



The use of topographic indices as predictors of the energy fluxes in the Rur catchment

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Subsurface hydrodynamics is a fundamental component of the hydrologic cycle and a key factor in the determination of the land surface processes. Therefore, we simulate the ground-vegetation-atmosphere system with a fully coupled subsurface-land surface model over the Rur catchment, Germany.

The 3D parallel watershed model ParFlow computes the water flow at the surface and in the subsurface, while the physical and biogeochemical processes at the land surface are simulated by the Community Land Model CLM. The weather prediction and climate model of the German weather service, COSMO, provides the atmospheric forcing for the simulation. The exchange of variables and energy fluxes between the models ensures the physical consistency of the system.

This study is part of the MiKlip program on seamless decadal climate prediction. For this purpose decadal runs are needed, which are not feasible with the above mentioned model environment at high resolution. In order to reduce the computational burden of a fully coupled simulation, a Model Complexity Reduction Approach is proposed, which intelligently combines full complex system runs and simplified simulations. To correct the simplified runs towards the full runs, statistical rules are applied. We assess the influence of selected predictors on the energy fluxes at the surface.

The computational domain (on the order of 10^6 km²) presents heterogeneous land use, soil texture and topography, which were the first intuitive classifiers of the different grid cells. The analysis of individual and correlated effects on the energy fluxes, suggested to focus on the topography and particularly on compound indices, such as modified topographic wetness index (TI) and depth-to-water index (DTW) as proxies for the availability of soil moisture for transpiration and evaporation. TI and DTW were determined based on the slope of the cell, the specific contributing area and distance to surface water, thus both carry information on the specific grid cell and the grid cells that are hydrologically related to it. The first-order effects of vegetation (e.g. root depth) and soil composition (e.g. porosity, hydraulic conductivity) are also taken into account for their relation to the topography of the catchment.