Retrieving solar-induced chlorophyll fluorescence from GOSAT measurements with considering radiance offset's dependence on solar zenith angle and observed radiance

*Haruki Oshio[1], Yukio Yoshida[1], Tsuneo Matsunaga[1]

1. National Institute for Environmental Studies

In recent years, satellite remote sensing of solar-induced chlorophyll fluorescence (SIF) has attracted attention as a method for elucidating the photosynthetic activity of terrestrial vegetation. SIF is emitted by chlorophyll molecules: part of the solar radiation absorbed by chlorophyll is not used for photosynthesis and re-emitted as red and far-red radiation. SIF includes information on partitioning of the absorbed solar radiation by chlorophyll. Several studies retrieved SIF from high-resolution spectra in far-red domain obtained by the greenhouse gases observing satellite (GOSAT). The retrieval principle was based on the filling-in of Fraunhofer line by SIF. Non-linearity of the analog circuit in GOSAT spectrometer adds indistinguishable zero-level offset term to SIF. Therefore, the zero-level offset correction becomes important to obtain the SIF accurately.
The zero-level offset can be evaluated from the retrieved filling-in signal (= zero-level offset + SIF) over the vegetation-free areas where the value of SIF is expected to be zero. Previous studies showed that the zero-level offset increases according to the increase of observed radiance. We investigated the zero-level offset for different land covers and locations and found that the zero-level offset relies not only on the observed radiance but also on the solar zenith angle (SZA). Even when the observed radiance was same, the zero-level offset increased according to the decrease of SZA. Therefore, 2-D correction table considering the observed radiance and SZA was prepared for the zero-level offset correction.
Monthly variation of SIF corrected by the present method was compared with that corrected by the previous method. The comparison was conducted for central Africa (woody savanna), southeast USA (evergreen needle leaf), and west Europe (grassland and cropland). The difference was largest for central Africa and smallest for west Europe for almost all month. The maximum difference reached 0.23 and 0.15 $mW/m^2 \cdot sr \cdot nm$ for central Africa and west Europe, respectively. Typical monthly averaged SIF ranged 0–1.5 $mW/m^2 \cdot sr \cdot nm$, thus the difference is significant. Furthermore, the difference was largest in summer for southeast USA and west Europe and in spring for central Africa. This study highlights that indispensable attention is required when the value of SIF is directly used and seasonal cycle is compared among locations having different surface cover and latitude.

Keywords: solar-induced chlorophyll fluorescence, GOSAT, photosynthetic production

