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Satellite footprint data from OCO-2 and TROPOMI reveal significant spatio-temporal and inter-vegetation type variabilities of solar-induced fluorescence yield in the U.S. Midwest

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ABSTRACT

Solar-induced chlorophyll fluorescence (SIF) measured from space has been increasingly used to quantify plant photosynthesis at regional and global scales. Apparent canopy SIF yield ($SIF_{yield\ apparent}$), determined by fluorescence yield (Φ_F) and escaping ratio (f^{esc}), together with absorbed photosynthetically active radiation (APAR), is crucial in driving spatio-temporal variability of SIF. While strong linkages between $SIF_{yield\ apparent}$ and plant physiological responses and canopy structure have been suggested, spatio-temporal variability of $SIF_{yield\ apparent}$ at regional scale remains largely unclear, which limits our understanding of the spatio-temporal variability of SIF and its relationship with photosynthesis. In this study, we utilized recent SIF data with high spatial resolution from two satellite instruments, OCO-2 and TROPOMI, together with multiple other datasets. We estimated $SIF_{yield\ apparent}$ across space, time, and different vegetation types in the U.S. Midwest during crop growing season (May to September) from 2015 to 2018. We found that $SIF_{yield\ apparent}$ of croplands was larger than non-croplands during peak season (July–August). However, $SIF_{yield\ apparent}$ between corn (C4 crop) and soybean (C3 crop) did not show a significant difference. $SIF_{yield\ apparent}$ of corn, soybean, forest, and grass/pasture show clear seasonal and spatial patterns. The spatial variability of precipitation during the growing season could explain the overall spatial pattern of $SIF_{yield\ apparent}$. Further analysis by decomposing $SIF_{yield\ apparent}$ into Φ_F and f^{esc} using near-infrared reflectance of vegetation (NIR_V) suggests that f^{esc} may be the major driver of the observed variability of $SIF_{yield\ apparent}$.

1. Introduction

Accurate and timely estimation of ecosystem photosynthesis measured as gross primary production (GPP) is crucial for understanding carbon exchange between the biosphere and atmosphere (Beer et al., 2010). GPP also largely determines vegetation net primary

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