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Uncertainties in Measuring and Modeling Evapotranspiration in Open Savanna Ecosystems in West-Africa

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In recent years, several methods have been developed to estimate the spatial distribution of actual evapotranspiration (ET) by the means of remote sensing (RS). One frequently used approach is to calculate ET from latent heat fluxes modeled as residuum of the surface energy balance. For this purpose, ground heat fluxes and sensible heat fluxes are subtracted from the energy available on the land surface. One of these methods is the Surface Energy Balance Algorithm for Land (SEBAL), which has been applied to many ecosystems and different sensors. ET mapping from remotely sensed satellite images is critical for water management since the estimation of spatial and temporal ET distributions over large areas is impossible using only ground measurements. A major difficulty for the calibration and validation of operational ET RS algorithms is the validation against ground measurements of ET at a scale similar to the spatial resolution of the remote sensing image.

The spatial length scale of remote sensing images covers a range from 30 m (Landsat) to 1000 m (MODIS). Direct methods to measure the latent heat flux (W/m2) –i.e. the evapotranspiration rate (mm/day) multiplied by the latent heat for vaporization– such as eddy covariance (EC) only provide measurements at a scale that may be considerably smaller than the estimate obtained from a remote sensing method. The Large Aperture Scintillometer (LAS) flux footprint area is larger (here about 1 km^2) and its spatial extent better constraint than that of EC systems. Nevertheless, it is only an indirect method for estimation of ET. A detailed footprint analysis and its changes during the day is therefore necessary as well as uncertainties introduced by the different temporal scales. Overflight missions for mapping land surface properties were carried out to bridge the gap between the different spatial scales.

The objective of this contribution is to present our experiences with time series of ET mapping using ground observations and the Surface Energy Balance Algorithms for Land (SEBAL) in an open savanna ecosystem in Burkina Faso, West Africa. Most of the area is agriculturally used land on a spatial scale considerably smaller than pixel size of the RS imagery. Two years of continuous data from LAS as well as EC systems are analyzed and compared to modeled estimates of ET using remote sensing. Meteorological and biophysical boundary conditions of West African climate are highly variable between dry and rainy season and lead to seasonal differences in the time series and energy balance closure. This is analyzed with regard to applicability of the different approaches to estimate ET.