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Hydrological functioning of irrigated maize crops in southwest France using Eddy Covariance measurements and a land surface model

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This study aims to analyze the main components of the energy and hydric budgets of irrigated maize in southwestern France. To this objective, the ISBA-A-gs (Interactions between Soil, Biosphere, and Atmosphere) is run over six maize growing seasons. As a preliminary step, the ability of the ISBA-A-gs model to predict the different terms of the energy and water budgets is assessed thanks to a large database of *in situ* measurements by comparing the single budget version of the model with the new Multiple Energy Balance version solving an energy budget separately for the soil and the vegetation. The *in situ* data set acquired at the Lamasquere site (43.48° N, 1.249° E) includes half-hourly measurements of sensible (H) and latent heat fluxes (LE) estimated by an Eddy Covariance system. Measurements also include net radiation (Rn), ground heat flux (G), plant transpiration with sap flow sensors, meteorological variables, and 15-days measurements of vegetation characteristics. The seasonal dynamics of the turbulent fluxes were properly reproduced by both configurations of the model with an R^2 ranging from 0.66 to 0.89, and a root mean square error lower than 48 W m^{-2}. Statistical metrics showed that H was better predicted by MEB with R^2 of 0.80 in comparison to ISBA-Ags (0.73). However, the difference between the RMSE of ISBA-Ags and MEB during the well-developed stage of the plants for both H and LE does not exceed 8 W m^{-2}. This implies that MEB only has a significant added value over ISBA-Ags when the soil and the canopy are not fully coupled, and over a heterogeneous field. Furthermore, this study made a comparison between the sap flow measurements and the transpiration simulated by ISBA-A-gs and MEB. A good dynamics was reproduced by ISBA-A-gs and MEB, although, MEB (R^2= 0.91) provided a slightly more realistic estimation of the vegetation transpiration. Consequently, this study investigated the dynamics of the water budget during the growing maize seasons. Results indicated that drainage is almost null on the site, while the observed values of cumulative evapotranspiration that was higher than the water inputs are related to a shallow ground table that provides supplement water to the crop. This work provides insight into the modeling of water and energy exchanges over maize crops and opens perspectives for better water management of the crop in the future.