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Transferability of hydraulic properties from lab measurements to a lysimeter

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The aim of this study was to test whether flow processes on a lysimeter scale could be predicted based on hydraulic properties that were determined on a small scale. The small scale was defined by soil columns in the laboratory with a length of L = 6.8 cm, whereas the length scale of the lysimeter was 10-fold (L = 74 cm). To test the transferability, we performed a long-time multi-step outflow (MSO) experiment on a lysimeter at the ICG-4 (Agrosphere), Forschungszentrum Jülich GmbH, Germany. The lysimeter was packed with a silty fine sand. The same material was investigated at the Technical University of Braunschweig by MSO experiments on packed columns. In both cases, the initially saturated soil was stepwise drained by applying a defined suction at the bottom, and the temporal course of water contents and pressure heads at various depths, and the cumulative outflow were monitored. The determination of hydraulic properties was done by inverse simulation, using the van Genuchten/Mualem parameterization and free-form functions as models for the hydraulic properties.

The results showed very similar hydraulic properties of the laboratory columns and the lysimeter. However, the use of the lab-determined properties to predict the lysimeter behaviour indicated a systematic mismatch of predicted water fluxes. In particular, the total amount of draining water was overestimated in the prediction. This demonstrates the great sensitivity of flow processes on seemingly small differences in hydraulic properties. We explain the observed discrepancies with a smaller initial saturation in the lysimeter, as compared to the laboratory columns. This different initial saturation

is likely to be a fundamental problem of scales. Whereas it is common practice in the laboratory to strive for maximum initial saturation in determining retention curves, field soils will behave more like lysimeters, and will also never reach full water saturation. Therefore, the prediction of water dynamics based on measurements on small laboratory samples must be questioned.