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Simulating Water Flow and Heat Transfer in Arid Soil Using Weighing Lysimeter Data

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Deserts cover about one third of the Earth's land surface. Rather little though is known about the physics of desert soils and their implications for the ecology and hydrology of arid environments. The recently constructed weighing lysimeters located in Boulder City, Nevada, were designed to improve our understanding of the physical processes and properties of arid soils at the meter scale. In this study, we developed a HYDRUS-1D model to simulate water infiltration, hydraulic redistribution, and heat transfer for one of the lysimeters. HYDRUS-1D solves the coupled equations for water flow and heat transfer in variably saturated soil. Soil hydraulic and thermal properties were initialized based on prior knowledge and characterizations of the lysimeter soil. Soil hydraulic and thermal parameters were further refined by inverse simulation using a subset of the soil water content, water potential and temperature measurements at various depths. The model was validated using a separate portion of the soil moisture and temperature data set that was not used for calibration. The calibrated model provides a tool to virtually test future experiments in the lysimeters such as changes in the irrigation regime or the incorporation of plants. The model will also help to assess the impact of the placement of physical structures (such as solar panels) on the water and heat balance of desert soils.