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Constraining global terrestrial gross primary productivity based on the OCO-2 chlorophyll fluorescence in a global carbon assimilation system framework

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The gross primary productivity (GPP) is one of the largest carbon fluxes in the terrestrial carbon cycle. Constraints on GPP are critical for understanding the terrestrial carbon sinks and sources. In this study, we attempt to constrain, on the regional to global scales, the terrestrial GPP through the optimized photosynthetic parameter (the carboxylation capacity at 25 °, or V_{cmax}), derived from the Orbiting Carbon Observatory-2 (OCO-2) solar-induced chlorophyll fluorescence (SIF) that is fed into a global carbon assimilation system. We suggest that the V_{cmax} of different plant functional types (PFTs) can be properly optimized both in the spatial and temporal scales. Importantly, the optimized V_{cmax} in spatial distribution and seasonal variation is broadly consistent with the observation in the plant trait database (TRY). We find that, compared to the prior simulation, the constrained global GPP in 2015 decreases by 9.68% to 118.64 Pg C yr^{-1}, more consistent with the satellite-based estimates (MODIS and WECANN). The most significant decrease occurs in the tropics (-6.54 Pg C yr^{-1}), followed by the boreal northern hemisphere (-2.92 Pg C yr^{-1}). We also find that GPP of all PFTs decreases, and the relative changes ranges from -19.12% in grass to -1.06% in crop. This effective pathway to constrain GPP based on the satellite SIF provides us an opportunity for better understanding the terrestrial and global carbon cycle.