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Monitoring functional and structural responses of alpine grasslands in a manipulation experiment with sun induced fluorescence, spectral vegetation indices and plant traits.

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Vegetation responses to Climatic Change induced increases of temperature, atmospheric CO_2 and extreme events frequency are not well understood. The ClimGrass experiment (Gumpenstein, Austria) provides the opportunity to analyzes changes in an alpine grassland composition, structure and function under different levels of CO_2 (+0, +150, +300 ppm), temperature (+0, +1.5, + 3 ºC) and water stress (rain manipulation with shelters). Two field campaigns were carried out in summer, before and after grass ripening. Vegetation pigments and leaf area index (LAI) measurements were carried out in the different treatments. Also, maximum carboxylation rate and maximum photosynthesis rate were derived from leaf A-Ci curves. Near simultaneous chamber gas exchange and hyperspectral proximal sensing measurements provided gross primary production, reflectance factors and sun induced fluorescence (SIF) in the O_2-A ($\sim$760 nm) and O_2-B ($\sim$680 nm) absorption features. Spectral data were acquired with a FLoX system (JB Hyperspectral Devices).

We analyze the changes induced by each treatment on pigments concentration, LAI, spectral vegetation indices and SIF and several derived variables such as SIF yield, SIF peaks ratios or the stress intensity fluorescence index (SIFI). Treatment effect on vegetation is not uniform among variables, and some of them were not very sensitive to some of the treatments. Preliminary results on the SIFI index show clear patterns in the response for the joint CO_2, water and temperature manipulation, and for CO_2 only, whereas not clear patterns are observed in other treatments. SIFI was the most sensible variable, providing information also on the response driver (water stress, temperature stress, CO_2 enrichment...). Results are further analyzed using SCOPE model in order to separate structural from physiological effects on the measured optical signals.

This work proves the potential of SIF and especially of SIFI index to provide relevant information on vegetation responses to environmental changes, and its use could contribute to better understand physiological responses in manipulation experiments in a novel fashion.