Solar-induced chlorophyll fluorescence for detecting ecosystem photosynthetic activity by high-resolution spectrum measurement in a paddy field in Japan

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The terrestrial ecosystem is the main sink of carbon storage through plant photosynthesis which can be expressed as gross primary productivity (GPP). Accurate tracking of photosynthesis in the ecosystem level is essential because it is involved in global carbon cycling and the carbon balance between land and atmosphere. Recently, Solar-Induced Chlorophyll fluorescence (SIF) has been used for tracking changes in plant photosynthesis at the global scale by satellite. However, the coarser spatial-temporal scale by satellite needs to be validated by performing a ground-based SIF assessment to better understand the dynamics of CO2 uptake by plants. The high-resolution spectrum for SIF detection was measured at the Mase eddy flux site (36.05˚N, 140.03˚E, 11 m ASL.) in Tsukuba, Japan. The study area is a rice paddy field (*Oryza sativa* L.; cultivar Koshihikari), which is a main Asia crop type. Transplanting seedlings and harvesting crop were processed in early-May and mid-September, respectively. The spectrum was measured from April to December in 2018 using five spectroradiometers; FLAME, HR4000 x 2, QE Pro x 2 (Ocean Optics, Dunedin, FL, USA) with 0.11-1.08 nm of the full-width at half maximum (FWHM). For recording the irradiance with 5 minutes interval time, the spectroradiometers were connected via fiber switches (FSM1x8, Piezosystem Jena GmbH, Jena, Germany, and MOL-1x8-600-H, LEONI Fiber Optics GmbH, Föritztal, Germany) to three optical fiber cables: the first one was set looking downward at a viewing zenith angle of 45˚ as bare fiber (field of view (FOV) of 25˚, cable length of 15m), the second one was vertically set looking downward with cosine corrector (FOV of 180˚, cable length of 15m), and the third one was vertically set looking upward to the sky with cosine corrector (FOV of 180˚, cable length of 6m). The SIF was calculated by multispectral methods derived from the Fraunhofer Line Depth (FLD) principle 2FLD, 3FLD, iFLD and Spectral Fitting Method (SFM). In this study, the preliminary results of SIF detection are shown together with other conventional vegetation indices such as the normalized difference vegetation index (NDVI) and Enhanced Vegetation Index (EVI) for evaluating their relationship and finally verifying the SIF to be a promising proxy of photosynthesis tracking in the paddy field ecosystem.

Keywords: Ground-based SIF measurement, Fraunhofer Line Depth, Gross primary productivity, Photosynthesis, Spectroradiometers

