



Retrieval of atmospheric carbon dioxide and methane from GOSAT data with the photon path length probability density function method

Sergey Oshchepkov, Andrey Bril, Tatsuya Yokota, Yukio Yoshida, and the TCCON Team

National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Japan
(sergey.oshchepkov@nies.go.jp)

The Greenhouse Gases Observing Satellite "IBUKI" (GOSAT) is the world's first spacecraft to measure the concentrations of carbon dioxide (CO₂) and methane (CH₄). The satellite has been operating properly from January 23, 2009. This paper presents retrievals of CO₂ and CH₄ from GOSAT data with the photon pathlength probability density function (PPDF) method that has been developed at the National Institute of Environmental Studies.

This paper focus on a validation of the retrievals using satellite data during 38 months of GOSAT operation from June 2009 and ground-based Fourier Transform Spectrometer measurements from the Total Carbon Column Observing Network (TCCON) as the reference data for the column-averaged dry air mole fractions of the atmospheric gases. The TCCON–GOSAT coincidence criteria for validating the satellite-based retrievals included GOSAT single scan data over land within a 5° radius latitude/ longitude circle centered at each of 12 TCCON stations. The ground-based TCCON data were mean values measured within plus/minus 1 hour of the GOSAT overpass time.

We use the latest version of PPDF-based method that retrieves simultaneously gas abundance and light path modification through the atmosphere. The radiance spectra from all three GOSAT SWIR bands (0.76 μm; 1.6 μm and 2.0 μm) were used to retrieve CO₂ and basic PPDF parameters that described light path shortening and light path lengthening. The retrieval state vector also included vertical profile of CO₂ mixing ratio; scaling factor of prior water vapor profile; and stretch factor for adjusting the position of the wave-number grids. Temperature and surface pressure data were prescribed and provided by Japan Meteorological Agency. For the methane retrievals we processed radiance spectra in 1.67-μm absorption band using PPDF parameters derived from simultaneous CO₂ and PPDF retrievals.

In particular, a statistical pairwise comparison between GOSAT and TCCON coincident measurements of CO₂ column abundance (over 3500 GOSAT single scans) performed with the weighed least squares fit showed a correlation coefficient 0.8; a standard deviation of 1.9 ppm, negative bias of 0.4 ppm; and slope of 1.04 for the slope-intercept form of the linear regression. After a posteriori bias correction these characteristics were 0.9; 1.65 ppm; 0.01 ppm; and 0.99, respectively.