Alberti et al. compared multiple products of total column measurements of greenhouse gases, including ground- and space-based observations and model simulations, at two high-latitude Russian cities, St. Petersburg and Yekaterinburg. As high-latitude total column observations are sparse, such evaluations are quite useful. The paper is well written, with some structural improvements, it will be suitable for publication at AMT.

General comments:

We would like to thank anonymous Referee #2 for evaluating our manuscript and for the constructive comments that will definitely improve it. Below, we list the original comments/questions in blue colour and our respective answers in black, respectively.

1. Many products are compared. However, it is not clear whether there is a reference. On the one hand, COCCON retrievals were described biased low compared to other products, on the other hand, COCCON retrievals were used to scale the CAMS simulations. Are COCCON retrievals linked to the WMO scales? In a similar way as done for TCCON. With the current version, it gives the readers an impression that various products were compared.

We believe that the COCCON data products can be regarded as to be linked to WMO scale and can be used as a reference for validation purposes. Firstly, strong emphasis is put on achieving an accurate calibration of each spectrometer using laboratory characterisation procedures and side-by-side solar measurements with the TCCON station in Karlsruhe and the COCCON reference spectrometer operated by KIT. The procedures are described by Frey et al., 2019, and Alberti et al., 2021. Secondly, for the COCCON network in total, the Xgas products generated with the PROFFAST code are calibrated using TCCON as the reference. TCCON in turn is linked to the WMO scale by using in situ-profiles. That the applied procedures are successful and has been investigated in the framework of the ESA project FRM4GHG. The results of this project have been published by Sha et al., 2019. Therefore, we do not believe that COCCON suffers from a low bias and we decided to scale the CAMS fields as suggested by the COCCON results. We regard the COCCON scale as reference in this comparison. We therefore state in the abstract that "These adjusted CAMS data are then used for satellite validation".

We agree that our statement "COCCON XCO_2 is biased low by about 0.8-3.1 ppm in comparison to CAMS and other satellite products" is misunderstood in this context. We therefore changed it into "CAMS and the satellite products show a high bias of about 0.81-3.1 with respect to COCCON."

2. The scaling of CAMS data based on the COCCON data is a practical way of obtaining more matches. The scaled CAMS data could be called bias corrected CAMS data, instead of upscaled COCCON data. Since COCCON retrievals are obtained by scaling the priors, if the priors would be CAMS, it will be more straightforward to obtain the scaling factor, correct?

We do not fully agree with the suggested wording of "bias corrected CAMS data", as we do not apply a global bias correction to the CAMS data, but a scaling which is variable on time scales of several weeks (see Fig A-5 to A-7 showing the variability of the scaling factor). We agree that the operation also removes a general bias between CAMS and COCCON (and implicitly handles COCCON as the true scale), but it also reduces e.g. seasonal variations that are imperfectly reproduced by the model. We therefore would like to maintain the wording concerning the generation of a "scaled" CAMS dataset (one also might think of instead using the term "adjusted" or "tuned" for the resulting CAMS dataset?).

In general, COCCON aims at delivering data, which are compatible with TCCON. For this reason, we decided to adopt the a-priori profiles assumed by TCCON for the COCCON data analysis for the manuscript in discussion. However, we agree with the referee that in the context of adjusting the CAMS model using the CAMS profile as a-priori choice would be preferable. Therefore, we have re-processed the COCCON dataset by using CAMS profiles as a-priori and we have updated all the figures and results accordingly.

Some detailed comments:

L84: in this region instead of on this region

Changed accordingly

L94: compare already means intercompare/inter-compare, just use compare

Changed accordingly

L224: please rephrase the sentence. The dry air column from the ECMWF simulations?

Sorry, our statement was confusing. We rephrased the sentence as follows:

XCO is computed by dividing the CO total column by the dry air column extracted from the co-located TROPOMI CH_4 file. This dry air column is obtained from the surface pressure and water vapour column as provided by the European Center for Medium-Range Weather Forecast (ECMWF) analysis (Schneising et al., 2019; Lorente et al., 2021)

L279: were averaging kernels considered in the integrating process?

In the revised version of the manuscript, the CAMS profiles are used as a priori for COCCON. Therefore, no smoothing correction appears in this profile.

L290: why is COCCON XCO2 biased low by about 0.81 – 3.1 ppm? Is the difference indeed caused by a bias in COCCON XCO2? How is it known?

We changed the wording accordingly. We are not aware of a COCCON bias.

L417: how many points? It seems that very little data is available at Yekaterinburg.

As mentioned in L190, for the whole period of measurements, a total of twenty measurements days were collected. Considering that the active measurement period was October-April (autumn-spring), which are not the best months in terms of sunny conditions, the amount of measurements is still sufficient for applying the scaling method.

L432: I wonder whether the linear regressions are significant? What are the R-squared values?

As we apply a scaling on the CAMS data, the required factor is deduced from a linear regression forced through the origin. Therefore, the resulting R value is very near to one.

L478: please show some objective ways of assessing the agreement as "close agreement" cannot be judged.

Thank you for pointing this out! We accordingly added the table below in the appendix, which contains the actual variability (standard deviation) over the full measurement period as indicated by CAMS, and the bias and standard deviation of the difference between CAMS and COCCON, and between scaled CAMS and COCCON for each studied city, respectively. The value in the column “CAMS variability” can be regarded as minimum requirement for an acceptable agreement; while a “close agreement” between adjusted model and observation should be a fraction of this value. As can be seen from the table, the standard deviation between scaled CAMS and COCCON is significantly smaller than the actual variability, so this justifies the statement of a “close agreement” and this applies for both cities.

We added the following statement to the text of the paper.

From the Table A-2 in the appendix, it can be observed that the bias and the standard deviation between scaled CAMS and COCCON is significantly smaller than the CAMS variability of the original data-set. This further demonstrates the "close agreement" between adjusted model and observation.

Table A- 1. The variability (standard deviation) of the original CAMS products during the COCCON measurement period in each city, and bias and standard deviation for the difference between CAMS and COCCON, and between scaled CAMS and COCCON.

Species	Peterhof			Yekaterinburg		
	Variability of original CAMS products	CAMS - COCCON	scaled CAMS - COCCON	Variability of original CAMS products	CAMS - COCCON	scaled CAMS - COCCON
XCO_2	3.45 ppm	1.76 ± 0.82 ppm	0.18 ± 0.79 ppm	2.24 ppm	1.31 ± 0.69 ppm	-0.008 ± 0.56 ppm
XCH_4	11.81 ppb	14.97 ± 8.7 ppb	-1.95 ± 6.84 ppb	5.95 ppb	19.9 ± 5.88 ppb	-0.58 ± 4.19 ppb
XCO	10.67 ppb	0.59 ± 6.51 ppb	-1.92 ± 4.90 ppb	11.58 ppb	1.96 ± 6.50 ppb	2.16 ± 5.03 ppb