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3D soil water nowcasting using electromagnetic conductivity imaging and the ensemble Kalman filter

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Mapping and immediate forecasting of soil water content (θ) and its movement can be challenging. Although apparent electrical conductivity (EC_a) measured by electromagnetic induction has been used, it is difficult to apply it along a transect or across a field. Across a 3.95-ha field with varying soil texture, an ensemble Kalman filter (EnFK) was used to monitor and nowcast θ dynamics in 2-d and 3-d over 16 days. The EnKF combined a physical model fitted with θ measured by soil moisture sensors and an Artificial Neural Network model comprising estimate of true electrical conductivity (σ) generated by inversions of DUALEM-421S EC_a data. Results showed that the spatio-temporal variation in θ can be successfully modelled using the EnKF (Lin's concordance = 0.89). Soil water dried fast at the beginning of the irrigation and decreased with time and soil depth, which were consistent with the classical soil drying theory and experiments. It was also found that the soil dried fast in the loamy and duplex soils across the field, which was attributable to deep drainage and preferential flows. It was concluded that the EnKF approach can be used to better the irrigation practice so that variation in irrigation is minimised and irrigation efficiency is improved by applying variable rates of irrigation across the field. In addition, soil water status can be nowcasted using this method with weather forecast information, which will provide guidance to farmers for real-time irrigation management.