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Modeling surface energy fluxes from a patchwork of fields with different soils and crops

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Agroecosystems are a dominant terrestrial land-use on planet earth and cover about 36% of the ice-free surface (12% pasture, 26% agriculture) [Foley2011]. Within this land use type, management practices vary strongly due to climate, cultural preferences, degree of industrialization, soil properties, crop rotations, field sizes, degree of land use sustainability, water availability, sowing and harvest dates, tillage, etc. These management practices influence abiotic environmental factors like water flow and heat transport within the ecosystem leading to changes of land surface fluxes.
The relevance of vegetation (e.g. crops), ground cover, and soil properties to the moisture and energy exchanges between the land surface and the atmosphere is well known [McPherson 2007], but the impact of vegetation growth dynamics on energy fluxes is only partly understood [Gayler et al. 2014].
Thus, the structure of turbulence and the albedo evolve during the cropping period and large variations of heat can be measured on the field scale [Aubinet2012]. One issue of local distributed mixture of different land use is the measurement process which makes it challenging to evaluate simulations.
Unfortunately, for meteorological flux-measurements like the Flux-Gradient or the Eddy Covariance (EC) method, comparability with simulations only exists in the ideal case, where fields have to be completely uniform in land use and flat within the reach of the footprint. Then a model with one specific land use would have the same underlying source area as the measurement. An elegant method to avoid the shortcoming of grid cell resolution is the so called mixed approach, which was recently implemented into the ecosystem model framework Expert-N [Biernath et al. 2013].
The aim of this study was to analyze the impact of the characteristics of five managed field plots, planted with winter wheat, potato and maize on the near surface soil moistures and on the near surface energy flux exchanges of the soil-plant-atmosphere interface. The simulated energy fluxes were compared with eddy flux tower measurements between the respective fields at the research farm Scheyern, North-West of Munich, Germany.
These simulations were done by coupling the ecosystem model Expert-N to an analytical footprint model [Mauder & Foken 2011] . The coupled model system has the ability to calculate the mixing ratio of the surface energy fluxes at the flux tower position. The approach accounts for the temporarily and spatially changing contributions of the patchwork of environmental land surface conditions (land use, management, soil properties) which influence the energy flux tower measurements due to the footprint dynamics.
The statistical evaluation between simulation and measurements showed that the mixed approach improved the comparability in most cases. Furthermore, the management impact on single patches can be clearly detected, both in the measurements and the simulation. We conclude that reasonable simulations of energy and matter fluxes can be obtained if the heterogeneity of the land surfaces is taken into account.