GOSAT data-based study for GOSAT-2 new products, proxy-based XCH_4 and solar induced chlorophyll fluorescence

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The Greenhouse gases Observing SATellite (GOSAT) has been operating for more than nine years. As a successor mission to the GOSAT, GOSAT-2 is planned to be launched in FY2018. In addition to the full-physics based column-average dry mole fractions of carbon dioxide, methane, water vapor, and carbon monoxide (XCO_2, XCH_4, XH_2O, and XCO) products, we are planning to provide the proxy-based XCH_4 and the solar induced chlorophyll fluorescence (SIF) as new products.

Proxy-based method has been used to retrieve XCH_4 from solar backscatter observations (Frankenberg et al., 2005). In the same way as previous studies, retrieval of XCH_4 and XCO_2 under clear-sky assumption ($XCH_{4,clear}$ and $XCO_{2,clear}$) was conducted using GOSAT CH_4 1.67 μm band and CO_2 1.6 μm band, respectively. Before multiplying XCO_2 model value to their ratio ($XCH_{4,clear}$ / $XCO_{2,clear}$) to obtain XCH_4, we compared the ratio with ground-based measurements (Total Carbon Column Observing Network: TCCON) while considering the cloud fraction and the existence of cirrus . As expected, most of the cloud and aerosol related errors were canceled in the ratio. Data having large error could be effectively screened out using goodness of spectral fit, difference in air pressure between retrieval and prior value, and cone angle. The retrieved ratio showed only small positive bias (0.2% ±0.8% and 0.3% ±0.9% for no 2μ cirrus exist and 2μ cirrus exist data, respectively) compared with TCCON. The variations in the bias between TCCON sites were 0.3% and 1.1%, respectively.

SIF has been retrieved from satellite data using Fraunhofer lines near O_2 A-band (Frankenberg et al., 2011). For GOSAT, correction of the artifact signal (zero-level offset caused by non-linearity of the analog circuit in the spectrometer) is required to obtain SIF (retrieved signal = SIF + zero-level offset). The zero-level offset can be evaluated from the retrieved signal over the areas where the value of SIF is expected to be zero. Although it is currently unknown that such correction is required for GOSAT-2 SIF retrieval, zero-level offset correction was tested using GOSAT data. We investigated the retrieved signal for clouds and bare soils and confirmed its applicability to the offset correction. Zero-level offset correction was then conducted separately for the P and S polarized components while considering offset’s temporal change and dependence on the observed radiance. The derived SIF was compared with the Orbiting Carbon Observatory-2 (OCO-2) SIF product. For some specific locations, influence of the difference in viewing angle between GOSAT and OCO-2 on the comparison was assessed using three-dimensional radiative transfer model of vegetation.

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