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Evaluation of the SEBS parameterizations over tall vegetation using SCOPE estimated turbulent fluxes

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Accurate estimation of global evapotranspiration is considered of great importance due to its key role in hydrology and meteorology. Accurate estimation of ET is of importance for applications such as, irrigation management, weather forecasting and climate model simulations. Therefore in the framework of the Water Cycle Multi Mission Observation Strategy (WACMOS) project a global evapotranspiration product is currently developed. Global estimation of evapotranspiration can only be achieved by using remote sensing data. Several algorithms, like the Two Source Energy Balance model and the Surface Energy Balance Algorithm for Land have been developed that are capable of estimating the daily evapotranspiration from remote sensing data. However the applicability of these models for global estimation of evapotranspiration is limited, because these models either require local calibration or are too complex for global application. The Surface Energy balance System (SEBS) circumvents these problems by using a physically based parameterization of the turbulent heat fluxes for different states of the land surface and the atmosphere, and therefore provides the best compromise between the number complexity and input requirements.

SEBS has been validated extensively over several land surface types in different researches. However these validation researches are limited to low vegetation types. The research presented here focuses on the effect of tall vegetation on the parameterizations within the SEBS algorithm. Evaluation of remote sensing algorithms in general is problematic because of differences in spatial and temporal resolutions between remote sensing observations and field measurements. Long time series of ET by remote sensing sensors are uncommon due to cloud contamination within the pixel and spatial footprints of remote sensing products are a factor higher than footprints of ground measurements.

In this research, the Soil Canopy Observation, Photochemistry and Energy fluxes (SCOPE) model is applied for the evaluation of the SEBS model. SCOPE was employed to parallel simulate remote sensing observations and act as a validation tool. The advantages of the SCOPE model in this validation are a) the temporal continuity of the data, and b) the possibility of comparing different components of the energy balance. The SCOPE model was run using data from the Reading University over their maize field in Sonning, United Kingdom. This data set comprises of a whole growth season of the maize crop. After the maize had reached its maximum LAI, the crop was thinned progressively during several stages. Therefore this data set is ideal for characterizing the sensitivity of the SEBS algorithm for different LAI values.

It is shown that the original SEBS algorithm produces significant uncertainties to the turbulent flux estimations due to the misparameterizations in the ground heat flux and sensible heat flux estimations. In the original SEBS formulation the fractional vegetation cover is used to calculate the ground heat. As this variable saturates very fast for increasing LAI the ground heat flux is underestimated. It is shown that a parameterization based on LAI greatly improves the estimation from 25 W m-2 to 18 W m-2. The uncertainties in the sensible heat flux arise due to a misparameterization of the roughness length for heat. In the original SEBS formulation the roughness length for heat is only valid for short vegetation. Extra parameterizations for tall vegetation were implemented in the SEBS algorithm to correct for this. This improved the correlation between the SEBS and the SCOPE algorithm from -0.05 to 0.69, and a decrease in error from 123 W m-2 to 94 W m-2 for the latent heat, with SEBS latent heat consistently lower than the SCOPE reference.