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Comparative Analysis of Remote Sensing Platforms for Assessing Crop Biophysical Characteristics and Evapotranspiration

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Abstract. Assessing crop actual evapotranspiration (ETa) through remote sensing (RS) techniques is crucial for optimizing irrigation management across various spatial scales. ETa models are, in part, based on crop biophysical characteristics (CBPC). However, the accuracy of CBPC estimation using multispectral data from different RS platforms and algorithms is mostly unknown. This research investigates the impact of different RS data and algorithms in the estimation accuracy of vegetation indices (VIs), Leaf Area Index (LAI), Crop Height (HC), and vegetation Fractional Cover (Fc). VIs such as the Normalized Difference Vegetation Index (NDVI) and the Optimized Soil Adjusted Vegetation Index (OSAVI) were evaluated. Multispectral imagery from an Unmanned Airborne System (UAS), PlanetDove microsatellites, and satellites Sentinel2 and LandSat8-9 were used. These images captured surface reflectance over fully and deficit-irrigated (sub-surface drip) corn fields near Greeley, CO, in 2022. Computed VIs were then used to estimate the CBPCs and ETa using published empirical functions. An energy balance algorithm, instantaneous to daily flux extrapolation, and energy budget closure techniques were applied to corn heat fluxes measured with an Eddy Covariance system and thus obtain corn "measured" corn ETa data. Estimated VIs results were statistically compared to observed field data. These VIs were also employed in the application of the different empirical CBPC models. In turn, the estimated CBPC values were evaluated with in-situ measurements across different crop growth stages throughout the crop season. The statistical analysis compared the performance of VIs and CBPC estimates across the various RS platforms. All RS platforms demonstrated good performance in terms of MBE% and RMSE%. Further, a comparison of CBPC functions showed varying performance for the different RS platforms. As for ETa estimation, the RMSE% reported for each RS-platform, using four different ETa methods, was rather large, indicating varying degrees of underestimation or overestimation of corn ETa calculations.