Adapting a Remote-Sensing Method for Soil Moisture to Account for Regional Soil, Vegetation, and Climatic Characteristics

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Abstract. A remote-sensing method based on optical and thermal satellite imagery has been proposed to estimate fine-resolution (30 m) soil moisture over large regions. This method uses the Landsat satellite to calculate all the components of the surface energy balance and then calculates the evaporative fraction (Λ) as the ratio of the latent heat flux to the sum of the sensible and latent heat fluxes. Root-zone soil moisture (θ) is then estimated from an empirical relationship with Λ. A similar approach has also been proposed to estimate the degree of saturation. Previous research on a semiarid region of southeastern Colorado has shown that a single relationship between θ and Λ does not apply universally. The primary objective of this study is to more broadly evaluate the impact of regional soil, vegetation, and climatic conditions on the form and strength of the Λ- θ relationship. To accomplish this goal, a global sensitivity analysis is performed using the Extended Fourier Amplitude Sensitivity Test (FAST) and a physically-based model (Hydrus-1D) that simulates both the land-surface energy balance and soil moisture dynamics. The results show that the parameters that define the relationship Λ- θ depend most strongly on soil characteristics while the strength of the relationship depends most strongly on vegetation characteristics. Different relationships also apply for different climatic regions. A set of equations is proposed to enhance the empirical method and better capture regional soil, vegetation, and climatic conditions.