Geophysical Research Abstracts
Vol. 13, EGU2011-12309, 2011
EGU General Assembly 2011

Global remote sensing of chlorophyll fluorescence using high-resolution O_2 A-band spectra recorded by the GOSAT satellite

Christian Frankenberg (1), Andre Butz (2), Joshua B. Fisher (1), Geoffrey C. Toon (1), Akihiko Kuze (3), Tatsuya Yokota (4), Grayson Badgley (1), and John Worden (1)

(1) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA. (christian.frankenberg@jpl.nasa.gov), (2) SRON Netherlands Institute for Space Research, Utrecht, The Netherlands., (3) Japan Aerospace Exploration Agency, Tsukuba, Japan., (4) National Institute for Environmental Studies, Tsukuba, Japan.

Solar-induced chlorophyll fluorescence is a powerful proxy for assessing biomass photosynthetic activity since part of the energy absorbed by Chlorophyll is dissipated by fluorescence. This gives rise to re-emission of light between approximately 670 and 780 nm. Passive methods to quantify the fluorescence signal are mainly based on the filling-in of highly saturated O_2 absorption structures. This method, however, was mostly applied in above-canopy measurements and is not directly applicable to space-borne retrievals. We show that variability of aerosols in the atmosphere load and surface pressure cannot be unequivocally be disentangled from fluorescence since all these factor impact the absorption depths of O_2 lines. This gives rise to biases in the retrieved scattering properties in typical multi-spectral XCO_2 retrievals when using the O_2 A band.

In the vicinity of the O_2 A-band, however, several narrow and strong absorption features in the solar spectrum (so called Fraunhofer lines) exist whose absorption depth is not affected by atmospheric scattering but only by fluorescence. The Japanese GOSAT satellite is the first to provide high spectral resolution in the O_2 A-band and thereby allows for quantification of fluorescence using Fraunhofer lines in the 755-775 nm range. We will a) present our retrieval method based on an iterative, non-linear least-squares fitting of Fraunhofer lines and b) discuss the potential impact on XCO_2 retrievals.

The retrieval method has been applied to a full year of GOSAT data, providing global maps of chlorophyll fluorescence, clearly correlating with photosynthetic activity. On the global scale, tropical regions are most pronounced but show little seasonal variability. The seasonal cycle of biomass activity in the northern hemisphere can be clearly detected. We will discuss the annual average and seasonal variability of retrieved fluorescence and compare with other methods to derive photosynthetic activity (such as NDVI or model GPP). While the prime objective of dedicated greenhouse-gas satellites such as GOSAT (and OCO-2) is to deliver top-down constraints on carbon-fluxes, quantification of chlorophyll fluorescence now even provides a unique and unexpected bottom-up constraint as a proxy for photosynthetic activity.