Evaluating Hydrological Model Outputs with Satellite derived Land Surface Temperature

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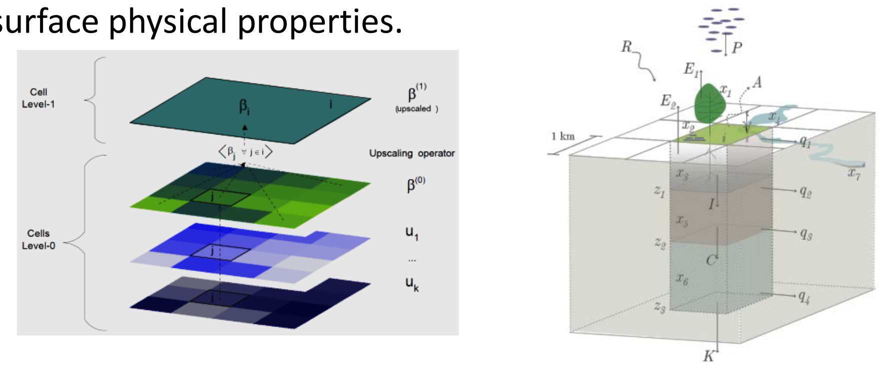
1. Motivation

Hydrological models are commonly evaluated against streamflow measured at gauging stations. This evaluation procedure does not provide any information regarding the spatial distribution of state variables and water fluxes such as soil moisture and evapotranspiration. Consequently additional methods should be investigated. The objective of this study is to evaluate the spatio-temporal distribution of the simulated Land Surface Temperature (LST) against those retrieved by remote sensing.

2. Mesoscale Hydrologic Model (mHM)

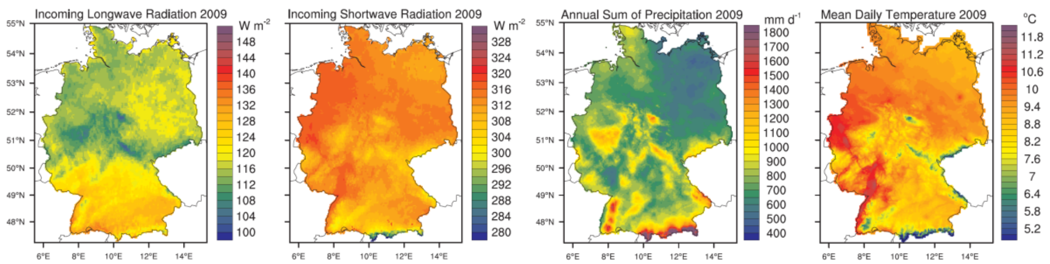
A process based hydrological model (mHM) was used to obtain daily fields of evapotranspiration over Germany. The model parameters were regionalized with the multiscale parameter regionalization scheme (MPR). MPR accounts for the subgrid variability of the model parameters, which, in turn, are related to land surface physical properties.



Multiscale Parameter Regionalization scheme (left) and model structure of mHM (right)

3. Input Data

- LSA SAF: Land Surface Temperature (LST), long - and shortwave radiation, albedo
- German Weather Service (DWD): air temperature, precipitation
- NCEP-CFSR: wind data
- German authorities(BKG, BfG, BGR): DEM, soil and geology



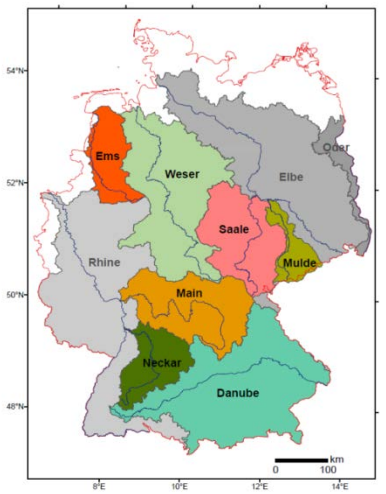
Fields of longwave and shortwave radiation, precipitation and temperature

4. Hydrological Evaluation

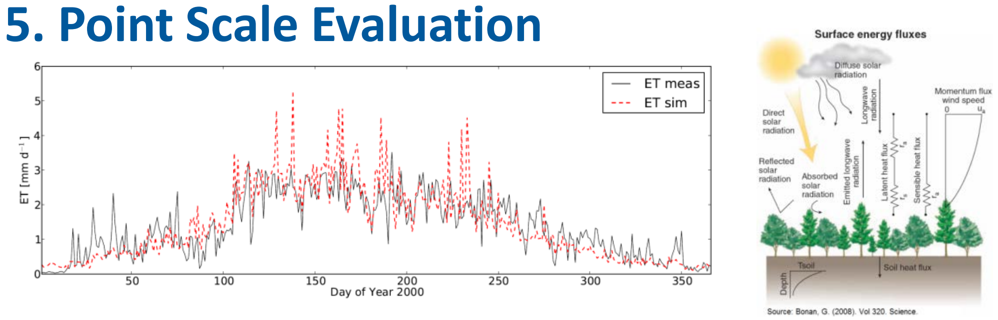
	NSE[1]	NSE[2]
Danube	0.81	0.66
Weser	0.93	0.70
Main	0.92	0.87
Saale	0.74	0.48
Neckar	0.92	0.92
Ems	0.86	0.58
Mulde	0.84	0.67

1) NSE of the validation period 1965 – 1999

2)NSE cross location experiment (parameters which have been determined in the Neckar catchment are used for simulations in all the other catchments)



5. Point Scale Evaluation



Evaluation of ET estimations of mHM with Eddy Flux measurements in Tharandt (needleleaf forest). Comparison with 3 other sites (crop, grassland, deciduous forest) show coefficients of correlation ranging from 0.62 to 0.85.

6. Method for Spatial Evaluation

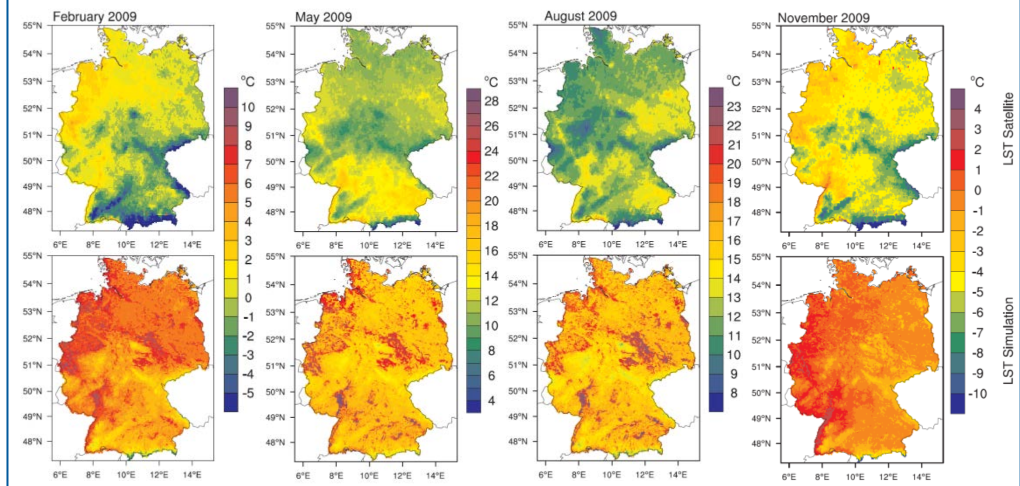
The simulated LST was estimated indirectly by combining the water and energy balance equations with the sensible heat formulation. The latter, was determined as residual of the energy balance ($H=R_n-\lambda E$), assuming that the soil heat flux is negligible at the daily time scale.

$$H = \rho \cdot c_p \frac{T_s - T_a}{r_a}$$

The evapotranspiration was obtained by closing the water balance ($ET=P-R-\Delta S$) in mHM. The net radiation was, in turn, estimated by solving the radiation budget using short and long wave radiations, albedo, and emissivity derived from remote sensing. Finally, to determine the LST, the aerodynamic resistance was parameterized.

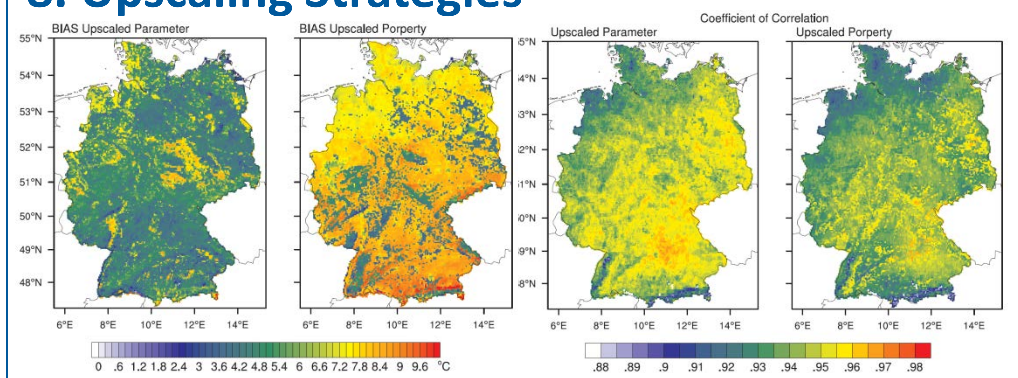
$$T_s = r_a \cdot \frac{R_n - \lambda E}{\rho \cdot c_p} + T_a$$

7. Result LST Simulations



Comparison of satellite derived (upper row) with simulated LST (lower row)

8. Upscaling Strategies



BIAS and correlation coefficient between satellite derived and simulated LST with upscaled canopy height (MPR) vs. that derived with canopy height estimated with an aggregated land cover class

9. Outlook

Further improvement of the LST model has to be done:

- Improvement of the estimation of the aerodynamic resistance
- Improvement of the estimations of ET of mHM
- Estimation of effective parameters with MPR and inverse modelling

References

Bonan, G. B. (2008). Forests and climate change: forcings, feedbacks, and the climate benefits of forests. *Science*, *320*(5882)

Samaniego, L., Kumar, R., & Attinger, S. (2010). Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale. *Water Resources Research*, *46*(5)

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