Evaluating the relationship between SIF and GPP under climate extremes

Sebastian Wieneke, Ana Bastos, Manuela Balzarolo, José Miguel Barrios, and Ivan Janssens

1 Remote Sensing Centre for Earth System Research, University of Leipzig, Leipzig, Germany
2 Max Planck Institute for Biogeochemistry, Dept. of Biogeochemical Integration, 07745 Jena, Germany
3 Plants and Ecosystems (PLECO), University of Antwerp, Wilrijk, Belgium
4 Royal Meteorological Institute of Belgium, B-1180 Uccle, Belgium

Sun Induced Chlorophyll Fluorescence (SIF) is considered as a good proxy for photosynthesis given its closer link to the photosynthetic light reactions compared to remote sensing vegetation indices typically used for ecosystem productivity modelling (e.g. NDVI). Satellite-based SIF shows significant linear relationships with gross primary production (GPP) from in-situ measurements across sites, biomes and seasons. While SIF can be considered a good proxy for large scale spatial and seasonal variability in GPP, much of the SIF-GPP co-variance can be explained by their common dependence on the absorbed photosynthetically active radiation. Whether SIF can be an equally good proxy for interannual variability in GPP especially during periods of vegetation stress (drought/heat) is, so far, not clear.

In this study, we evaluate the relationship between satellite-based SIF and in-situ GPP measurements during vegetation stress periods (drought/heat), compared to non-stress periods. GPP is obtained from eddy-covariance measurements from a set of forest sites pre-filtered to ensure homonegeneous footprints. SIF is obtained from GOME-2 covering the period 2007-2018. Because of scale mismatch between each site's footprint (in the order of hundred meters) and the spatial resolution of GOME-2 (ca. 50km), we additionally use SIF from the downscale product from Duveiller et al. 2020 (ca. 5km) and the more recent dataset from TROPOMI (ca. 7 x 3.5 km), covering only the last year of the study period.

We develop a classification of stress periods that is based on both the occurrence of drought/heat extreme events and the presence of photosynthetic downregulation. We then evaluate the relationship between SIF and GPP and their yields, for different plant functional types and at site-level. We evaluate how these relationships vary depending on environmental conditions and in particular for “stress” versus “non-stress” days.
