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Energy flux simulation in heterogeneous cropland – a two year study

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Recent studies show that uncertainties in regional and global climate and weather simulations are partly due to inadequate descriptions of the energy flux exchanges between the land surface and the atmosphere [Stainforth et al. 2005]. One major shortcoming is the limitation of the grid-cell resolution, which is recommended to be about at least 3x3 km^2 in most models due to limitations in the model physics. To represent each individual grid cell most models select one dominant soil type and one dominant land use type. This resolution, however, is often too coarse in regions where the spatial heterogeneity of soil and land use types are high, e.g. in Central Europe.
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].
An elegant method to avoid the shortcoming of grid cell resolution is the so called mosaic approach. This approach is part of the recently developed 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.
To perform these simulations, we coupled 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 a given point within one grid cell (in this case at the flux tower between the two fields).
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. Our simulation results show that a mosaic approach can improve modeling and analyzing energy fluxes when the land surface is heterogeneous. In this case our applied method is a promising approach to extend weather and climate models on the regional scale.
A mixed approach for surface fluxes simulations can improve the understanding of the measured surface fluxes of crop fields located in a small distance to the flux tower. Simulated surface fluxes using the mixed approach are not always better representing the measurements than single crop simulations, but the simulation results are more stable and more reliably than taking only one vegetation and soil model configuration.