Geophysical Research Abstracts
Vol. 14, EGU2012-13412, 2012
EGU General Assembly 2012

Parameterization of a hydrological model using remote sensing data

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The alteration of land cover by humans has multiple consequences on biological systems ranging from local to global scales. The United Nations have rated land use changes as one of the major issues for the coming centuries. In Northern Germany a significant land use change can be observed since 2004, i.e. the amendment of the Renewable Energies Act. Since then, an increasing number of biogas plants have been built resulting in an increased cultivation of so-called energy crops, especially in direct neighbourhood to these plants.
Conversion of land is known to alter hydrological processes such as the exchange of energy and water. To investigate the effects of land use change on the water cycle in lowland river catchments in Northern Germany, we used a series of land cover data for the Upper Stoer, a sub-catchment of the river Elbe, as the input for a hydrological model. To derive the land cover data, we applied maximum-likelihood classifications of Landsat TM data for the years 2003 and 2010. The open source model suite SWAT (Soil Water Assessment Tool) was used to model the water cycle. SWAT has proven to be a useful tool for simulating the effect of watershed processes and management practices on water resources. A comparison of the modelled and observed discharge at the outlet of the catchment (gauge Willenscharen) showed good results (Nash Sutcliffe = 0.62). However, the land use change had no measurable effect on the discharge at the outlet due to the masking influence of high groundwater levels in the catchment. Therefore focusing on the discharge at the outlet is not a suitable approach in such cases.
To represent the spatial characteristics of a catchment as realistically as possible, the catchment area must be spatially discretized. The configuration used primarily within SWAT is the sub-watershed discretization scheme. This results in a loss of spatial information, which is problematic for our intended applications. Therefore we developed an alternative model interface to manage input and output data based on grid cells. This enabled us to model the changes in evapotranspiration patterns in the catchment with changing land use more realistically and to calculate the water balance for each grid cell without losing its geographic reference. Therefore, the grid cells can interact with each other and exchange matter and energy, which was not possible using the sub-watershed approach. Therefore, the grid-cell interface enables the implementation of remote sensing data to provide a spatially distributed modelling.