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Soil evaporation from cropping systems: a revised look at PET-based remote sensing methods

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Evapotranspiration is the process by which moisture and energy are exchanged between the Earth's surface and atmosphere. It can be divided into two main components: transpiration or the movement of water through vegetation canopies to the atmosphere during photosynthesis/respiration and evaporation directly from the soil or canopy surface following a wetting event. Transpiration accounts for ∼61% of global evapotranspiration due to the abundance of tropical rainforests and other highly productive ecosystems. In dryland systems where vegetation cover is low, soil evaporation is much more important and can account for up to ∼49% of evapotranspiration. Soil evaporation in these systems is particularly high for cultivated lands at the onset of the growing season when vegetation cover is extremely low and water is supplied by irrigation. Evapotranspiration models are increasingly used to understand moisture/energy dynamics in cultivated lands of dryland systems. Potential evapotranspiration methods that involve Earth observation imagery, such as the Priestley–Taylor Jet Propulsion Laboratory (PT-JPL) model, perform particularly well for humid systems and less so for dryland systems. We hypothesize that the poorer performance of these models in dryland systems is due to the weak parameterization of soil evaporation. We will test our hypothesis by comparing the original soil evaporation component of PT-JPL with three new parameterizations. The parameterizations are based on the apparent thermal inertia method, land surface water index, and a newly developed index we call the soil water divergence index. The three parameterizations were derived from the MODIS Aqua land surface temperature (MYD11A2), land surface reflectance (MYD09A1), and ocean reflectance produced for land (MYDOCGA) products, respectively. The products were brought to a common 8-day 1 km temporal and spatial resolution. The transpiration component of PT-JPL was forced with micrometeorological data from 12 eddy covariance towers that are part of the Ameriflux (http://ameriflux.ornl.gov/) network and vegetation indices derived from MYD09A1. These towers measure evapotranspiration from adjacent rainfed and irrigated agricultural fields in dry areas of the contiguous United States. The evaluation will be evaluated with standard performance metrics on the residuals of PT-JPL transpiration versus eddy covariance evapotranspiration. We expect that the soil water divergence index will outperform other parameterizations, since a previous analysis involving ground-based spectroradiometric data (https://www.sciencedirect.com/science/article/pii/S0168192315008163) showed that the soil water divergence index explained nearly 70% of the variability in soil evaporation.