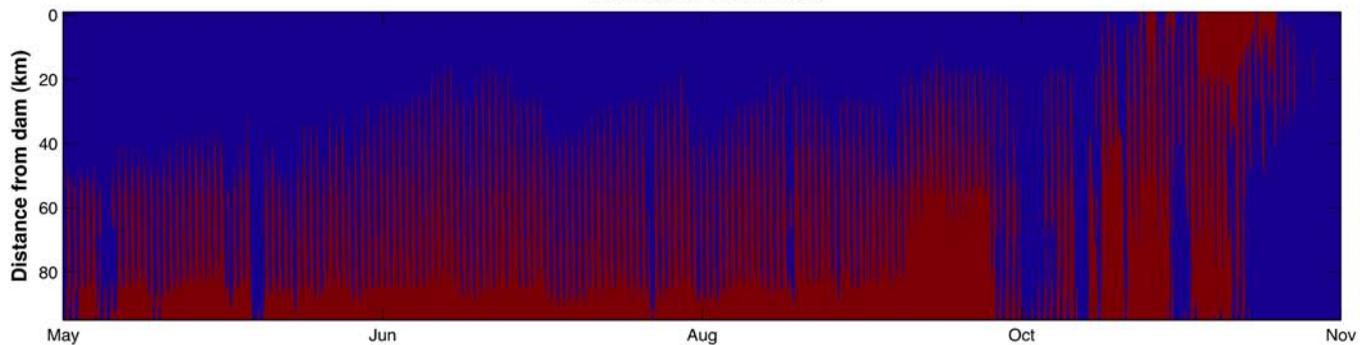
Exceedance 15.6°C



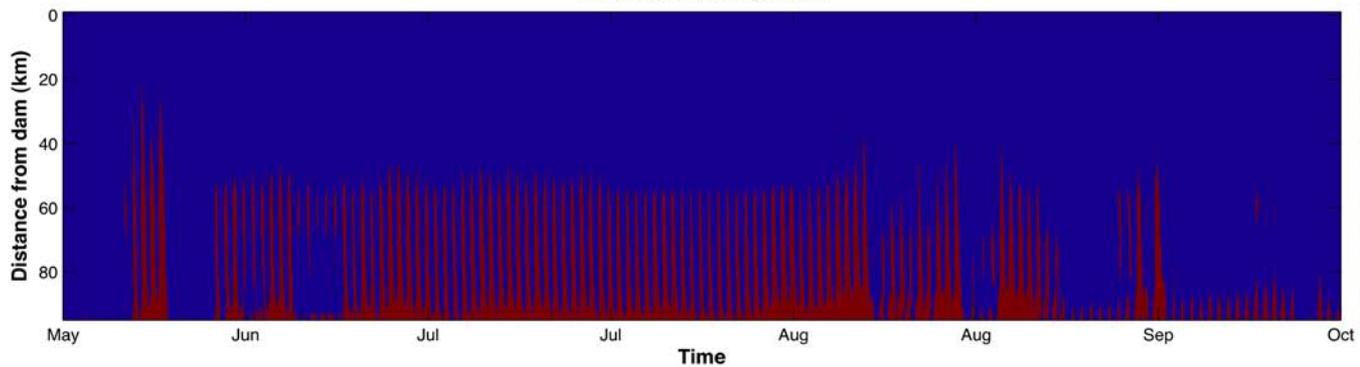
Exceedance 13.9°C 2008



Exceedance 13.9°C 2009



Exceedance 13.9°C 2010

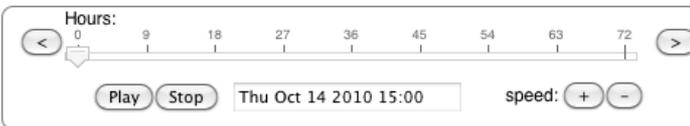


Make results available to water and fisheries managers



Please note: This site is a prototype of a user-interface for a stream temperature model and is for demonstration purposes only.

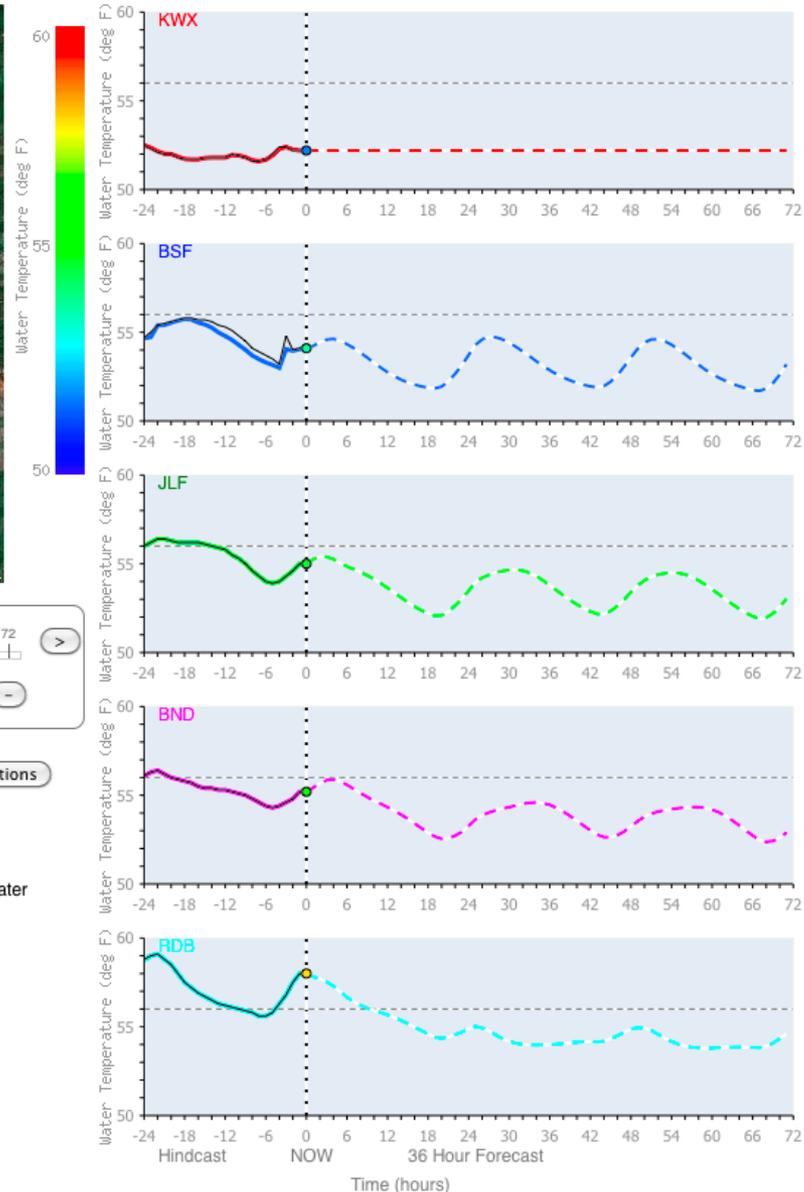
Forecast for current conditions: Flow 5970 cfs, Release Temperature 52.2 deg F



[Remove Stations](#)

Notes:

- Lines: black line is measured water temperature, colored lines are modeled water temperature
- Bubble color: **Measured water temperature** as shown in color bar
- Bubble size: scaled by **number of hours measured temperature is over 56 deg F** (see mouseover tooltip for value)
- Horizontal dashed line at 56 deg F





CVP Stream Temperature DSS Test

Home

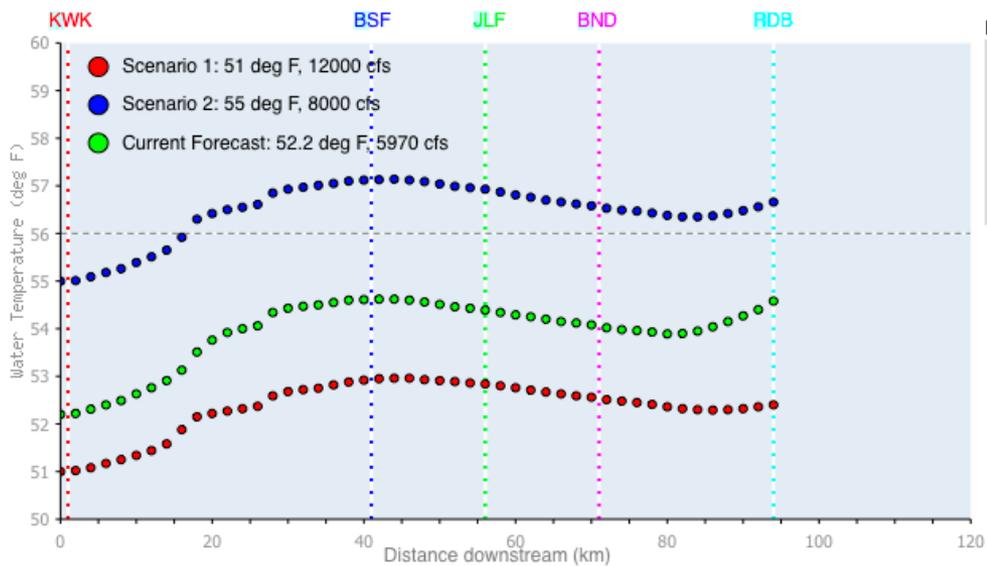
Management Scenarios

Forecasts

Project Information

Links

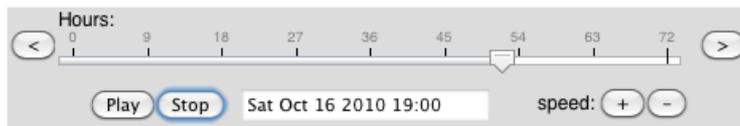
Please note: This site is a prototype of a user-interface for a stream temperature model and is for demonstration purposes only.



Enter new discharge scenarios:

Scenario	Temperature	Flow
1	51 deg F	12,000 cfs
2	55 deg F	8,000 cfs

Show these scenarios



Notes:

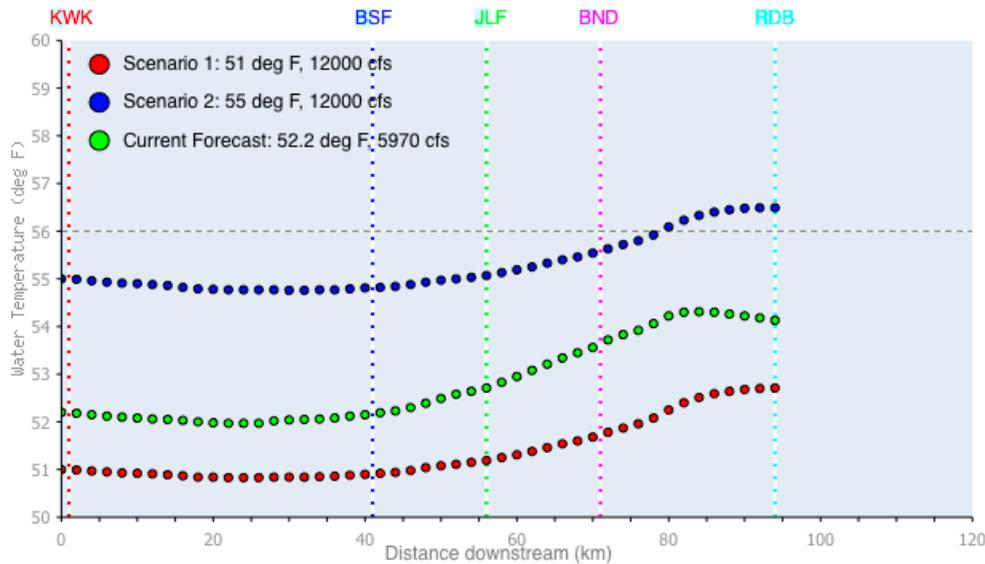
- Bubble color: scenario
- Vertical dotted lines represent station locations (see home page)
- Bubble size: scaled by number of hours over 56 deg F (see mouseover tooltip for value)
- Horizontal dashed line at 56 deg F



CVP Stream Temperature DSS Test

[Home](#)[Management Scenarios](#)[Forecasts](#)[Project Information](#)[Links](#)

Please note: This site is a prototype of a user-interface for a stream temperature model and is for demonstration purposes only.



Enter new discharge scenarios:

Scenario	Temperature	Flow
1	<input type="text" value="51"/> deg F	<input type="text" value="12,000"/> cfs
2	<input type="text" value="55"/> deg F	<input type="text" value="12,000"/> cfs

Hours:

speed:

Notes:

Bubble color: **scenario**

Vertical dotted lines represent station locations (see home page)

Bubble size: scaled by **number of hours over 56 deg F** (see mouseover tooltip for value)

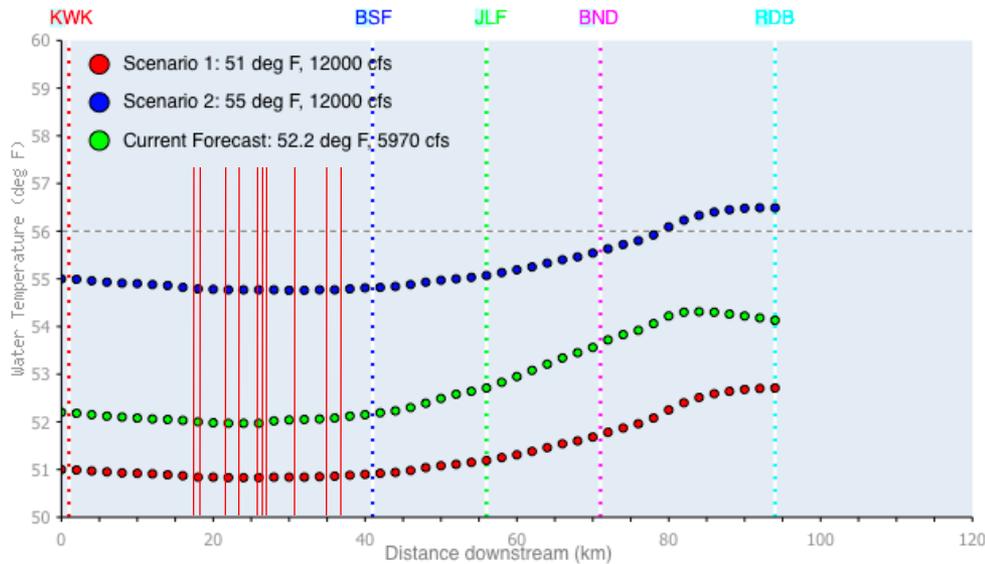
Horizontal dashed line at 56 deg F



CVP Stream Temperature DSS Test

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1	51 deg F	12,000 cfs
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Show these scenarios

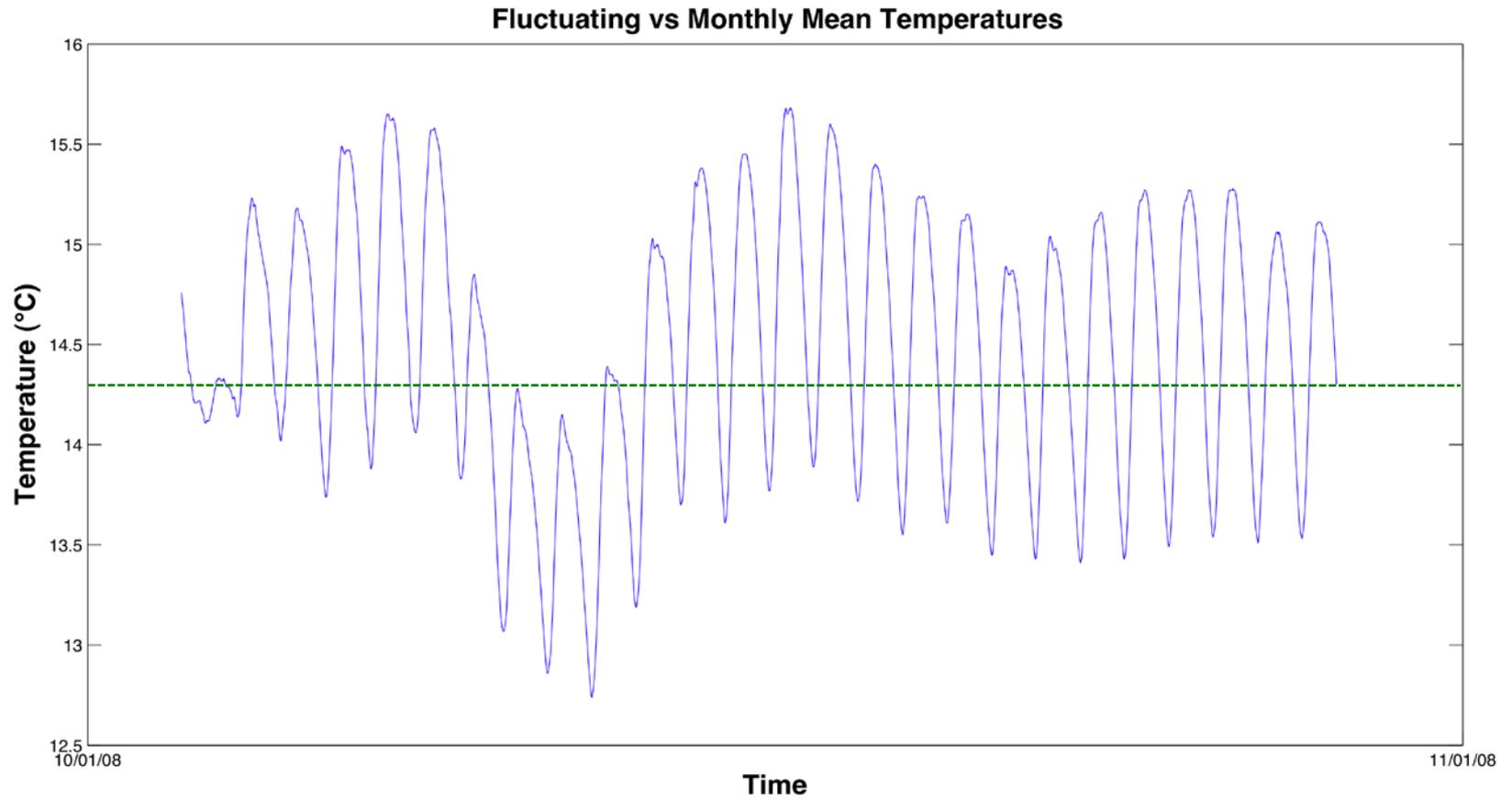
Hours: 0 9 18 27 36 45 54 63 72

Play Stop Sat Oct 16 2010 07:00 speed: + -

Notes:

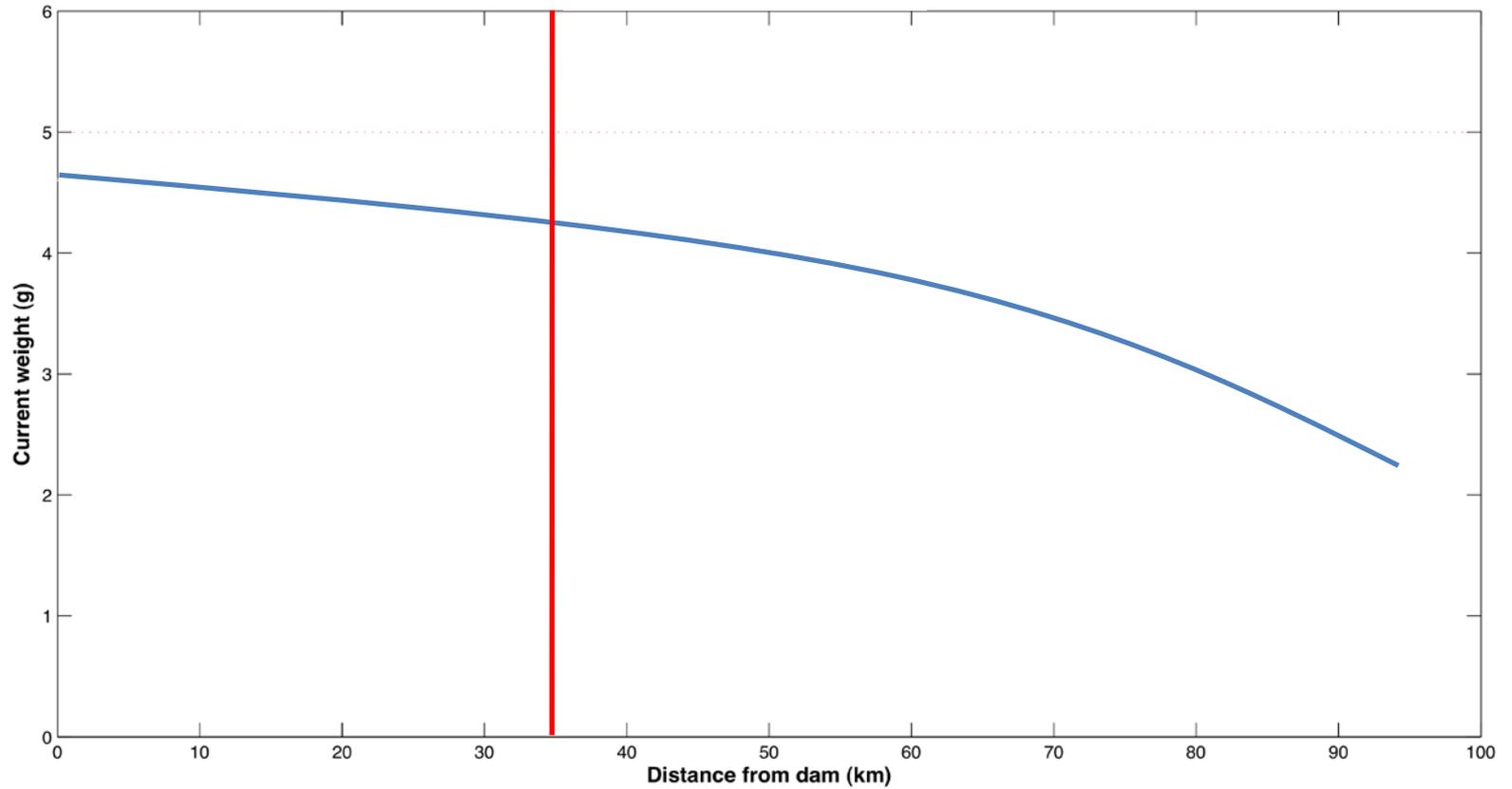
- Bubble color: **scenario**
- Vertical dotted lines represent station locations (see home page)
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- Horizontal dashed line at 56 deg F

Bioenergetics



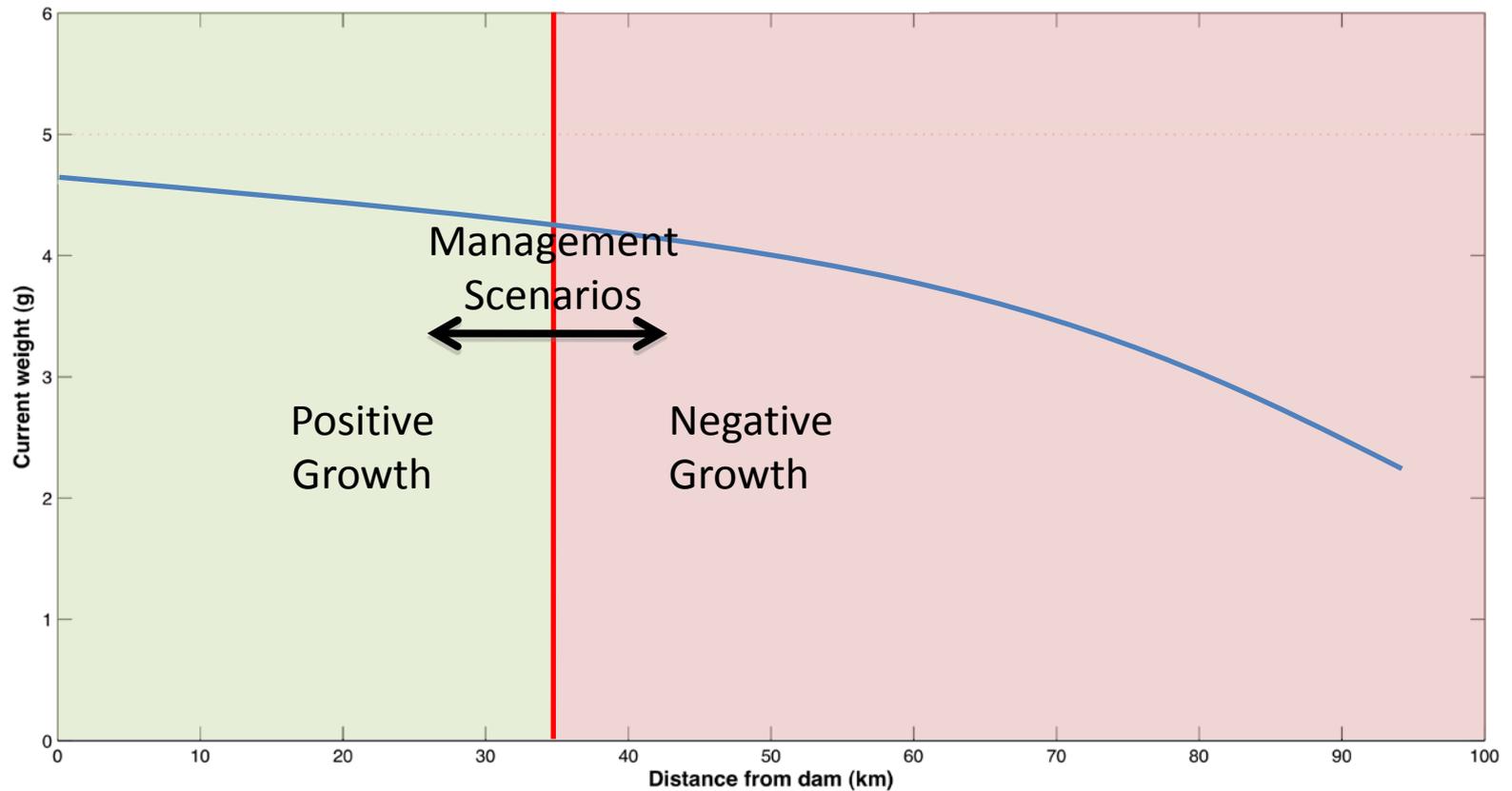
Modeling Juvenile Growth

October 15, 2010



Modeling Juvenile Growth

October 15, 2010



Summary

Capture diurnal temperature variation

Complete temperature landscape

Growth models operating at the appropriate scales

Results in a useful format

Feedback

Acknowledgements

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Southwest Fisheries Science Center, Environmental Research Division

