

On the relationship between sub-daily instantaneous GPP and daily total GPP: implications for interpreting satellite SIF measurements

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Spatial and temporal continuous estimation of plant photosynthetic carbon fixation (or gross primary production, GPP) is crucial to our understanding of the global carbon cycle and climate change. The GPP has not only spatial, seasonal and interannual variation, but also strong diurnal variation. The satellite retrieved solar-induced chlorophyll fluorescence (SIF) provides a spatially continuous, but temporally discrete measurement of plant photosynthesis, and has the potential to be used to estimate GPP at global scale. However, whether we can use the seasonal course of these snapshots taken at a fixed time of day to infer the daily total GPP variation at spatial and seasonal scale remains unclear. In this study, we first used the GPP measurements from 136 flux sites, which cover a wide range of plant species and latitude to investigate the relationship between the instantaneous GPP (GPP_{inst}) and daily GPP (GPP_{daily}) at the seasonal course for different times of the day. Latitudinal and diurnal patterns were found which correspond to the variation of photosynthetically active radiation (PAR) and light use efficiency (LUE), respectively. We then used the Soil-Canopy Observation Photosynthesis and Energy Balance (SCOPE) model to investigate the instantaneous and daily SIF-GPP relationship at five flux tower sites along a latitudinal gradient. The results showed that the daily SIF had stronger linear correlation with GPP at seasonal scale and the instantaneous to daily SIF conversion factor also followed the latitudinal pattern driven by PAR. Our study highlights the necessity to take the latitudinal and diurnal factors into consideration when building the SIF- GPP relationship or using SIF for phenology analyses.