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Estimating the Hydraulic Properties of Mountainous Podzol Soils Using Inverse Modeling Methods

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The aim of this research is an evaluation of the soil hydraulic parameters (SHP) for a mountainous podzolic soil profile. The SHPs for the lower layers can be identified using standard approaches – a single ring (SR) infiltration experiment and a Guelph permeameter (GP) measurement. However, the thickness of the top soil layer is often much lower than the depth required to embed an SR or GP device, and the SHP for the top soil layer exhibits large temporal and spatial changes due to changes in vegetation activity during the seasons and a distinct alternation of wetting and drying cycles. SHPs for the top soil layer are therefore very difficult to measure directly. The SHPs for the top soil layer were therefore identified here by inverse modeling of the SR infiltration process, where, especially, the initial unsteady part of the experiment can provide very useful data for evaluating the retention curve parameters and the saturated hydraulic conductivity. This inverse analysis is the main topic of this paper. We discuss issues in assigning the initial and boundary condition setup, and the influence of spatial and temporal discretization on the values of the identified SHPs. Since the infiltration process is a typical case of a model that describes the progressive breakthrough of the wetting curve, we made use of adaptive domain decomposition (dd-adaptivity) described by Kuraz et al. (2013, 2014, 2015) for sequential activation and deactivation of the segments of our computational domain. Finally, we conducted a sensitivity analysis of our objective function on the SHP set.