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Retrieving useful information from global sensitivity analysis performed on soil-plant-atmosphere model DAISY

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In recent years, perturbations of precipitation regime have intensified due to climate change and it has led to frequent droughts and waterlogged periods. Under these conditions, plants show specific responses and these events often lead to yield losses. In order to have a better understanding of the impact of these perturbations on carbon and nitrogen dynamic transfers within plants as well as between plants, soil and atmosphere, a modelling approach was combined with measurements. The 1D/2D DAISY model was used as it has already been evaluated and compared to others frequently used models (Palosuo et al., 2011; Kollas et al., 2015) and as it meets most of our criteria. Indeed, this open-source model simulates plant production and keeps track of water, nitrogen and carbon content in soil and within plants with an hourly time resolution. Moreover, a SVAT component along with Farquhar formalism for photosynthesis allows DAISY to simulate energy, CO_2, N_2O and H_2O exchanges (Hansen et al., 2012).

Our objective is to apply this model to a 4-year crop rotation (winter wheat, potato, winter wheat, sugar beet) in Lonzée that is representative of Belgian agricultural system. As this site is part of the ICOS network, fluxes (CO_2, N_2O and H_2O) are measured along with continuous meteorological and edaphic conditions data as well as a regular follow-up of organs biomass and LAI. Soil texture has been assessed, identifying Lonzée soil as a silty loam (USDA).

As a first step in this modelling procedure, a global sensitivity analysis (GSA) was performed according to the Morris method. To our knowledge, no GSA had been carried out on DAISY before and, moreover, this step is often overlooked in modelling even though it can give useful information. Sensitivity indices were computed at each time step, providing information on which parameter are influential in general but also at specific phenological stages and under specific conditions such as droughts or waterlogged periods. Furthermore, GSA identified which parameters need thorough measurement or estimation and detected interaction effects between parameters.

The followed methodology and the obtained results will be presented as well as an analysis over the agricultural cycle (from sowing to harvest), leading to propositions to improve the ICOS experimental set-up.

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