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The effect of soil macro-structure on bare soil evaporation – using HYDRUS 3D simulation on X-ray µCT determined soil structures

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Evaporation of soil water depends not only on climatic conditions, soil texture, and soil hydraulic properties but also on the soils' macro-structure. Often, evaporation is characterised by water losses over time for a defined soil volume where soils are assumed to be homogeneous in texture and structure. In this study, we investigated the potential and limitations of 3D modelling of evaporation processes on soil cores with structural features ≥ 480 µm determined by X-ray computed tomography (X-ray µCT). The method was tested for two contrasting soil structures (ploughed vs. non-ploughed grassland) which experienced structural changes due 19 cycles of freezing and thawing. For all real soil samples, we simulated three different conditions of atmospheric demand with Hydrus 3D. It was hypothesised that the different distribution of air-filled macro-pores, the macro-connectivity of soil matrix and the surface area will affect bare soil evaporation and more specific the transition from stage 1 to stage 2 evaporation. To evaluate the effect of soil macro-structure on the column scale, we investigated the spatial distribution of water content and water fluxes. The combination of X-ray µCT and HYDRUS 3D was able to capture the effect of ploughing and freezing-thawing on soil macro-structure and to quantify the effect on the water dynamics inside the samples for various atmospheric demands and thus the feedback with evaporation.