Summary of the Final Report of Research Results

1). Title of the proposed research

Algorithm developments for SWIR FTS GOSAT data processing with regard to atmospheric horizontal inhomogeneity

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4). Summary

In this report we present two basic topics that have been studied in the connection of atmospheric horizontal inhomogeneity when processing GOSAT L1B data.

First topic concerns cloud inhomogeneity within the GOSAT field of view. The GOSAT single scans that contain thin broken clouds are very difficult for the processing because all GOSAT full physics algorithms assume atmospheric horizontal homogeneity when using radiative transfer modeling for theoretical radiance spectra. To study this phenomenon, we apply PPDF-D method to identify GOSAT single scans "contaminated" by the clouds over the ocean. Then, we look at the improvements of the gas retrievals after removing the detected scans. This method was compared with TANSO-CAI spatial coherence test that is utilized in NIES operational algorithms. We have shown that PPDF-based selection provides reliable filtering regarding the number of selected single scans as well as substantial reduction of column averaged gas amount negative bias and standard deviations. As a case study, Figure 1 illustrates this statement for July 2009. PPDF-D selection is seen from Figure 1 substantially reduce negative bias and standard deviation (right-hand panel) and has some advantages over TANSO-CAI spatial coherence test with respect to the number of scans available for the processing and standard deviation (bars).

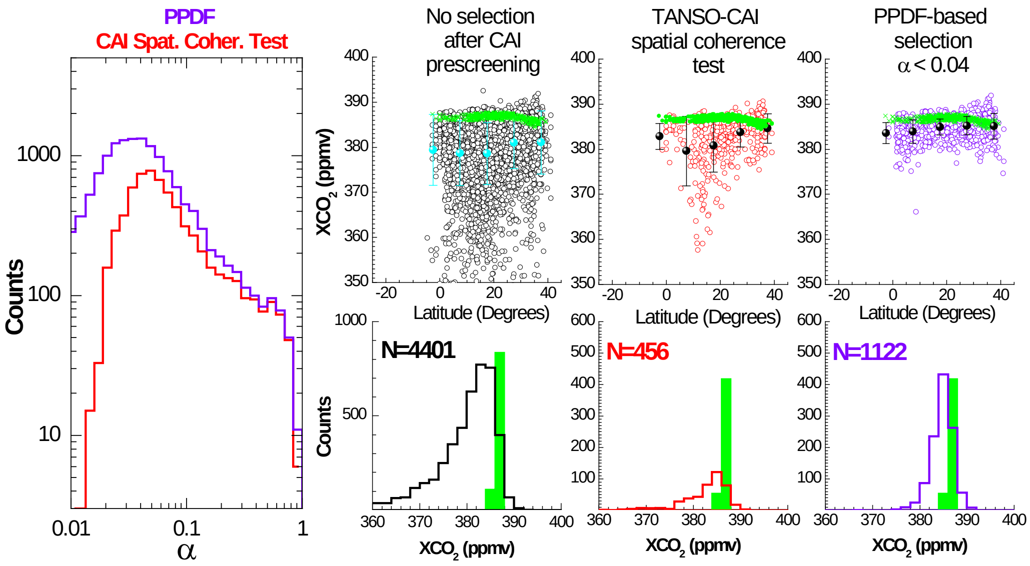

Figure 1. Counts and latitudinal distribution of X_{CO2} retrievals with DOAS-based algorithm from CO_2 absorption bands after CAI spatial coherence test (red) and PPDF-D selection from O_2 absorption band (blue). Green color corresponds to X_{CO2} transport model. GOSAT data are over sea from July 2009. Black and cyan symbols shows X_{CO2} average values within latitude bin.

Second topic of this research concerns improvement of the GOSAT data processing using multi-pixel analysis. As a first step, we correct a set of GOSAT single scan PPDF-S retrievals that fall into a certain region over sites from the Total Carbon Column Observing Network (TCCON) using TCCON data and multivariate analysis of variance (MANOVA). MANOVA tests for the difference in two or more vectors of means. The MANOVA statistics was applied to the GOSAT raw data using reference TCCON measurements. These 12 sites were in the Northern hemisphere: Bialystok, Poland (53.2°N, 23.1°E); Bremen, Germany (53.1°N, 8.85°E); Garmisch, Germany (47.5°N, 11.1°E); Lamont, USA (36.6°N, 97.5°W); Orleans, France (48.0°N, 2.11°E); Park Falls, USA (45.9°N, 90.3°W); Sodankyla, Finland (67.4°N, 26.6°E); Tsukuba, Japan (36.0°N, 140.2°E); and from the Southern hemisphere: Darwin, Australia (12.4°S, 130.9°E); Lauder, New Zealand (45.0°S, 169.7°E); Wollongong, Australia (34.4°S, 150.9°E). GOSAT single scans were selected within a 5° radius latitude/longitude circle centered over each TCCON station, TCCON data were mean values measured within plus/minus 1 hour of the GOSAT overpass time, and 43 months of GOSAT operation from June 2009 we considered. Figure 1 represents correlation diagram between GOSAT and TCCON measurements of X_{CO2}. A posteriori bias correction (black symbols) noticeable improves the GOSAT-TCCON agreement. This can be seen from the insets in each panel of Figure 2.

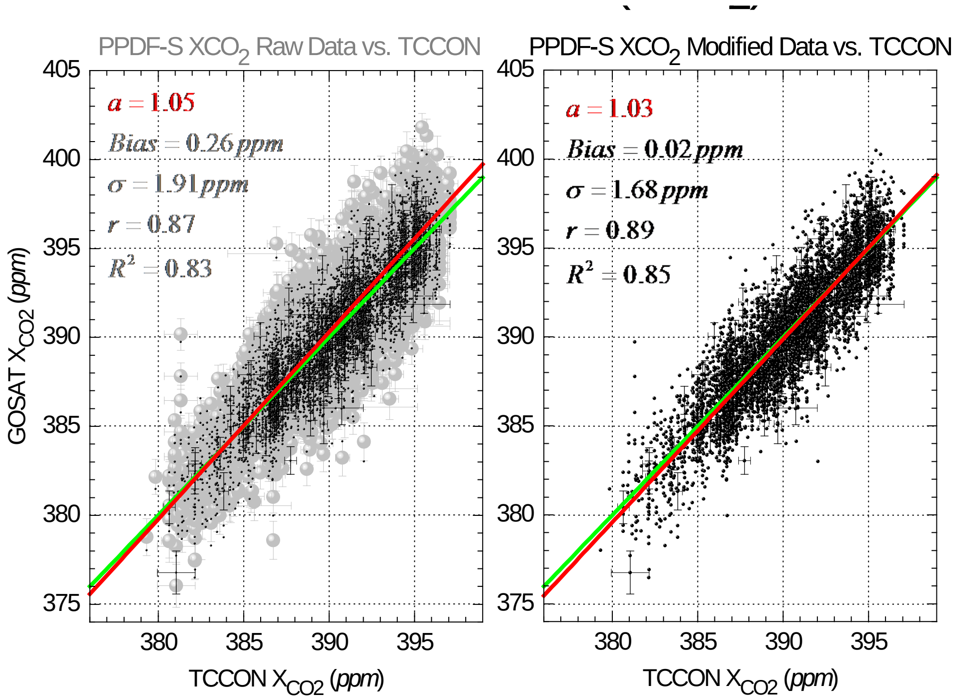

Figure 2. Correlation diagrams between GOSAT and TCCON measurements of X_{CO2} for raw PPDF-based data (left-hand panel, grey symbols) and after post-processing correction (right-hand panel). Red lines correspond to the best fit and the green line representing one-to-one correspondence.

5). List of publications

We plan to submit the material from second section of the report to Journal Geophysical Research.

6). Further recommended research

Further improvement of data quality is expected from new version of the PPDF-S algorithm (under development) that explicitly accounts for the strong XCO_2 correlations between temporally and spatially adjacent observations through joint variance-covariance matrix. To implement this approach we assume similar CO_2 vertical profiles for adjacent observations and retrieve scaling coefficients to allow for spatial and temporal variations. This approach is expected to provide additional information (as compared with scan-by-scan retrievals) for the estimation of the PPDF parameters.