Summary of the validation on GOSAT-2 TANSO-FTS-2 SWIR L2 Chlorophyll Fluorescence and Proxy-method Product (Ver. 02.00)

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NIES GOSAT-2 Project

For the validation of 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 GOSAT-2 PROXY product (Ver. 02.00) were 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. 02.00 was used. The comparison period is from March 1, 2019 to February 28, 2023. Land data is defined for data with a land fraction of 10% or more in the comparison area, and Ocean data is defined for data with a land fraction of less than 10% in the comparison area. There is no distinction between gains. Only data with the quality flag "Good" were used.

TCCON data

The TCCON data used are obtained from the TCCON data archive (http://tccondata.org), which were retrieved by the algorithm GGG2020. The median differences between data retrieved by GGG2020 and GGG2014 are found to be −5.70 ppb for XCH_4 and +6.40 ppb for XCO (J. L. Laughner et al., AGU Fall meeting, 2021). TCCON data used for the comparison were averaged from values taken within 30 minutes before and after GOSAT-2 passed over each TCCON site.

Comparison conditions of GOSAT-2 PROXY product with TCCON data

- The GOSAT-2 PROXY product obtained in the comparison areas of ±0.1°, ±1°, ±2°, and ±5° in latitude and longitude centered at each TCCON site were compared with the TCCON data by Land and Ocean. Since many TCCON sites are located inland, the number of comparison 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 were excluded from the comparison.

Results

The number of comparison data, mean bias, standard deviation, and their relative values in each comparison area by Land and Ocean are listed in Table 1.

Table 1. Comparison of the GOSAT-2 PROXY product (Ver. 02.00) with the TCCON data. The number of comparison data (N), mean bias (Bias), its standard deviation (Std), and their relative values in each comparison areas are shown. Land indicates data over land, and Ocean indicates data over ocean.

SWPR V02.00 2019/3/1-2023/2/28		Comparison area	N	Bias [ppb]	Std [ppb]	Bias [%]	Std [%]
Land	XCH_4	±0.1°	2329	4.87	14.66	0.26	0.78
		±1°	13513	3.88	16.23	0.21	0.86
		±2°	18195	6.16	17.27	0.33	0.92
		±5°	37593	9.11	19.25	0.49	1.03
	XCO	±0.1°	1743	7.12	7.73	7.66	7.75
		±1°	9907	6.46	13.84	6.78	11.71
		±2°	13486	7.18	14.12	7.60	12.06
		±5°	28352	8.03	15.53	8.73	13.65
Ocean	XCH_4	±0.1°	0	-	-	-	-
		±1°	114	20.45	15.59	1.10	0.85
		±2°	390	20.49	18.58	1.11	1.01
		±5°	3400	19.74	21.89	1.07	1.18
	XCO	±0.1°	0	-	-	-	-
		±1°	85	14.13	7.24	18.37	10.01
		±2°	295	12.19	7.86	15.21	9.59
		±5°	2517	11.68	12.97	14.14	13.32

The scatter plots of the GOSAT-2 PROXY product against the TCCON data 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 each comparison area by Land and Ocean are shown in Figure 3.
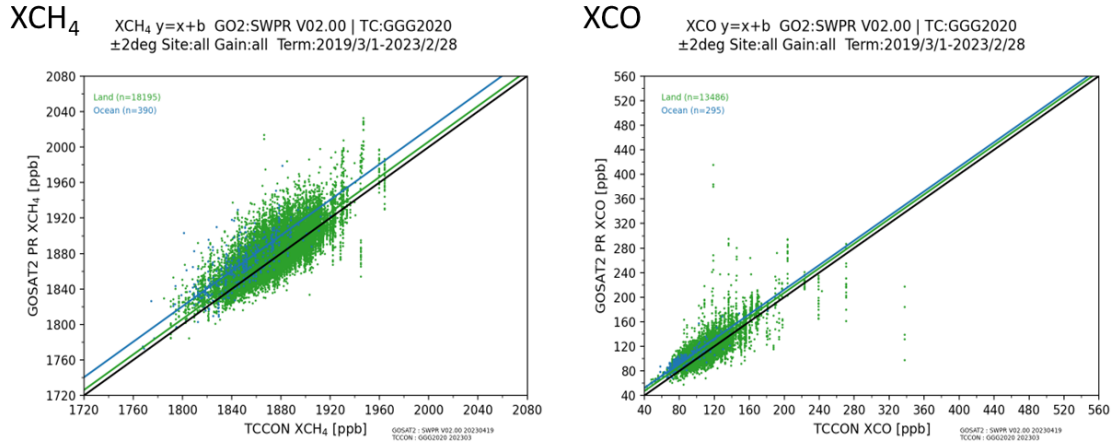
Figure 1. Scatter plots of GOSAT-2 PROXY product against TCCON data in the comparison area of ±2° by Land and Ocean for XCH₄ and XCO (green: Land data, bule: Ocean data).
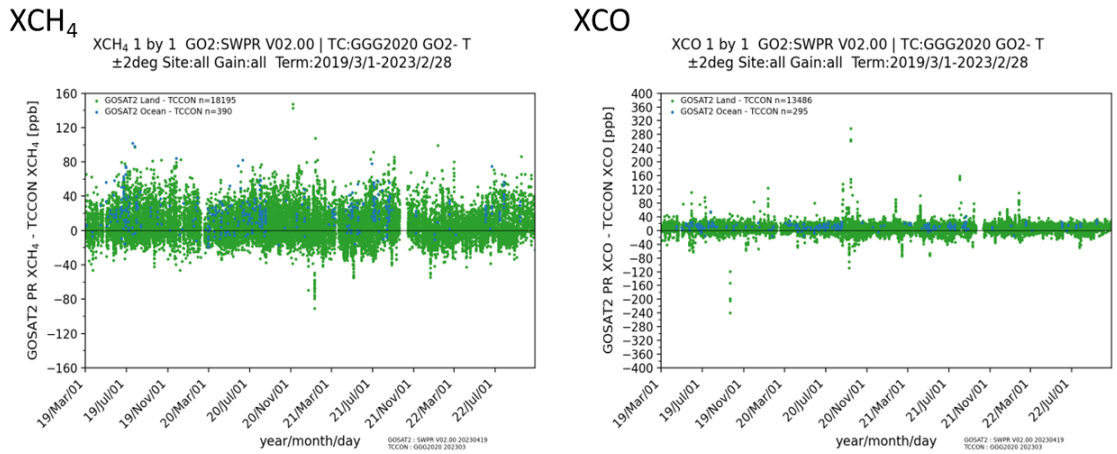

Figure 2. Time series of biases in the comparison area of ±2° by Land and Ocean for XCH₄ and XCO (green: Land data, bule: Ocean data).
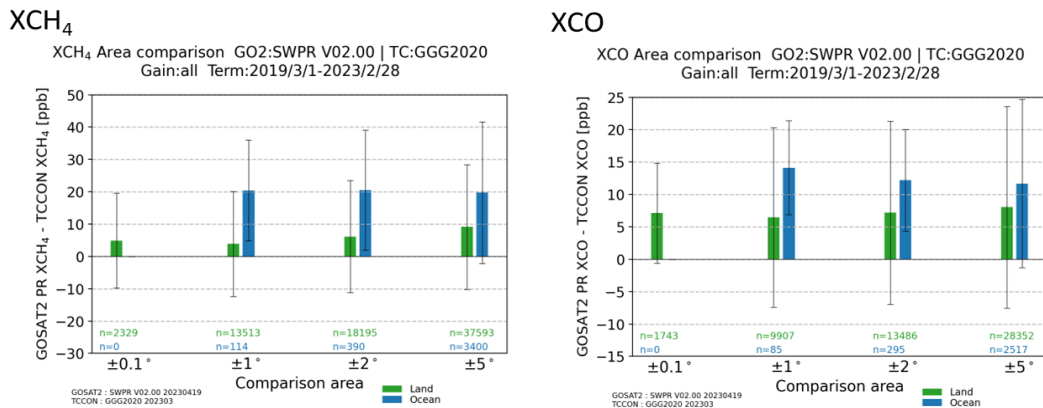

Figure 3. Mean biases in each comparison area by Land and Ocean for XCH₄ and XCO (green: Land data, bule: Ocean data).

Summary of GOSAT-2 PROXY product validation

The GOSAT-2 PROXY product for XCH_4 and XCO (Ver. 02.00: March 1, 2019 – February 28, 2023) was compared with the TCCON data. In the comparison area of $\pm2^\circ$, the validation of GOSAT-2 PROXY product is summarized as follows.

- The mean biases and their standard deviations of XCH_4 over Land and Ocean are 6.16 ± 17.27 ppb ($0.33\pm0.92\%$) and 20.49 ± 18.58 ppb ($1.11\pm1.01\%$), respectively.
- The mean biases and their standard deviations of XCO over Land and Ocean are 7.18 ± 14.12 ppb ($7.60\pm12.06\%$) and 12.19 ± 7.86 ppb ($15.21\pm9.59\%$), respectively.
- Though the biases for XCH_4 show some variations during the validation period, they are not so large or not systematic. Most of the biases for XCO are within ±40 ppb with few large variations.

The validation of GOSAT-2 PROXY product in other comparison areas is summarized as follows.

- For XCH_4, the mean biases over Land are 4–9 ppb in all comparison areas and the standard deviations are larger than their mean biases. The mean biases over Ocean are about 20 ppb, except for the $\pm0.1^\circ$ comparison area where there is no match-up data. In the $\pm1^\circ$ and $\pm2^\circ$ comparison areas, the standard deviations are smaller than their mean biases.
- For XCO, the mean biases over Land are 6–8 ppb in all comparison areas and the standard deviations are larger than their mean biases. The mean biases over Ocean are generally 12–14 ppb, and decrease with broadening the comparison areas. In the $\pm1^\circ$ and $\pm2^\circ$ comparison areas, the standard deviations are smaller than their mean biases.

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