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Bottom-up design of a root water uptake model to simulate water dynamics at the field scale

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An efficient management of underground water quality and quantity requires a comprehensive vision of soil water dynamics, particularly in cropped fields where water is not only the main vector of most of the chemicals transferred through the soil to the groundwater but can also be a key factor in crop yield. In this domain where observation techniques are still expensive and lack of precision, modelling of the soil-plant water dynamics (including root water uptake modelling) could become a tremendous management tool after its accuracy and speed were proved on sufficiently large scales. Yet, nowadays, no root water uptake model possesses both of these qualities. On the one hand, physically-based models considering a 3-D root architecture and water fluxes inside of the root system tend to be more realistic but are quite time-consuming. On the other hand, simpler models can predict root water uptake very quickly but for a quite narrow range of conditions close to the calibration conditions.

As a response to that issue, a new root water uptake model has been created. While being as fast as a simpler model, it is also sensible to root architecture, root hydraulic properties and water distribution in the soil surrounding the roots and moreover able to reproduce with a good accuracy the predictions of a more realistic model (Doussan model) in a large range of conditions.

Nonetheless, the limits of the new root water uptake model had to be tested for different soil water contents, soil types and transpiration levels. The results of this analysis are shown and the relevance of the new concepts introduced in this study is discussed and compared to the performances of previous simple root water uptake models.