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Diurnal and seasonal patterns of photosynthesis and its relationship to F687, F760 and a revised PRI

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Because of its direct link to the photosynthetic process, sun-induced fluorescence (F) has shown to be a promising signal for an improved spatio-temporal monitoring of photosynthesis. However, due to the lack of long term measurements, the diurnal and seasonal relationship between photosynthesis and the two energy dissipation mechanisms of fluorescence and non-photochemical quenching (NPQ) is still unclear.
We here present results of a 2-month measurement campaign carried out during the European heatwave of 2015. We used a spectrometer system (SIF-Sys) that measured in the 350- 1100 nm range, with a high spectral resolution (FWHM: 1 nm) and a fast sampling frequency of 6 sec. The measurements were carried out in close proximity (3 m) to a micro meteorological station, designed for Eddy Covariance measurements. We then analyzed the diurnal and seasonal relationship of the absorbed photosynthetic active radiation (APAR), F and gross primary production (GPP) as well as Fyield (Fyield = F/APAR), light use efficiency (LUE = GPP/APAR) and the structural and chlorophyll corrected photochemical reflectance index (rPRI) under changing environmental conditions.
We show that under drought conditions the relationship between F and GPP weakens due to the physiological regulation of photosynthetic efficiency that is non-linearly reflected in F. We also show that far-red fluorescence yield (F760yield) can explain 49% of the diurnal and 78% of the seasonal variance in LUE during non-stressed and drought conditions. Red fluorescence yield (F687yield) in contrast shows to be a poor predictor of LUE under drought conditions. We furthermore show that under unstressed conditions the general positive relationship between F760yield and LUE might invert after solar noon, due to a higher degree of photochemical quenching (PQ).