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Sensitivity of bare non-vegetated soil moisture dynamic simulations to prescribed soil-atmosphere interface boundary condition forcings

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Soil moisture is closely linked to the near-surface heat and mass transfer that couples the land and atmospheric states. The accurate simulation of the spatiotemporal distribution of soil moisture is constrained by existing knowledge gaps with respect to the mechanisms and processes linking the atmospheric and soil states, their magnitude, and sensitivity to applied soil conditions. In this study, we explore the effects of variations in microclimate conditions on state variable distributions and water balances for different bare soil conditions. A series of evaporative experiments were conducted at the Center for Experimental Study of Subsurface Environmental Processes (CESEP) wind tunnel-porous media test-facility to generate atmospheric and subsurface datasets that were in turn applied in the prescribed soil-atmosphere boundary conditions of a heat and mass transfer numerical model. Experimental results showed that for the length scale and edaphic conditions tested, variations in local soil-atmosphere coupling had a slight impact on the lateral distribution of soil moisture. This localized soil moisture variability could not be reproduced with numerical model. From a water balance perspective however, cumulative water loss could be adequately captured with little loss of fidelity. This demonstrates that heat and mass transfer models may be insensitive to the local microclimate driving bare-soil evaporation but are strongly influenced by local soil properties (i.e., heterogeneity). Together, these findings suggest that greater focus should be given to characterizing subsurface conditions and subsurface constitutive models and heat and mass transfer theory than localized near-surface atmosphere conditions.

References

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