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Comparisons between NICAM-TM and GOSAT/TANSO-FTS TIR CO2 data

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Greenhouse gases Observing SATellite (GOSAT), which was the first satellite for global observations of greenhouse gases, was successfully launched on 23 January 2009. Our recent analysis suggested that CO_2 vertical profiles retrieved from Thermal and Near Infrared Sensor for Carbon Observation (TANSO) - Fourier Transform Spectrometer (FTS) thermal infrared (TIR) band had a negative bias in the middle troposphere. In this study, we globally evaluated the magnitude of the bias through the comparisons between the TIR CO_2 data and Nonhydrostatic Icosahedral Atmospheric Model - based Transport Model (NICAM-TM) CO_2 data [Niwa et al., 2011]. Furthermore, we calculated a correction factor to modify the bias for each latitude band and applied the latitude-dependent correction factors to the TIR CO_2 data on 500 hPa; here, we estimated the correction factors on the basis of comparisons between CO_2 profiles observed over airports by Continuous CO_2 Measuring Equipment (CME) in Comprehensive Observation Network for Trace gases by Airliner (CONTRAIL) project [Machida et al., 2008] and the coincident TIR CO_2 profiles. Then, we analyzed seasonal variations of the modified TIR CO_2 data to check the validity of the correction factors estimated here.

Comparisons of the differences of CO_2 concentrations on 500 hPa and 200 hPa (500 hPa minus 200 hPa) between TIR CO_2 data and NICAM-TM CO_2 data showed that the differences of the TIR CO_2 data were larger than those of the NICAM-TM CO_2 data because of the negative bias of the mid-tropospheric TIR data. The CO_2 differences between the two pressure levels of the TIR data were particularly large (~8 ppmv) in low latitudes; this characteristic was not seen both in the NICAM-TM CO_2 data and the a priori CO_2 data (NIES-TM05). Next, we applied the latitude-dependent correction factors to the TIR CO_2 data on 500 hPa, and then compared the CO_2 differences on 500 hPa and 200 hPa. In low latitudes (25 ^{o} S-25 ^{o} N), the CO_2 differences between the two pressure levels of the TIR data became closer to the CO_2 differences of the NICAM-TM CO_2 data and the a priori CO_2 data when we applied the correction factor estimated over Bangkok. On the other hand, in northern high latitudes (northern latitudes of ~40 ^{o} N), most of the CO_2 differences between the two pressure levels of the TIR data were positive unlike the NICAM-TM CO_2 and the a priori CO_2 data when we applied the correction factor estimated over Amsterdam. In boreal summer, surface CO_2 concentrations are lower than middle and upper tropospheric CO_2 concentrations; in that sense, the correction factor applied here was not appropriate in northern high latitudes in summer. These results suggest that the magnitude of the negative bias seen in TIR CO_2 data would vary depending on seasons as well as regions, and therefore, we should estimate a latitude-dependent correction factor for each season.

Furthermore, we compared time series of TIR CO_2 data with those of NICAM-TM CO_2 data and the a priori CO_2 data for several different regions that were categorized in terms of climatic divisions and latitude bands [Niwa et al., 2011]. Our preliminary results showed that the seasonal variations of the TIR CO_2 data in some regions were closer to those of the NICAM CO_2 data than of the a priori CO_2 data. For future work, we should review how to compare the three CO_2 data sets, and then closely analyze the differences in seasonal variations among the three data sets globally.

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Keywords: CO2, satellite remote sensing, GOSAT