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Simplified evaporation method for determining soil hydraulic properties: a reinvestigation of linearization errors

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Accurate knowledge of the soil hydraulic properties is a prerequisite for reliable modelling of soil water dynamics. As a consequence, many methods have been developed to derive these constitutive relationships either under field or laboratory conditions. Among these methods, the simplified evaporation method conducted on soil samples in the laboratory has found widespread use and application, mainly due to its relative ease of implementation and its straightforward evaluation of the experimental data. This method, however, relies on various simplifying assumptions. A common approach to assess the validity of these assumptions and to explore potential linearization errors associated with them is the use of synthetic data. In the past, such synthetic data were generated using rather simplistic models considering liquid water flow in capillaries only. In this study, we reinvestigated the accuracy of the simplified evaporation method using a more realistic process description of evaporative drying of the soil sample, including both liquid water flow in capillaries and films, as well as isothermal water vapour diffusion. In contrast to previous results reported in the literature, our results show that the simplifying assumptions used to evaluate the experimental data may result in biased estimates of the soil hydraulic properties, particularly for coarse textured soils. The bias typically increased progressively during stage-two evaporation, which is characterized by the development of a dry surface layer in which water flow is dominated by diffusion of water vapour, resulting in strongly nonlinear pressure head and water content profiles. We investigated various strategies for correcting for this bias caused by simplifying assumptions.