

Summary of the validation on GOSAT-2 TANSO-FTS-2 SWIR L2 Chlorophyll Fluorescence and Proxy-method Product (Ver. 02.10)

February 2025
NIES GOSAT-2 Project

For the validation of the GOSAT-2 TANSO-FTS-2 SWIR L2 Chlorophyll Fluorescence and Proxy-method Product (hereafter abbreviated as GOSAT-2 PROXY product), the column-averaged dry-air mole fractions of methane (XCH_4) and carbon monoxide (XCO) of the GOSAT-2 PROXY product (Ver. 02.10) are compared with those obtained by the ground-based high-resolution Fourier transform spectrometers (FTS) belonging to the Total Carbon Column Observing Network (TCCON) (hereinafter abbreviated as TCCON data). The results of the validation are summarized as below.

GOSAT-2 PROXY product

The GOSAT-2 PROXY product of Ver. 02.10 is used. The comparison period is from March 1, 2019 to January 31, 2024. Land data is defined for data with a land ratio of 10% or more in the comparison area, and Ocean data is defined for data with a land ratio of less than 10% in the comparison area. There is no distinction between gains. Only data with the quality flag “Good” are used.

TCCON data

The TCCON data used are obtained from the TCCON data archive (<http://tccondata.org>), which are retrieved by the algorithm GGG2020. They are averaged over within ± 30 min of GOSAT-2 overpass time. The correction factor for the XCH_4 product evaluated against the in-situ data is 1.003 on the WMO X2004 scale. Note that no correction is made for XCO .

Comparison conditions of GOSAT-2 PROXY product with TCCON data

- The GOSAT-2 PROXY product obtained in the comparison areas of $\pm 0.1^\circ$, $\pm 1^\circ$, $\pm 2^\circ$, and $\pm 5^\circ$ in latitude and longitude centered at each TCCON site are compared with the TCCON data by Land and Ocean. Since many TCCON sites are located inland, the amount of data over Ocean is smaller than that over Land.
- Among the GOSAT-2 PROXY product, those with a difference between the footprint altitude and the altitude of the TCCON site greater than 500 m are excluded from the comparison.

Results

The number of comparison data, mean biases (GOSAT-2 PROXY product minus TCCON data), standard deviations, and their relative values in the comparison areas by Land and Ocean are listed in Table 1.

Table 1. Comparison of GOSAT-2 PROXY product (Ver. 02.10) with TCCON data: number of comparison data (N), mean bias (Bias), its standard deviation (Std), and its relative values in comparison areas. Land indicates data over land, and Ocean indicates data over ocean.

SWPR V02.10 2019/3/1- 2024/1/31	Comparison area	Land					Ocean				
		N	Bias [ppb]	Std [ppb]	Bias [%]	Std [%]	N	Bias [ppb]	Std [ppb]	Bias [%]	Std [%]
XCH ₄	±0.1°	5256	-5.84	11.71	-0.31	0.63	5	-7.05	12.37	-0.38	0.67
	±1°	25523	-5.63	12.88	-0.30	0.69	460	-1.65	15.88	-0.09	0.86
	±2°	34941	-3.98	13.95	-0.21	0.74	1516	-3.75	19.15	-0.20	1.04
	±5°	76703	-3.34	15.70	-0.18	0.84	14031	-6.42	19.42	-0.35	1.06
XCO	±0.1°	3918	3.98	8.07	5.19	8.94	4	2.35	18.42	2.84	20.55
	±1°	18547	4.24	12.03	4.97	11.06	300	7.81	9.98	9.95	11.89
	±2°	25726	4.64	12.61	5.44	11.44	1059	7.16	9.47	9.16	10.86
	±5°	55542	4.66	14.84	5.59	13.31	9810	6.21	11.24	8.53	12.95

The scatter plots of the GOSAT-2 PROXY product in the comparison area of ±2° by Land and Ocean are shown in Figure 1. The time series of biases in the comparison area of ±2° by Land and Ocean are shown in Figure 2. The mean biases in the comparison areas by Land and Ocean for this version (Ver. 02.10) and the previous version (Ver. 02.00) are shown in Figure 3.

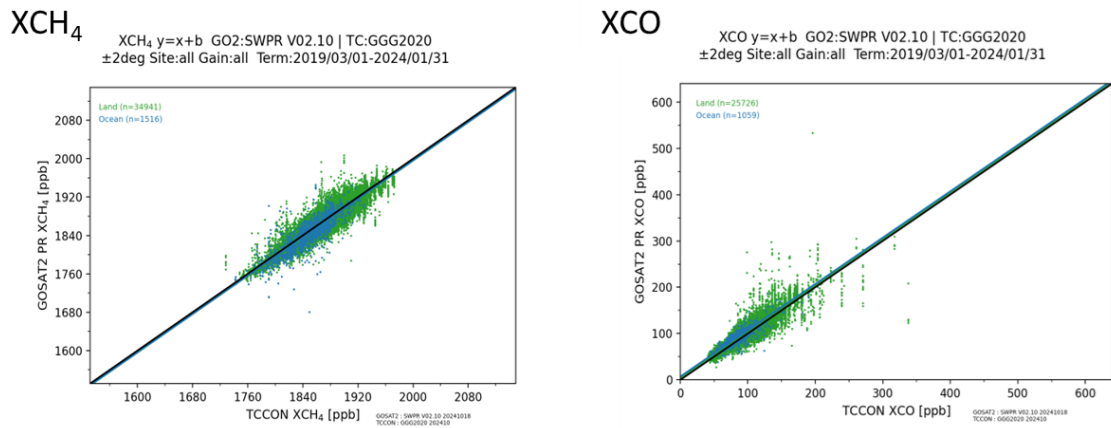


Figure 1. Scatter plots of GOSAT-2 PROXY product against TCCON data in the comparison area of ±2° by Land and Ocean for XCH₄ and XCO (green: Land data, blue: Ocean data).

ΔXCH_4

ΔXCO

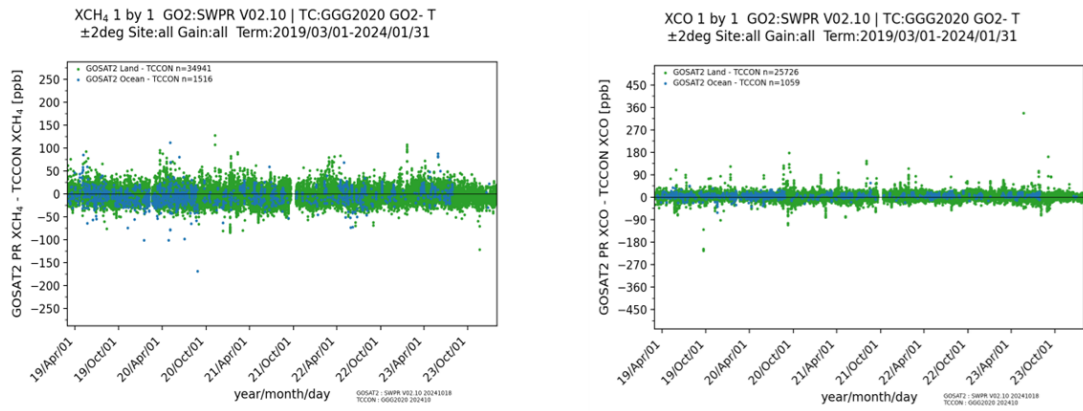


Figure 2. Time series of biases in the comparison area of $\pm 2^\circ$ by Land and Ocean for XCH_4 and XCO from March 2019 to January 2024 (green: Land data, blue: Ocean data).

ΔXCH_4

ΔXCO

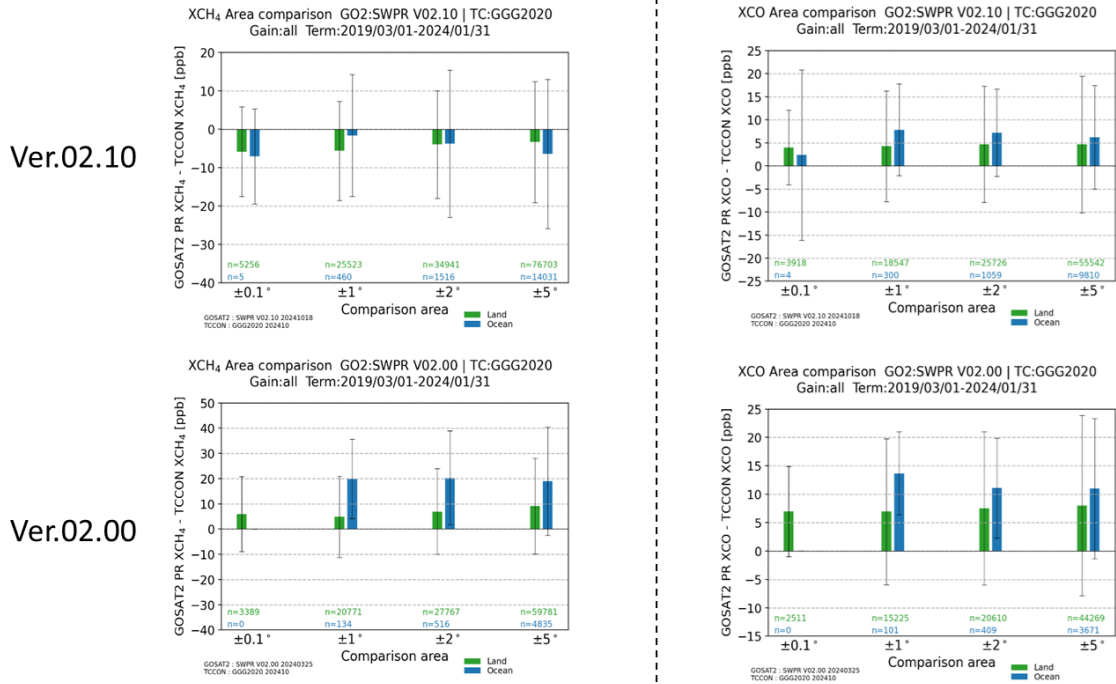


Figure 3. Mean biases (top: Ver. 02.10, bottom: Ver. 02.00) in the comparison areas by Land and Ocean for XCH_4 and XCO (green: Land data, blue: Ocean data).

Summary of GOSAT-2 PROXY product validation

The GOSAT-2 PROXY product for XCH₄ and XCO (Ver. 02.10, March 1, 2019 – January 31, 2024) are compared with the TCCON data. The results of the validation of in the comparison area of $\pm 2^\circ$ are summarized as follows.

- The mean biases and their standard deviations of XCH₄ over Land and Ocean are -3.98 ± 13.95 ppb ($-0.21 \pm 0.74\%$) and -3.75 ± 19.15 ppb ($-0.20 \pm 1.04\%$), respectively.
- The mean biases and their standard deviations of XCO over Land and Ocean are 4.64 ± 12.61 ppb ($5.44 \pm 11.44\%$) and 7.16 ± 9.47 ppb ($9.16 \pm 10.86\%$), respectively.
- Several biases of the TCCON site for XCO exceed $+100$ ppb and/or -100 ppb, but most of them are within ± 50 ppb. The time series of bias for XCH₄ and XCO are stable and show no systematic trends.

The results of the validation of the GOSAT-2 PROXY product in other conditions are summarized as follows.

- For XCH₄, the mean biases over Land are negative and within the range from -6 to -3 ppb in all the comparison areas. Similar to the mean biases over Land, those over Ocean are negative and within the range from -8 to -1 ppb. All the standard deviations of both Land and Ocean are larger than their mean biases.
- For XCO, the mean biases over Land are positive and within the range from 3 to 5 ppb in all the comparison areas. All the standard deviations are larger than their mean biases. The mean biases over Ocean are positive and within the range from 2 to 8 ppb. All the standard deviations of both Land and Ocean are larger than their mean biases.

The comparison of mean biases of this version (Ver. 02.10) with those of the previous version (Ver. 02.00) is summarized as follows.

- For XCH₄, signs of all the mean biases over both Land and Ocean change from positive (previous version) to negative (this version). The absolute mean biases over Ocean of this version are smaller than those of the previous version.
- For XCO, all the mean biases of this version are smaller than those of the previous version, particularly over Ocean.

In order to improve the quality of the GOSAT-2 PROXY product, further studies in calibration, algorithm and validation are necessary.