Reviewer #2

The paper "Validation of XCO_2 and XCH_4 retrieved from a portable Fourier transform spectrometer with those from in-situ profiles from aircraft borne instruments" by Ohyama et al. presented the validation study of EM27/SUN using in-situ aircraft profile measurements. They have done thorough analyses of the descending and ascending aircraft profiles and used descending profile to derive the correction factors for XCO_2 and XCH_4 for the portable FTS. The paper is clearly written and the approach and technical details are well elaborated and presented. Because this study is one of the first attempt to derive the correction factors for EM27/SUN using in-situ profiles from aircraft borne instruments, I recommend publication with the following comments addressed:

We thank you for reading our paper carefully and providing valuable comments. We have revised our manuscript according to your comments. Please see our specific responses below.

1. Abstract: The sentence "The EM27/SUN XCO_2 and XCH_4 data...were not applied" is in my opinion redundant. You may remove this sentence and add a separate sentence to compare the correction factors for EM27/SUN and TCCON instrument.

We have simplified the sentence as follows: "The EM27/SUN XCO_2 and XCH_4 data were derived by using the GGG2014 software without applying air mass independent correction factors (AICFs)." In addition, we have added the following sentence (lines 55–56): "Applying AICFs being utilized for the TCCON data (0.9898 for XCO_2 and 0.9765 for XCH_4) to the EM27/SUN data induces an underestimate for XCO_2 and an overestimate for XCH_4."

2. Line 84: other satellite validation studies include: https://www.atmos-meas-tech-discuss.net/amt-2020-19/ https://www.atmos-meas-tech.net/8/5023/2015/amt-8-5023-2015.pdf

We have revised the sentence as follows: "An additional observation campaign for satellite data validation was conducted in the desert areas of Australia (Velazco et al., 2019). Furthermore, EM27/SUN data obtained above the Atlantic Ocean (Klappenbach et al., 2015) and in boreal areas (Tu et al., 2020) have been utilized for satellite validation studies."

3. Line 85: Long-term observations using EM27/SUN have also been conducted in urban areas, for example in Munich when deploying an automated enclosure system (https://www.atmos-meas-tech.net/11/2173/2018/amt-11-2173-2018.html).

We have revised the sentence as follows: "Long-term observations have also been conducted in Africa where operational observation by the IFS 125HR is difficult (Frey et al., 2020), and in urban areas, e.g. in Munich when deploying an automated enclosure system (Heinle and Chen, 2018)."

4. The authors have specified the total time duration for the ascending and descending flights, could you please specify how long they take individually to get a sense about the time duration for the profile sampling.

We have revised the sentences on the KORUS-AQ flight as follows: "The descending profile was measured from 10.81 to 0.10 km *in ~34 min* with a spiral flight pattern over the Rikubetsu site. The ascending profile was measured up to an altitude of 11.51 km *in ~27 min* in a linear manner on the west side of the Rikubetsu site."

Similarly, the sentences on the EMeRGe flight have been revised as follows: "The descending profile was measured from 6.47 to approximately 0.6 km *in ~20 min* approaching the Burgos site from south to northeast. The low-level flight at approximately 0.6 km was performed as near as possible to the north side of the Burgos site *for ~9 min*. The ascending profile was measured up to 9.32 km *in ~11 min* after the low-level flight west of the Burgos site. Additional data for the profiles above 6.47 (descent flight) and 9.32 km (ascent flight) were taken from the same aircraft data measured during the descent flight *lasting for ~10 min* from an altitude of 13.87 km west of Manila."

5. Line 227: can you please elaborate more in detail how did you determine the errors in the aircraft CO_2 on the basis of precision and accuracy of the LICOR NDIR spectrometer?

We have added the following sentence in Sect. 3.1 (lines 239–241): "We estimated the uncertainties in the aircraft CO_2 data to be 0.27 ppm from the square root of the sum of the squares of both a precision of 0.1 ppm and an accuracy of 0.25 ppm (Vay et al., 2011; Tang et al., 2018)."

6. Figure 1 and Figure 3, subfigures b and c: Can you please show/mark the tropospheric heights together with the measurement profiles?

We have added three types of tropopause heights (lapse rate tropopause, dynamical tropopause, and the GGG2014 derived tropopause) in Figs. 1b and 1c and have added the GGG2014 derived tropopause in Figs. 3b and 3c.

7. Line 354: compare the influence of the transport on XCO_2 and XCH_4 with the uncertainties. Please specify the uncertainties or referring a citation e.g. Frey et al. 2019.

We have revised the sentence as follows: "Thus, the influence of EM27/SUN transports on the XCO_2 and XCH_4 retrievals are comparable to their 2σ uncertainties (0.6 ppm for XCO_2 and 2.2 ppb for XCH_4 (Frey et al., 2019))."

8. Line 377: the number of EM27/SUN data are 4 and 24 according to the temporal coincident criterion are not really visible in the Figure 5.

In Figure 5, we have highlighted the time satisfying the temporal coincident criterion.

9. I would include the instrument line function parameters in the table 3 or table 4. The different instrument line function of the EM27/SUN at different locations could be part of the reason for the different relative differences.

We have added the modulation efficiency in Table 3 and have added the following sentences in Sect. 3.4 (lines 429–435): "Provided that the mean value of the modulation efficiency before and after the transport was that during the campaign, the difference in the modulation efficiency between the campaigns (EMeRGe – KORUS-AQ) was –0.0031 (Table 3), which corresponds to a change of –0.047 % for the XCO_2 value. Because the relative difference between the EM27/SUN and the aircraft XCO_2 data differed by –0.072 % (Table 4) between the campaigns (EMeRGe – KORUS-AQ), the change in the ILS of the EM27/SUN for the campaign periods may have partly contributed to the difference in the relative differences."

10. Figure 5: it is hard to see the comparison between corrected EM27/SUN, TCCON and airborne instruments, maybe you can zoom in a bit.

We have changed the scale of y-axis of Figure 5.

11. Figure 5, caption: without.... (AICFs = 1) and with (AICFs ~= 1)

We have revised the caption.

12. Table 3 caption: we note -> please note

We have revised the caption.

13. I would recommend language check including usage for commas and consistency check for past and present tenses.

A language check has been conducted for the entire manuscript by a native English speaker who is a co-author.