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Simulating Surface Energy Fluxes from a Winter Wheat Stand Using the Noah Land Surface Model

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Land surface models (LSM) of various complexities are coupled to atmospheric models to provide the energy and water fluxes between the atmosphere and the land surface. A LSM of medium complexity is the Noah LSM, which is coupled e.g. to the Weather Research Forecast (WRF) model. The vegetation plays a key role in the interactions between the atmosphere and the land surface. Here, croplands may cover a major part of the simulation domain. Land surface properties of croplands show distinct seasonal dynamics, which strongly affect the partitioning of net radiation in sensible, latent and soil heat flux. The aim of the present study was to test the performance of the Noah land surface model (LSM) with regard to the energy partitioning and soil water dynamics on a winter wheat stand in Southwest Germany. The model was tested against a set of eddy covariance data collected in the season of 2009. With respect to the energy partitioning, the default parameterization performed well during the main vegetation period. From the period of maturing, starting in mid of July until harvest on August 7th, however, the sensible heat flux was distinctly underestimated by up to 175 W/m2. As a consequence, evapotranspiration was overestimated during this period of time. After adjusting the parameterization of the green vegetation index, the leaf area index and the albedo to the field-specific conditions the model performed much better. Also during maturing phase, the model delivered acceptable results.

Because of the assumption of a uniform root distribution across the soil profile the default Noah LSM was unable to simulate soil water dynamics in the top soil during the dry phases in June. While the measured water content declined drastically from about 40 to 15 Vol.-% the simulated volumetric water content did not fall below 25 Vol.%. By implementing a simple root water uptake compensation scheme based on an exponential root distribution the simulation of the soil water dynamics could be considerably improved. Our results underline the importance of improving the representation of root distribution and plant water uptake in LSM.