Retrieval of greenhouse gas concentrations from GOSAT-2 observations

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Abstract

Atmospheric concentrations of carbon dioxide, methane and carbon monoxide are retrieved from hyper spectral data measured by The Greenhouse Gases Observing Satellite 2 (GOSAT-2). Development, validation and improvement of the retrieval algorithm are also carried out.

Ref. URL: https://www.eorc.jaxa.jp/earthview/2020/tp200203.html

Reasons and benefits of using JAXA Supercomputer System

The JAXA supercomputer system is used to retrieved greenhouse gas concentrations from measurement data of the GOSAT-2 satellite. About 100 hours of CPU time is needed to process 1day measurement data. It takes about 1 hour to process 1 day measurement data, using 10 nodes of the PrePost system computers with 12 cores.

Achievements of the Year

We are developing the JAXA/EORC research algorithm (Level 2 algorithm) for GOSAT and GOSAT-2 which derives from the Level 1 data the atmospheric concentrations of carbon dioxide and methane. The simultaneous use of both shortwave infrared (SWIR) and thermal infrared (TIR) spectra is one of the characteristics of our algorithm, which enables us to retrieve not only the column averaged concentrations, but also the vertical profiles with up to two layers in the troposphere for carbon dioxide and methane. We also utilize the polarization information in the SWIR to correct the undesirable effects of aerosols on the accurate retrievals the greenhouse gas concentrations. Our goal is to improve the estimate of the emission/absorbing fluxes of the greenhouse gases by fully utilizing the GOSAT/GOSAT-2 measurements.

In this year we worked on improving the algorithm concerning the sensor characteristics. Specifically, by optimizing the instrument line shape function we could improve considerably the precision of the retrieved greenhouse gas concentrations.

With the improved level 2 algorithm, we processed GOSAT-2 level 1 data version 210210 on JSS3, producing four year data set of the atmospheric concentrations of carbon dioxide and methane. These data are to be released as the JAXA/EORC research product (version 3). A quality check is underway to remove outliers due to cloud contamination.

Figure 1 shows the monthly mean of the column averaged concentrations of carbon dioxide (XCO2) in July 2020 (left) together with the lower tropospheric concentrations of carbon dioxide (right). The global distribution of the lower tropospheric concentrations was improved compared with that retrieved with the older algorithm, in which the lower tropospheric concentrations are too high over the ocean in the Southern Hemisphere. Figure 2 shows that both the column average (XCH4) and the lower tropospheric concentrations of methane are retrieved successfully.

We verified the accuracy of XCO2 and XCH4 by comparing with the TCCON (Total Carbon Column Observing Network) data. Figure 3 (left) is the result of the validation of XCO2. We selected 14 TCCON sites for which there are at least 8 match up data with the GOSAT-2 observations. The bias of the XCO2 is -0.1 ppm in total, with the standard deviation of 1.8 ppm. The mean bias over the 14 TCCON sites was 0.0 ppm, with the standard deviation of 0.6 ppm. These results are a significant improvement over the previous ones.

Similarly, the accuracy of the retrieved XCH4 was improved as shown in Figure 3 (right).

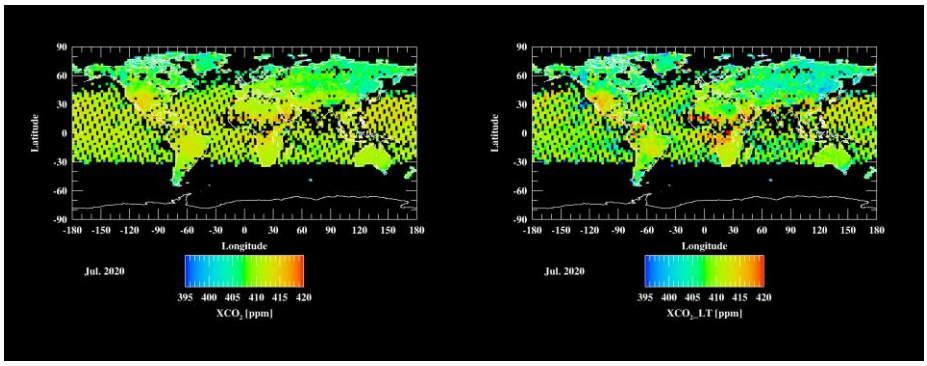

Fig. 1: (left) Monthly mean of the column averaged concentrations of carbon dioxide in July 2020 retrieved from GOSAT-2 observations. (right) Similar to left, but for the lower tropospheric concentrations of carbon dioxide.

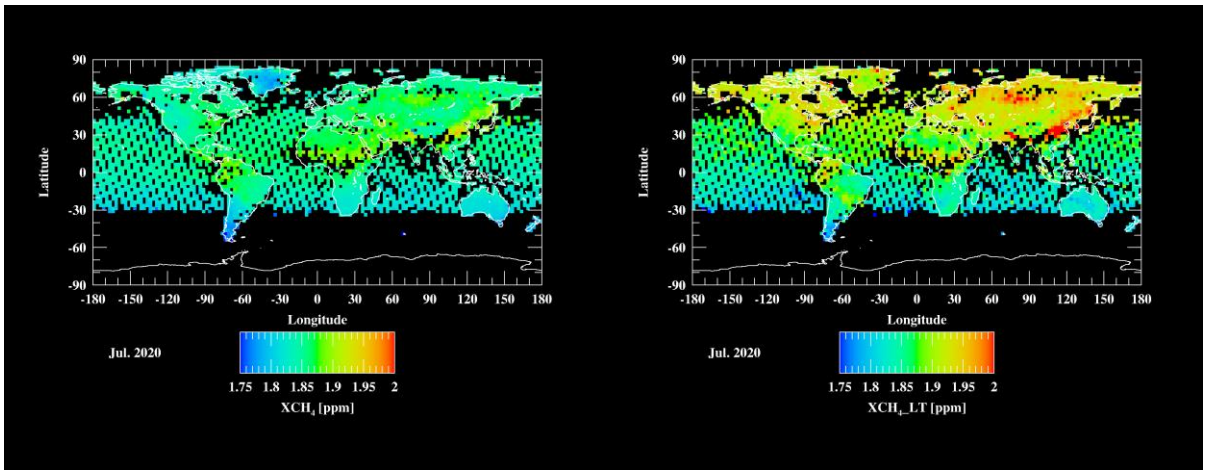

Fig. 2: (left) Monthly mean of the column averaged concentrations of methane in July 2020 retrieved from GOSAT-2 observations. (right) Similar to left, but for the lower tropospheric concentrations of methane.

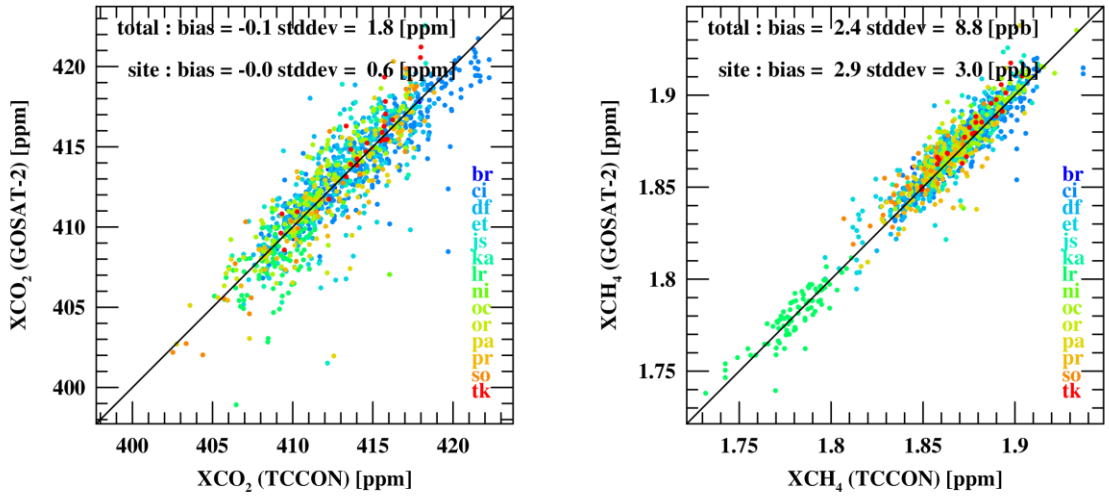

Fig. 3: (left) Comparison of the column averaged concentrations of carbon dioxide retrieved from GOSAT-2 observations with TCCON data. (right) Similar to left, but for the column averaged concentrations of methane.

Publications

- Web

https://www.eorc.jaxa.jp/GOSAT/GPCG/index_GOSAT2.html

Usage of JSS

Computational Information

Process Parallelization Methods	N/A
Thread Parallelization Methods	OpenMP
Number of Processes	1
Elapsed Time per Case	10 Hour(s)

JSS3 Resources Used

Fraction of Usage in Total Resources[*1](%): 0.07

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-ST	572,422.11	0.57
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	34.27	0.03
/data and /data2	102,742.62	0.79
/ssd	342.62	0.05

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	221.57	0.98

*1: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

*2: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage*2 (%)
ISV Software Licenses (Total)	0.00	0.00

*2: Fraction of Usage：Percentage of usage relative to each resource used in one year.