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A process-based evapotranspiration model incorporating coupled soil water-atmospheric controls

Erfan Haghighi and James Kirchner
Physics of Environmental Systems, ETH Zurich, Zurich, Switzerland

Despite many efforts to develop evapotranspiration models (in the framework of the Penman-Monteith equation) with improved parametrizations of various resistance terms to water vapor transfer into the atmosphere, evidence suggests that estimates of evapotranspiration and its partitioning are prone to bias. Much of this bias could arise from the exclusion of surface hydro-thermal properties and of physical interactions close to the surface where heat and water vapor fluxes originate. Recent progress has been made in mechanistic modeling of surface-turbulence interactions, accounting for localized heat and mass exchange rates from bare soil surfaces covered by protruding obstacles. We seek to extend these results partially vegetated surfaces, to improve predictive capabilities and accuracy of remote sensing techniques quantifying evapotranspiration fluxes. The governing equations of liquid water, water vapor, and energy transport dynamics in the soil-plant-atmosphere system are coupled to resolve diffusive vapor fluxes from isolated pores (plant stomata and soil pores) across a near-surface viscous sublayer, explicitly accounting for pore-scale transport mechanisms and environmental forcing. Preliminary results suggest that this approach offers unique opportunities for directly linking transport properties in plants and adjacent bare soil with resulting plant transpiration and localized bare soil evaporation rates. It thus provides an essential building block for interpreting and upscaling results to field and landscape scales for a range of vegetation cover and atmospheric conditions.