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Soil moisture estimation with limited soil characterization for decision making

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Many decisions in agriculture are conditional to soil moisture. For instance in wet conditions, farming operations as soil tillage, organic waste spreading or harvesting may lead to degraded results and/or induce soil compaction. The development of a tool that allows the estimation of soil moisture is useful to help farmers to organize their field work in a context where farm size tends to increase as well as the need to optimize the use of expensive equipments.

Soil water transfer models simulate soil moisture vertical profile evolution. These models are highly sensitive to site dependant parameters. A method to implement the mechanistic soil water and heat flow model (the TEC model) in a context of limited information (soil texture, climatic data, soil organic carbon) is proposed [Chanzy et al., 2008]. In this method the most sensitive model inputs were considered i.e. soil hydraulic properties, soil moisture profile initialization and the lower boundary conditions. The accuracy was estimated by implementing the method on several experimental cases covering a range of soils. Simulated soil moisture results were compared to soil moisture measurements. The obtained accuracy in surface soil moisture (0-30 cm) was 0.04 m3/m3. When a few soil moisture measurements are available (collected for instance by the farmer using a portable moisture sensor), significant improvement in soil moisture accuracy is obtained by assimilating the results into the model. Two assimilation strategies were compared and led to comparable results: a sequential approach, where the measurement were used to correct the simulated moisture profile when measurements are available and a variational approach which take moisture measurements to invert the TEC model and so retrieve soil hydraulic properties of the surface layer. The assimilation scheme remains however heavy in terms of computing time and so, for operational purposed fast code should be taken to simulate the soil moisture as with the Ross model [Ross, 2003, Crevoisier et al, 2009].

To meet the decision support context, we evaluated the model ability of evaluating the soil moisture level in comparison to a moisture threshold that splits soil conditions into desirable and undesirable cases. This threshold depends on soil properties, the farming operation and equipment characteristics. We evaluate the rate of making good decisions using either the TEC model with and without soil moisture measurements or an empirical algorithm that simulate the decision processes followed by farmers, currently. This later is a reference case that allows appreciating the adding value of using soil water transfer models. We found a significant improvement with a rate of success, which increases from 65% with the reference case to 90% when using the model with soil moisture assimilation.

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