Modeling river water temperatures in critical habitat ESA listed salmon: the importance of spatial and temporal scales

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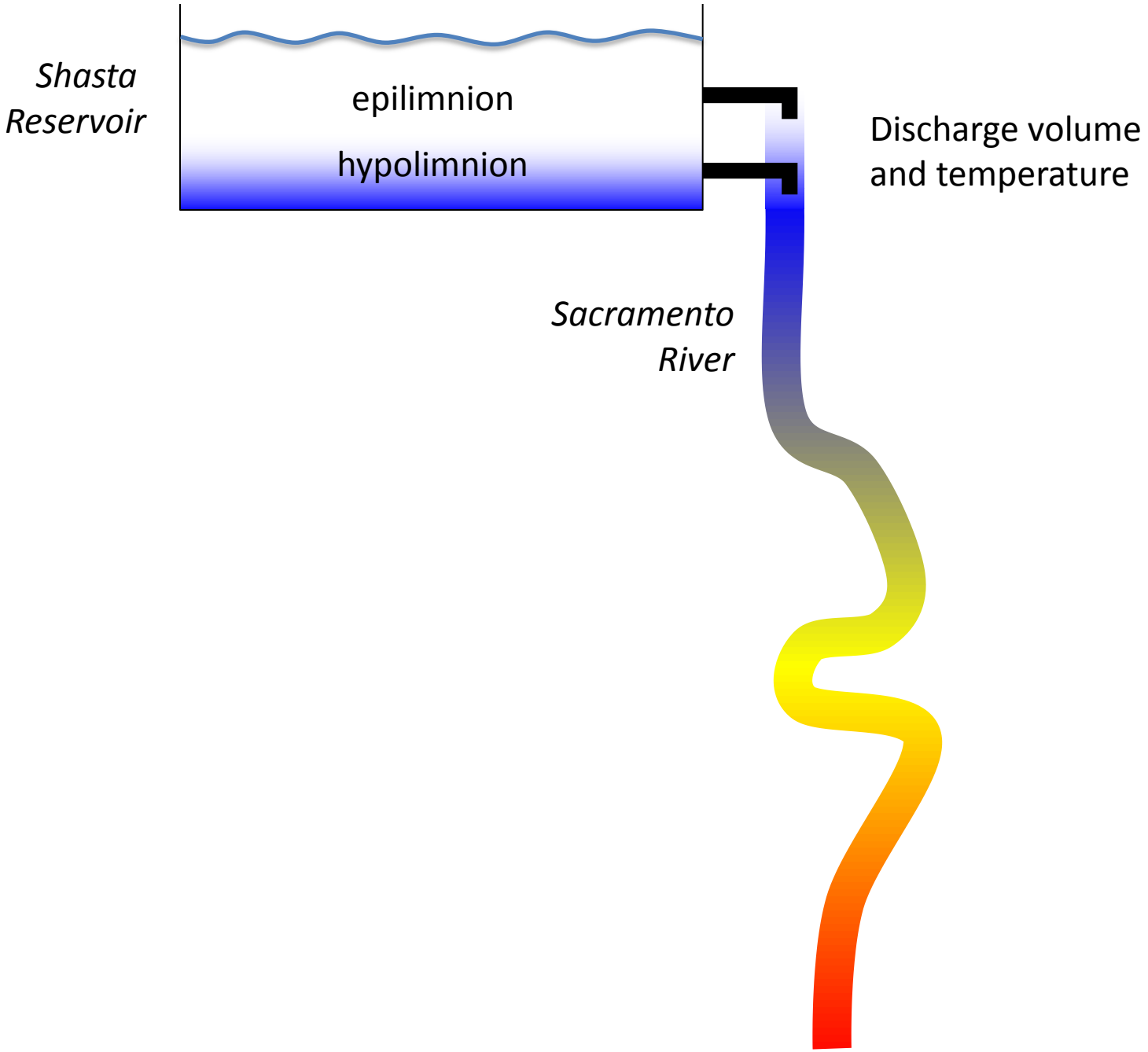
Southwest Fisheries Science Center

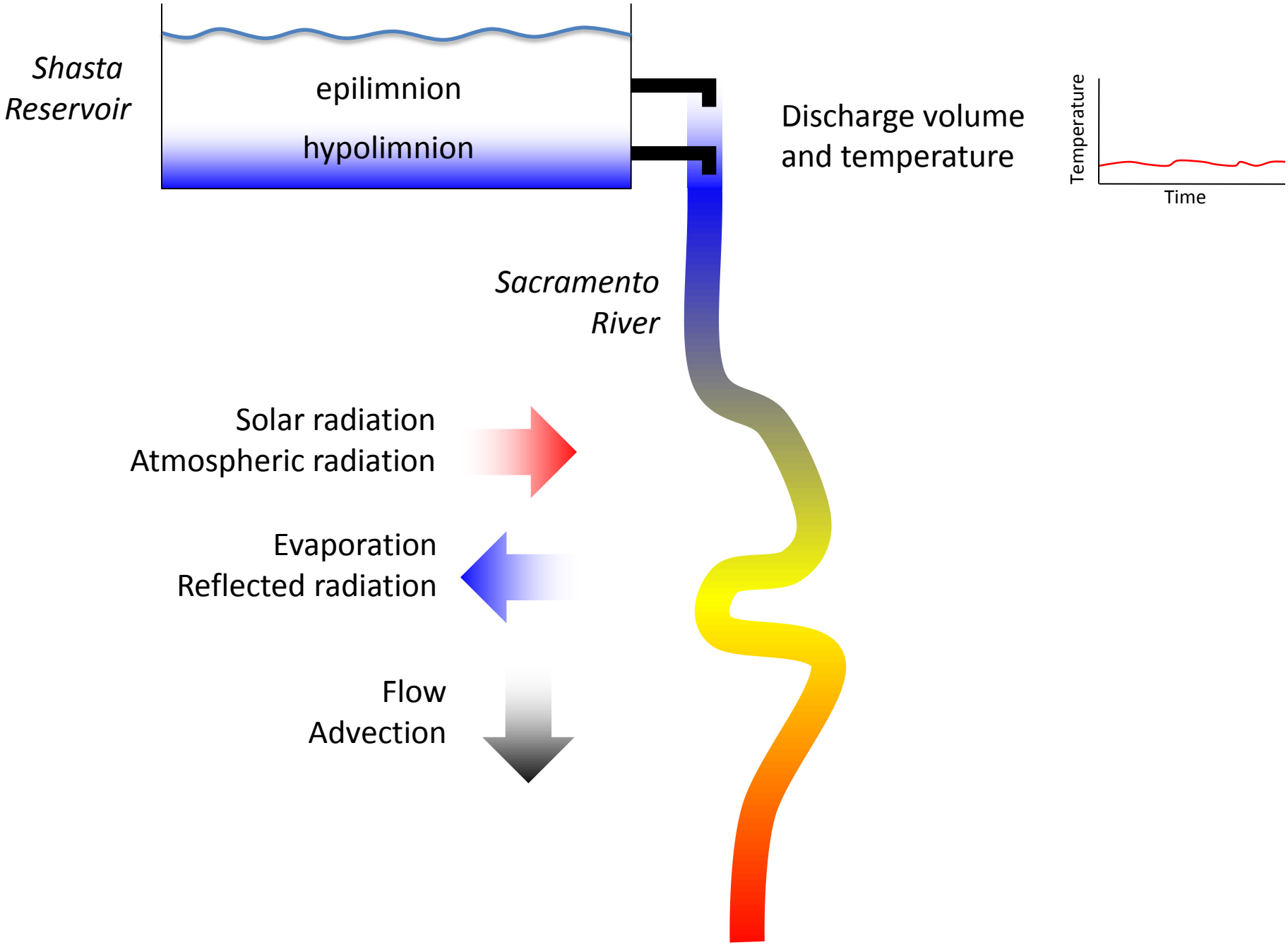
Talk Overview

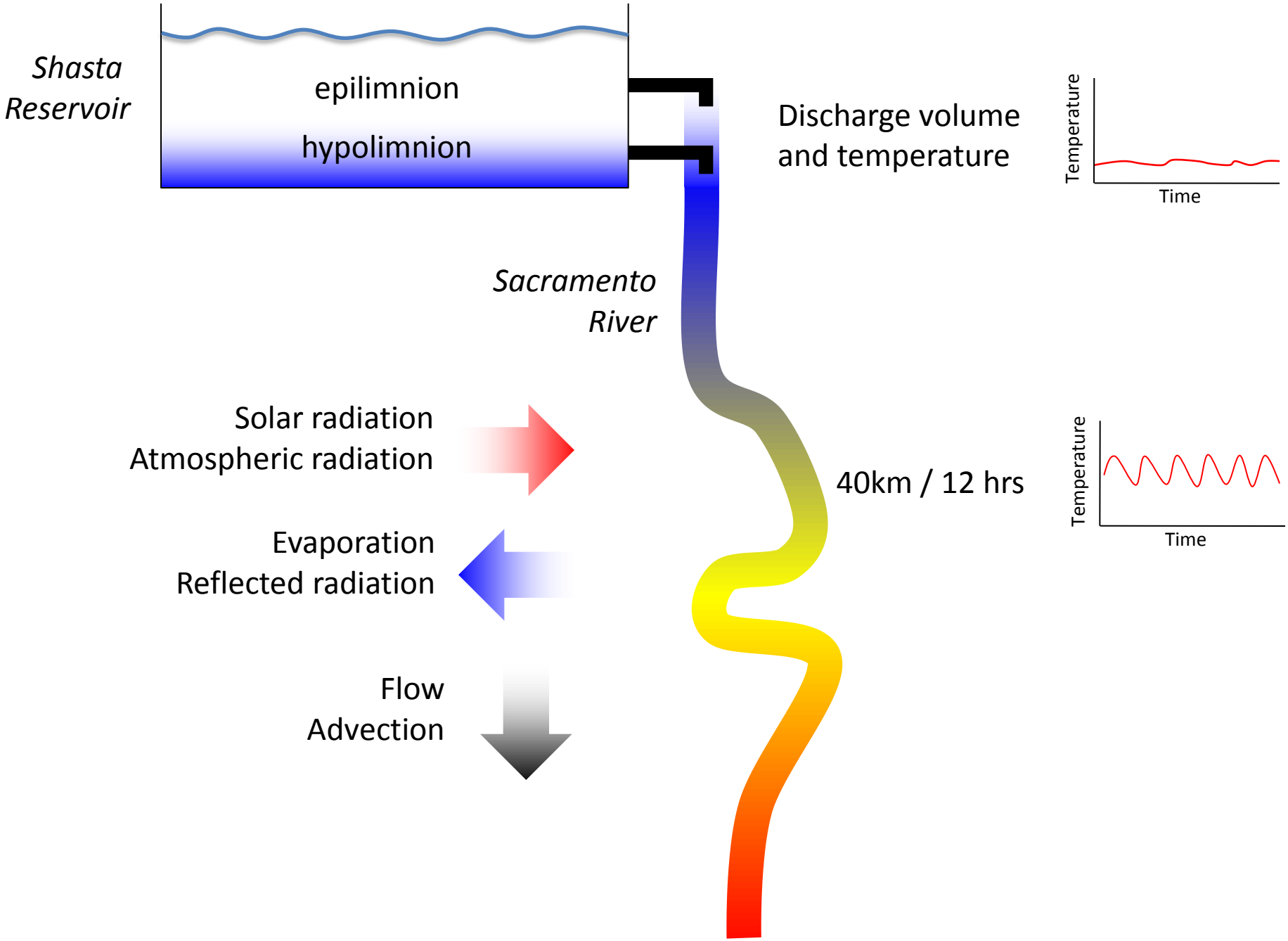
Project goal: improve decision support for water releases from Shasta Dam with respect to salmon habitat

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

Make results easily accessible to the end-users


Shasta Reservoir
epilimnion
hypolimnion
Discharge volume and temperature
Sacramento River


Shasta Reservoir
epilimnion
hypolimnion
Discharge volume and temperature
Temperature
Time
Sacramento River
Solar radiation
Atmospheric radiation
Evaporation
Reflected radiation
Flow
Advection


Shasta Reservoir
epilimnion
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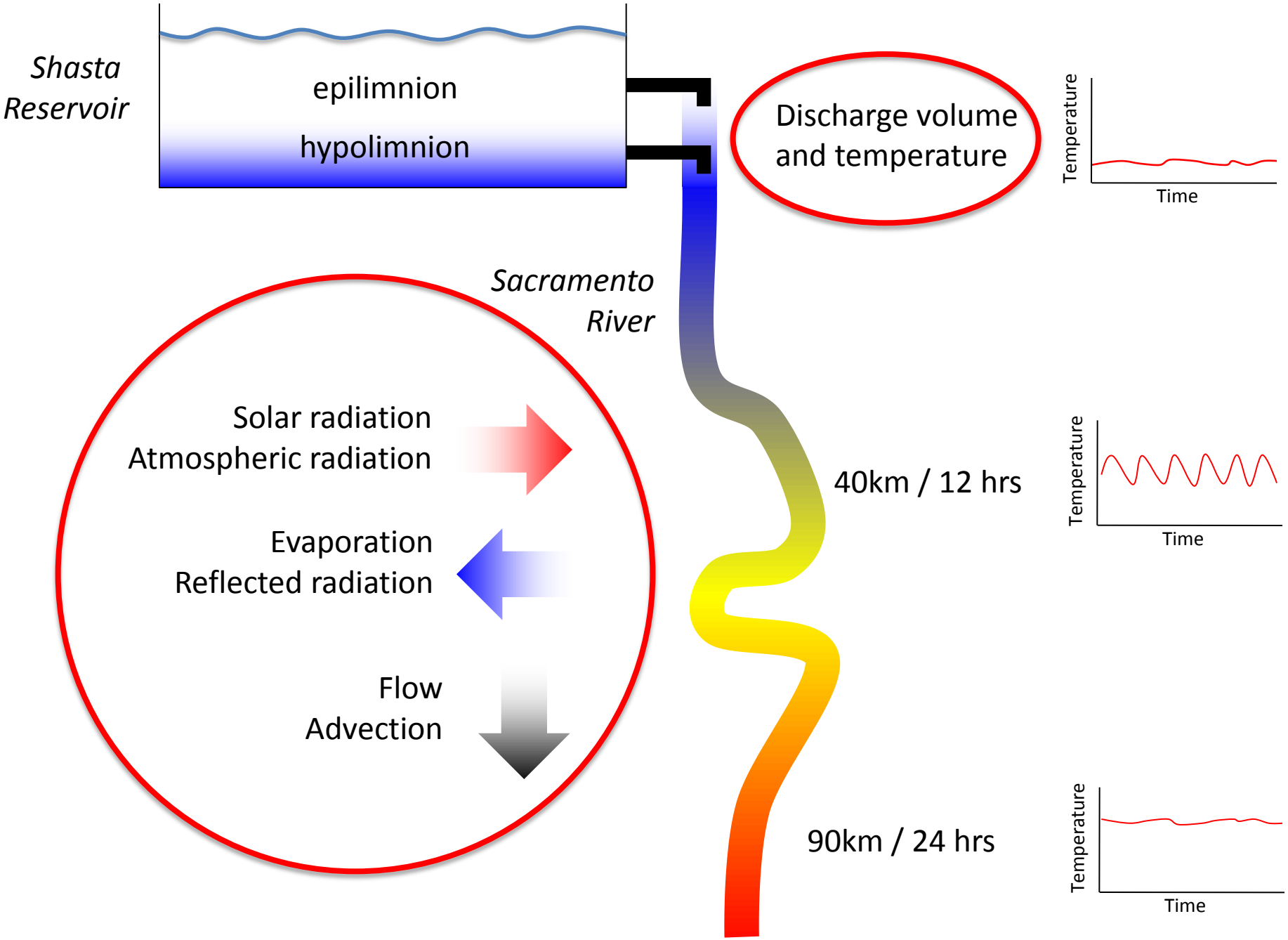
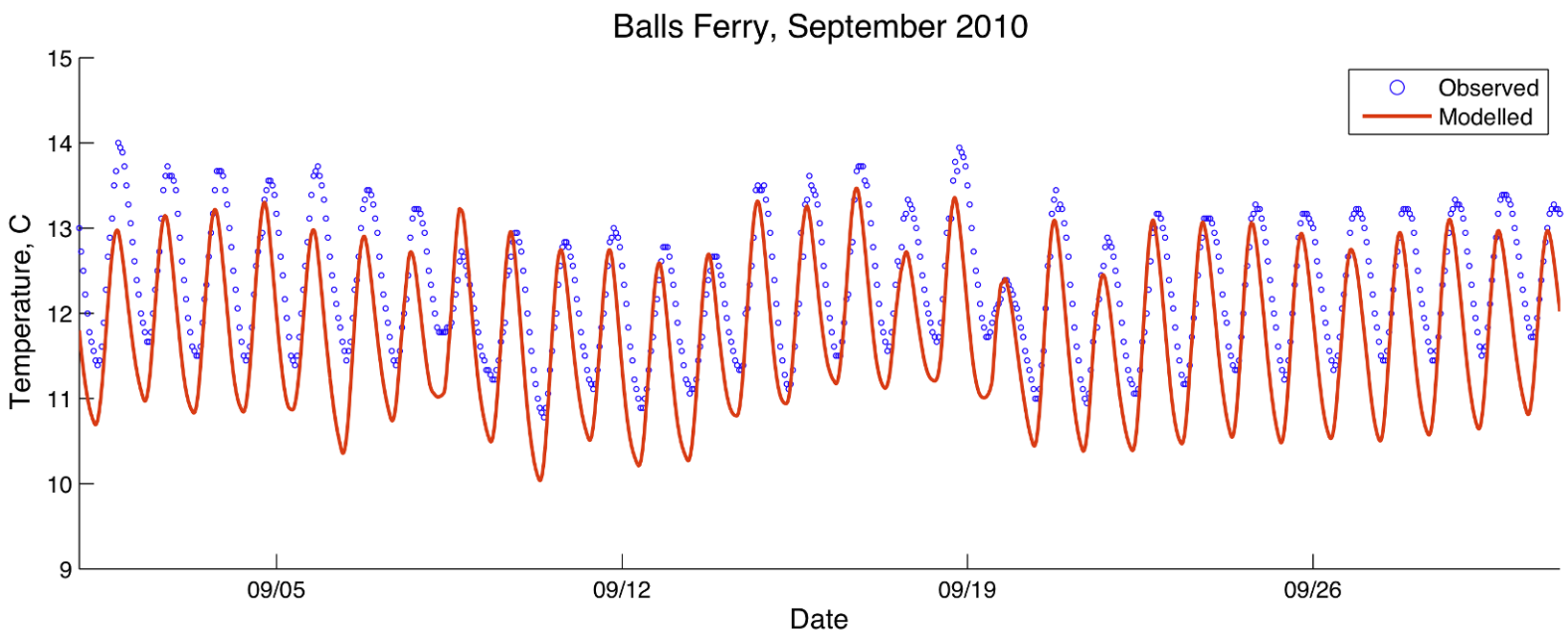
Discharge volume and temperature
Temperature
Time
Sacramento River
Solar radiation
Atmospheric radiation
Evaporation
Reflected radiation
Flow
Advection
40km / 12 hrs
Temperature
Time


Shasta Reservoir
epilimnion
hypolimnion
Discharge volume and temperature
Temperature
Time
Sacramento River
Solar radiation
Atmospheric radiation
Evaporation
Reflected radiation
Flow
Advection
40km / 12 hrs
Temperature
Time
90km / 24 hrs
Temperature
Time

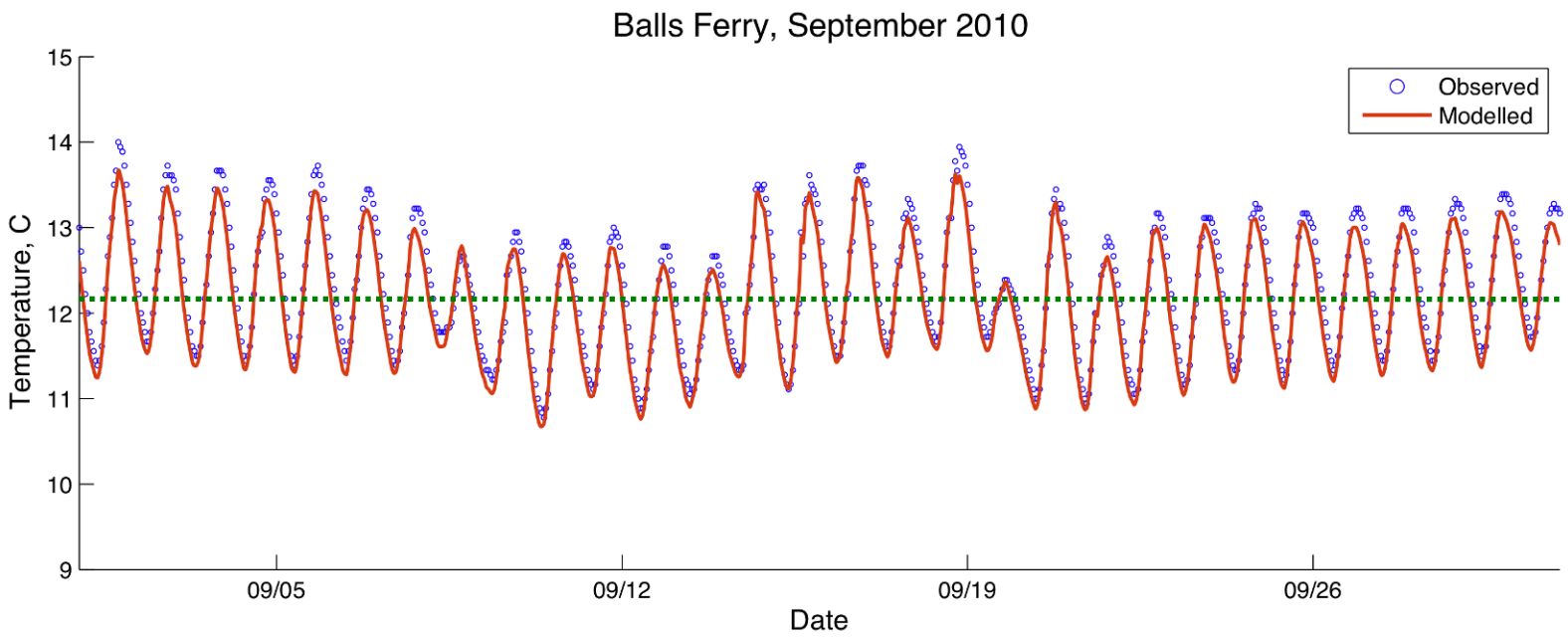
Model Results

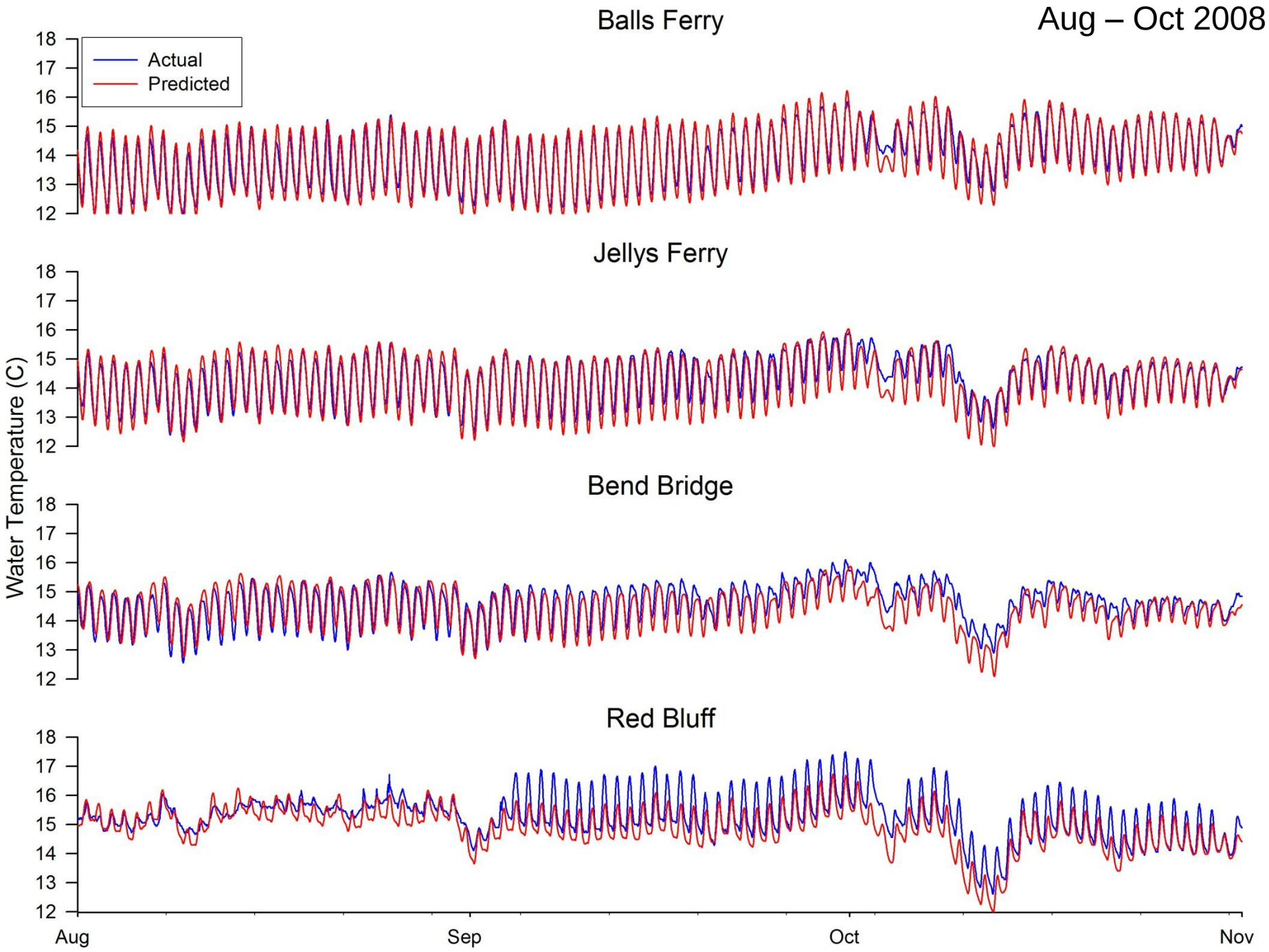
(without assimilation)

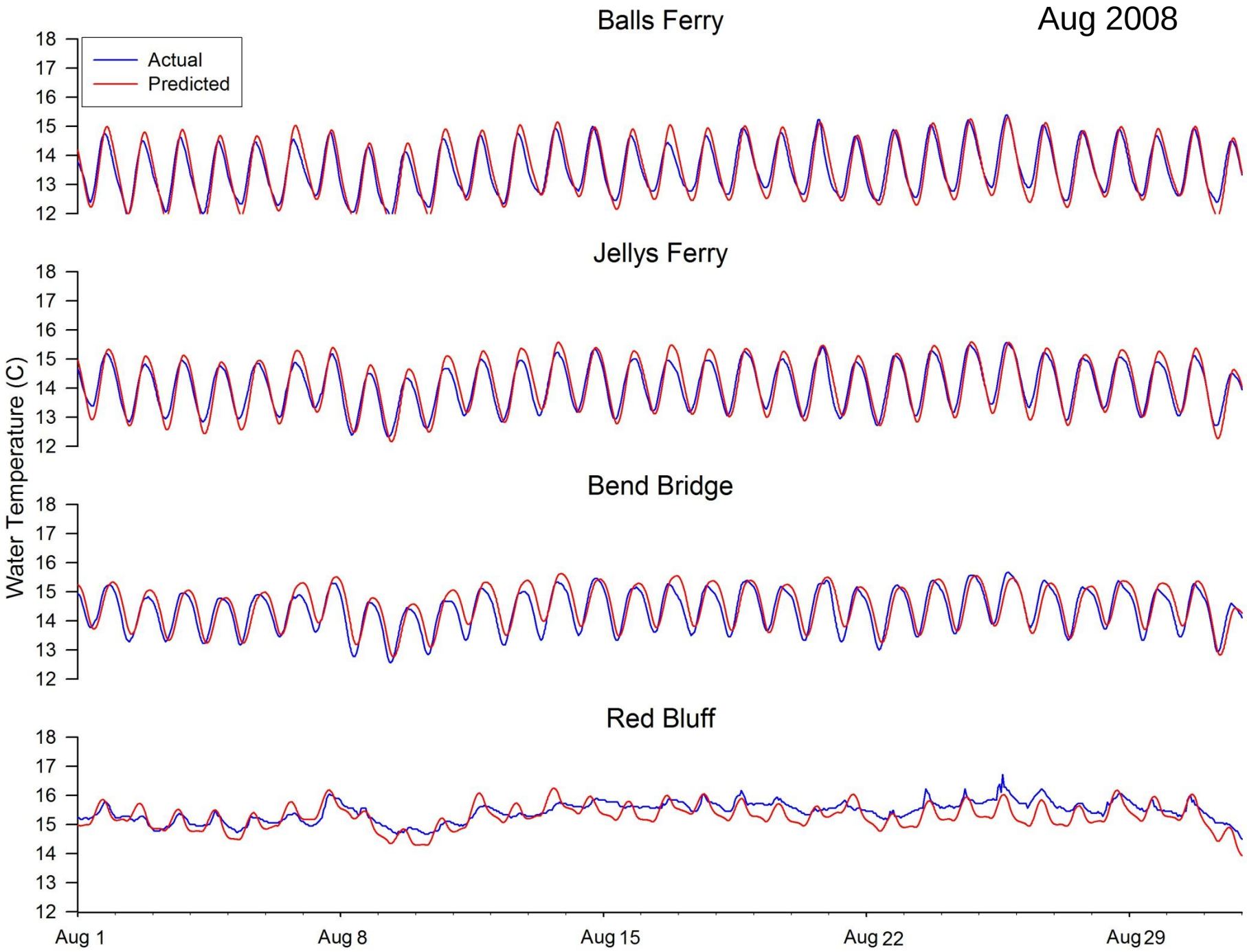


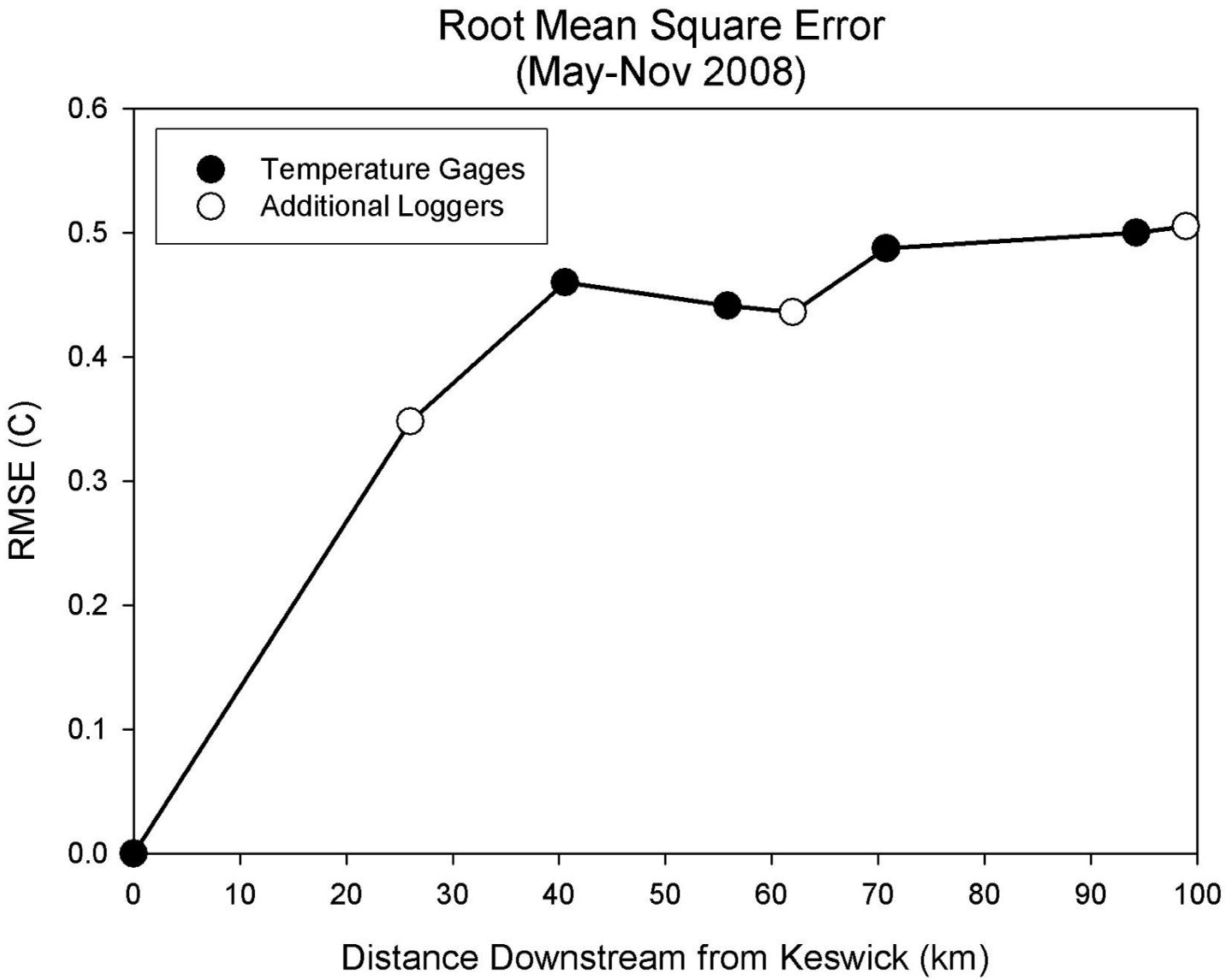
Model Results

(with assimilation)

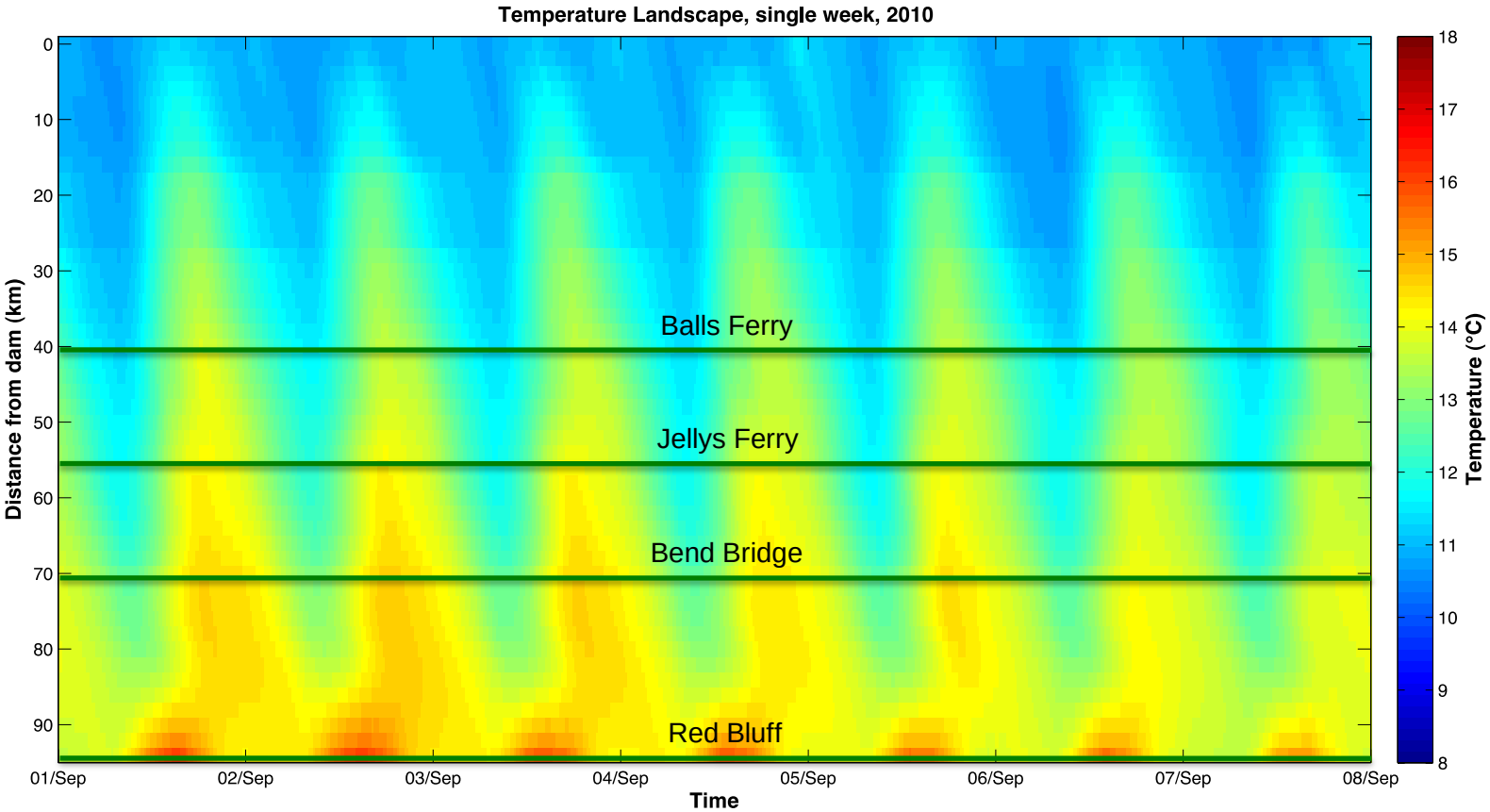



Aug – Oct 2008
Balls Ferry
Jellys Ferry
Bend Bridge
Red Bluff
Actual
Predicted
Water Temperature (C)
18
17
16
15
14
13
12
Aug
Sep
Oct
Nov

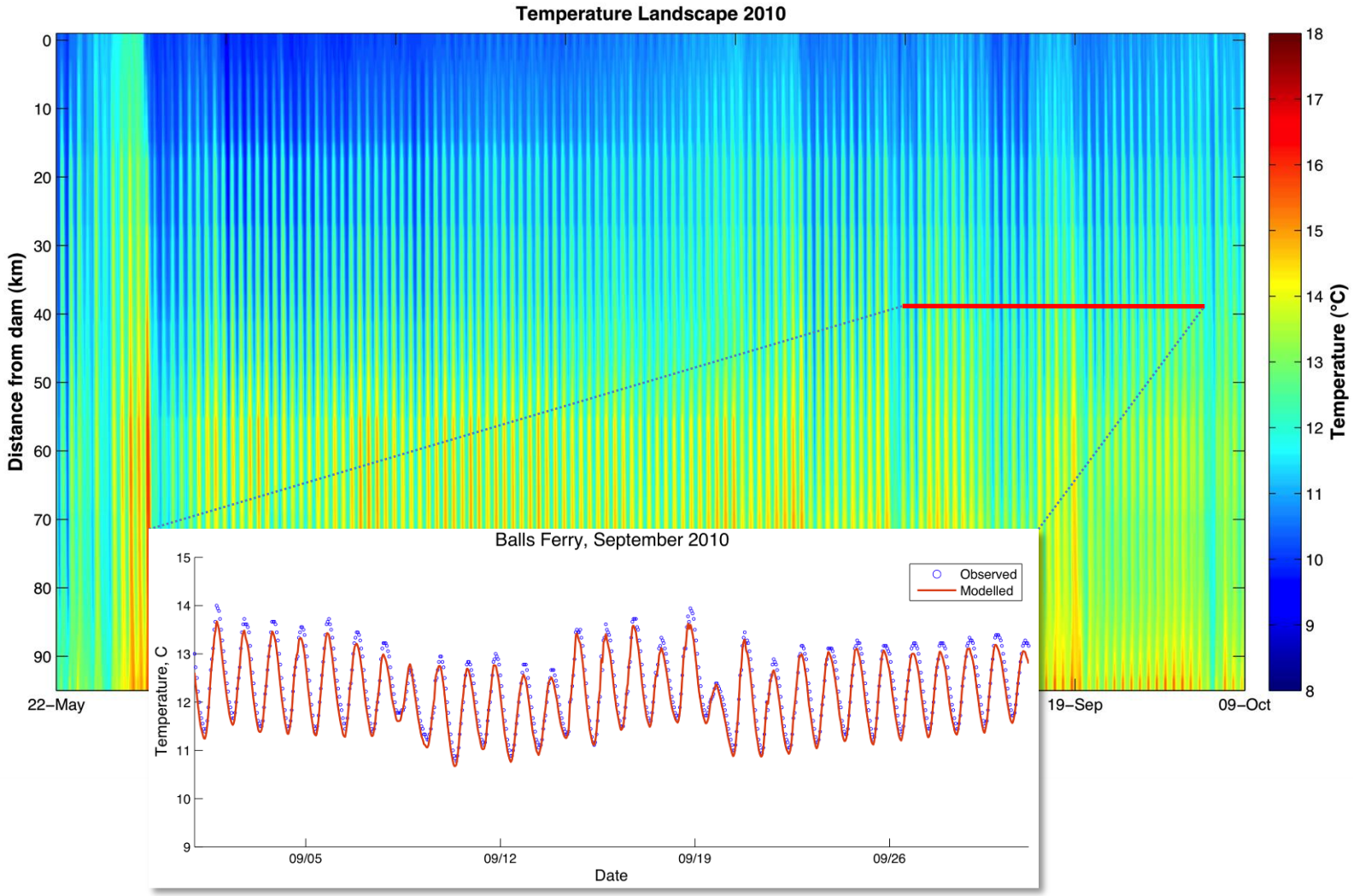

Balls Ferry
Aug 2008
Actual
Predicted
Jellys Ferry
Bend Bridge
Red Bluff
Water Temperature (C)
18
17
16
15
14
13
12
Aug 1
Aug 8
Aug 15
Aug 22
Aug 29


Root Mean Square Error
(May-Nov 2008)
Temperature Gages
Additional Loggers
RMSE (C)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
10
20
30
40
50
60
70
80
90
100
Distance Downstream from Keswick (km)

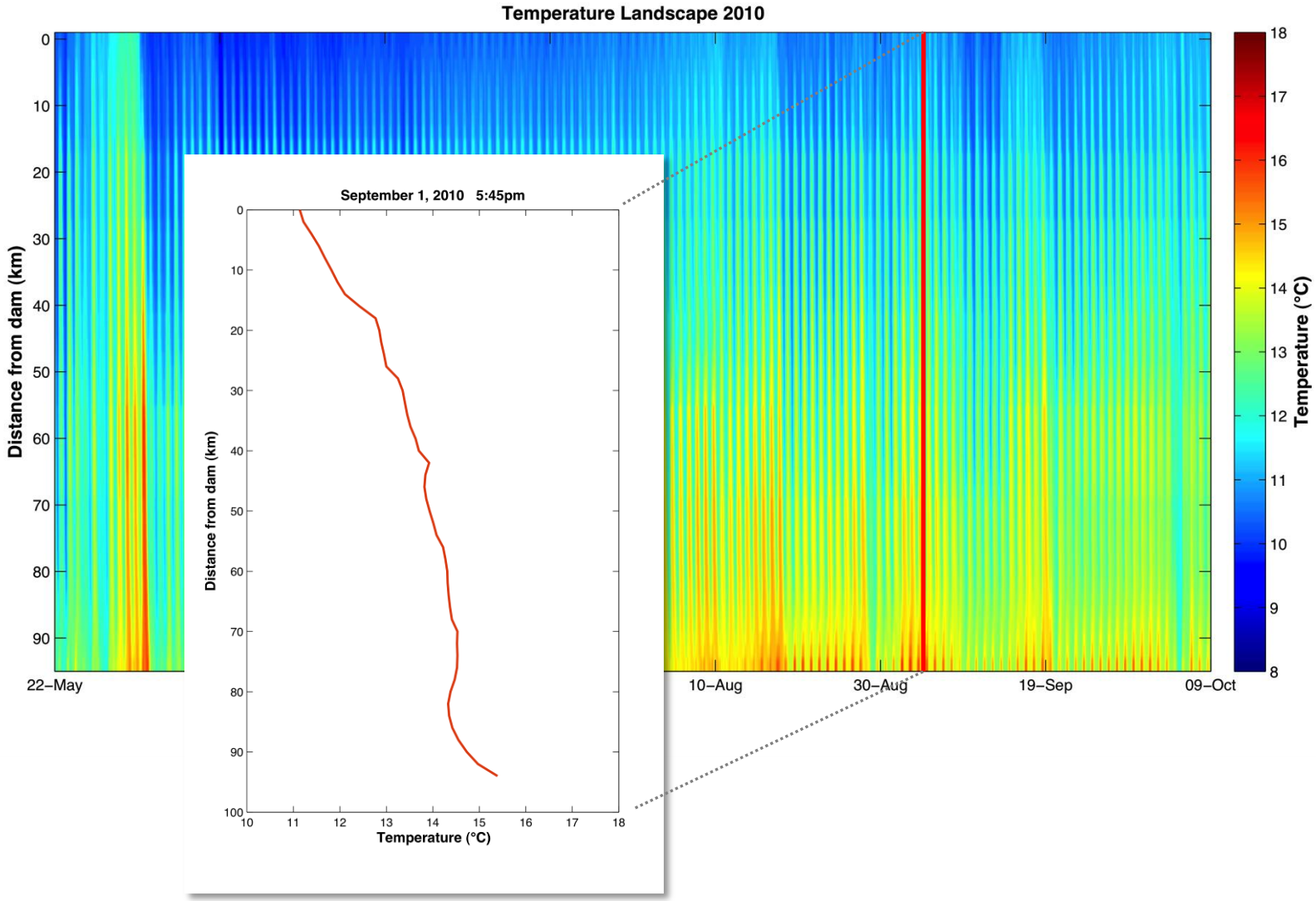
Temperature Landscape – one week

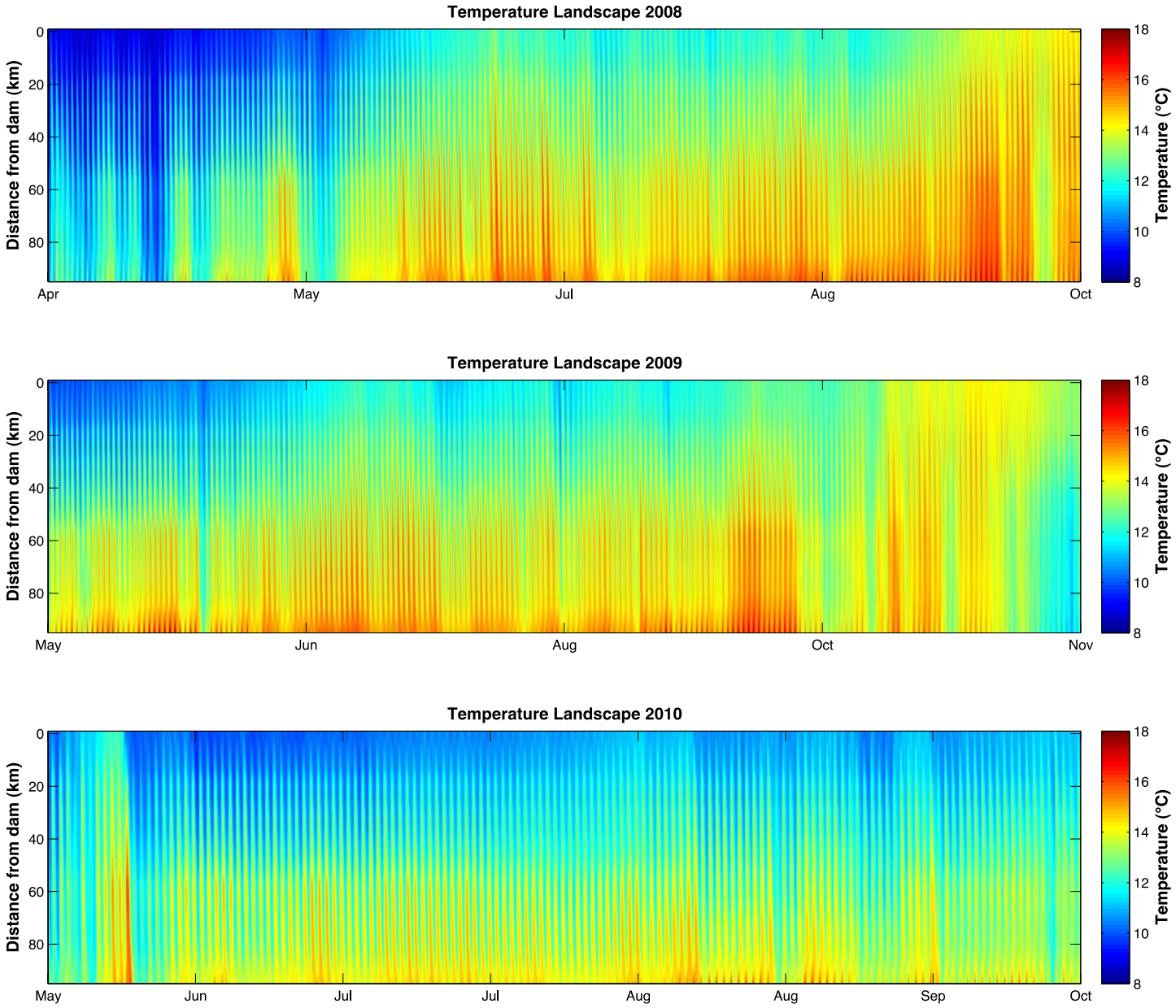


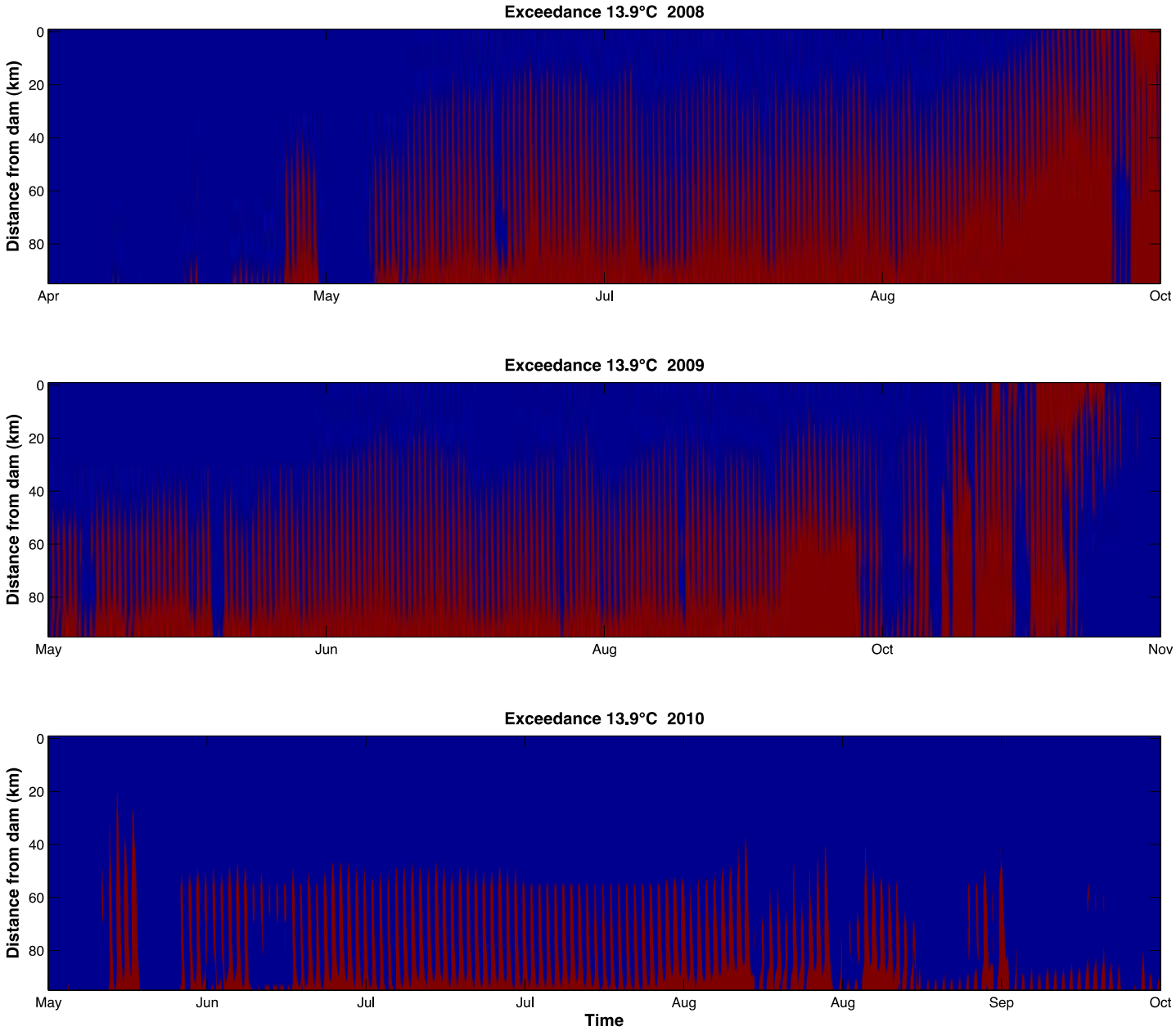
Temperature Landscape – entire season

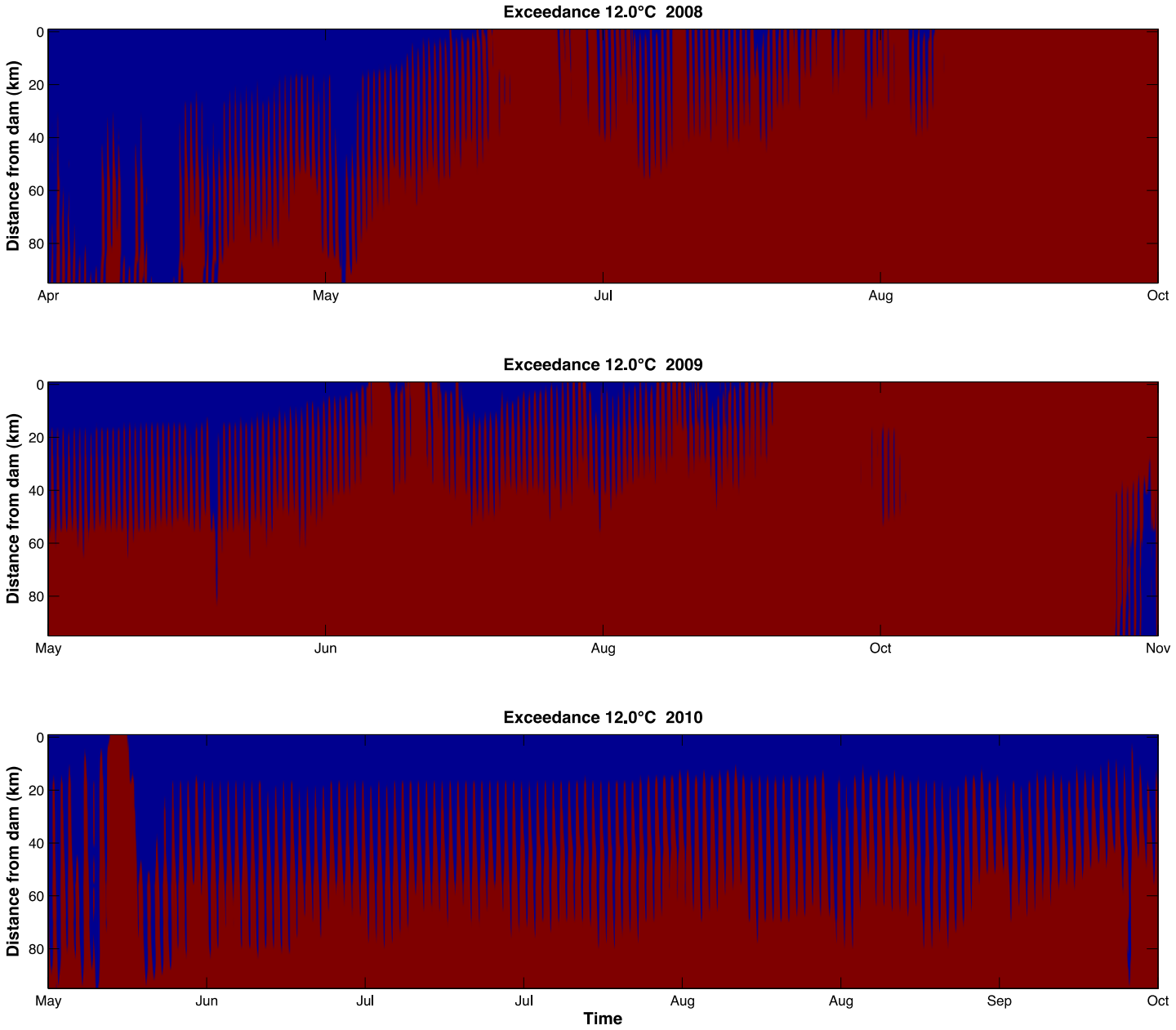


Longitudinal Profile




Temperature Landscape 2008
Distance from dam (km)
0
20
40
60
80
Apr
May
Jul
Aug
Oct
Temperature (°C)
18
16
14
12
10
8
Temperature Landscape 2009
Distance from dam (km)
0
20
40
60
80
May
Jun
Aug
Oct
Nov
Temperature (°C)
18
16
14
12
10
8
Temperature Landscape 2010
Distance from dam (km)
0
20
40
60
80
May
Jun
Jul
Jul
Aug
Aug
Sep
Oct
Temperature (°C)
18
16
14
12
10
8


Exceedance 13.9°C 2008
Distance from dam (km)
0
20
40
60
80
Apr
May
Jul
Aug
Oct
Exceedance 13.9°C 2009
Distance from dam (km)
0
20
40
60
80
May
Jun
Aug
Oct
Nov
Exceedance 13.9°C 2010
Distance from dam (km)
0
20
40
60
80
May
Jun
Jul
Jul
Aug
Aug
Sep
Oct
Time


Exceedance 12.0°C 2008
Distance from dam (km)
0
20
40
60
80
Apr
May
Jul
Aug
Oct
Exceedance 12.0°C 2009
Distance from dam (km)
0
20
40
60
80
May
Jun
Aug
Oct
Nov
Exceedance 12.0°C 2010
Distance from dam (km)
0
20
40
60
80
May
Jun
Jul
Jul
Aug
Aug
Sep
Oct
Time

Use the results to make informed management decisions

CVP River Temperature Forecast DSS

Home | Forecasts | Management Scenarios | Temperature History | Project Information | Links

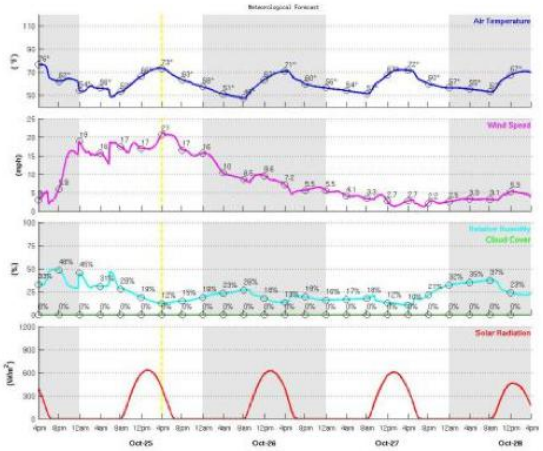
Please note: This site is a prototype user-interface for a stream temperature model and is for demonstration purposes only.

Thu Oct 27 2011 10:00 forecast for current conditions: Flow **7050.0 cfs**, Release Temperature **51.4 deg F**

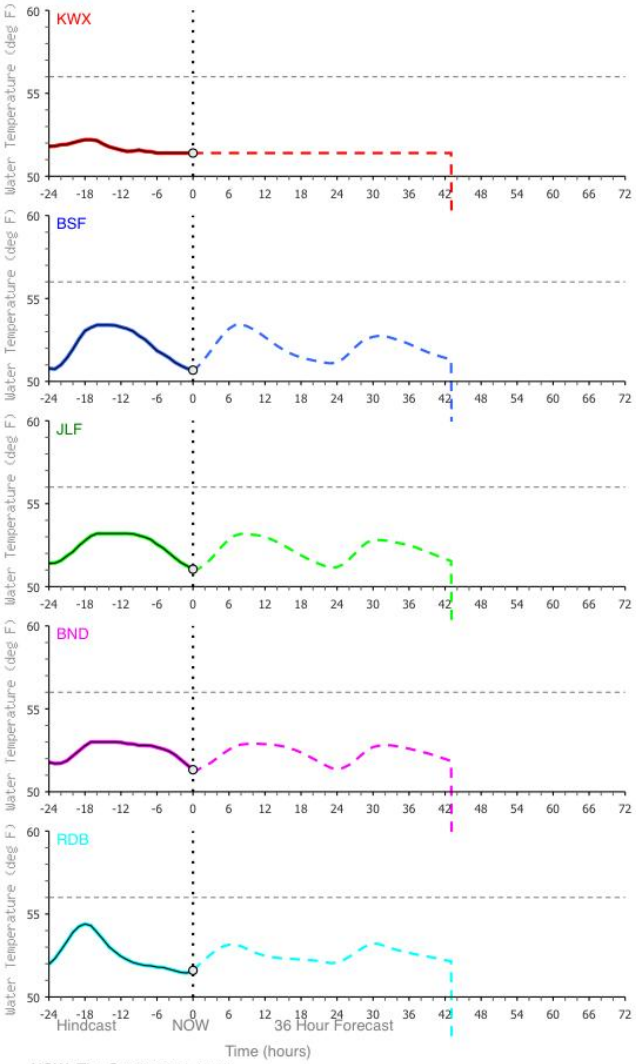
Hours: 0 9 18 27 36 45 54 63 72

Play Stop Thu Oct 27 2011 10:00 speed: + -

Remove Stations

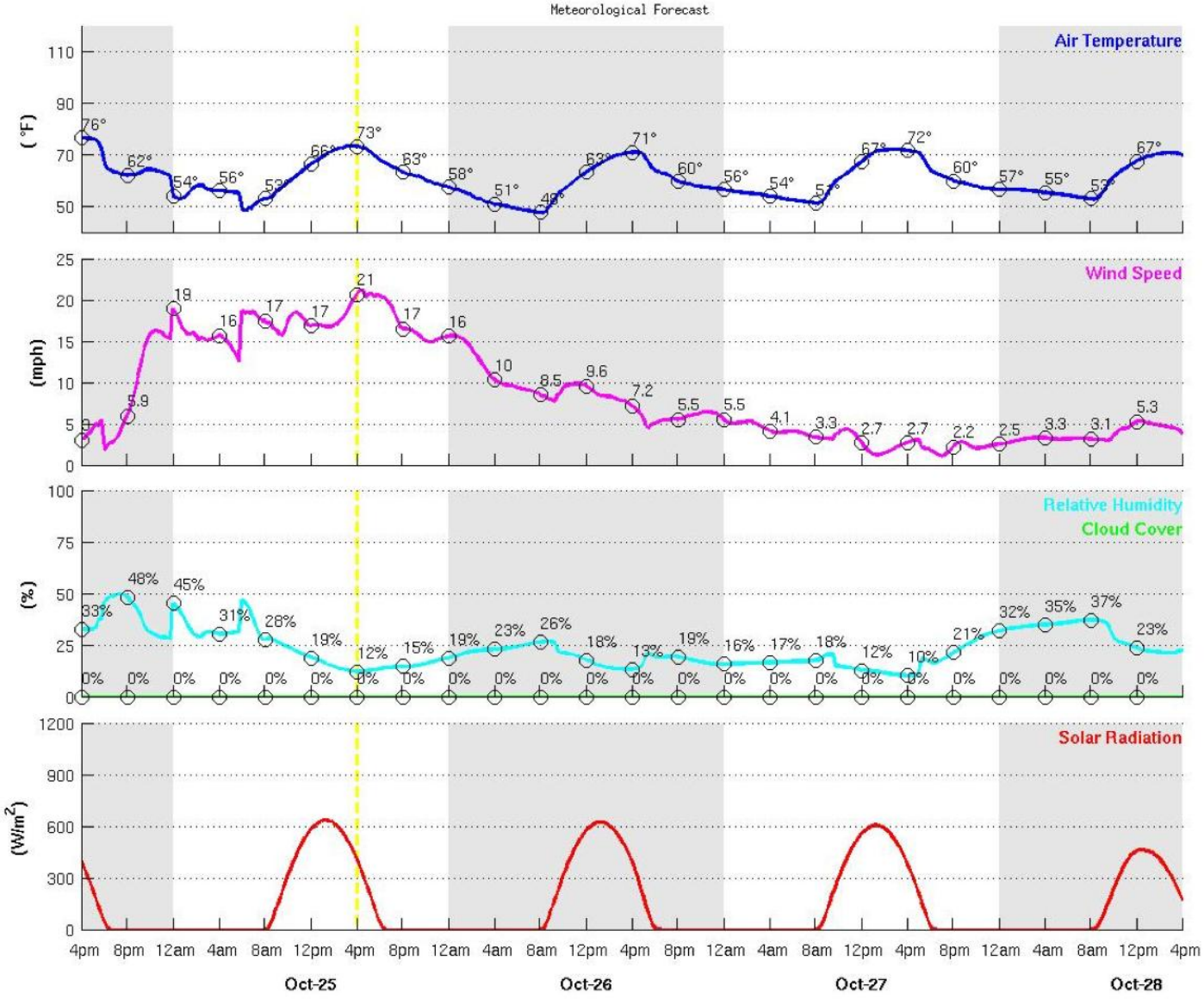


view larger image



NOW: Thu Oct 27 2011 10:00

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** (currently disabled)
Horizontal dashed line at 56 deg F



4-Day Forecast

CVP River Temperature Forecast DSS

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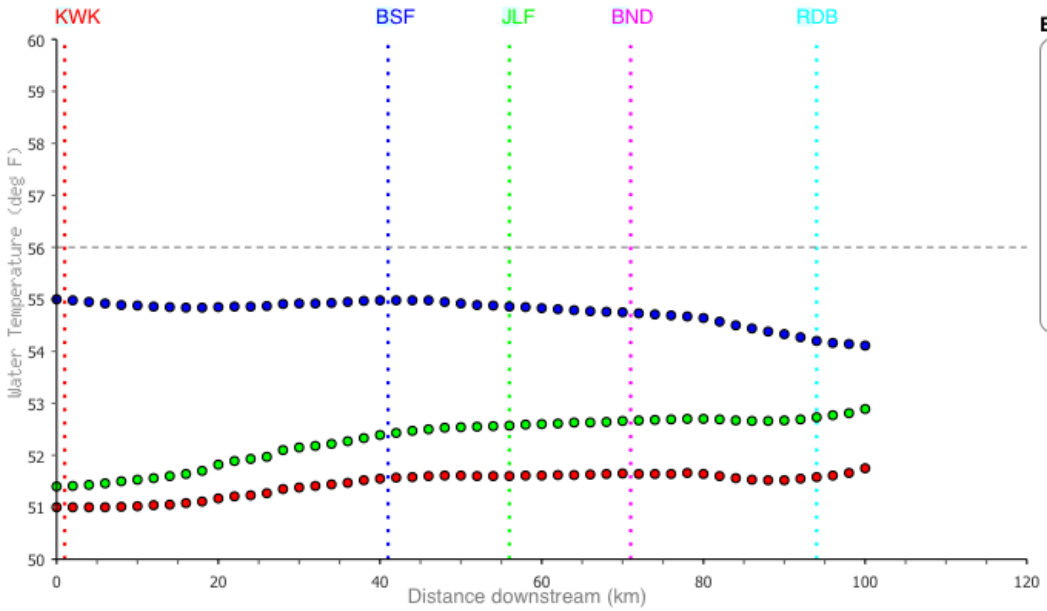

Hours:

< 0 9 18 27 36 45 54 63 72 >

Play | Stop | Fri Oct 28 2011 21:00 | speed: + -

Enter new discharge scenarios:

Scenario	Temperature	Flow
	51 deg F	12,000 cfs
	55 deg F	8,000 cfs
Current Discharge	**Temperature**	**Flow**
	51.4 deg F	7050.0 cfs

CVP River Temperature Forecast DSS

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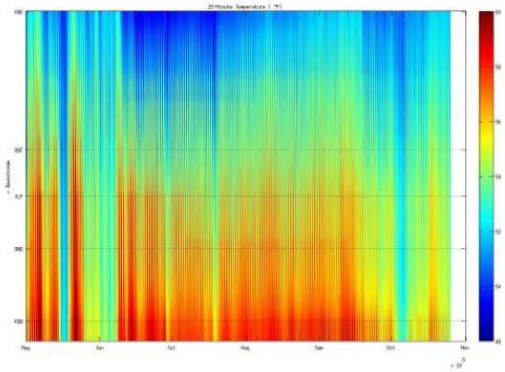
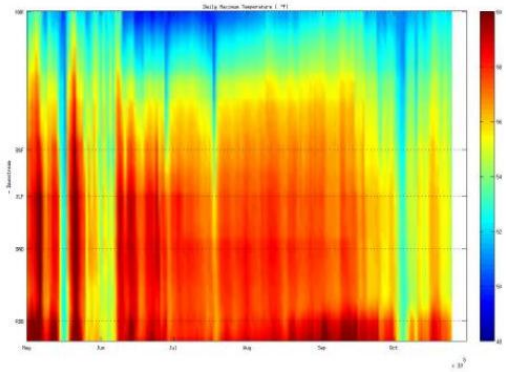
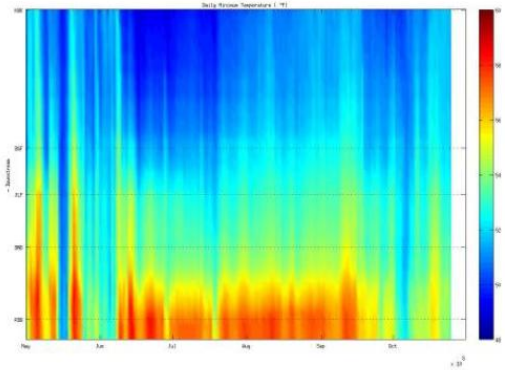
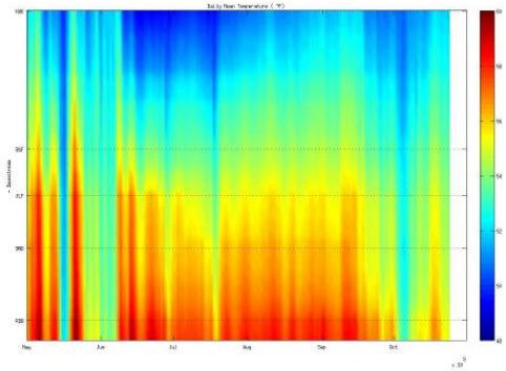
Temperature History for the 2011 Season

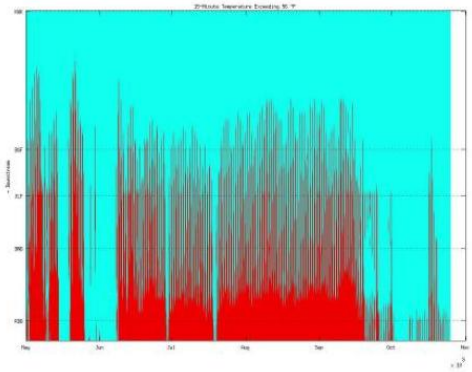
(click on any image to see full size images)

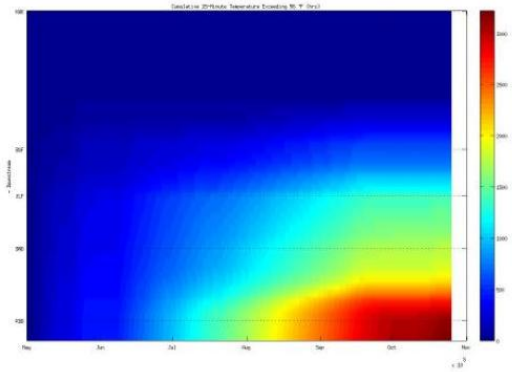


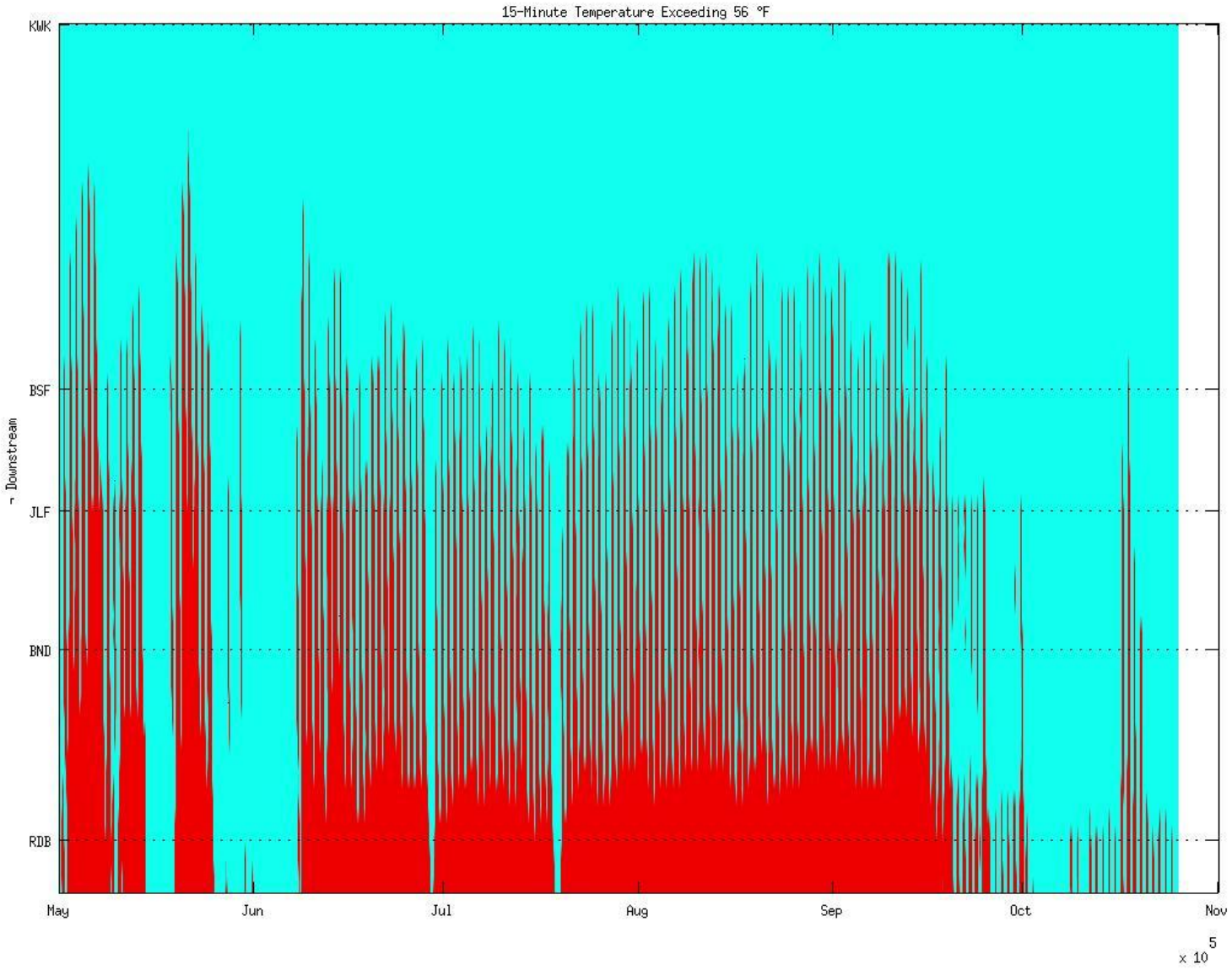


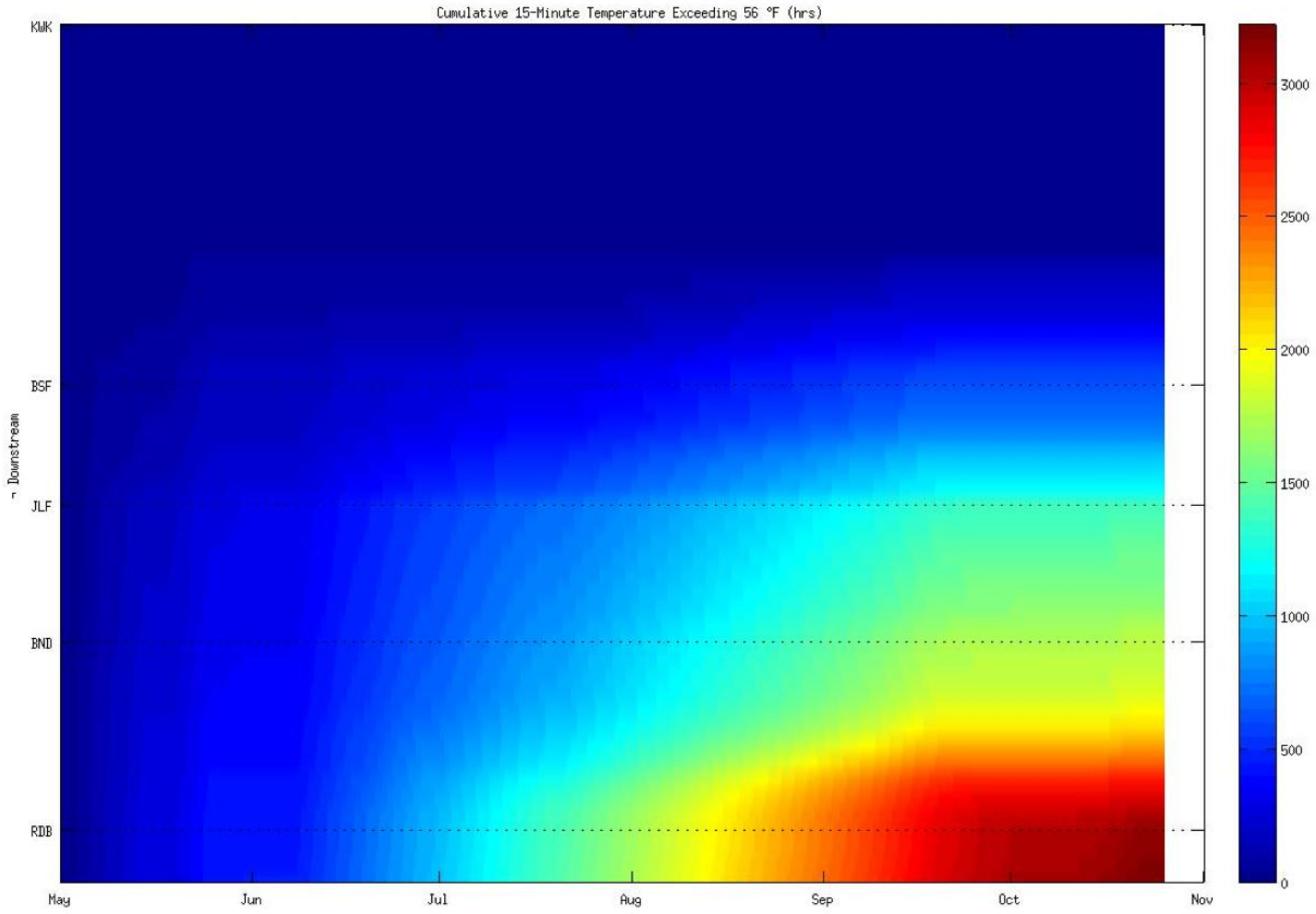









15-Minute Temperature Exceeding 56 °F
KWK
BSF
JLF
BND
RDB
Downstream
May
Jun
Jul
Aug
Sep
Oct
Nov
x 10^5


Cumulative 15-Minute Temperature Exceeding 56 °F (hrs)
KWK
BSF
JLF
BND
RDB
← Downstream
May
Jun
Jul
Aug
Sep
Oct
Nov
3000
2500
2000
1500
1000
500
0

CVP Stream Temperature DSS Test

Home | Forecasts | Management Scenarios | Temperature History | Download | Project Information | Links

Data Download Options

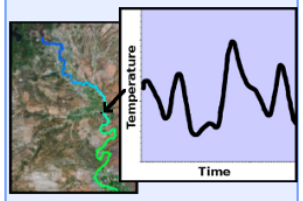
Forecast or History?

- **Forecast Temperature**
- **Observed Temperature**
- **Modeled Temperature History**

☑ Use current conditions:
Temperature: 51.4 Flow: 7140.0
OR: Choose forecast scenario:
51 deg F 12,000 cfs

vs time or vs distance?

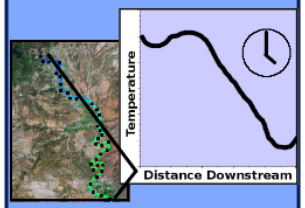
Time series at a specific location on the river



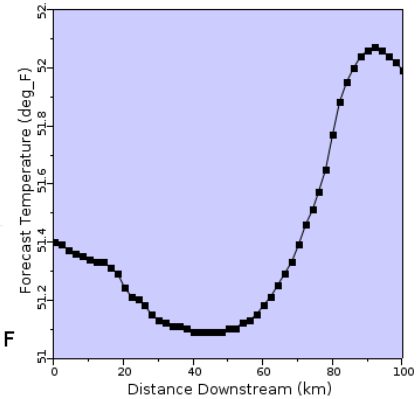
Choose a location:
KWK (0 km)

OR

Temperature along the river at a specific time



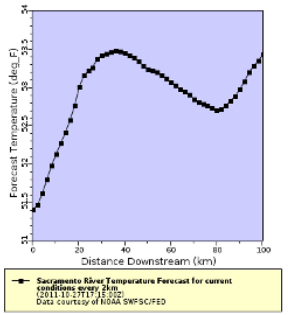
Choose a time:
2011-10-28 09:15

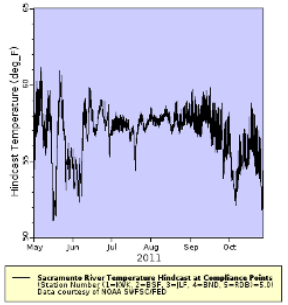


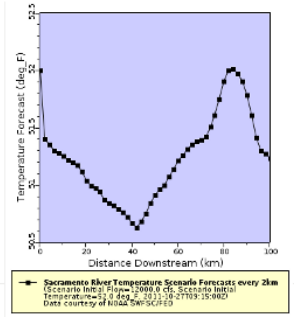
Forecast at
2011-10-28 09:15
for current conditions:
Temperature: 51.4 deg F
Flow: 7140 cfs

Download as csv

Previous Selections







Summary

Capture diel temperature variation

Forecasts

Complete temperature landscape

Results in a useful format

Future work:

- fish growth models
- coupled reservoir models

Acknowledgements

NOAA Grant
NAO7NMF4540337

NASA Applied Sciences
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Southwest Fisheries Science Center, Fisheries Ecology Division
Southwest Fisheries Science Center, Environmental Research Division