



Supplement of

Update on the GOSAT TANSO–FTS SWIR Level 2 retrieval algorithm

Yu Someya et al.

Correspondence to: Yu Someya (someya.yu@nies.go.jp)

The copyright of individual parts of the supplement might differ from the article licence.

1 Difference in the solar irradiance spectra

The solar irradiance spectra used in the V02 and V03 are compared in the following figure. The blue and red lines are for V02 and V03 and the differences in those are depicted below.

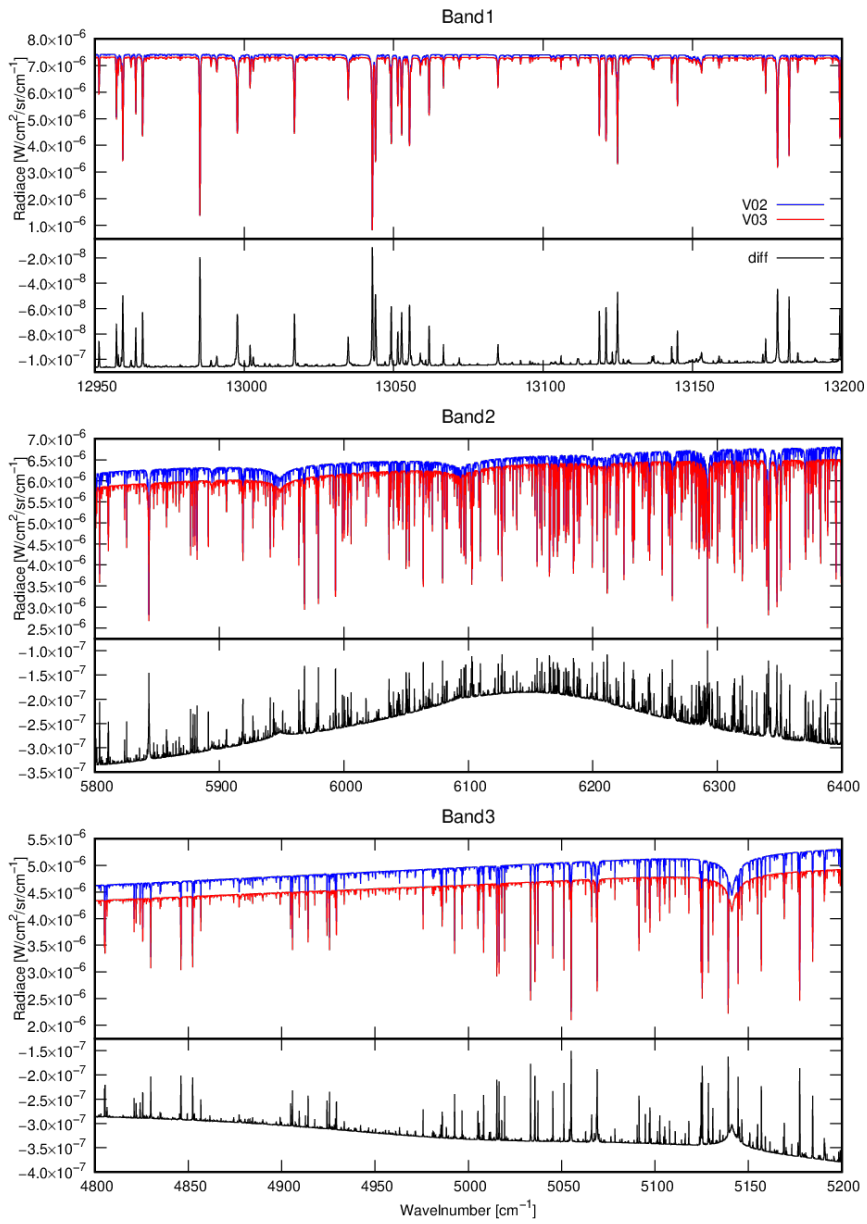


Fig. S1: Solar irradiance spectra used in V02 (blue) and V03 (red) algorithms.

2 Comparison of the spectral residuals

The averaged and normalized spectral residuals from V02.90/91 and V03.00 obtained in April 2020 are shown in the same figure as Fig. S2 and S3. In addition, the specific spectral ranges over land are shown in Fig. S4.

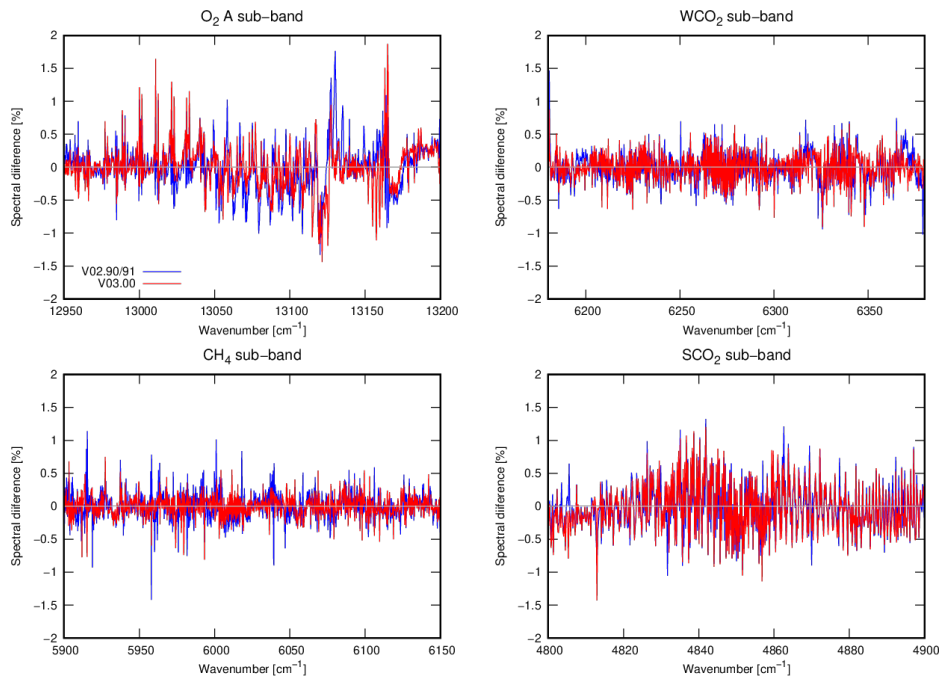


Fig. S2: Averaged and normalized spectral residuals over land obtained in April 2022 from V02.90/91 (blue) and V03.00 (red) for each sub-band.

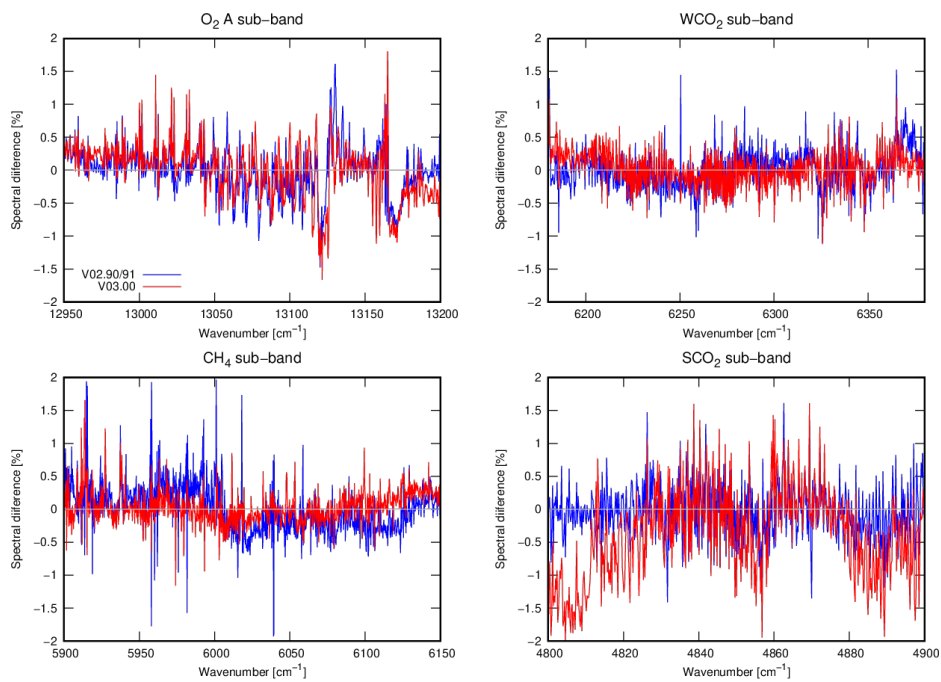


Fig. S3: Same as Fig. S2 but for over the ocean.

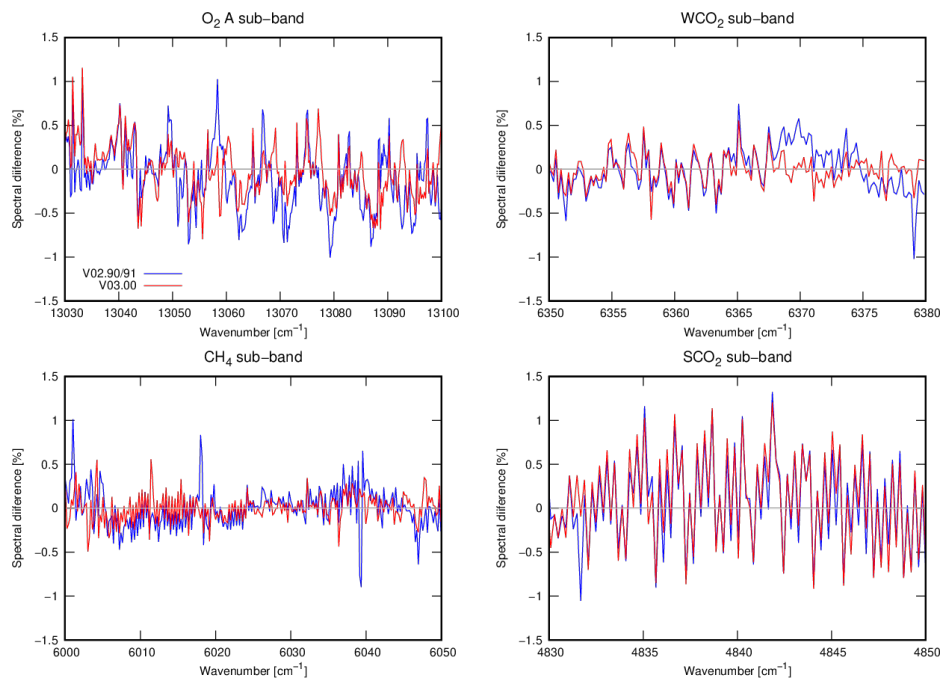


Fig. S4: Same as Fig. S2 but the specific spectral ranges are zoomed in.

3 Correlation between the changes in Xgas and Ps

Correlations between the changes in the retrieved surface pressure and those in Xgas from both versions are shown in Fig. S5. Significant correlations are seen for XCO₂ over land and XCH₄ over both surfaces.

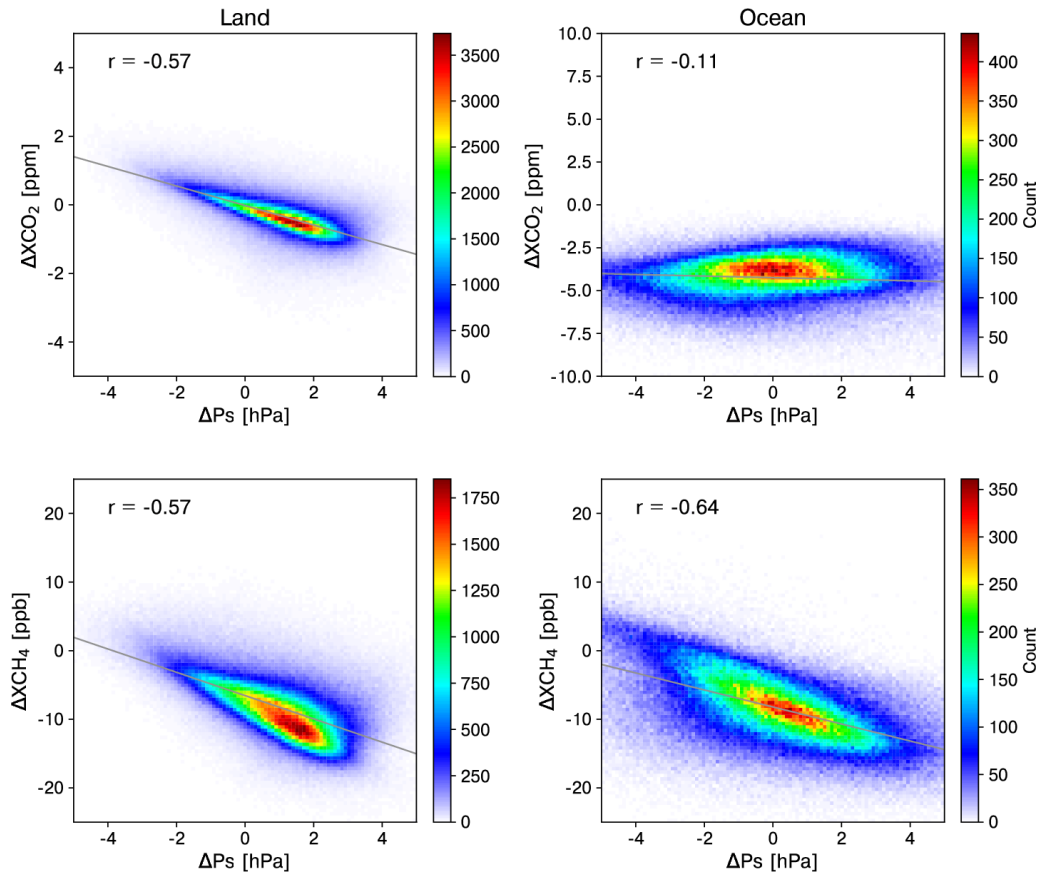


Fig. S5 Correlations between the changes in the retrieved surface pressure and those in Xgas from V02.90/91 and V03.00 over land and over the ocean.

4 Comparison results for the individual TCCON sites

The validation results of V02.90/91 and V03.00 against the individual TCCON measurements are shown below. The version of TCCON data is GGG2020. The match-up condition is $\pm 2^\circ$ horizontally and ± 30 min temporally. The sum of N for the individual sites and N for the total can be inconsistent because the total results contain only the nearest TCCON site data for each GOSAT observation.

Table S1: Validation results for V02.90/91 over land with gain H

V02.90/91 (Land/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	45	0.21	2.16	45	11.38	9.93
Burgos (bu)	33	0.85	2.71	33	13.57	10.97
Caltech (Pasadena) (ci)	2240	-0.90	1.83	2240	2.02	10.65
East Trout Lake (et)	4	-2.78	2.24	4	-1.53	10.13
Fourcorners (fc)	17	-0.45	1.76	17	2.04	13.62
Indianapolis (if)	34	-0.03	1.91	34	5.78	10.82
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	753	-0.39	1.92	753	3.02	11.65
Karlsruhe (ka)	222	0.03	2.41	222	3.71	12.26
Lauder01 (lh)	5	-0.82	1.91	5	12.93	3.49
Lauder02 (ll)	221	-1.46	2.00	226	-0.57	11.24
Lauder03 (lr)	147	-2.18	1.67	149	-5.07	10.28
Lamont (oc)	1397	-1.22	1.70	1397	0.93	12.17
Manaus (ma)	0			0		
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	230	-0.77	2.16	230	8.83	10.80
Paris (pr)	241	-0.95	2.12	241	-0.01	11.30
Reunion (ra)	0			0		
Rikubetsu (rj)	119	-0.02	2.07	119	8.79	10.59
Saga (js)	332	1.38	2.30	332	12.22	10.93
Sodankyla (so)	51	-0.21	1.91	52	5.75	10.80
Tsukuba (tk)	859	0.57	2.11	859	4.30	10.91
Xianghe (xh)	598	0.02	2.50	598	4.76	14.33
Total	7357	-0.56	2.13	7365	2.97	11.94

Table S2 Validation results for V02.90/91 over land with gain M

V02.90/91 (Land/M)	XCO ₂			XCH ₄		
	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	0			0		
Burgos (bu)	0			0		
Caltech (Pasadena) (ci)	1256	-0.78	1.88	1256	8.51	19.09
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	195	-1.16	1.92	195	5.68	18.56
Karlsruhe (ka)	0			0		
Lauder01 (lh)	0			0		
Lauder02 (ll)	0			0		
Lauder03 (lr)	0			0		
Lamont (oc)	0			0		
Manaus (ma)	0			0		
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	0			0		
Reunion (ra)	0			0		
Rikubetsu (rj)	0			0		
Saga (js)	0			0		
Sodankyla (so)	0			0		
Tsukuba (tk)	0			0		
Xianghe (xh)	0			0		
Total	1385	-0.79	1.89	1385	8.13	19.17

Table S3 Validation results for V02.90/91 over ocean with gain H

V02.90/91 (Ocean/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	1	-0.19	0.00	1	-1.87	0.00
Burgos (bu)	39	-1.52	2.56	39	3.99	15.07
Caltech (Pasadena) (ci)	0			0		
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	0			0		
Karlsruhe (ka)	0			0		
Lauder01 (lh)	0			0		
Lauder02 (ll)	0			0		
Lauder03 (lr)	0			0		
Lamont (oc)	0			0		
Manaus (ma)	0			0		
Nicosia (ni)	9	-2.74	2.62	9	5.78	18.26
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	0			0		
Reunion (ra)	9	-3.62	1.34	9	-4.40	7.91
Rikubetsu (rj)	0			0		
Saga (js)	14	-0.05	2.31	14	16.91	11.59
Sodankyla (so)	0			0		
Tsukuba (tk)	0			0		
Xianghe(xh)	0			0		
Total	72	-1.63	2.62	72	5.60	15.43

Table S4 Validation results for V03.00 over land with gain H

V03.00 (Land/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	54	0.33	2.37	54	2.60	11.55
Burgos (bu)	77	1.27	2.36	77	2.02	7.89
Caltech (Pasadena) (ci)	2691	-1.24	1.83	2691	-7.09	10.49
East Trout Lake (et)	4	-1.38	1.74	4	1.52	8.67
Fourcorners (fc)	12	-0.97	1.24	12	-4.63	8.78
Indianapolis (if)	41	-0.39	1.99	41	-3.22	10.10
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	907	-0.81	1.93	907	-6.46	11.71
Karlsruhe (ka)	295	0.03	2.44	295	-5.02	11.78
Lauder01 (lh)	5	-0.54	1.25	5	11.94	4.05
Lauder02 (ll)	226	-0.96	1.95	234	-6.49	10.54
Lauder03 (lr)	179	-1.53	1.58	181	-9.94	9.52
Lamont (oc)	1618	-1.06	1.82	1618	-4.51	11.68
Manaus (ma)	3	1.36	0.69	3	-4.95	4.74
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	288	-0.89	2.25	288	0.61	11.61
Paris (pr)	321	-0.86	2.10	321	-7.23	11.47
Reunion (ra)	0			0		
Rikubetsu (rj)	152	-0.20	2.24	152	2.44	10.94
Saga (js)	398	1.12	2.50	398	3.60	12.17
Sodankyla (so)	59	-0.17	2.01	59	-2.75	9.99
Tsukuba (tk)	1017	0.74	2.24	1017	-0.83	11.15
Xianghe (xh)	670	0.10	2.67	670	0.10	14.86
Total	8780	-0.61	2.20	8790	-4.23	11.97

Table S5 Validation results for V03.00 over land with gain M

V03.00 (Land/M)	XCO ₂			XCH ₄		
	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	0			0		
Burgos (bu)	0			0		
Caltech (Pasadena) (ci)	1229	-0.90	1.94	1229	-0.11	19.01
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	166	-0.94	2.18	166	-1.90	21.23
Karlsruhe (ka)	0			0		
Lauder01 (lh)	0			0		
Lauder02 (ll)	0			0		
Lauder03 (lr)	0			0		
Lamont (oc)	0			0		
Manaus (ma)	0			0		
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	0			0		
Reunion (ra)	0			0		
Rikubetsu (rj)	0			0		
Saga (js)	0			0		
Sodankyla (so)	0			0		
Tsukuba (tk)	0			0		
Xianghe (xh)	0			0		
Total	1360	-0.88	1.97	1360	-0.19	19.29

Table S6 Validation results for V03.00 over ocean with gain H

V03.00 (Ocean/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	1	-7.68	0.00	1	-16.87	0.00
Burgos (bu)	33	-7.80	3.00	33	-9.03	13.04
Caltech (Pasadena) (ci)	0			0		
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	0			0		
Karlsruhe (ka)	0			0		
Lauder01 (lh)	0			0		
Lauder02 (ll)	0			0		
Lauder03 (lr)	0			0		
Lamont (oc)	0			0		
Manaus (ma)	0			0		
Nicosia (ni)	10	-8.05	2.89	10	-3.72	16.25
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	0			0		
Reunion (ra)	7	-10.36	1.69	7	-14.14	9.83
Rikubetsu (rj)	0			0		
Saga (js)	10	-7.72	2.05	10	-14.12	18.19
Sodankyla (so)	0			0		
Tsukuba (tk)	0			0		
Xianghe (xh)	0			0		
Total	61	-8.12	2.81	61	-9.71	14.60

The results of the stricter horizontal match-up condition ($\pm 0.01^\circ$) are shown in Tables S7 and S8. The results are only shown for over land with gain H.

Table S7: Validation results of the stricter match-up condition for V02.90/91 over land with gain H

V02.90/91 (Land/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	0			0		
Burgos (bu)	20	2.54	1.79	20	20.11	5.88
Caltech (Pasadena) (ci)	878	-0.27	1.67	878	5.16	9.67
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	229	0.59	1.52	229	8.61	8.77
Karlsruhe (ka)	0			0		
Lauder01 (lh)	5	-0.82	1.91	5	12.93	3.49
Lauder02 (ll)	144	-1.32	1.93	144	0.32	10.96
Lauder03 (lr)	30	-0.44	1.45	30	2.39	8.44
Lamont (oc)	268	-0.92	1.57	268	3.15	8.55
Manaus (ma)	0			0		
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	14	-0.59	1.64	14	1.58	7.15
Reunion (ra)	0			0		
Rikubetsu (rj)	4	-0.13	1.70	4	4.50	5.80
Saga (js)	75	0.88	1.77	75	12.13	7.17
Sodankyla (so)	19	-0.63	2.09	20	4.09	12.96
Tsukuba (tk)	141	-0.01	1.66	141	2.41	9.54
Xianghe (xh)	0			0		
Total	1743	-0.31	1.76	1744	4.81	9.81

Table S8: Same as Table S7 but for V03.00.

V03.00 (Land/H)	XCO ₂			XCH ₄		
Site	N	Bias (ppm)	SD (ppm)	N	Bias (ppb)	SD (ppb)
Bremen (br)	1	3.39		1	1.93	
Burgos (bu)	57	2.33	1.56	57	4.80	6.03
Caltech (Pasadena) (ci)	1072	-0.70	1.69	1072	-4.66	9.48
East Trout Lake (et)	0			0		
Fourcorners (fc)	0			0		
Indianapolis (if)	0			0		
Izana (iz)	0			0		
JPL01 (jc)	0			0		
JPL02 (jf)	289	0.03	1.61	289	-1.86	9.28
Karlsruhe (ka)	0			0		
Lauder01 (lh)	4	-0.67	1.37	4	12.03	4.53
Lauder02 (ll)	147	-0.75	1.86	148	-5.35	10.41
Lauder03 (lr)	42	0.07	1.40	42	-3.81	8.44
Lamont (oc)	307	-0.75	1.61	307	-2.36	8.50
Manaus (ma)	0			0		
Nicosia (ni)	0			0		
Ny-Alesund (ny)	0			0		
Park Falls (pa)	0			0		
Paris (pr)	18	-0.71	1.40	18	-6.58	7.66
Reunion (ra)	0			0		
Rikubetsu (rj)	5	0.10	1.80	5	1.58	8.58
Saga (js)	83	0.32	2.20	83	3.53	9.76
Sodankyla (so)	23	-0.22	2.05	23	-3.51	11.82
Tsukuba (tk)	170	0.29	1.83	170	-1.64	10.56
Xianghe (xh)	0			0		
Total	2111	-0.43	1.81	2112	-3.30	9.68