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Time-scale dependent relations of vegetation productivity with Earth Observation based proxies and with climate drivers

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New satellite products hold promise to improve our understanding of terrestrial ecosystem functioning, yet it remains a key challenge to measure global gross primary productivity (GPP) and its climate-induced fluctuations. While global estimates of GPP exist and several new satellite products hold potential for better GPP estimation, the best proxy of GPP may depend on the temporal and spatial scale considered, because available satellite products may differentially represent different time scales of vegetation dynamics. For example, vegetation indices such as NDVI and EVI may capture seasonal phenology well, while sun-induced fluorescence (SIF) may be more sensitive to short-term fluctuations of photosynthesis, and vegetation optical depth (VOD) may best represent slower changes in aboveground biomass. SIF in particular is proposed as a promising proxy for GPP as they show linear relationships with ecosystem-dependent slopes, but this may not be the case at all time scales.

In this study, we compare different Earth Observation vegetation proxies to FLUXCOM GPP in order to understand which vegetation proxy best represents GPP at sub-annual, annual and long-term scales with the aim to enable more accurate short- and long-term prediction of GPP and its drivers. We further assess the dominant climatic drivers of vegetation productivity and the vegetation's sensitivity from sub-annual to inter-annual time scales using a multiple linear regression approach. We find the dominant drivers of vegetation productivity to differ across time scales in relation to land cover and climate.

In summary, depending on the time-scale, different satellite products best represent GPP and its climatic drivers. Considering this may help improve GPP estimates and predictions of long-term land carbon sink dynamics in the future.