Geophysical Research Abstracts
Vol. 16, EGU2014-728, 2014
EGU General Assembly 2014

The influence of the groundwater table dynamics on the land surface-subsurface interactions

Mostaquimur Rahman (1), Stefan Kollet (2,3), and Mauro Sulis (1)

(1) Meteorological Institute, University of Bonn, Germany (mrahman@uni-bonn.de), (2) Institute for Bio- and Geosciences, Agrosphere, Research Centre Jülich, Germany (s.kollet@fz-juelich.de), (3) Centre for High-Performance Scientific Computing in Terrestrial Systems

The terrestrial hydrological cycle comprises complex processes in the subsurface, land surface and atmosphere. These processes interact at different space-time scales, resulting in a non-linear system behavior with two-way feedback between different compartments. In order to understand the overall mechanisms of the hydrological cycle, it is important to study the space-time variance of different processes and their influence on the mass and energy balance components of the coupled water and energy cycles. In this study, the coupled subsurface-land surface model ParFlow.CLM is applied over a ~28,000 km2 model domain encompassing the Rur catchment, Germany, to simulate the fluxes and states of the coupled water and energy cycles. The model is forced by hourly atmospheric data from the COSMO-DE model (numerical weather prediction system of the German Weather Service) over the years 2009 and 2010. The space-time variability in different processes of the coupled water and energy cycles over the Rur catchment has been studied previously using the same modeling platform. The simulation results demonstrate that the land surface is exposed to a dual boundary forcing of the atmosphere and the free groundwater transforming the spatial and temporal structures of both forcings, which is reflected in distinct patterns in the moisture and energy fluxes. In this study, we perform multiple model runs considering different temporal variations in the lower boundary condition (e.g., monthly, seasonally, and yearly) conserving the average spatial heterogeneity to study explicitly the influence of temporal groundwater table dynamics on the land surface mass and energy balance components. Analyzing the model results across different time scales using statistical, geostatistical, and wavelet transform techniques demonstrate that the temporal variation in the lower boundary condition influences the land surface mass and energy balance components, especially under moisture limited conditions. The lower boundary condition is influenced by the processes in the atmosphere, as the variance in the atmospheric forcing affects the groundwater table dynamics after being filtered for smaller scale variability by the land surface and subsurface. The time series analysis suggests that the variability in the lower boundary condition and land surface processes (e.g., evaportanspiration) are generally in phase for a shallow groundwater table, while a phase shift is evident for deeper water tables, which has been discussed in a number of previous studies. Utilizing multi-year simulation results, we test the hypothesis that for increasing phase shifts and amplitudes in water table fluctuations, seasonal impacts of groundwater dynamics on the land surface energy fluxes can be predicted quantitatively at the yearly time scale.