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Inverting a comprehensive crop model in parsimonious data context using Sentinel 2 images and yield map to infer soil water storage capacity.

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Soil Water storage Capacity (SWSC) is an important quantity in the field of hydrology and agronomy to represent the hydrological functioning of a territory and/or the dynamics of a crop. SWSC spatial variability is often strong resulting from heterogeneity in texture and structure as well as soil depth. In situ measurement of SWSC is expensive, destructive and cannot be considered over a large area. Therefore, the characterization of SWSC by non-destructive methods is a mean of addressing the mapping issue. In this study we took profit of the new capacities offered by the Sentinel 2 mission, which allows characterizing relevant features in vegetation dynamic linked to stresses. In addition, yield map offers an additional source of information. Both yield and vegetation development are sensitive to several factors as the water and nitrogen supply, crop installation or pest. To isolate the influence of water supply, and therefore access parameters involved in the SWSC, an option is to delineate the effect of su factors by inverting a crop model able to simulate the observation together with the representation of most of influencing factors. The STICS crop model implemented in study is suitable to consider interactions between carbon, nitrogen and water cycles, plant development and farming practices. The issue is then to demonstrate tha parsimony in field characterization can be overcome by using satellite and yield observations to implement and invert comprehensive model such as STICS. A sensitivity analysis (Lammoglia et al. 2019) indicates that once plant variety parameters are calibrated, the parameters linked to crop installation, as the sowing depth and the sowing density, the initial soil mineral nitrogen and the SWSC are the main quantities to consider in an inversion procedure. The GLUE Bayesian method was used to retrieve the different parameters. The procedure was tested on non-irrigated winter durum wheat in a Mediterranean context in south-eastern France. The approach was evaluated in farm context 20 on heterogeneous fields over three years (2016-2018). Evaluation was made either by comparing inverted SWSC to observations and/or assessing the crop model performances on subsequent years. Soil heterogeneities are well captured by the method, but some heterogeneities interpreted as soil heterogeneities might be artefacts. A multi-year analysis is then necessary to get the permanent features that are most likely linked to soil properties. Discussion on the adding value of combining both soil vegetation dynamic (FAPAR, LAI) and yield, on the inversion strategy (calibration steps, data being considering, initialisation) and on the cost function (to reduce the impact of uncertainties on crop parameters) was made. The study has shown that LAI/FAPAR and yield observations make the use of complex model in data parsimonious context possible. In particular, the study highlights the importance of having frequent image acquisition, as it allows to capture short feature as the senescence rate which appears as an important proxy of the availability of water in the soil.

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