Multi-year assessment of a land surface model: Impact of the uncertainty on soil parameters on the evapotranpiration of a mediterranean crop site

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allowing short averaging flux intervals down to a couple of seconds. When determining the averaging-time-dependent systematic- and random errors in the H_2O and CO_2 fluxes, we found that eddy-covariance is not apt to measure 1-minute averaged fluxes, whereas our new method is. Even for 1-minute averaging intervals, our new method does not have a averaging-time-dependent systematic error and the random error is only halve that of the eddy-covariance method. Thus, we demonstrate that our new method reproduces reliable estimates of H_2O and CO_2 fluxes for 1-minute averaging intervals and show that not only individual plants, but also at field scales wheat responds rapidly to changes in solar radiation.

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Abstract: Generic land surface models (LSM) are designed to produce large scale simulations of land water, energy, and carbon fluxes. This kind of model is generally not able to represent complex crop rotation systems. In this study, an attempt was made to implement the ISBA-A-gs LSM at a local scale, over a Mediterranean crop site. The objective of this work is to assess the uncertainties affecting the simulated evapotranspiration (ETR). While similar past studies focused on particular crop types and limited period of time, the originality of this paper consists in implementing the LSM and assessing its uncertainties over a long period of time. Continuous simulations through a 12-yr (April 2001-December 2012) crop rotation were performed. The crop rotation plan included 13 crop cycles, 14 inter-crop bare soil periods, and five crop types (wheat, sorghum, maize, sunflower, and pea). We found that when the model was driven by large scale meteorological analyses and was based on large scale parameter maps, the largest ETR discrepancies were induced by errors in both the atmospheric and the vegetation dynamic forcing. When the model was driven by local meteorological observations, and local vegetation and soil texture observations, errors in ETR estimations were caused to a large extent by key soil hydrodynamic parameters. Using generic values of these parameters triggered a substantial underestimation of the ETR and a concomitant overestimation of the soil water content for both crop and inter-crop periods. A lack of ~1617 mm (27%) in cumulative ETR at the end of the 12-year simulation period illustrates the substantial error propagation over a long period of time. The use of in situ soil hydrodynamic properties substantially reduced the ETR bias. We showed the key roles of (1) the wilting point soil moisture in the simulation of both the transpiration and the root-zone soil moisture during the dry soil periods and (2) the saturation soil moisture in the representation of the superficial soil water content dynamics and the resulting soil evaporation. The unresolved random scattering of the difference between simulated and observed ETR was attributed to uncertainties in the eddy covariance measurements (random errors and non closure of the energy balance), and to modeling uncertainties. Finally, we discuss the ability of a multi-layer diffusion schemes to better represent the soil vertical heterogeneity as well as the influence of the succession of crop and bare soil periods on the soil hydrology.