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Improvement of PPDF-S method for retrieving XCO_2 over aerosol dense areas

Chisa Iwasaki (1), Ryoichi Imasu (1), Andrey Bril (2), Sergey Oshchepkov (2), Yukio Yoshida (3), Tatsuya Yokota (3,4), Vyacheslav Zakharov (5), Konstantin Gribanov (5), and Nikita Rokotyan (5)

(1) Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa-shi, Chiba 277-8568, Japan, (2) Institute of Physics of National Academy of Sciences of Belarus, 68 Prospekt Nezavisimosti, Minsk BY-220072, Republic of Belarus, (3) National Institute for Environmental Studies, Onogawa 16-2, Tsukuba, Ibaraki, 305-8506, Japan, (4) Department of Information Networking for Innovation and Design, Faculty of Information Networking for Innovation and Design, Toyo University, 1-7-11 Akabanedai, Kita-ku, Tokyo 115-0053, Japan, (5) Laboratory of Climate and Environmental Physics, Ural Federal University, Lenina Ave. 51, Yekaterinburg city 620083, Russia

Photon path length probability density function-Simultaneous (PPDF-S) method is one of effective algorithms for retrieving column-averaged concentrations of carbon dioxide (XCO_2) and methane (XCH_4) from Greenhouse gases Observing SATellite (GOSAT) spectra in Short Wavelength InfraRed (SWIR) (Oshchepkov et al., 2013). In this study, we tried to improve the PPDF-S method referring to the vertical profile of the retrieved CO_2 vertical profiles as an index of analysis error based on the simulation for observation conditions of various types of aerosols and surface albedos. In the PPDF-S method, the PPDF parameter is retrieved at the same time as the CO_2 concentration. However, if the constraint condition on the a priori value of the PPDF parameter is looser than necessary, the solution can take erroneous value and can affect the retrieval result of the CO_2 concentration. Therefore, the magnitude of the influence was evaluated by the magnitude of the radiance corresponding to the variance range of the PPDF parameter, and then the parameter having a large influence was found and optimized. This improvement was particularly useful for retrieval analysis in the atmosphere including aerosol except Soot. Based on these simulation results, the improved PPDF-S method was applied to the analysis of GOSAT data observed in the region of biomass burning in Western Siberia. As a result, the number of data that became retrievable has increased by about 70 % to the data which could not be analyzed until now, including cases where retrieval was possible under the condition that smoke existed. Furthermore, it was suggested that the value of PPDF parameter may be able to identify aerosol species that affected CO_2 analysis. Under the atmosphere including Soot, we found that XCO_2 has been underestimated by the improved PPDF-S method through the simulation studies. However, the underestimating of XCO_2 was improved by resetting the PPDF parameter to represent the effect of shortening the optical path length by Soot. These results suggest that more accurate XCO_2 can be retrieved by applying the further improved PPDF-S retrieval algorithm corresponding to aerosol species.