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A linear method for the retrieval of sun-induced chlorophyll fluorescence from GOME-2 and SCIAMACHY data

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Global retrievals of near-infrared sun-induced chlorophyll fluorescence (SIF) have been achieved in the last several years by means of space-borne atmospheric spectrometers. SIF is an electromagnetic signal emitted by the chlorophyll-a of photosynthetically active vegetation in the 650–850 nm spectral range. It represents a part of the excess energy during the process of photosynthesis and provides a measure of photosynthetic activity.

The key challenge to retrieve SIF from space is to isolate the signal from the about 100 times more intense reflected solar radiation in the measured top of atmosphere (TOA) radiance spectrum. Nevertheless, it has been demonstrated that a number of satellite sensors provide the necessary spectral and radiometric performance to evaluate the in-filling of solar Fraunhofer lines and/or atmospheric absorption features by SIF.

We will present recent developments for the retrieval of SIF from medium spectral resolution space-borne spectrometers such as the Global Ozone Monitoring Experiment (GOME-2) and the Scanning Imaging Absorption SpectroMeter for Atmospheric ChartographY (SCIAMACHY). Building upon the previous work by Joiner et al. 2013, our approach solves existing issues in the retrieval such as the non-linearity of the forward model and the arbitrary selection of the number of free parameters. In particular, we use a backward elimination algorithm to optimize the number of coefficients to fit, which reduces also the retrieval noise and selects the number of state vector elements automatically. A sensitivity analysis with simulated spectra has been utilized to evaluate the performance of our retrieval approach. The method has also been applied to estimate SIF from real spectra from GOME-2 and for the first time, from SCIAMACHY.
We are able to present a time series of GOME-2 SIF results covering the 2007–2011 time period and SCIAMACHY SIF results between 2003–2011. This represents an almost one decade long record of global SIF.
We compare SIF retrieval results from GOME-2 and SCIAMACHY data as well as results obtained Joiner et al.. We find a good correspondence of the absolute SIF values and the spatial patterns from the two sensors, which suggests the robustness of the proposed retrieval method. In addition, we examine uncertainties and use our GOME-2 retrievals to show empirically the low sensitivity of the SIF retrieval to cloud contamination.