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The relationship between Gross Primary Productivity and Sun-Induced Fluorescence in a nutrient manipulated Mediterranean grassland is controlled primarily by canopy structure

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Recent studies have shown how human induced N/P imbalances affect essential ecosystem processes, and might be particularly important in water-limited ecosystems. Hyperspectral information can be used to directly infer nutrient-induces variation in structural and functional changes of vegetation under different nutrient availability. Among those, sun-induced fluorescence in the far-red region provides a new non-invasive measurement approach that has the potential to quantify dynamic changes in light-use efficiency and photosynthetic carbon dioxide uptake (Gross Primary Production, GPP). However, the mechanistic link between GPP and sun-induced fluorescence under different environmental conditions is not completely understood.
In this contribution we investigated the structural and functional factors controlling the emission of SIF at 760 nm in a Mediterranean grassland with different levels of nutrient availability (Nitrogen (N), Phosphorous (P), and Nitrogen and Phosphorous (NP)). We showed how nutrient-induced changes in canopy structure (i.e. changes in plant forms abundance that influence leaf inclination distribution function, LIDF) and functional traits (e.g. nitrogen content per dry mass of leaves, N%, Chlorophyll ab concentration – Cab, and maximum carboxylation capacity, Vcmax) affected the observed relationship between SIF and GPP.
Simultaneous measurements of canopy scale GPP and SIF were conducted with transparent transient-state canopy chambers and narrow-band spectrometers, respectively. To disentangle the main drivers of the GPP-SIF relationship we performed a factorial modeling exercise with the Soil-Canopy Observation of Photosynthesis and Energy (SCOPE) model.
We conclude that the addition of nutrients imposed a change in the abundance of different plant forms and biochemistry of the canopy. This lead to changes in canopy structure (leaf area index, leaf inclinaton distribution function LIDF parameters) and functional traits (N%, P%, Cab and Vcmax) that eventually controlled the spatial patterns of SIF. Changes in LIDF mainly control the GPP-SIF relationship, with a secondary control of Cab and Vcmax. In order to exploit SIF data to model GPP at global/regional scale canopy structural variability, plant community, and plant functional traits are important confounding factors that have to be considered to correct the plant-functional type specific relationship between sun-induced fluorescence and GPP.