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Modeling gross primary production of maize cropland and degraded grassland in northeastern China using multi-temporal MODIS imagery and CO2 eddy flux tower data

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CO2 flux measurements at individual CO2 eddy flux sites provide valuable information on the seasonal dynamics of gross primary production (GPP). In this study, we estimated seasonal dynamics of GPP from 3 years (2004-2006) of the eddy covariance observations at maize cropland and degraded grassland in a semi-arid area of Tongyu county (44.5667N, 122.8833E), Northeast China. The biophysical performance of vegetation indices (EVI, NDVI, and LSWI) derived from the 8-day Moderate Resolution Imaging Spectroradiometer (MODIS) surface reflectance product and their relations to GPP dynamics were evaluated. The quantitative relationships between the vegetation indices and CO2 flux data clearly demonstrated the improvement of EVI over NDVI, in terms of the phase and magnitude of photosynthesis. Canopy-level maximum light use efficiency, $\varepsilon 0$, was estimated for both maize and grassland by using the observed CO2 flux data and photosynthetically active radiation (PAR) data from eddy flux tower sites. For maize cropland, the $\varepsilon 0$ value is 0.560 g C/mol PAR, and for degraded grassland, the $\varepsilon 0$ value is 0.372 g C/mol PAR. We conducted a simulation of the Vegetation Photosynthesis Model (VPM) using the Enhanced Vegetation Index (EVI) and the Land Surface Water Index (LSWI) derived from the 8-day (MODIS) surface reflectance product, as well as site-specific climate data. The comparison between simulated GPP and estimated GPP from tower CO2 flux data showed good agreement in both maize cropland and degraded grassland. This study highlighted the biophysical performance of improved vegetation indices in relation to GPP and demonstrated the potential of the satellite-driven VPM model for scaling-up of GPP of maize cropland and grassland in semi-arid ecosystems.