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The combined water-balance and water temperature model LARSIM-WT

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The water-balance model LARSIM (large area runoff simulation model) was extended, to simulate and forecast river water temperatures along with river discharges. The original LARSIM simulates all components of the terrestrial water-balance (i.e. snow, interception, evapotranspiration, soil water, runoff generation, runoff concentration, river routing etc.). For LARSIM-WT an additional module was added, to calculate stream temperatures.

The implemented physical heat-balance approach accounts for all relevant heat fluxes between the water body on one hand and the atmosphere as well as the river bed on the other hand. These heat exchange processes are coupled with the 1D advection-dispersion-equation, which is used to route the water's heat content through the river network. The new module also allows to account for point sources of heat and water (i.e. power plants, waste-water treatment plants) as well as water withdrawal. Hence, the physically based module, provides stream temperatures for any location within the modelled watershed.

In addition to the physical approach, it is also possible to calculate stream temperatures with simpler regression models, for user specified points of the river network. This is particular helpful, if there is insufficient data to model the heat balance on a complete physical basis. The results of the regression models may be used as boundary conditions for downstream simulations with the physical approach.

LARSIM-WT can be run with different spatial and temporal resolutions. It is suited for offline simulations as well as for online real-time forecasting. Offline, LARSIM-WT has been successfully used to predict the effects of climate change on stream temperatures.

LARSIM-WT was also successfully used to implement an operational stream temperature forecasting system for the River Neckar (Germany) as part of a joint project of the federal state of Baden-Württemberg and the power supply company Energie Baden-Württemberg AG. The real-time forecasting model for the 14,000 km^2 watershed is in operation since summer 2004. It automatically provides daily discharge and stream temperature forecasts for up to seven days ahead. These forecasts warn the federal authorities and the power supply company well in advance of critical discharge or stream temperature conditions, providing sufficient time for appropriate counter measures.