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Assimilation of ERT data to improve Feddes parameters in a hydrological model during a root water uptake experiment

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Mitigating plant water stress while reducing irrigation is one of the biggest challenges that sustainable agricultural practices aim to tackle. The rhizosphere is the main unknown component controlling the water distribution in the soil, but non-destructive observations of root physiology are often lacking due to methodological limitations.

Numerous studies relate the use of electrical resistivity tomography (ERT) or stem-based methods to measure soil water content changes associated with root water uptake (RWU) in the rhizosphere area. Nevertheless, geoelectrical data are correlated with many rhizosphere parameters and their interpretation needs to be supported by physics-based models of root hydrology.

Here, we use a Data Assimilation (DA) framework to combine geoelectrical data with a hydrological model (Mary et al. 2021). DA offers the possibility to estimate model parameters governing RWU, such as in the well-known Feddes approach while introducing data observations to update them.

In a synthetic experiment mimicking a top-down infiltration in a rhizotron containing a wine plant (Vitis Vinifera), we simulated different scenarios of ERT data assimilation with the CATHY surface-subsurface hydrological model. The rooting depth associated with the Feddes parameters are perturbed to generate the ensemble states. At each observation time, model states and root depth parameters are updated using the Ensemble Kalman Filter (ENKF).

Expected results aim to demonstrate (i) what is the best ENKF scheme to integrate ERT measurements with the hydrological model and (ii) how much the uncertainties on the Feddes parameters can be reduced with the assimilation of ERT data. In a future work, the best approach identified will be applied to real soil and plant observation datasets.

Mary, B., Peruzzo, L., Iván, V., Facca, E., Manoli, G., Putti, M., et al. (2021). Combining Models of Root-Zone Hydrology and Geoelectrical Measurements: Recent Advances and Future Prospects. Front. Water 3, 767910. doi:10.3389/frwa.2021.767910.