



Applied Sciences Program
*Discovering Innovative & Practical
Applications of NASA Earth Science*

January Program Highlights



River Temperature Decision Support System (DSS) Modeled Data Helps Water Managers

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Highlight:

Water managers will now have the possibility of controlling the proper amount and temperature of water to release on the Sacramento River, through the development of a River Temperature DSS model. On November 8, 2011, the project PI presented these results to an expert panel on water operations in California's Central Valley, to show potential temperature impacts on endangered salmon on the Sacramento River. The upper graph in each pair displays the modeled temperature for the primary spawning habitat on the river over the season. The lower graph in each pair displays where the temperatures exceeded the compliance target of 13.9°C. Inter-annual differences are evident between 2008 (a warm summer) and 2011 (a cool summer). While these results are retrospective, the real-time use of our temperature model will inform water managers of the proper amount and temperature of water to release to avoid exceedance in future years.

Relevance: Before the development of our model, it was not possible to forecast downstream weather conditions (and therefore river temperatures). Water managers could not know how much water to release in order to maintain downstream temperatures below 13.9°C, a critical threshold for developing salmon eggs. Now through the coupling of a heat budget model and high resolution meteorological data from NASA's Ecological Forecasting lab, it is possible to determine the appropriate water release scenarios to avoid exceedance.

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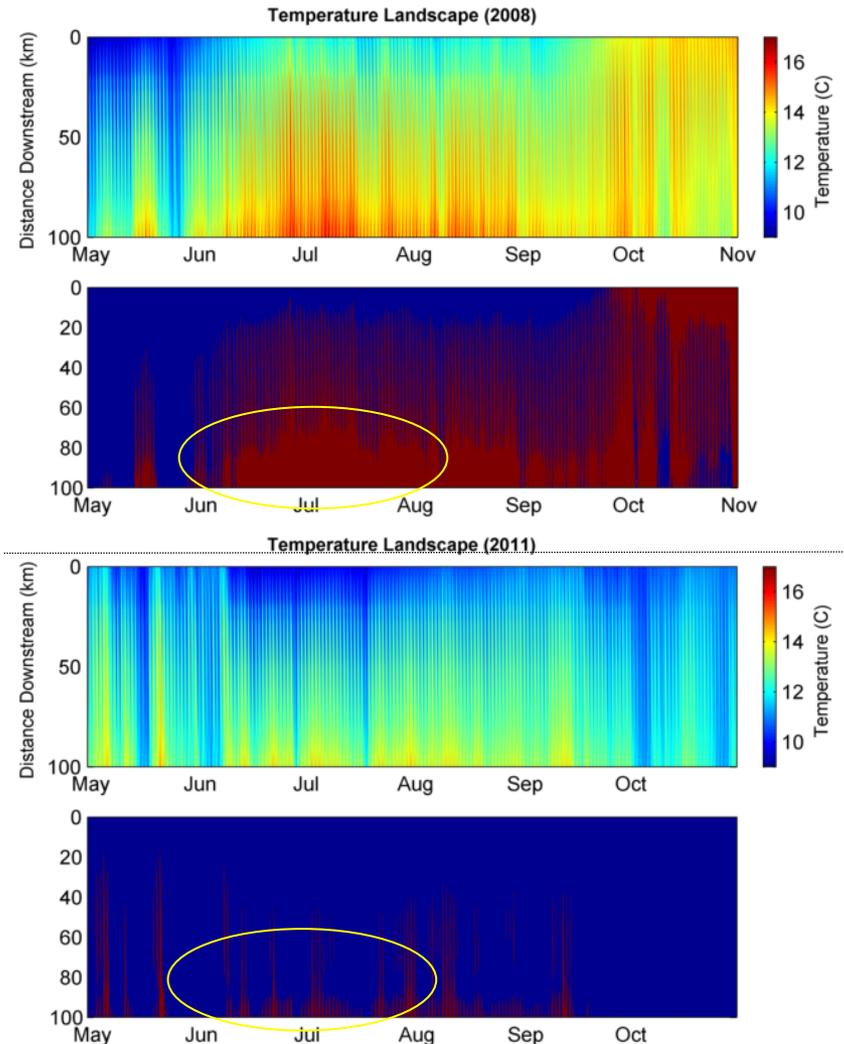


Figure 1. Temperature Model results showing where temperatures exceeded compliance target of 13.9°C, for a warm summer (2008 top pair) and a cool summer (2010 bottom pair).



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Project Summary: Water operations in California's Central Valley must take into account temperature and flow regarding Ecological Society of America (ESA) listed salmonids, but the current DSS is limited by flaws in the existing models. This project corrects these flaws by substantially improving the spatiotemporal scale of river temperature forecasts from monthly assessments at a few locations, to sub-hourly forecasts at 1km spatial resolution. These improvements are possible through inputs from the NASA Terrestrial Observation and Prediction System (TOPS), which provides satellite observations land surface temperature, gridded meteorological surfaces, and regional forecasts of surface conditions.

Earth Science Products: NASA Terrestrial Observation and Prediction System (TOPS) modeling software system using MODIS data from Terra and Aqua.

Technical Description of the Images: The upper graph in each pair displays the modeled temperature for the primary spawning habitat on the river over the critical temperature season. The lower graph in each pair displays where the temperatures exceeded the compliance target of 13.9°C. Interannual differences are evident between 2008 (a warm summer) and 2011 (a cool summer). It should be clear that the differences between the two years are mostly driven by environmental conditions and are not the result of water operators using our model. The first year of operational model use will be 2012.

Application to Decision Making: Before the development of our model, it was not possible to forecast downstream weather conditions (and therefore river temperatures) with precision and accuracy. Water managers could not know how much water to release in order to maintain downstream temperatures below 13.9°C, a critical threshold for developing salmon eggs. Now through the coupling of a heat budget model and high resolution meteorological data from NASA's Ecological Forecasting lab, it is possible to determine the appropriate water release scenarios to avoid exceedance.

Scientific Heritage: The development of the NASA Terrestrial Observation and Prediction System (TOPS) is the key component of the success of this project. The Ecological Forecasting Lab is able to provide the meteorological inputs for the river temperature heat budget model at the required temporal and spatial scales (sub-hourly, 1km grid). It would not have been possible to model temperatures at the desired scale with without this resolution input data.

References:

State space model for river temperature prediction Bravo et al. Water Resources Research, Vol. 29, No. 5, 1457-1466, 1993
[Monitoring and forecasting ecosystem dynamics using the Terrestrial Observation and Prediction System \(TOPS\)](#)

Ramakrishna Nemani, Hirofumi Hashimoto, Petr Votava, Forrest Melton, Weile Wang, Andrew Michaelis, Linda Mutch, Cristina Milesi, Sam Hiatt, Michael White, Remote Sensing of Environment 113 (2009) 1497-1509;
[Terrestrial Observation and Prediction System \(TOPS\): Developing ecological nowcasts and forecasts by integrating surface, satellite and climate data with simulation models](#)

Ramakrishna Nemani, Petr Votava, Andrew Michaelis, Michael White, Forrest Melton, Cristina Milesi, Lars Pierce, Keith Golden, Hirofumi Hashimoto, Kazuhito Ichii, Lee Johnson, Matt Jolly, Ranga Myneni, Christina Tague, Joseph Coughlan, Steve Running
Research and Economic Applications of Remote Sensing Data Products, American Geophysical Union, 2005

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