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Retrieval and interpretation of global maps of chlorophyll fluorescence derived from GOSAT-FTS space measurements

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A small fraction of the solar radiation absorbed by green leaves is emitted as chlorophyll-a fluorescence (Fs) after energy conversion. The Fs emission occurs as two broadband peaks centered in the red (685 nm) and far-red (740 nm) spectral regions. Fs has been demonstrated to be a direct indicator of CO_2 uptake from the leaf to the canopy levels.
Even though there has been an intense activity in the field of the remote sensing of suninduced chlorophyll fluorescence in the last years, it has not been until 2011 that the first global maps of Fs have been produced [1]-[3].

Global Fs retrieval has been achieved thanks to the high spectral resolution measurements provided by the Fourier Transform Spectrometer (FTS) onboard the Greenhouse gases Observing SATellite "IBUKI" (GOSAT). The band 1 of the FTS covers the 755–775 nm spectral window with a spectral resolution of around 0.025 nm in 760 nm. This high spectral resolution has enabled the application of the Fs in-filling approach to individual solar Fraunhofer lines located around the O_2-A absorption feature. By choosing groups of Fraunhofer lines in spectral windows free from atmospheric bands, the retrieval of Fs becomes almost insensitive to atmospheric scattering [4], which enables the application on a global basis. Even though the fluorescence signal is emitted by green vegetation, its estimation from space can be considered a typical atmospheric retrieval problem.

We will present an overview of ongoing activities devoted to both Fs retrieval from GOSAT measurements and the subsequent data interpretation. The general radiative transfer set-up for the inversion of at-sensor radiance to Fs will be described briefly, as well as a sensitivity analysis to illustrate the robustness of the retrieval against atmospheric scattering. The usefulness of the Fs signal for improved modeling of land-atmosphere interactions will be assessed by means of the analysis of almost 3 years of GOSAT-FTS data. We compared Fs with state-of-the-art gross primary production (GPP) data sets on global and seasonal basis, and assessed the dependency of the Fs signal on different meteorological parameters such as at-surface photosynthetically active radiation (PAR) and vapor pressure deficit. These results reinforce the confidence in the feasibility of Fs retrievals with GOSAT and open several points for future research in this emerging and multidisciplinary field of research.