Geophysical Research Abstracts
Vol. 15, EGU2013-11225, 2013
EGU General Assembly 2013


# Improving the spatial estimation of evapotranspiration by assimilating land surface temperature data

Matthias Zink, Luis Samaniego, and Matthias Cuntz
Hemlholtz Centre for Environmental Research - UFZ, Computational Hydrosystems, Leipzig, Germany
(matthias.zink@ufz.de)

A combined investigation of the water and energy balance in hydrologic models might lead to a more accurate estimation of hydrological fluxes and state variables, such as evapotranspiration ET and soil moisture. Hydrologic models are usually calibrated against discharge measurements, and thus are only trained on the integrated signal at few points within a catchment. This procedure does not take into account any spatial variability of fluxes or state variables. Satellite data are a useful source of information to incorporate spatial information into hydrologic models.

The objective of this study is to improve the estimation of evapotranspiration in the spatial domain by using satellite derived land surface temperature $T_s$ for the calibration of the distributed hydrological model mHM. The satellite products are based on data of Meteosat Second Generation (MSG) and are provided by the Land Surface Analysis - Satellite Application Facility (LSA-SAF). mHM simulations of $T_s$ are obtained by solving the energy balance wherein evapotranspiration is determined by closing the water balance. Net radiation is calculated by using incoming short- and longwave radiation, albedo and emissivity data provided by LSA-SAF. The Multiscale Parameter Regionalization technique (MPR, Samaniego et al. 2010) is applied to determine the aerodynamic resistance among other parameters. The optimization is performed for the year 2009 using three objective functions that consider (1) only discharge, (2) only $T_s$, and (3) both discharge and $T_s$. For the spatial comparison of satellite derived and estimated $T_s$ fields, a new measure accounting for local spatial variabilities is introduced. The proposed method is applied to seven major German river basins, i.e. Danube, Ems, Main, Mulde, Neckar, Saale, and Weser.

The results of the $T_s$ simulations show a bias of 4.1 K compared to the satellite data. We hypothesize that this bias is inherent to the satellite data rather than to the model simulations. This is corroborated by the comparison of LSA-SAF $T_s$ with measured data of air temperature which shows a similar offset of 4.9 K. When optimizing for discharge (1) the discharge simulations show the best fit (NSE exceeding 0.8) compared to the optimizations using $T_s$ (2) and $T_s$ and discharge (3). But the spatial fields of evapotranspiration seem to have random variability at some days. When optimizing only for $T_s$ (2) high flows are well represented while the estimation of low flows fails. Furthermore, this strategy reveals a broader discharge uncertainty band compared to the discharge only optimization (1). This indicates that optimizing for $T_s$ (2) has predictive power regarding flood estimations if no discharge data are available. Additionally in comparison to the discharge only optimization (1) the spatial distribution of ET looks much more realistic. Optimizing with discharge and $T_s$ data simultaneously (3) preserves the narrow discharge uncertainty band of the discharge only optimization (1) but also the more realistic spatial distribution of ET of the $T_s$ only optimization (2). Furthermore, the uncertainty in the estimation of ET related model parameters is reduced by the combined discharge and $T_s$ optimization (3) compared to the discharge only optimization (1).

In summary, the estimated spatial distributions of ET and connected state variables such as soil moisture are improved by assimilating satellite data. Furthermore the simulation of floods using only $T_s$ in model optimization (2) is possible in ungauged basins while the estimation of low flows and thus hydrological droughts will fail.