Reply to comments raised by Referee 2

Comment on "Independent validation of IASI/METOP-A LMD and RAL CH_4 products using CAMS model, in situ profiles and ground-based FTIR measurements" by Bart Dils et al.

General:

This paper describes the validations of two methane products from IASI/METOP-A satellite sensor. This work is important, but I couldn't understand why the authors think that it is enough to use RAL data without correction. They pointed out there is a discontinuity in mid-2013 and compared some trends in Section 5.4. The corrected trend (5.6 ppb/yr) is significantly higher than the original one (4.2 ppb/yr) and the difference is larger than the standard deviation of original one. I think the trend analyses in Section 5.1 and 5.2 should be done using corrected data, or at least separately for the periods before and after mid-2013. Furthermore, the discontinuity should affect the results of validation in Section 4 but there is no explanation. The validation of RAL should also be done using corrected data, or separately for the periods before and after mid-2013.

The paper should be published after major revisions.

I would like to thank the reviewer for the useful comments. A common comment of both reviewers pertains to the structure of the paper and upon reflection, I have to concur with their observations.

Particularly, the comparisons with independent reference data are impacted by the various temporal instabilities that are present in both datasets be it gradual or sudden. In the current structure, these temporal issues are discussed in depth after the in situ comparisons (in part because the temporal hiatus was discovered during the project). We therefore suggest a change in the structure of the paper in which we first focus on the LMD and RAL side-by-side comparisons using CAMS as an intermediate, including a figure that shows the LMD-RAL global bias distribution (as the bottom row of current figure 4) as a function of time (see figure below as an example). Then, after a discussion on the various temporal dependencies that are at play, we will turn to the independent reference data, where we break up the RAL data into two segments due to its bias shift in 2023.

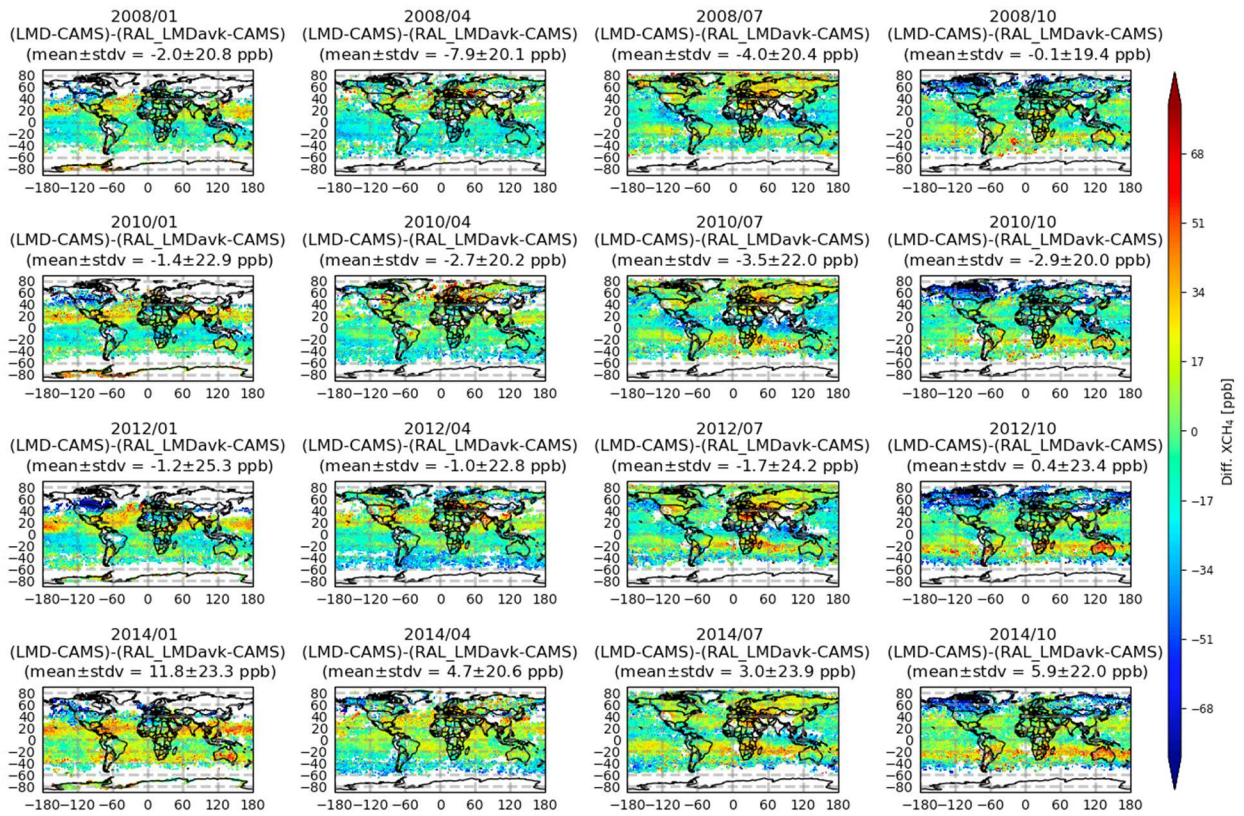

Figure 1: The difference in LMD and RAL_LMDavk biases relative to CAMS for different months (columns) and years (rows)

Comments and questions:

All technical suggestions will be implemented in the revised document. More specific questions are answered below.

Abstract

p1, l17

The long-term stability --> The long-term trend

This will be corrected

Section 1

p2, l5 and 8

IPCC, 2013 --> It is better to refer newer report (IPCC, 2021)

This will be corrected

Section 2

p6, l8

largly --> largely

This will be corrected

p7 2.4

It is better to describe the original spatial resolution of CAMS because it was averaged onto a 1-degree latitude and 1-degree longitude grid before comparison.

This will be implemented

Section 3

p9, l8-9

Please discuss on the impact of this difference to the validation results in Section 4.7.

This section will be impacted by the planned restructuring of the paper. However we will add a paragraph on discussing the potential impact of the sensitivity differences on their respective validation results.

Section 4

p13, l4

What is 'pixel'? Is it mostly the same as IFOV? Please explain it in Section 2.

The paragraph bottom of page 13 (line 29-31) states the difference between RAL and LMD regarding their use of the IFOV with the highest Brightness temperature vs. the average thereof. So what we further indicate as pixel depends on the algorithm. A line will be added so to better define this term, and if possible the ambiguous term itself is replaced by measurement.

p14, l28

June --> July

This will be corrected

p15, l24

… and IAGOS … : IAGOS isn't used for Figure 6. This is misleading.

Re-word in the revised version.

This will be corrected

l28-29

XCH_4 generally …: What does this sentence mean? Are there any relations to the validation results?

I agree that the term is too vague. The phrase points to Figure 6. Where you see a clear increase in the 0-6 km layer as you move from the equator to Northern latitudes. The 'general' alludes to the fact that this of course does not hold true from an individual measurement to another individual measurement basis. We will rephrase it as such:

The 0-6km partial column, figure 6 (top), shows a consistent qCH4 upward trend with latitude in the Northern Hemisphere. For the 6-12km partial column, figure 6 (bottom), two qCH4 concentration peaks can be observed around 35°N and 75°N.

p16, l32

Figure 8 --> Figure 8 (left)

This will be corrected

p17, l7

Figure 8 --> Figure 8 (right)

This will be corrected

l10

Tule --> Thule

This will be corrected

l11-13

Why this sentence is put here and the content is different from that described in l2-3.

This is indeed an oversight on our behalf. An erroneous statement was left in the text next to its correction. The strongest biases are observed in spring (when ice starts to thaw) and therefore the last sentence is redundant and will be removed.

p18, l3-6

… temporally …: Does HIPPO observation limited to some season? What figure in the top row of Figure 4 should be referred? This sentence is too vague.

The HIPPO measurements were taken on a campaign basis and each campaign was by default limited in time. All campaigns combined do make sure that all seasons are covered. HIPPO I took place in January 2009; HIPPO II in October-November 2009; HIPPO III in March-April 2010, HIPPO IV in June- July 2011, and HIPPO V in August-September 2011. (These period descriptions will be added to the HIPPO description)

However, this sentence specifically alludes to the observation that when we look at the subset of HIPPO comparisons in figure 7 where the bias was the strongest we found that they matched the location and timeframe that corresponded with our earlier assessments. We will make this more exact, denoting the locations and timeframes in question.

Section 5

p20, l11

It is found that … --> At land regions, it is found that ...

This will be corrected

l33-p21, l1

What about Maido?

Maïdo only started NDACC measurements since 2013 (so only a short time coverage), therefore concerning the issue discussed, it does not provide a clear message and therefore it is not listed here.

p21, l25-27

What is the definition of ‘similar’ and ‘different’? Why Wollongong is ‘similar’ but Lauder isn’t categorized?

Here 'similar' means: the patterns of their seasonal variations are the same. 'different' means the patterns of their seasonal variations are different or opposite. We will reword the sentence to make clear it pertains to the seasonal cycle and/or phase. We listed stations as examples, not as an extensive list. In this case however we probably listed too many stations as examples giving the impression that it indeed should be a full list. We will make this clear in the revised document.

Section 6

p23, l3

Section 4.1 --> Section 4.3.1

This will be corrected

Section 7

p26, l8

The long-term stability --> The long-term trend

This will be corrected

Many figures

Thanks for bringing up these points regarding the figures. We will correct all mistakes and will work to make them clearer. As for figure size, we realize that we needed to make a compromise between avoiding overloading the paper with (larger) figures and disseminating enough information. We will work on improving their visibility.

The legends covered some of data plot. Move them not to cover the data.

Size of the figure is too small.

Figure 1

There are many mistakes. For example,

I couldn't find 'AirCore' mark at Sodankylä.

I found 'NDACC' mark at Ny-Ålesund but Ny-Ålesund isn't listed in Table 2.

I found 'NDACC' mark at Rikubetsu but Rikubetsu is listed in Table 1 (TCCON site).

Please check carefully.

This will be corrected

Figure 2 caption

The solid data --> The solid line

This will be corrected

Figure 5, 6, and 7

The correlation plots should be written with HIPPO values in horizontal axis. The values to be validated (RAL or LMD) should be in the vertical axis.

This will be corrected

Figure 5 caption

the scatter plot between the RAL and HIPPO XCH_4.

--> the scatter plot between the RAL and HIPPO XCH_4 (right).

This will be corrected

Please add the explanation of the gray bar in the left figure, black bar, black solid line, and pink dashed line in the right figure.

This will be corrected

Figure 6 caption

Same as the comments for Figure 5.

This will be corrected

Figure 7 legend

GB --> AIR

This will be corrected

Figure 14

There is no error bar for Rikubetsu.

There are only 8 co-located satellite-FTIR data pairs at the Rikubetsu site. Therefore the uncertainty is very large. In the revised version, we have removed Rikubetsu in Figure 14.