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Remote Estimation of Net Ecosystem Carbon Dioxide Exchange in Crops: Principles, Algorithm Calibration and Validation [ABSTRACT]

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Remote Estimation of Net Ecosystem Carbon Dioxide Exchange in Crops: Principles, Algorithm Calibration and Validation

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Accurate estimation of spatially distributed CO₂ fluxes is of great importance for regional and global carbon balance studies. Tower-based instruments provide flux data from a small footprint area and scaling beyond the footprint to the region is quite challenging. We developed a technique that relates tower-based mid-day CO₂ exchange data with remotely sensed reflectances in the near infrared and either the green (around 550 nm) or the red-edge (near 700 nm) spectral ranges, to accurately estimate net ecosystem CO₂ exchange (NEE) in commodity crops. The technique, which is solely based on remotely sensed data, was tested for mid-day NEE estimation in irrigated and rainfed maize and soybean during three seasons (2001 through 2003). The technique provides accurate estimations of mid-day NEE in crops, explaining more than 88% of NEE variation in maize and 86% in soybean, and shows great potential for remotely tracking crop NEE. The technique was validated by an independent data set; root mean square error in predicting mid-day NEE in the range 0-2.5 mgCm⁻²s⁻¹ was 0.3 mgCm⁻²s⁻¹ using NIR and red-edge bands and 0.38 mgCm⁻²s⁻¹ using NIR and green bands. The developed technique will improve our understanding of how to retrieve crop ecosystem CO₂ exchange synoptically. By improving the accuracy of retrievals, we will advance the understanding of regional and global carbon dynamics, reducing the uncertainties attendant to NEE estimation in crops.