Response to Reviewer #2
An eleven year record of XCO_2 estimates derived from GOSAT measurements using the NASA ACOS version 9 retrieval algorithm

T.E. Taylor et al.

Thank you to the reviewer for the suggestions and comments. We appreciate your time and concern. We have addressed each enumerated point below. The original reviewer comment is given in black. Our reply is given in blue. Modifications to the manuscript text are given in red as needed.

1. L28: "TANSO-FTS", the abbreviation is not introduced.

   It was introduced in the abstract, but I see the journal house rules require it to be introduced again in the main text. Therefore, the sentence now reads:

   Each day, GOSAT's Thermal And Near infrared Sensor for carbon Observation - Fourier Transform Spectrometer (TANSO-FTS) acquires approximately ten thousand high spectral resolution measurements of reflected sunlight ($\simeq$ 36.5 M in ten years).

2. L30-31: Focus of the manuscript is ACOSv9 algorithm that does not deal with CH4. Is it necessary to mention XCH4?

   This is a valid point and we have removed the references to methane, here and at the opening of Section 2. We also removed the citation of [Parker, ESSD, 2020, GOSAT-CH4-ten-years].

3. L55: "the L2FP retrieval", do you mean L2FP retrieval algorithm?

   Correct.

   Motivated by these early studies, as well as the launch of the OCO-2 sensor in July 2014, the ACOS team continued to refine the L2FP retrieval algorithm.

4. L71: Add a comma after "In Section 3".

   Done.

5. L191: "IDP", the abbreviation is not introduced.

   The IDP was inadvertently introduced later in the document, so we moved the introduction to be at the first use instead of later.

6. L215: Why were these specific collocation criteria of +/- 2.5 ° Lat and +/-5 Lon selected? Also mentioned by the first referee.

To collocate GOSAT with TCCON, we followed the spatial criteria laid out in Section 4 of [Wunch, AMT, 2017, https://doi.org/10.5194/amt-10-2209-2017]. The sentence now reads: Following the criteria defined in (Wunch, 2017), the spatial collocation criteria for GOSAT soundings were those falling within $\pm 2.5°$ latitude and $\pm 5°$ longitude of a TCCON station for most sites. It is worth keeping in mind that GOSAT samples on any given orbit are order several hundred kilometers apart, i.e., it is quite spatially sparse. Therefore the spatial collocation criteria cannot be too strict.

7. L453: "ACOS GOSAT v9 XCO2 versus OCO-2", the comparative results can be summarized into a table for the convenience of the reader.

This is a great suggestion. We compiled a table listing the N, means delta XCO_2 and standard deviation by year and season for each observation mode. This helps provide a more complete picture of the differences between the two XCO_2 products. The following brief discussion and table were added to the text.

A set of summary statistics for the ACOS GOSAT v9 versus OCO-2 v10 XCO_2 product is given in Table 1. The values reported here are on the individual collocations by year and season, rather than the spatially gridded averages as given in Figures 13 and 14 [in the original submission]. For the land observations, there has been a very slight upward trend in time of the $\Delta XCO_2^{OCO\text{-}2}$ to slightly more positive values (GOSAT v9 larger than OCO-2 v10 XCO_2). On the other hand, for Ocean-Glint observations, the general trend has been an increasingly more negative $\Delta XCO_2^{OCO\text{-}2}$ in time, as was seen in Figure 15 [in the original submission]. Additional investigation will be required to determine the root cause(s) of these differences.

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Table 1. A set of summary statistics for the comparison of the ACOS GOSAT v9 XCO_2 to the OCO-2 v10 product. Individual collocations for each year and season are given by N, while the mean ΔXCO_2 and the standard deviation from the mean are given by μ and σ, respectively, both in units ppm. The top portion of the table is for land observations, while the bottom is for Ocean-Glint (OceanH).

Land		DJF			MAM			JJA			SON	
Year	N	μ	σ	N	μ	σ	N	μ	σ	N	μ	σ
2014	0	–	–	0	–	–	0	–	–	4564	0.11	1.37
2015	1963	0.02	1.36	3160	0.15	1.47	5631	-0.08	1.34	4108	-0.01	1.39
2016	4379	0.01	1.28	3672	-0.07	1.42	4701	-0.04	1.41	4923	0.02	1.43
2017	3610	0.10	1.40	4097	-0.04	1.37	3450	0.02	1.34	2892	-0.02	1.41
2018	3605	0.11	1.41	3904	-0.06	1.33	4738	0.06	1.36	4218	0.21	1.46
2019	2779	0.16	1.39	3917	0.06	1.41	4911	0.09	1.35	4823	0.24	1.40
2020	3422	0.17	1.37	3833	-0.04	1.34	1183	-0.03	1.22	0	–	–
OceanH		DJF			MAM			JJA			SON	
Year	N	μ	σ	N	μ	σ	N	μ	σ	N	μ	σ
2014	0	–	–	0	–	–	0	–	–	2603	0.10	0.76
2015	2373	0.29	0.74	3139	0.14	0.84	2982	-0.13	0.87	3103	0.14	0.81
2016	6029	0.07	0.80	5460	-0.45	0.90	5109	-0.66	0.89	7673	-0.26	0.85
2017	6847	-0.13	0.82	6235	-0.39	0.87	3523	-0.55	0.94	4332	-0.18	0.85
2018	5888	-0.05	0.86	5680	-0.47	0.89	2767	-0.65	0.90	5887	-0.32	0.85
2019	4815	-0.14	0.91	4887	-0.50	0.93	4511	-0.61	0.92	6972	-0.37	0.95
2020	5451	-0.34	0.94	4812	-0.60	1.01	385	-0.69	1.08	0	–	–