

Evaluation of a method to estimate root-zone soil moisture based on optical and thermal satellite imagery

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Abstract. Knowledge of soil moisture (volume water content) is critical to making prudent decisions in a wide range of disciplines. Weather forecasting, flood prediction, wildfire mitigation, and military operations can all utilize accurate soil moisture estimates. Knowledge of soil moisture is particularly valuable for agricultural systems because root-zone soil moisture strongly impacts crop health and productivity. Field-based measurements of soil moisture are impractical for the large spatial extents (e.g., 10,000 ha) that are necessary for some agricultural applications. Various remote sensing methods are available to estimate soil moisture, but few address the fine spatial resolutions (i.e., 30 m grid cells) and substantial depth (i.e., root zone) requirements for agricultural applications. The primary objective of this study is to test the use of thermal and optical imagery to estimate root-zone soil moisture. In this approach, the evaporative fraction is first estimated from LandSat imagery using the ReSET (Remote Sensing of ET) algorithm and then transformed into root-zone soil moisture or degree of saturation using empirical relationships. Twenty-two fields with native grassland vegetation in semiarid southeastern Colorado were studied over the summer months of three years (2009, 2011, and 2012). In-situ soil moisture data was compared with estimates calculated from the satellite imagery. The results suggest that the empirical relationships between evaporative fraction and soil moisture (or degree of saturation) that have been proposed in the literature are not applicable to this region. However, if the function is calibrated to the in-situ soil moisture data, performance is achieved that might be useful for various applications. The results also show that the method is more reliable at estimating degree of saturation than volumetric water content.