Observing solar-induced chlorophyll fluorescence from GOSAT-2: preliminary results and inter-sensor comparison

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Global observation of solar-induced chlorophyll fluorescence (SIF) from satellite has attracted attention as a potential means of reducing the uncertainties in the estimation of photosynthetic production. SIF is a weak radiation emitted by chlorophylls during the photosynthesis process and thus is considered to be a better proxy for photosynthetic activity than the conventional vegetation indices. SIF has been observed by several satellite sensors since the world's first global map of SIF was derived by a Japanese satellite sensor, Thermal And Near infrared Sensor for carbon Observation –Fourier Transform Spectrometer (TANSO-FTS) onboard the Greenhouse gases Observing Satellite (GOSAT). Currently, constraining the photosynthesis estimates by utilizing SIF data from multiple satellite sensors is an important research topic.

GOSAT was launched on 23 January 2009 and has been operating for more than 11 years. GOSAT-2, a successor mission to the GOSAT, was launched on 29 October 2018. GOSAT-2 is expected to observe SIF as the TANSO-FTS-2 onboard GOSAT-2 has a high spectral resolution similar to the TANSO-FTS. Important features of the TANSO-FTS-2, which are related to the SIF observation, are the improved signal to noise ratio and the intelligent pointing system (pointing the FTS-2 to the cloud-free area using the information from a monitoring camera equipped with the FTS-2). Although the main target of the GOSAT series is the greenhouse gasses, continuous and high-quality SIF observation is also expected.

This presentation reports the preliminary results of SIF observation from GOSAT-2. First, the radiance offset in the TANSO-FTS-2 spectra was evaluated, and SIF was derived by correcting the offset. The random error in a single SIF observation, which was estimated from the noise in the spectra, was approximately 0.4 mW m^{-2} nm^{-1} sr^{-1} and was smaller than that for TANSO-FTS (0.7 mW m^{-2} nm^{-1} sr^{-1}). This is owing to the higher SNR for the TANSO-FTS-2 (approximately 300) than that for the TANSO-FTS (approximately 120). Then, the SIF derived from the TANSO-FTS-2 was compared with that derived from the TANSO-FTS, Orbiting Carbon Observatory-2 (OCO-2), and TROPOspheric Monitoring Instrument (TROPOMI). The differences in footprint size, observation angle, and observation time between the sensors were taken into account. The temporal variation of SIF in the Amazon rainforest was also investigated. The number of data points of the TANSO-FTS-2 was significantly larger than that of the TANSO-FTS owing to the intelligent pointing system, allowing the better tracking of variation of photosynthetic activity.

Keywords: solar-induced chlorophyll fluorescence, remote sensing, satellite, GOSAT-2, GOSAT

