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Abstract

Title: The surface energy balance over drying semi-arid terrain in West Africa
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One of the fundamental aspects of current research in earth system science is the proper understanding of land-atmosphere interactions. The role of the land surface is crucial in the climate system, since a large fraction of incoming solar radiation passes through the atmosphere and is converted at the surface into turbulent fluxes. For numerous regions, including the semi-arid regions, only little knowledge is available about the diurnal and seasonal cycle of land surface interactions. The semi-arid areas pose a big challenge due to the large contrasts of dry and wet situations within a seasonal cycle. This is especially valid for the semi-arid region in West Africa, since it is one of the most climatically sensitive and ecologically unstable regions in the world. The variability of weather and climate in the region is strongly influenced by complicated interactions and feedbacks between the land and the atmosphere. To analyze and to predict these interactions and feedbacks it is inevitable to measure and model the involved components. Since standard methods for this purpose are not always applicable to the heterogeneous surface in West Africa, new measurement and modeling techniques have to be applied.

The overall objective of this thesis is to analyze and to model the land surface interactions in the Volta basin, West Africa, by using meteorological data obtained in the framework of the GLOWA-Volta project. A focus is put on diurnal and seasonal time scales. For measuring turbulent fluxes the key instrument is the large aperture scintillometer. This robust method yields area-averaged fluxes over complex terrain, which are required when analyzing meteorological data from heterogeneous surfaces. It is found that it is a suitable technique for the kind of environment also in comparison to different measuring techniques.

Based on the analysis of the measurements, two different land surface schemes are evaluated. Both schemes are not able to reproduce the measured seasonal cycle in surface fluxes. Several changes are proposed to obtain enhanced model performance.

Based on the earlier findings a model is constructed, combining the best parts of each of the two land surface schemes. It is shown that the performance of the new formulation is more realistic. Using a factorial design as the sensitivity analysis method it is assessed, which parameters are the most important. Furthermore it is found that those important parameters and their interactions change significantly during one season.

As a final step the gained knowledge is utilized to construct a simple satellite based algorithm to obtain surface water flux as the important flux on a regional basis. For

evaluating this first order approach the large aperture scintillometer is utilized to evaluate fluxes on satellite pixel scale.