(19-240328-A) **The Weekly Cycle of Photosynthesis in Europe Reveals the Negative Impact of Particulate Pollution on Ecosystem Productivity**

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Aerosols can affect photosynthesis through radiative perturbations such as scattering and absorbing solar radiation. This biophysical impact has been widely studied using field measurements, but the sign and magnitude at continental scales remain uncertain. Solar-induced fluorescence (SIF), emitted by chlorophyll, strongly correlates with photosynthesis. With recent advancements in Earth observation satellites, we leverage SIF observations from the Tropospheric Monitoring Instrument (TROPOMI) with unprecedented spatial resolution and near-daily global coverage, to investigate the impact of aerosols on photosynthesis. Our analysis reveals that 64% of regions in Europe show increased SIF on weekends, when there is more plant-available sunlight due to reduced particulate pollution. By considering two plausible scenarios of improved air quality—reducing aerosol levels to the weekly minimum 3-d values and levels observed during the COVID-19 period—we estimate a potential of 41 to 50 Mt net additional annual CO_2 uptake by terrestrial ecosystems in Europe. Using satellite observational datasets, our findings provide compelling evidence that reducing particulate pollution has the potential to enhance ecosystem productivity by absorbing carbon from the atmosphere. Our work also calls for future efforts to incorporate climate-aerosol-ecosystem interactions into Earth system models for a comprehensive understanding of the impacts of human activities on the natural environment.

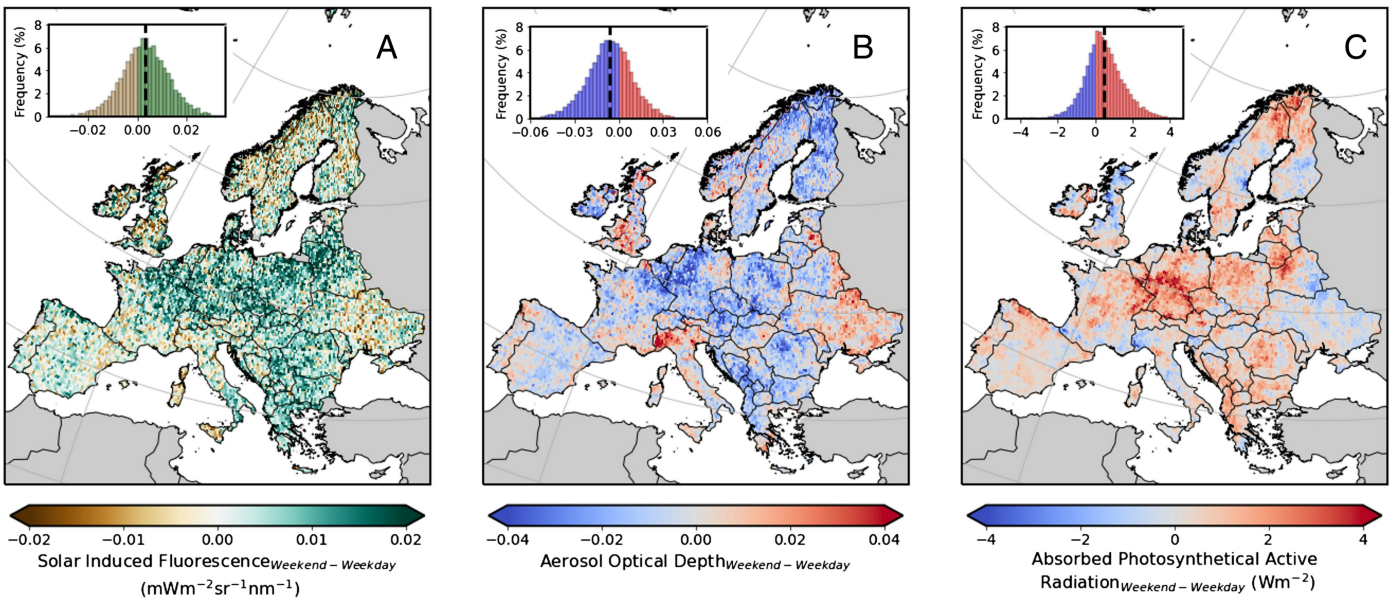

Figure 1. Weekend minus weekday SIF, AOD, and APAR. The maps show the difference of satellite observed (*A*) SIF, (*B*) AOD, and (*C*) APAR between weekend and weekday in Europe during 2018, 2019, and 2021. We excluded the year 2020 because human activities were greatly affected by the COVID-19 pandemic, leading to a less pronounced or even reversed weekly pattern shown. The insert histogram shows the distribution of the corresponding variable, with the black dahsed line representing the median. To determine the difference between weekends and weekdays for a specific variable each week, we calculated the difference between the average values during weekends (Saturday and Sunday) and weekdays (Monday–Friday). We then aggregated these weekly differences into an average pattern during 2018, 2019, and 2021.