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Effect of soil property on evaporation from bare soils

Chenming Zhang, Ling Li, and David Lockington
The University of Queensland, School of Civil Engineering, Australia

Quantifying the actual evaporation rate from bare soils remains a challenging task as it not only associates with the atmospheric demand and liquid water saturation on the soil surface, but also the properties of the soils (e.g., porosity, pore size distribution). A physically based analytical model was developed to describe the surface resistance varying with the liquid water saturation near the soil surface. This model considers the soil pore size distribution, hydraulic connection between the main water cluster and capillary water in the soil surface when the soil surface is wet and the thickness of the dry soil layer when the soil surface is dry. The surface resistance model was then integrated to a numerical model based on water balance, heat balance and surface energy balance equations. The integrated model was validated by simulating water and heat transport processes during six soil column drying experiments. The analysis indicates that the when soil surface is wet, the consideration of pore size distribution in the surface resistance model offers better estimation of transient evaporation among different soil types than the estimations given by empirically based surface resistance models. Under fixed atmospheric boundary condition and liquid water saturation, fine sand has greater evaporation rate than coarse sand as stronger capillary force devlivers more water from the main water cluster. When the soil surface becomes dry, the impact of soil property to evaporation becomes trivial as the thickness of the dry soil layer turns to be the key factor to determine the evaporation rate.