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Monitoring terrestrial sun-induced chlorophyll fluorescence 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 (SIF, for sun-induced chlorophyll fluorescence) after energy conversion. The SIF emission occurs as two broadband peaks centered in the red (685 nm) and far-red (740 nm) spectral regions. Extensive research at the laboratory and field scales during the last years has demonstrated that SIF is a good indicator of photosynthesis and gross primary production from the leaf to the canopy levels. Space observations of SIF can therefore provide a completely new view of vegetation photosynthesis on a global basis.

Global maps of SIF have become recently available thanks to the advent of very high spectral resolution measurements by the Fourier Transform Spectrometer (FTS) on board the GOSAT platform. SIF is retrieved from measurements in the 750-770 nm window using solar Fraunhofer lines superposed to the SIF emission spectrum in that spectral range. The retrieval is based on the modeling of the in-filling of those Fraunhofer lines by fluorescence. More than 3 years of global SIF data are now available from GOSAT-FTS measurements.

In this contribution we will present an overview of this new Earth observation data stream and its potential for an improved global monitoring of the carbon cycle and land-atmosphere interactions. In particular, we will summarize the results of on-going activities intended to (a) improve the retrieval of SIF from space, (b) understand the SIF signal at the biome scale represented by satellite observations as well as its relationship with EO-based greenness indices and meteorological parameters such as temperature, radiation and soil moisture, and (c) to determine for what biomes and environmental conditions fluorescence is a significantly better proxy for photosynthesis and gross primary production than traditional reflectance-based vegetation indices. For this purpose, a temporal series of about three years of global SIF retrievals has been compared with satellite-based gross primary production estimates as well as with other EO vegetation products and meteorological variables from re-analysis. Our first results demonstrate the potential of SIF observations for an improved monitoring of vegetation activity and carbon fluxes from space.