Dear anonymous referee #1,

Thank you very much for your careful reading of our revised manuscript and valuable suggestions. Early referee comments (before publication in AMTD) are indicated in green, and our responses to the early comments are described in red. The latest referee comments (after publication in AMTD) are indicated in blue, and our responses to the latest comments are described in black.

Comment on the reply to the first comment on "Validation of XCH4 derived from SWIR spectra of GOSAT TANSO-FTS with aircraft measurement data" by M. Inoue et al.

The manuscript becomes clearer. However, I still have some comments.

Dear anonymous referee#1,

Thank you very much for your careful reading of our manuscript and valuable comments.

Comment on "Validation of XCH_4 derived from SWIR spectra of GOSAT TANSO-FTS with aircraft measurement data" by M. Inoue et al.

General:
This paper describes the validation results of GOSAT XCH_4 Ver. 02.00 with aircraft measurement data from various projects and sites. The validation of the satellite measurement of greenhouse gases is important to estimate the global and temporal variations of the emission and sink of them.
The paper is well described and it should be published after some revisions.

Comments and questions:
2.2.6
p13, l1 equation (4)
Here 'Trend' is a constant value. But year to year variation of growth rate is large for CH_4. Are the fitting errors caused by this constant trend small enough for all sites?

We show "Trend" in the equation (4) and its fitting error at four sites (PFA, NHA, SGP, CMA) in Table R-1. The fitting error is about 0.7-0.8 ppb/year, and we consider that the fitting error caused by the constant trend is small for all sites.

Table R-1-1. Trends of aircraft-based XCH_4 and their fitting errors at each site.

site	Trend [ppb/year]	Fitting error of Trend term [ppb/year]
PFA	5.0	0.8
NHA	5.2	0.8
SGP	4.0	0.7
CMA	4.8	0.8

I understand that the fitting error of Trend is small. Please make some comments in the manuscript.

We added the following sentence in Sect. 2.2.6.

"*Trend* of the partial XCH_4 from the PBL through the tropopause was about 0.3 ppb month^{-1}, and the fitting error caused by this constant *Trend* was as small as 0.06 ppb month^{-1}. "

p13, l23-25

Did you examine seasonal dependences only for two sites?

In addition to the two sites (SGP and RTA) shown in the manuscript, we examined seasonal dependences of the uncertainties at another two sites (LEF and SGM).

It is better to describe that you examined seasonal dependences of the uncertainties at four sites although you only show for two sites.

We added monthly time series of σ_{pbl}, σ_{trp}, and σ_{str} of the partial XCH_4 data at LEF and SGM in Fig. 5 (i.e., replaced by Fig. R1-1) and revised the sentences in Sect. 2.2.6 as follows.

"In addition, we examined whether the uncertainties of the respective partial XCH_4 values were strongly seasonal. Monthly time series of σ_{pbl}, σ_{trp}, and σ_{str} of the partial XCH_4 data at SGP and RTA did not show a strong seasonal dependence (Fig. 5), and the uncertainties calculated over the entire period can be reasonably used as threshold values for data screening."

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"In addition, we examined whether the uncertainties of the respective partial XCH_4

values were strongly seasonal at four sites (SGP, RTA, LEF, and SGM). Monthly time series of σ_{pbl}, σ_{trp}, and σ_{str} of the partial XCH_4 data at SGP, RTA, and LEF did not show a strong seasonal dependence (Fig. 5a, 5b, and 5c), and the uncertainties calculated for the entire period can be reasonably used as threshold values for data screening. On the other hand, it was difficult to investigate seasonality of the uncertainties at several sites such as SGM due to lack of data for all months (Fig. 5d)."

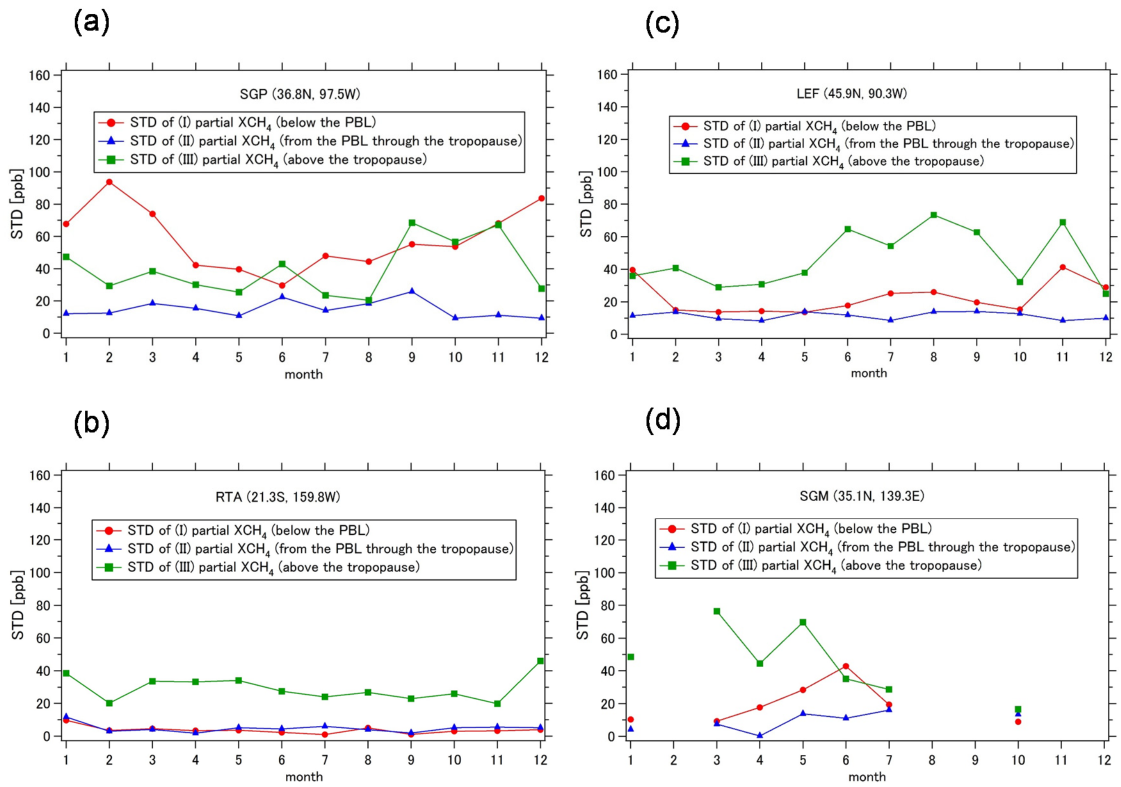

Fig. R1-1. Monthly time series of the uncertainty of partial XCH_4 at (a) the Southern Great Plains (SGP), (b) Rarotonga (RTA), (c) Park Falls (LEF), and (d) Sagami-bay (SGM). Red circles, blue triangles, and green squares are monthly σ_{pbl}, σ_{trp}, and σ_{str}, respectively.

2.3

Does 'temporally matched' mean the time difference less than 24 hrs or some shorter time? I guess that the maximum time difference is much shorter than 24 hrs because most of aircraft measurements and GOSAT observations maybe performed during daytime.

"Temporally matched" does not mean the time difference less than 24 hours (or some shorter time). More simply, it means that the GOSAT data and aircraft measurement data are obtained on the same day at each site. The maximum time difference was about 9 hours.

It is also better to describe that the maximum time difference was about 9 hours in the manuscript.

Thank you very much for good suggestion. The following sentences were added in Sect. 2.3.

"This means that the GOSAT data and aircraft measurement data were obtained on the same day at each site."
"The maximum time difference of matched data set was about 9 hours."

Fig. 7
The differences between aircraft-based XCH_4 with CAK and without CAK seem to have seasonal (or some temporal) variations. Can you explain this?

At this point, we do not have sufficient information to explain the seasonal variations you pointed out. However, we consider that since this may be related to the fact that CAK is a function of solar zenith angle, we may have to use aircraft-based XCH_4 with CAK when possible.

I see. Could you comment on the possibility of solar zenith angle dependency and it is small enough (or not) compared with other uncertainty?

Correlation coefficient between "difference between aircraft-based XCH_4 with application of CAK and without CAK" and "solar zenith angle" was -0.67 for all sites. This may indicate the possibility of solar zenith angle dependency. As shown in Table 4 of the manuscript, the difference between aircraft-based XCH_4 with and without application of CAK was less than ±9 ppb at maximum. On the other hand, total uncertainty in calculation the aircraft-based XCH_4 was about 12-16 ppb at most sites (Table 3). In a few cases, the differences between aircraft-based XCH_4 with and without application of CAK seem not to be small compared with total uncertainty.

Table 6
The increasing rate of matched data number is much larger over land than that over

ocean. Do you know why?

We believe that your question means why matched data number becomes much larger over land than that over ocean by expanding the spatial coincidence criteria (from ±2° boxes to ±5° boxes). Most of aircraft sites with much observation data (e.g., SGP, AAO, HIL, LEF) are located in inland. Even if we expand the spatial coincidence criteria, even the ±5° boxes cannot cover ocean regions. It means that expanding to ±5° boxes can lead to much larger matched data over land than ocean.

Sorry for confusing. I mean that the increasing rates of matched data number between direct and curve-fitting are larger over land (43 to 1543: 35.9 times, 102 to 8060: 79 times) than those over ocean (3 to 23: 7.7 times, 10 to 207: 20.7 times).

The curve fitting method is to compare with GOSAT data by gap-filling the aircraft-based XCH_4 time series through temporal interpolation. Basically, the GOSAT data obtained over land are much more than those over ocean. Consequently, the temporal interpolation by curve fitting can lead to obtaining more matched data over land than over ocean.