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# Assessment of the soil water balance by the combination of cosmic ray neutron sensing and eddy covariance technique in an irrigated citrus orchard (Marrakesh, Morocco)

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Irrigation water requirement plays a crucial role in many agricultural areas and especially in arid and semi-arid landscapes. Improvements in the water management and the performance of the irrigation systems require a correct evaluation of the hydrological processes involved. However, some difficulties can arise due to the heterogeneity of the soil-plant system and of the irrigation scheme.
To overcome these limitations, in this study, the soil water balance is analyzed by the combination of the Eddy Covariance technique (EC) and Cosmic Ray neutron Sensing (CRS). EC provides the measurement of the actual evapotranspiration over the area as it was presented in many field conditions. Moreover CRS showed to be a valuable approach to measure the root zone soil moisture integrated in a footprint of $\sim$30 ha. In this way, the combination of the two methodologies should provide a better analysis of the soil water balance at field scale, as opposed to point observations, e.g. by TDR, evaporimeter and fluxmeter. Then, this could increase the capability to assess the irrigation efficiency and the agricultural water management.
The study is conducted in a citrus orchard situated in a semi-arid region, 30 km southwest of Marrakesh (Morocco). The site is flat and planted with trees of same age growing in parallel rows with drip irrigation lines and application of fertilizer and pesticides. The original soil seems modified on the surface by the agricultural use, creating differences between trees, rows and lines. In addition, the drip irrigation creates also a spatial variability of the water flux distribution in the field, making this site an interesting area to test the methodology. Particular attention is given to the adaptation of the standard soil sampling campaign used for the calibration of the CRS and the introduction of a weighing function.
Data were collected from June to December 2013, which corresponds to the high plant transpiration. Despite the intention of the farmer to maintain constant soil water contents in the root zone throughout the period, the CRS results showed a relatively strong dynamic of the soil water conditions at field scale and respond well to the EC measurements. Strong spatial heterogeneities and the difficulties of direct comparison between the different scales of measurements pose a challenge for full quantification of the water balance. Further analysis will address the assessment of the irrigation efficiency at different scales and of deep percolation.

Keywords: Cosmic Ray Sensing, deep percolation, Eddy Covariance, evapotranspiration, irrigation, Morocco, soil moisture, semi-arid;