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Coupling Hydrus-1D and METRIC models to estimate soil water balance of a highly heterogeneous agricultural field

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Understanding spatiotemporal variability of agricultural fields is fundamental for the definition of dynamic management zones and enhancing precision irrigation techniques. Accurate crop evapotranspiration (ET) estimation helps understanding the hydrological dynamics that characterize the root zone, particularly with highly heterogeneous conditions. The FAO method for the ET estimation is the most widely used in hydrological modeling. However, this approach is only partly effective in describing the spatial variability of water and salt stress at the subfield scale. Recently, remote sensing has been utilized as a viable tool for capturing the actual crop ET (ETa) at different scales but its coupling with hydrological modeling is still challenging. In this study, an original method was developed to integrate the hydrological model Hydrus-1D with the satellite-based energy balance METRIC (Mapping Evapotranspiration at High Resolution with Internalized Calibration) model. To this end, a two-year trial was conducted in a maize field located in the southern margin of the Venice Lagoon, characterized by heterogeneous soil properties and seawater intrusion. Five automatic monitoring stations were installed to investigate soil physical characteristics and hydrological dynamics. Undisturbed soil cores were collected and analyzed to determine soil water retention curves and hydraulic conductivity. Disturbed soil sample were analyzed for texture and chemical properties. Volumetric water content and matric potential were hourly monitored at 0.1, 0.3, 0.5 and 0.7 m, while data of depth to the water table were collected every week. Meteorological data were retrieved from an on-site weather station. Two approaches were used for modeling and optimizing the water dynamics. Firstly, water content and pressure head data collected in the field were used as input to Hydrus-1D and the inverse method was applied for the optimization of the water retention curve. Then, METRIC was coupled with Hydrus-1D, by using the ETa calculated from Landsat 8 images as forcing variable to enhance the inverse solution. Preliminary results highlighted that the integration of Hydrus-1D and METRIC model allowed to capture the different hydrological dynamics found at the five stations.