Geophysical Research Abstracts,
Vol. 11, EGU2009-8207, 2009
EGU General Assembly 2009
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Spatial flow patterns in the vadose zone beneath an orchard

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We investigate the flow patterns beneath an orchard located above the Israeli Coastal Plain Aquifer. Two surface electrical resistivity tomography (ERT) lines were permanently installed along the drip irrigated rows, and perpendicular to the rows, with electrode separation of 0.5-1.0 m. Each line included 96 electrodes, allowing investigation depth of over 10 m. ERT surveys, each with approximately 2,300 individual measurements were conducted throughout the year (with at least one measurement during each season). In addition, a four days continuous survey was conducted around an irrigation event. Calibration of the petrophysical relations was conducted in three different ways, including at the laboratory scale, using undisturbed samples, and using deep FlexTDR data. Clear advantage for the on-site calibration was observed.

Our results indicate distinct difference between the flow beneath the tree rows, and between the rows. These patterns are associated to the combination of heterogeneity in boundary conditions (i.e. primarily irrigation drip lines in summer, rainfall and interception patterns in winter) and in root uptake patterns. The signature of these distinct patterns diminishes at depth of about 5 m, partially in reality because of flow dispersion, and partially because of the weakening of the geophysical signal. Our results also show that the different regions of the subsurface (beneath trees and between rows) behave differently in time. While the wet regions below the trees are characterized by a shallower depth in summer, and deeper in winter, the wet regions between the tree rows are permanently wet (but to lesser degree) and keep seemingly constant depth. This is somewhat expected as the top boundary conditions for these regions change differently in time, but it also indicates the spatial extent of the root uptake.

The distinct flow patterns indicate that treating an agricultural field as homogeneous unit for the purpose of evaluating recharge or contamination loads may be problematic, especially if the investigation is performed using traditional, point measurements. Such an investigation may be not representative and may lead to significant bias in estimation.