



Comparison of sun-induced chlorophyll fluorescence estimates from commercial spectroradiometers: an optimal setup for field measurement and aerial product validation.

Marco Celesti (1), Micol Rossini (1), Sergio Cogliati (1), Cinzia Panigada (1), Giulia Tagliabue (1,2), Francesco Fava (3), Tommaso Julitta (1), Alasdair MacArthur (4), and Roberto Colombo (1)

(1) University of Milano-Bicocca, LTDA, Earth and Environmental Sciences, Italy (m.celesti2@campus.unimib.it), (2) Forschungszentrum Juelich GmbH, Institute of Biogeosciences, IBG2, Juelich, Germany, (3) International Livestock Research Institute, Nairobi, Kenya, (4) NERC Field Spectroscopy Facility, School of Geosciences, University of Edinburgh, United Kingdom

Sun-induced chlorophyll fluorescence signal is explored as a novel remote sensing method, notable for its potential to be used as a direct indicator of photosynthetic efficiency.

In the last years, there was an increasing interest of the scientific community on the remote sensing of Sun-Induced chlorophyll Fluorescence (SIF). Several SIF estimates in the far-red region have been produced from spaceborne sensors, and the future FLEX satellite mission (European Space Agency, Earth-Explorer 8) aims to detect canopy level SIF in both red and far-red regions at global scale. In the context of FLEX calibration/validation activities, a network of ground station to calibrate/validate SIF estimates from space can be considered crucial, but few studies have proposed optimal technical requirements for commercially available spectroradiometers.

At canopy level, SIF is traditionally retrieved from incoming and upwelling radiance measurements, exploiting two narrow oxygen absorption bands, within the O₂-B and O₂-A spectral regions. Only recently, the feasibility of retrieving the SIF spectrum was demonstrated. The rationale behind the exploitation of narrow spectral regions, characterized by strong absorptions, resides in the higher contribution of SIF with respect to the reflected radiance. In order to detect the signal in those narrow spectral regions, high spectral resolution observation is needed.

In this study, we compared several high resolution field spectroradiometers with different Full Width at Half Maximum (FWHM), Spectral Sampling Interval (SSI) and Signal-to-Noise Ratio (SNR), to evaluate their performance in SIF estimates. We applied several state-of-the-art, radiance-based retrieval algorithms to radiance measurements taken with the FluoWAT. This device allows to measure leaf reflected and transmitted radiance, solar incident radiance and, upward and downward leaf fluorescence spectrum by means of a low pass filter, that were used as a reference..

Results show that there is a large variability in the Relative Root Mean Square Error (RRMSE) between reference and retrieved values among different setups (up to 45%). Among the tested spectrometers, those with a higher SNR, low SSI and low FWHM seem to be favoured. Retrieval algorithms based on the Spectral Fitting Method perform generally better than various implementation of the Fraunhofer Line Depth methods, particularly for O₂-B fluorescence, while differences are less evident for the O₂-A fluorescence.