Geophysical Research Abstracts
Vol. 19, EGU2017-15484, 2017
EGU General Assembly 2017

Analyzing the impact of land cover changes on water, energy and CO_2 fluxes in the West African Sudanian Savannah using Eddy Covariance stations

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An investigation of the impacts of land surface changes in West Africa, one of the most vulnerable regions of the world with respect to climate changes, require a sound understanding of the land-atmosphere exchange processes and their feedback mechanisms. An investigation of the impacts of land surface changes in West Africa require a sound understanding of the land-atmosphere exchange processes and their feedback mechanisms. To improve our process understanding regarding land-atmosphere interactions in the West African Sudanian Savannah, three micro-meteorological stations based on the Eddy Covariance (EC) technique have been installed in northern Ghana and in southern Burkina Faso during two field campaigns in October 2012 and January 2013. The EC stations are located along a transect of changing land cover to investigate how land surface changes influence energy, water and CO_2 fluxes between the land surface and the overlying atmosphere. The measurement sites are characterized by different vegetation cover due to different land use practices (near-natural versus intensively used grassland versus a mixture of fallow and cropland). Further site characteristics such as climate, soil and relief are similar. The analysis of the EC measurements was done for a period from January 2013 to August 2016 for four typical seasons in West Africa with different wind, moisture and radiation characteristics. Firstly, monsoonal winds from the southwest blowing over moist soils and lush vegetation between June and August during the monsoon peak, secondly, Harmattan winds from the northeast blowing over desiccated soils between December and February during the dry season, as well as transition periods with winds from various directions either over decaying vegetation and increasingly dry soils between September and November, or over growing vegetation and increasingly wet soils between March and May. Energy balance closures were best during the rainy season, however, we observed systematically poorer non-closures during the dry season at all three locations, with largest energy balance residuals between December and February.

We can also point out that the nearly natural site acts as a carbon sink like a typical Savannah site in contrast to the other more degraded sites. This site has also a clearly lower albedo resulting in a higher net radiation (30%) and significantly different energy and water fluxes between the sites.

The presented analysis enhances our understanding of the relevant processes in this particularly climate sensitive region and the datasets will serve as a valuable reference for climate modelling studies for the same area.