Geophysical Research Abstracts
Vol. 20, EGU2018-11412, 2018
EGU General Assembly 2018

Modeling a decade-long record of evaporation and recharge dynamics in a deep desert soil lysimeter using the surface evaporation capacitor concept

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About one third of the land surface is overlain by desert soils that support fragile ecosystems adapted to water scarcity. Surface evaporation in such systems is the primary flux that affects available water following episodic rainfall events. We recently proposed a physically-based framework for estimating evaporative losses from such surfaces termed the surface evaporative capacitor (SEC). The concept was tested based on decade-long dataset from a unique experimental facility consisting of 3-m deep weighing lysimeters located in the Mojave Desert of southern Nevada. Data show that despite very high potential evaporation (2000 mm/year) and low rainfall ($\sim$100 mm/year), net soil water storage in the lysimeter increased gradually during this decade highlighting the role of internal redistribution into deep soil layers in sheltering water from evaporation. A soil-dependent evaporative characteristic length determines the soil depth below which water is sheltered from evaporation. The soil "capacitor" is recharged by rainfall and is subsequently emptied at a rate determined by competition between drainage and surface evaporation. Model predictions were in good agreement with observations lending support to application of the SEC concept in a climatic context. Data show rainfall thresholds that contribute to net recharge shedding new light on the intermittent dynamics of this important component of the water balance.