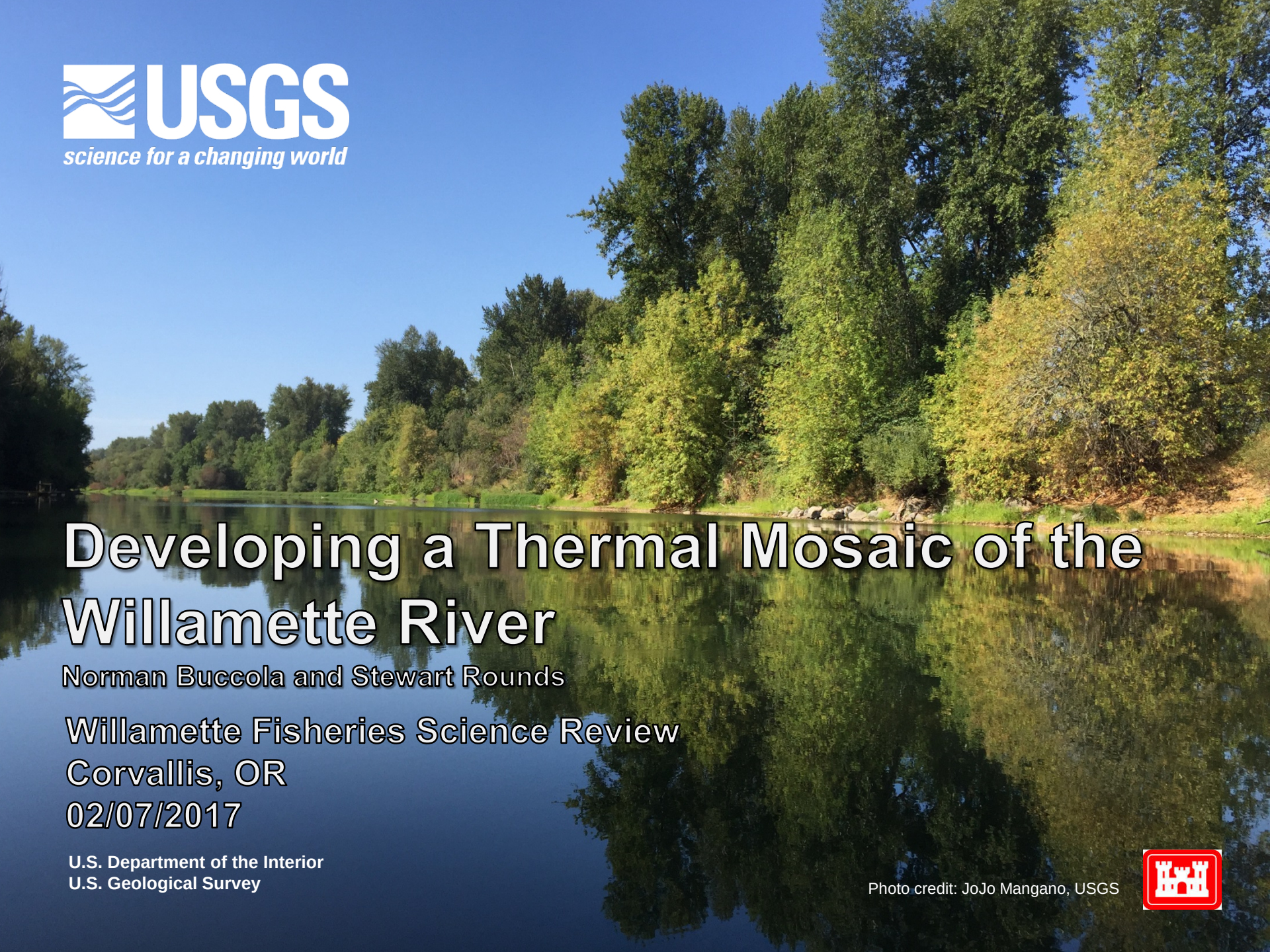

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science for a changing world

Developing a Thermal Mosaic of the Willamette River

Norman Buccola and Stewart Rounds

Willamette Fisheries Science Review
Corvallis, OR
02/07/2017

U.S. Department of the Interior
U.S. Geological Survey

Photo credit: JoJo Mangano, USGS

Thermal and Water-Quality Diversity

- **Summer Off-Channel monitoring**
  - **UO/OSU: 2007-2016 synoptic monitoring focus**
  - **USGS: 2015-2016 continuous monitoring focus**
- **Main channel temperature model (2015, 2011, 2001, 2002)**
- **Synthesis of measured and modeled data**
- **Flow Scenarios**
- **Temperature toolkit**

Photo credit : Norman Buccola, USGS

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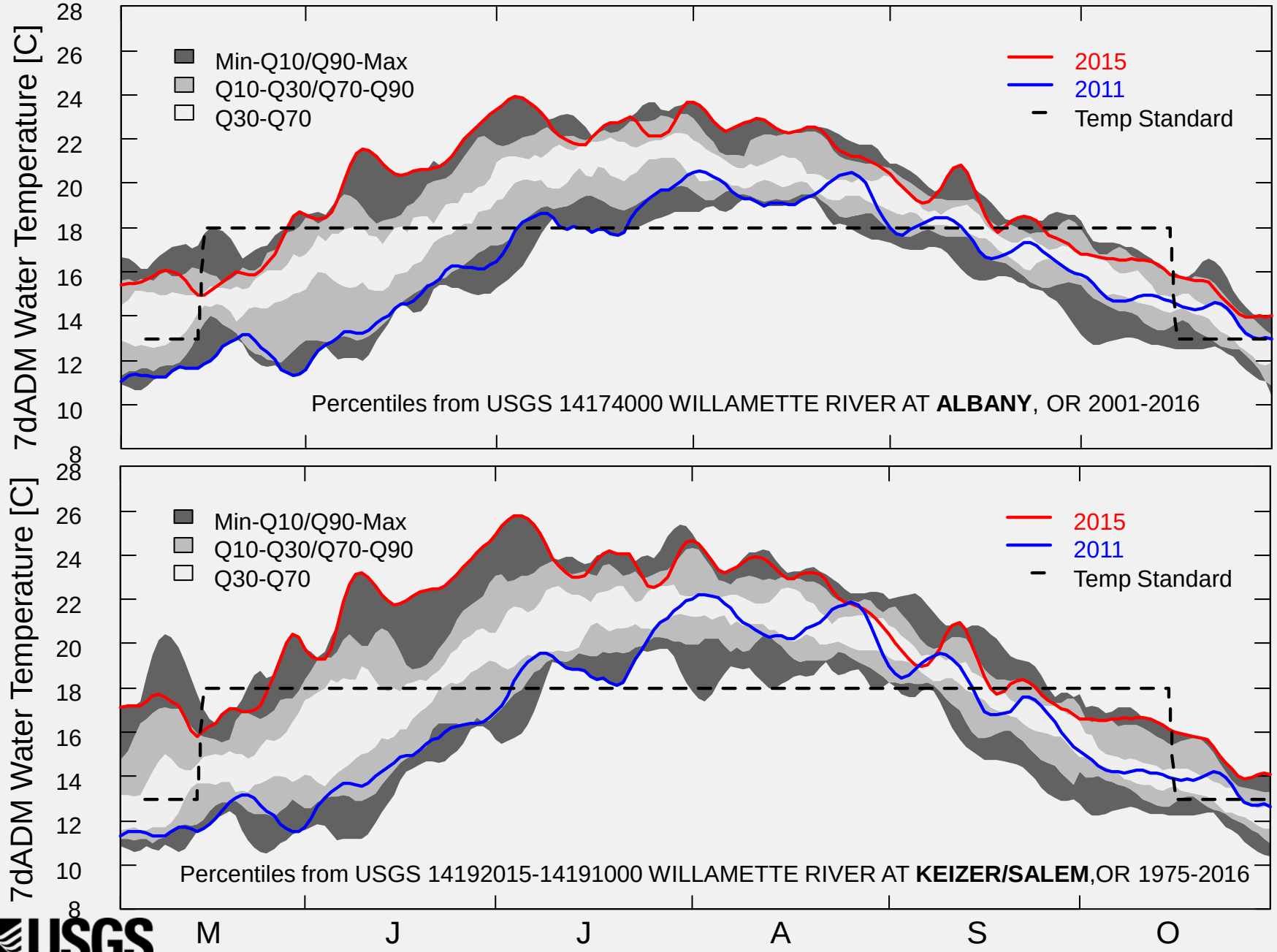
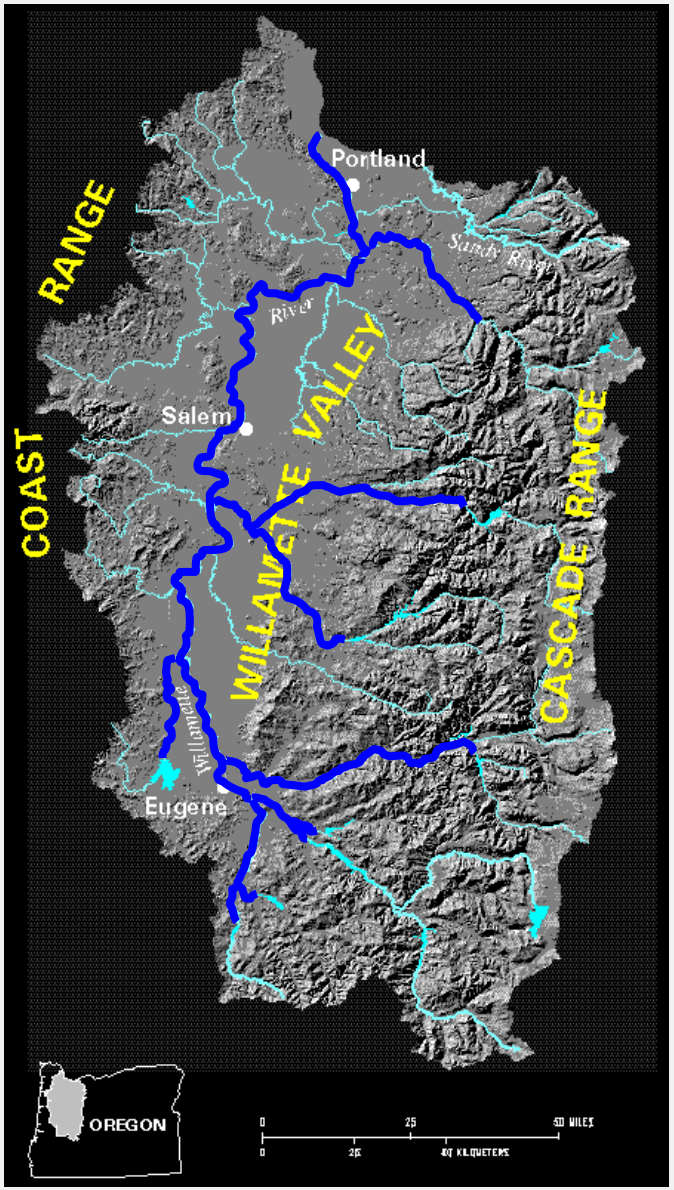
Willamette River 2011/2015 Temperature



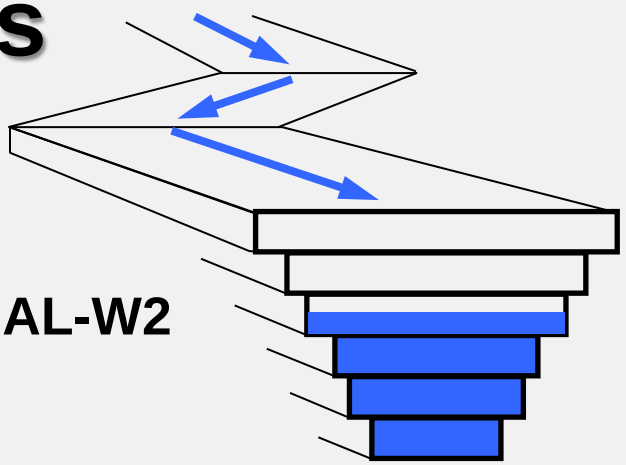
7dADM: 7-day average of daily maximum

Data from USGS, http://waterdata.usgs.gov/nwis

Willamette River Models



map from USGS



CE-QUAL-W2

- Calibrated for 2001 and 2002 for temperature TMDL.
- Used to assess effects of upstream dams.
- Used to evaluate 2011 (cool/wet) and 2015 (hot/dry) conditions and aid in evaluations of flow management
- Used to help quantify a *Thermal Mosaic* of the river.

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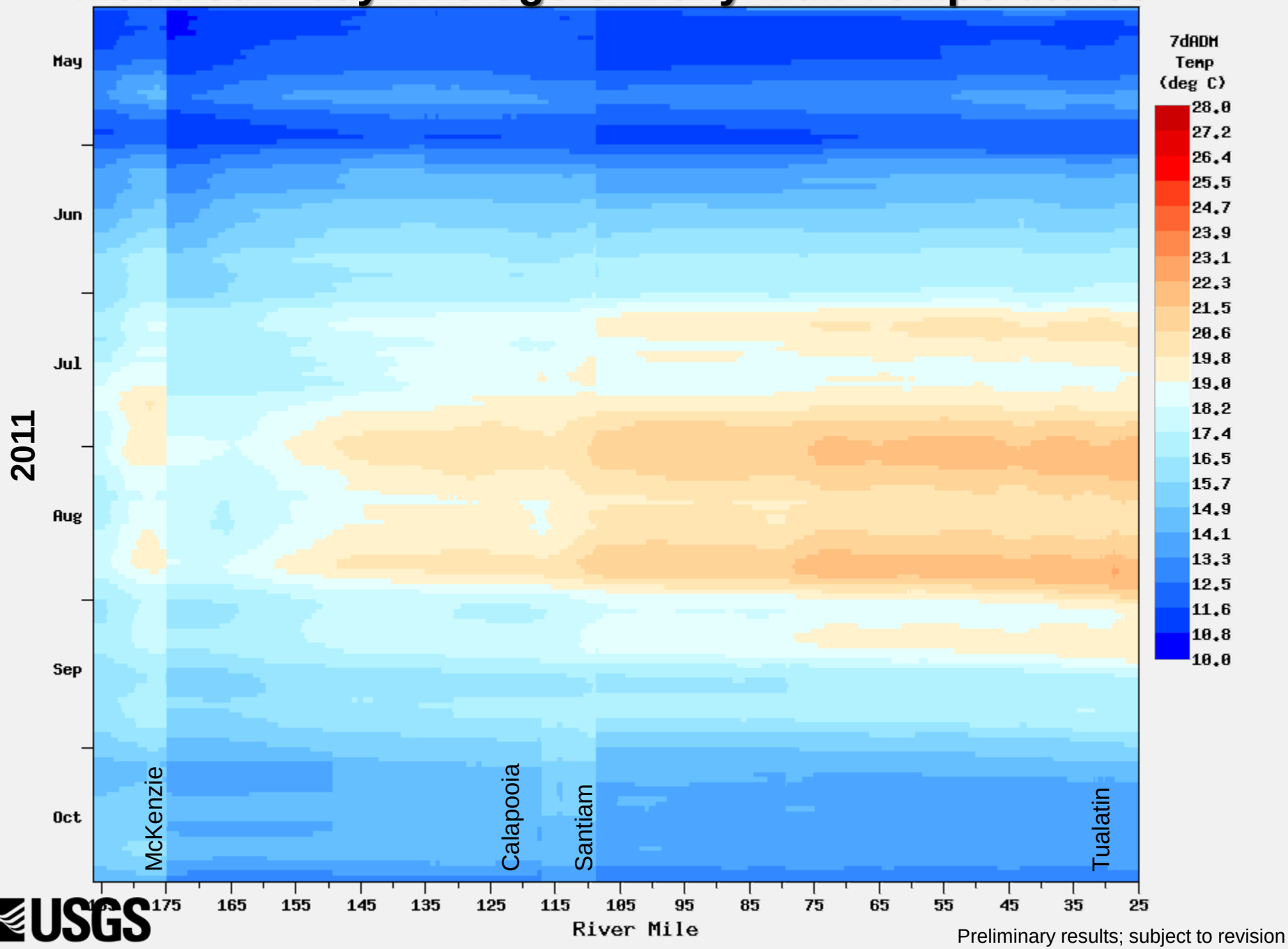
Modeled 7-day Average of Daily Max Temperatures



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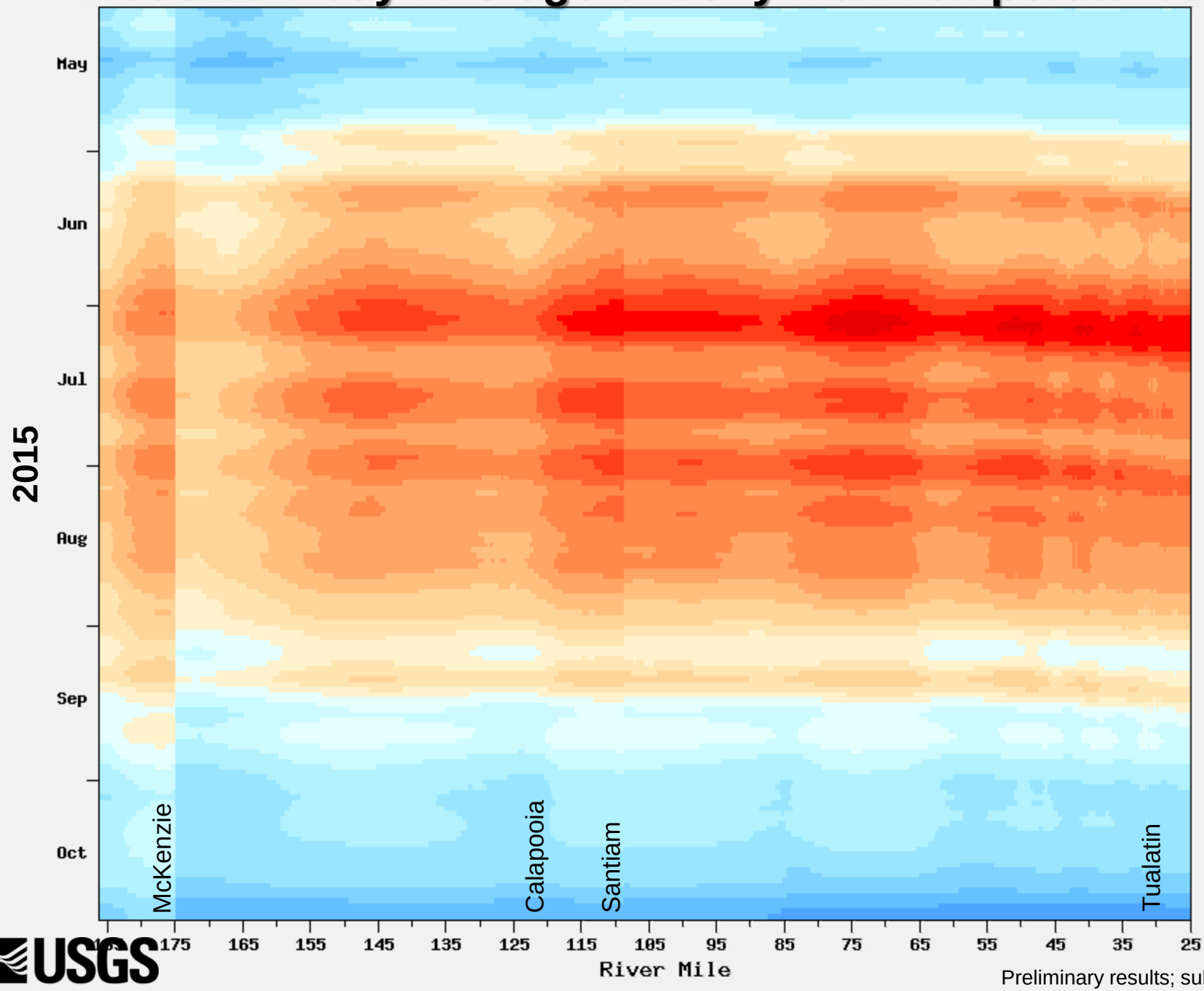
Preliminary results; subject to revision

Modeled 7-day Average of Daily Max Temperatures



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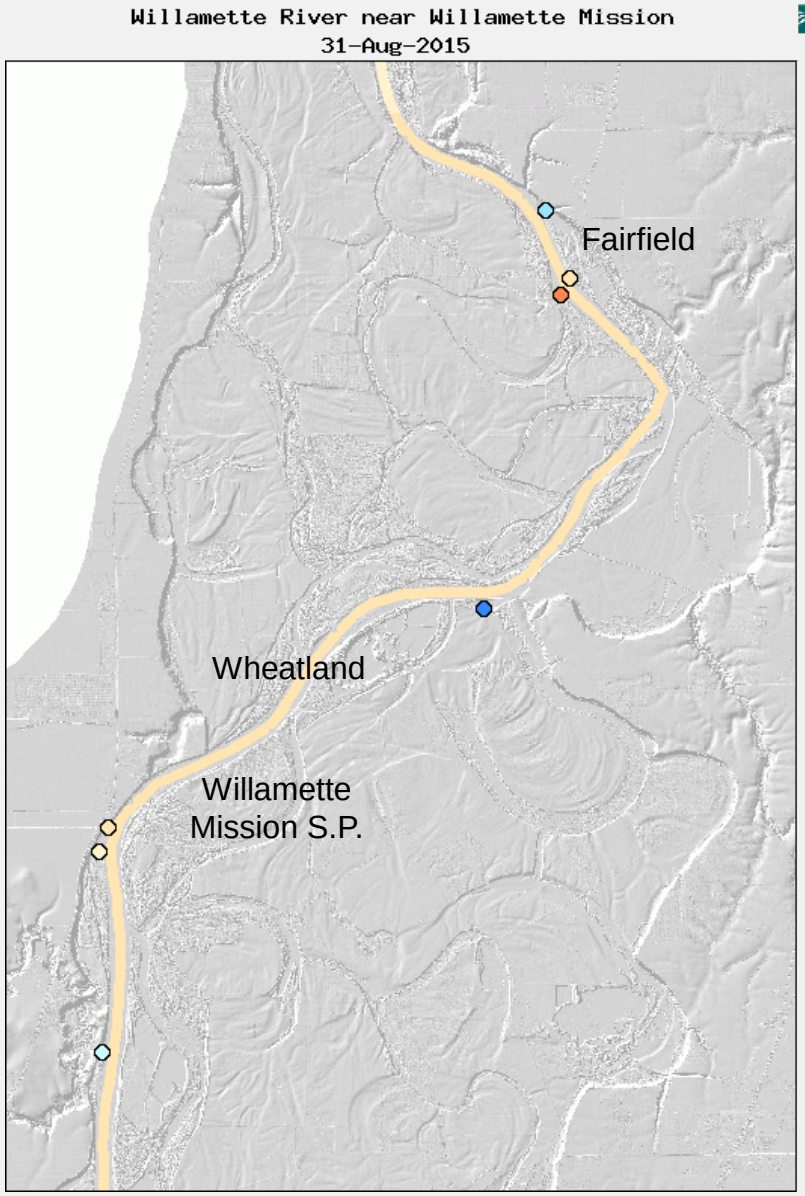
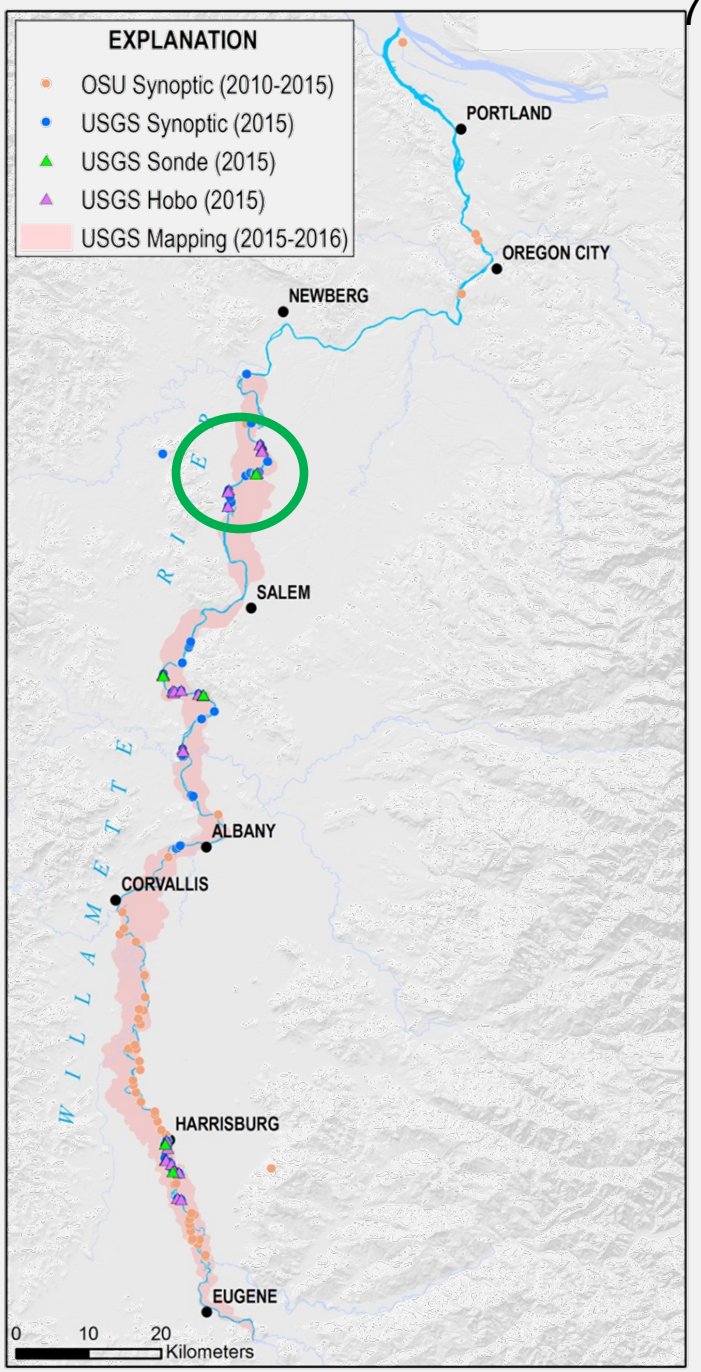
Preliminary results; subject to revision

Wheatland Ferry Reach (RM 67-77)





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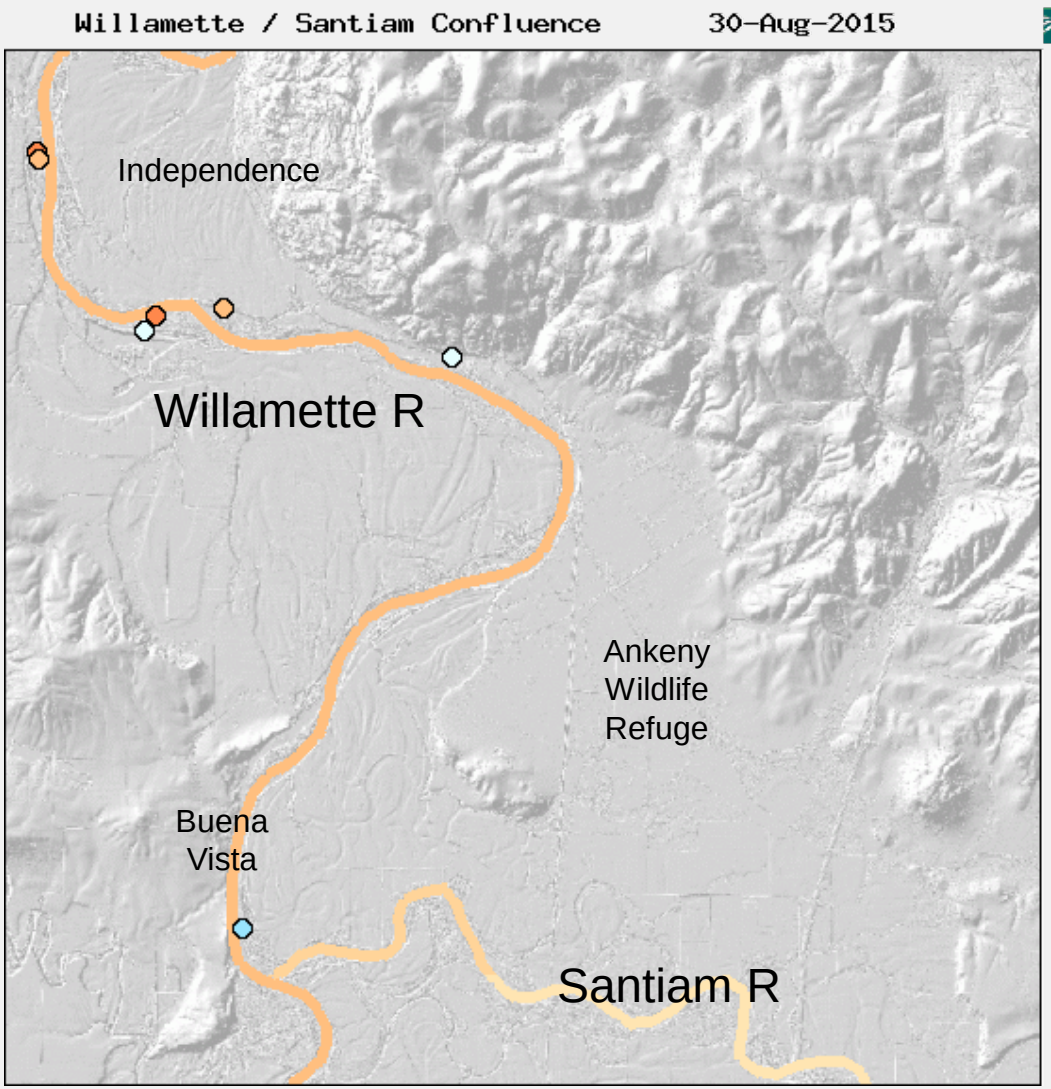
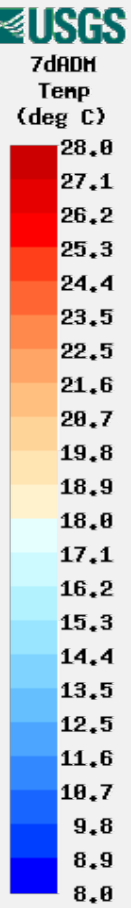
7dADM = 7-day average of daily maximum

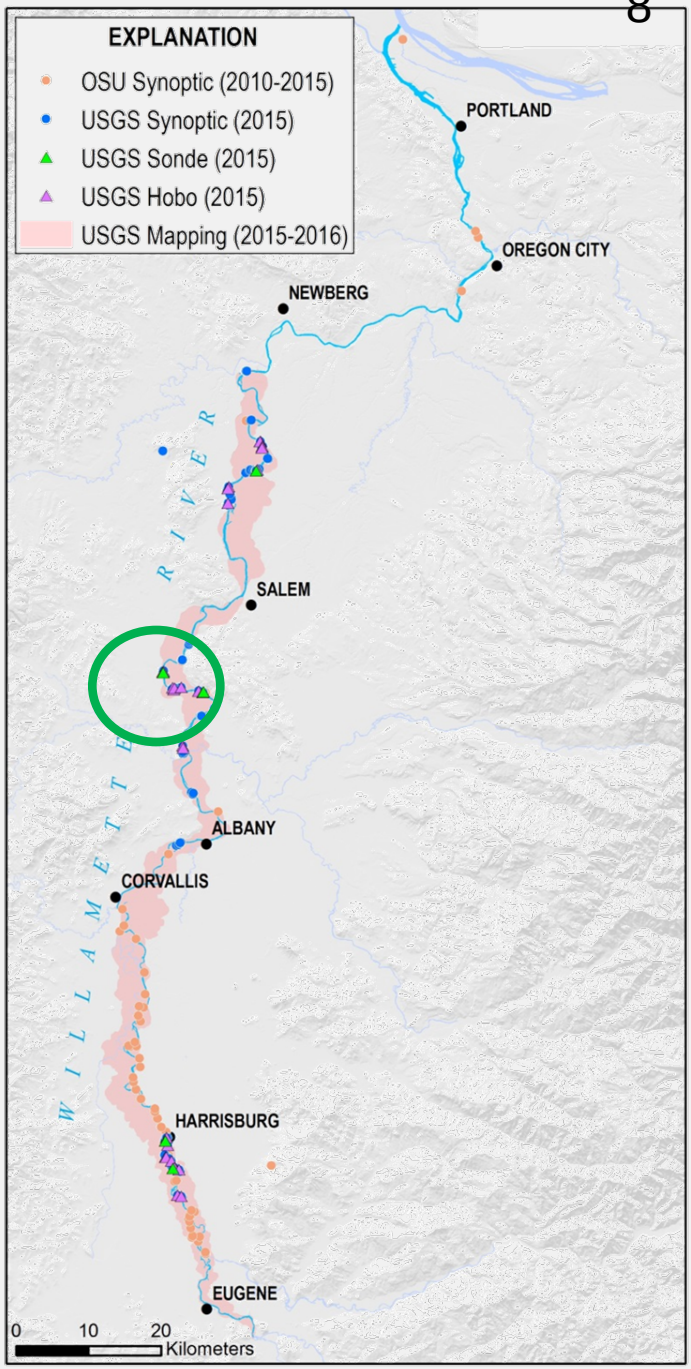
Provisional Data

Independence/Santiam (RM 96-108)





7dADM = 7-day average of daily maximum



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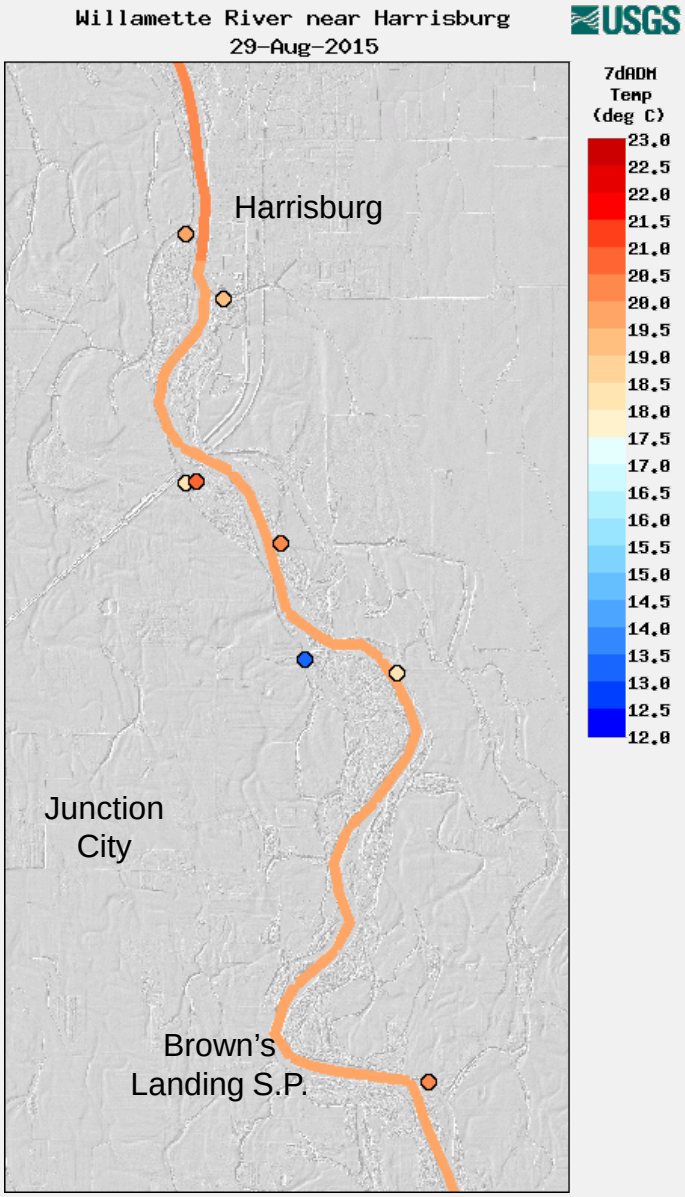
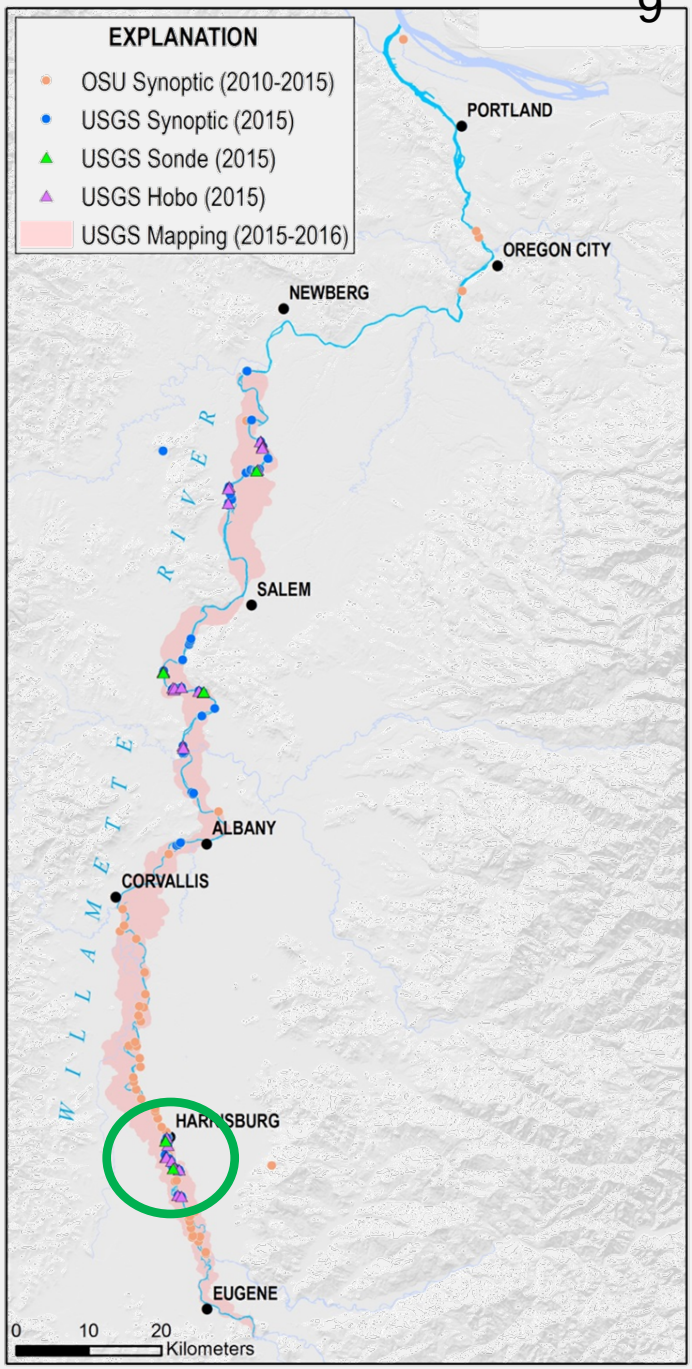
Provisional Data

Upstream of Harrisburg (RM161-164)





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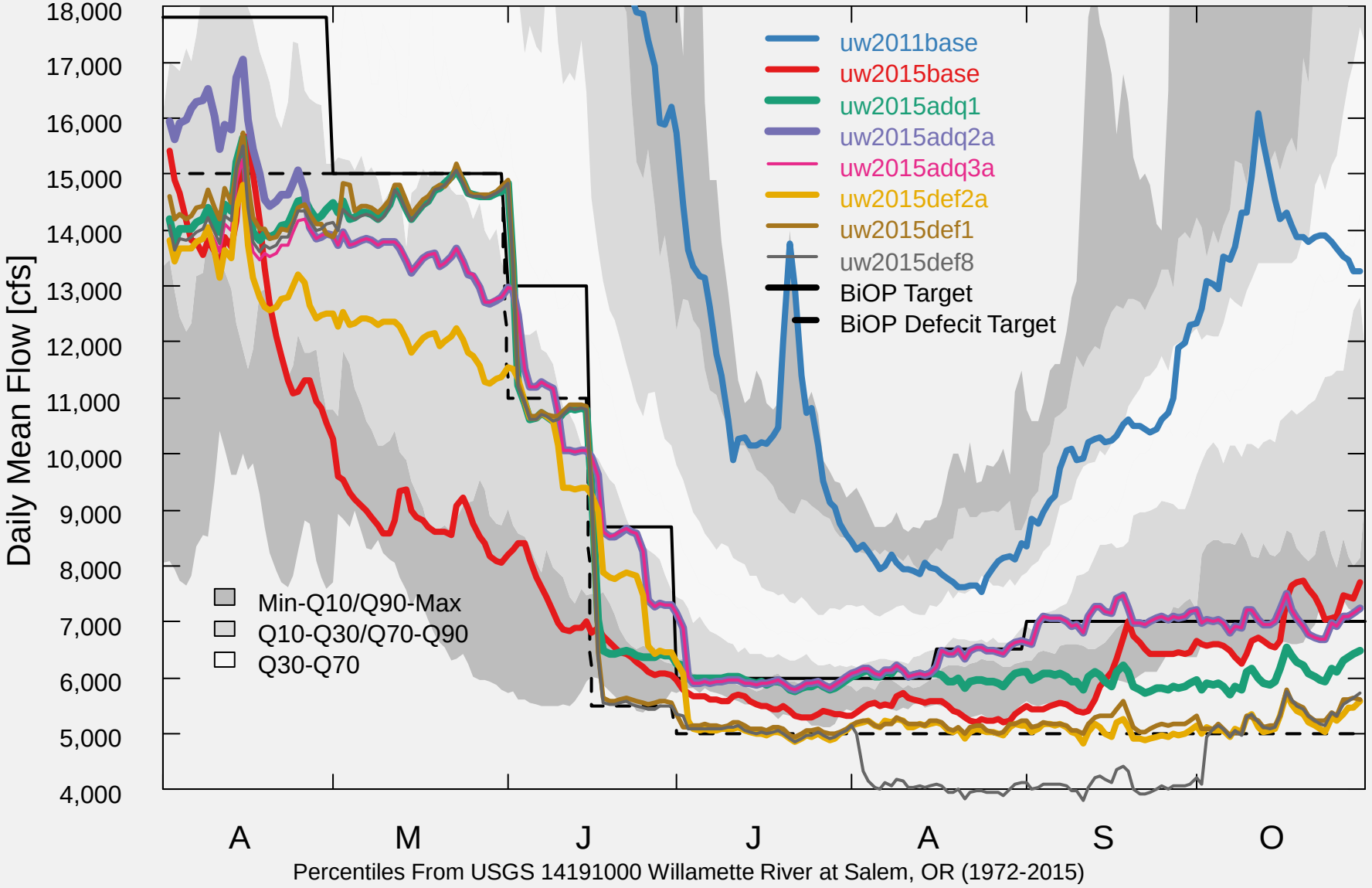
7dADM = 7-day average of daily maximum

Provisional Data

Operation Scenarios – Flows at Salem



Percentiles From USGS 14191000 Willamette River at Salem, OR (1972-2015)

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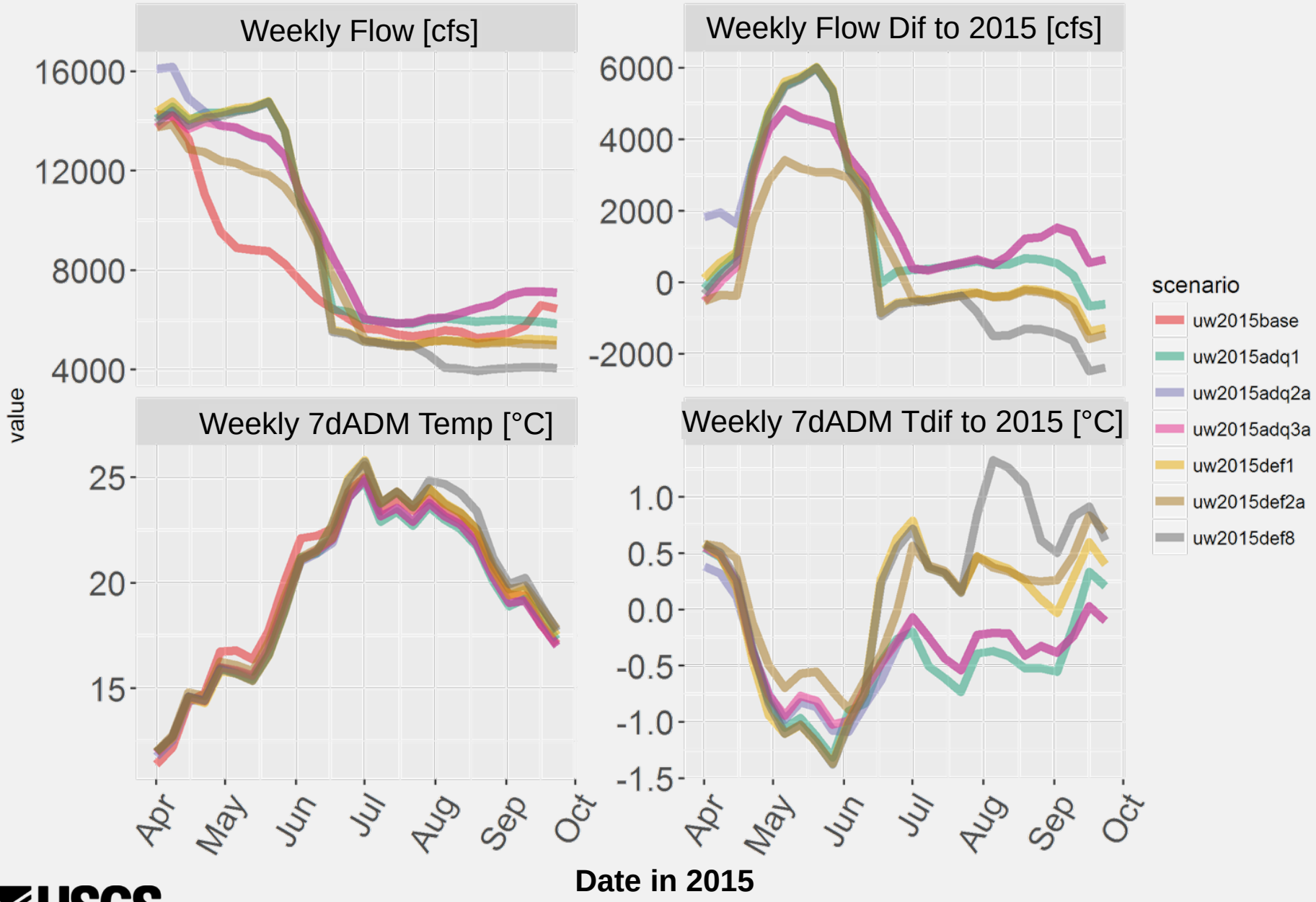
Preliminary results; subject to revision

Operation Scenarios at Salem – Flows and Temp



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Preliminary results; not for distribution

Regressions of Flow Scenarios at Salem

Apr1-Jun30 2015 ~ 0.26°C decrease for 1000 cfs increase

Jul1-Sep30 2015 ~ 0.46°C decrease for 1000 cfs increase

Qdif [cfs]	Tdif °C [Apr1-Jun30]	Tdif °C [Jul1-Sep30]
-2000		0.92
-1000	0.26	0.46
0	0	0
1000	-0.26	-0.46
2000	-0.53	-0.92
3000	-0.79	
4000	-1.05	
5000	-1.32	
6000	-1.58	

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Predicting Water Temperature at Salem

Question:

Is it possible to predict 7-day water temperature at Salem from other measured datasets, such as flow and air temperature?

Datasets:

14192015 - Willamette River at Keizer (water temperature [WT])

14191000 - Willamette River at Salem (streamflow [Q])

14207200 - Tualatin River at Oswego Dam (air temperature [AT])

Focus on spring period: April-June

Methods:

Multiple linear regression; different functional forms:

$$WT_{7d,Keizer} = a * AT_{7d,ODam} + b * Q_{7d,Salem} + c$$

$$WT_{7d,Keizer} = a * AT_{7d,ODam} + b * \log_{\mathbf{10}}\left(Q_{7d,Salem}\right) + c$$

$$WT_{7d,Keizer} = a * AT_{7d,ODam} + b/Q_{7d,Salem} + c$$

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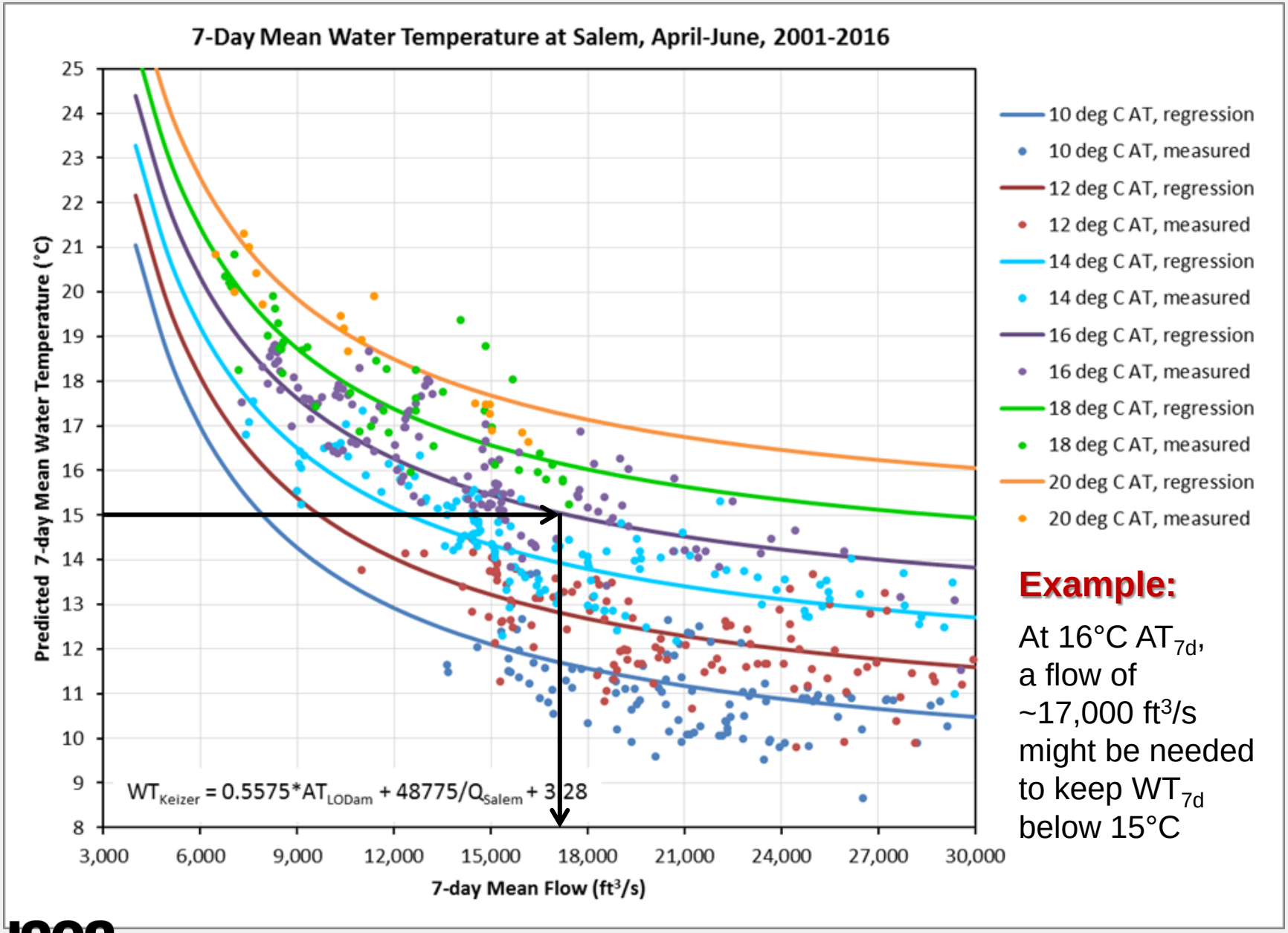
Predicting Water Temperature at Salem



Example:

At 16°C AT_{7d}, a flow of ~17,000 ft^3/s might be needed to keep WT_{7d} below 15°C

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Preliminary results; subject to revision

Conclusions

Thermal diversity in the Willamette exists, and is needed!

- Models quantify conditions in main channels
- Flow changes can affect temperature, but flow cannot overcome effects of weather
- Flow changes have larger effect during summer (low flow)
  - Spring ~ 0.26°C decrease for 1000 cfs increase
  - Summer ~ 0.46°C decrease for 1000 cfs increase
- Regression tools based on flow, air temperature could assist management

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Thank You

Visit http://or.water.usgs.gov/wq_modeling/ for links to projects and publications.

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