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NEW METHOD TO RETRIEVE VEGETATION PHOTOSYNTHETIC CAPACITY FROM SOLAR-INDUCED FLUORESCENCE FOR CROPLAND GPP MODELING

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ABSTRACT:

Space retrievals of solar induced chlorophyll fluorescence (SIF) have recently become available. These remote measurements of SIF enable to establish a direct link between remotely-sensed vegetation parameter and the actual terrestrial photosynthetic activity. Current widely used terrestrial biosphere models usually employed Farquhar's photosynthesis models, in which the maximum rate of carboxylation (V_{cmax}) is a key control parameter on leaf photosynthesis. Even though V_{cmax} is known to vary substantially in space and time in response to environmental controls, it is typically parameterized in models with tabulated values associated to plant functional types. Remote sensing can be used to produce a spatially-continuous and temporally-resolved view on photosynthetic efficiency, but traditional vegetation observations based on spectral reflectance lack a direct link to plant photochemical processes. Alternatively, recent space-borne measurements of SIF can offer an observational constraint on photosynthesis simulations. In this study, we focus on the estimations of seasonal V_{cmax} from SIF data retrieved from the GOME-2 instrument onboard the MetOp-A platform. We use the Soil-Canopy Observation of Photosynthesis and Energy (SCOPE) balance model to derive empirical relationships between seasonal Vcmax and SIF which are used to solve the inverse problem. We evaluate our Vcmax estimation method at six agricultural flux tower sites in the midwestern US using spaced-based SIF retrievals. Our V_{cmax} estimates agree well with literature values for corn and soybean plants and show plausible seasonal patterns. The seasonal V_{cmax} estimated from the SIF retrievals, rather than a fixed PFT-specific value, significantly improved the agreement of GPP and SIF modelling results with observed tower fluxes. Our results support the use of space-based SIF data as a proxy for photosynthetic capacity and pave the way to global, time-resolved estimates of V_{cmax}.

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