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Remote Sensing of chlorophyll fluorescence and the impact of clouds on the retrival

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Remote sensing of sun-induced chlorophyll fluorescence (SIF) is a new, alternative option to gain information about terrestrial photosynthesis and CO_2 assimilation on a global scale. The SIF is an electromagnetic signal emitted in the aprox. 650-800 nm spectral window by the photosynthesis apparatus, and can therefore be considered as a direct indicator of plant biochemical processes.

The general approach to measure SIF from space is the evaluation of the in-filling of solar Fraunhofer lines or atmospheric absorption bands by SIF. To distinguish the SIF signal from the total incoming radiance at the sensor, which is about 100 times more intense, is a challenge and high resolution measurements are required. The high spectral resolution (approx. 0.02 nm) of the Fourier Transform Spectrometer (FTS) on-board the Greenhouse Gases Observing Satellite (GOSAT) enables such a measurement of SIF by means of the evaluation of the in-filling of solar Fraunhofer lines by SIF. The narrow wavelength band from 755 to 759 nm and around 770 nm can be used for this purpose because they are free from atmospheric absorption features, the solar radiation shows several Fraunhofer lines and the SIF values in this region are relatively high.

A new SIF retrieval approach (GARLiC, for GOSAT Retrieval of cholorphyll fluorescence) will be presented in this contribution. This method is intended to simplify some of the assumptions of existing retrieval approaches without a loss in accuracy. The comparison of the GARLiC fluorescence retrievals with two state-of-the-art SIR retrieval methods such as those by Frankenberg et al. (2011) and Guanter et al. (2012) from GOSAT data shows corresponding and feasible results.

In addition to the basics of SIF remote sensing, this contribution will assess the effect of clouds in the retrieval. To do this, the SIF retrieval has been coupled to a cloud optical thickness (COT) retrieval algorithm adapted to GOSAT-FTS O_2A-band measurements, so that SIF and COT are estimated from the same soundings. Especial attention will be given to the impact of optically-thin cirrus clouds on SIF retrievals, which is of particular interest over tropical rainforest areas. The detection of cirrus clouds is difficult due to their optical properties. Therefore the measurement of GOSAT in the 2 μm region is applicable to add a cirrus filter. Due to the strongly absorbing H_2O-band in this spectral region, the signal in clear sky conditions should not be significantly higher than the noise level of the instrument. With the appearance of cirrus clouds, the light path is shortened and less absorption of H_2O yields to a significant signal. Based on this principle, different thresholds for a cirrus filter are applied to study the impact of cirrus clouds on the retrieved SIF.