Evaluation of a Method to Estimate Root-Zone Soil Moisture Based on Optical and Thermal Satellite Imagery

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Abstract. Knowledge of root-zone soil moisture conditions is critical for healthy agricultural production and sustainable rangeland management. Keeping soil moisture near an optimum level is vital for healthy crop production, but it is also critical for conserving water and regulating soil salinity. Rangeland management also benefits from soil moisture knowledge because it helps ranchers select the best locations for livestock grazing to avoid damaging fragile land. High-resolution estimates of soil moisture from remote sensing would save farmers and ranchers time and money that is expended physically scouting conditions. Previously-proposed remote-sensing methods have spatial resolutions that are too coarse (e.g., grid cells with linear dimensions that exceed 10 km) and measure soil moisture at too shallow of depths (e.g., 2-5 cm) to characterize root-zone soil moisture. Other field-based methods, like soil moisture probes, only measure soil moisture within small distances (centimeters) of the probes. In this project, we evaluate an alternative remote-sensing based method (ReSET) that can potentially estimate root-zone soil moisture at a more appropriate resolution (30 m grid cells). ReSET uses thermal and optical scans from satellites such as LandSat5 and LandSat7 to calculate the evaporative fraction (EF), which is the portion of the energy available at the ground surface that is used for evapotranspiration. Soil moisture is estimated using an empirical relationship to EF that has been suggested in previous research. To evaluate this method, six naturally-vegetated fields near Lamar, Colorado were instrumented. Fields were selected to achieve homogeneity in vegetation and other influential factors but to span a wide range of EF values. Time-domain reflectometry (TDR) probes were installed to measure soil moisture at two different depths (25 and 55 cm) at four locations within each field. On each date that LandSat5 or LanSat7 passed over the sites, soil moisture readings were obtained at the surface and from the buried probes. Additional soil moisture data were also gathered from pre-existing meteorological stations on the Pinon Canyon Manuever Site (PCMS), southwest of Lamar. These in-situ readings were compared to the estimates of soil moisture from ReSET using various approaches. The results suggest some correlation exists between the in-situ and remote-sensing estimates, but substantial scatter is also observed in some cases.