Reply to referee #1

First of all I would like to thank the reviewer for the thorough evaluation of our paper. All suggested technical corrections have been implemented. Furthermore there were some additional questions which I have reiterated below with our responses in italic

P14L24-29: edge viewing value vs. nadir value Why is the value for the edge viewing in case mtCH4 LMD larger than that for the nadir viewing, but the nadir value is larger in case XCH4 RAL?

Given the very different natures of both retrieval methods, it is very difficult to truly assess the impact of the viewing angles upon the final products and why they differ so much between algorithms. This is a topic of further investigation by the algorithm development teams.

P19L24-25: "Both results are close to the mtCH4 annual growth of 5.3 ppb/yr …."

What does "Both results" refer to? RAL_LMDavk and RAL_LMDavk (2 periods)?

This is an error on our behalf and it should be a singular expression: This result…

P21L10-17: in Section 6

It would be better to clearly state in this part that the RAL data used here is bias-corrected.

This has been implemented in the beginning of Section 6

All the technical corrections listed below have been implemented

3) Technical corrections

・Please unify abbreviations in the text.

NLIS (P1L4, P2L22) or NILS (P3L19, P4L2, P4L9, P7L8)

DOFs (P3L29, P6L7, P21L20) or DOFS (P15L15, P29L13) or DOF (P15L23 and L24,

P16L13) or DOF's (P30L16)

P4L23: "((Karion et al., 2010))" should be "(Karion et al., 2010)".

P5L12: IAGOS CARIBIC should be "IAGOS-CARIBIC".

P11L10: "((Rodgers and Connor, 2003))" should be "(Rodgers and Connor, 2003)".

P13L11: "A0" and "A1" should be "A0" and "A1", respectively.

P16L16 and P18L8: "mayor" may be "major".

P18L33-34: References on TransCom and Carbon Tracker are needed.

P19L22: "Table 6" should be "Table 3".

P22L30: “Table 3” should be “Table 4”.

P24L5: “Table 4” should be “Table 5”.

P24L12: “/textitin” may be “in”.

P28L26: “Table 5” should be “Table 6”.

P30L19: “Figure 11” should be “Figure 10”.

Table 6: The values for LMD differ from those in the text. Please check once.

Table 7: This table is not quoted in the text. Please delete the table or quote it appropriately in the text.

Figure 6: In the figure caption, “-20 deg to 20 deg”should be “-60 deg to 60 deg”.

Figure 11: In the caption, “Figure 12”should be “Figure 10”.

Figure 14: In the figure caption, “Figure 10”should be “Figure 13”.

Figure 15: The two plots (6-12 km and 0-6 km) on the left should be replaced.

Figure 15: Since N is not used in the figure, the figure caption does not need to explain it.

Reply to Referee #2

Again, I would like to thank the reviewer for his in depth and thorough report. All the suggested technical corrections have been implemented, and where questions were put forth, we replied to these in the text below (in italic).

On a more general note, there was some confusion as to the nature of the so-called core stations. We have tried to clarify this in the following paragraph as follows:

Here we compared the LMD and RAL methane data products with ground-based remote sensing data from the TCCON and NDACC networks. As with the in situ comparisons, a +6.7 ppb correction has been applied to the RAL post May 16th 2013 data. Also note that there is substantial difference in the time-periods covered by the individual stations. For TCCON, the stations that cover almost the entire time period (less than 2.5 years of missing data), and hence-forward referred to as core stations, are: Sodankyla, Bialystock, Orleans, Garmish, Park Falls, Lamont, Izana, Darwin, Wollongong and Lauder. Other stations on the other hand have noticeably shorter coverages (Rikubetsu and Edwards for instance have less than 2 years of co-located measurements). For NDACC, all stations are listed as core stations as they cover quasi the entire timeperiod, apart from Maïdo (2.5 years of data), which is excluded. Note that both Mauna Loa and St-Denis feature some large (> 1 year) data gaps in their time series and that even with a long time span, the number of co-located data pairs may differ greatly between stations. For instance at high latitude sites (Eureka, Thule) annual gaps occur in the dataset during wintertime (see Figures 16 and 17). For RAL, the amount of pre- versus post-discontinuity data largely determines the magnitude of the impact of the applied discontinuity-correction and therefore when comparing average

overall long-term trends we have restricted ourselves to the so-called core stations which cover a substantially long time period as listed above.

Comments and questions:
Abstract
p1, l14
difference is --> differences are
Section 2
p4, l3
AMSU --> Advanced Microwave Sounding Unit (AMSU)
p4, l23
((Karion et al., 2010)) --> (Karion et al., 2010)
p5, l2
'returned either over the Eastern Pacific, or over the Western Atlantic'
Is it true? I couldn't find Western Atlantic path in Figure 1.

This should of course be Western Pacific

Section 3
p8, l8
weighing --> weighting
p13, l11
A0, A1 --> A_0, A_1 (subscript)
p14, l2
60°N-60° correction --> 60°N-60°S correction
Section 4
p16, l15
short summary --> Short summary
p16, l16
mayor --> major
p16, l17
interpixel --> inter-IFOV
Section 5
p17, l25-27 and l30-32
The following two sentences maybe the same:
'In October, this positive bias band has shifted towards the Southern hemisphere. Strong negative biases are observed over the Canadian Boreal forests.'
'In October a positive latitudinal bias belt between 10°S and 30°S can be observed over land and sea, while outspoken negative biases are visible at high Northern latitudes'

They are indeed and have been merged

p18, l8
mayor --> major
p19, l22
Table 6 --> Table 3

p19, l24
‘Both results …’
I think you only compare one result (RAL_LMDavk (2 periods)) with that by LMD.

Yes, this phrase is now in a singular form

p19, l30
seasonal cycles --> seasonal cycle amplitudes
p20, Table 3 caption
RAL_LMDavk (corrected) --> RAL_LMDavk (2 periods)
p21, l1
short summary --> Short summary
Section 6
p21, l16
United States and Finland --> United States, New Zealand, and Finland
p22, l30
Table 3 --> Table 4
p23, l9
in the vertical range of 6-12 km --> Please remove.
p23, l16
You changed the order from
‘IAGOS and RAL measurements’
to
‘RAL measurements and IAGOS’.
If you want to use the order of
”to be validated” and “reference measurements”,
it is better to use this order throughout the paper.

This has been implemented throughout the paper

p23, l18
+6.6 ppb --> +9.6 ppb
p24, l5
Table 4 --> Table 5
p24, l10
comparisons --> Comparisons
p24, l12
/textitin situ --> in situ
p24, l20
post-discrepancy --> post-discontinuity
p24, l20
‘an obvious impact on the magnitude of the impact of the applied discontinuity-correction’
This is confusing because you use two ‘impact’. Please consider revising.

Reworded: For RAL, the amount of pre- versus post-discontinuity data largely determines the magnitude of the impact of the applied discontinuity-correction and therefore when comparing average overall

long-term trends we have restricted ourselves to the so-called core stations which cover a substantially long time period as listed above

p25, l26
by --> maybe 'in comparison with' is better
p26, 5-8
'Again looking … other stations.'
I couldn't understand what you want to say from the latter part of this sentence (after 'apart from' phrase).

Reworded: Again looking at the long-running core stations, the RAL-TCCON long-term trend bias difference, ranging between -2.72±0.62 ppb/year (Lamont) and -0.47±0.46 ppb/year (Lauder), shows little latitudinal dependence apart from the observation that Southern hemisphere RAL-TCCON trend differences are slightly smaller, compared to those observed at Northern hemisphere stations.

p27, l3
What is 'core station'?
p27, l6-7
'but there is unfortunately very little data within this range and the variability outside this range is considerable.'
I think 'this range' means 40°S-40°N. There are 10 stations within this range and 8 stations outside this range from Figure 20. I couldn't understand why you said 'very little data' without the definition of 'core station'.

The definition of core station has been added and section has been reworded: Overall the bias differences are more outspoken compared to the RAL-TCCON trend differences. We also typically find the strongest negative LMD-TCCON trend biases outside the 40°S-40°N range (-4.48 ppb/year at Lauder, 3.76 ppb/year at Sodankyla), but the variability within and outside the 40°S-40°N range is considerable. For instance, the trend difference at Orleans (48°N, -1.09 ppb/yr) is smaller than that observed at Lamont (36.6°N, -2.36 ppb/yr).

p28, Table 7
The numbers misplaced. For example, 4.84 ppb is the RAL mean at TCCON sites.
Also, there is no description of the Table 7 in the text.

This has been added:

Table 7 below shows the averaged (over all core stations) long term trends of both LMD and (bias-corrected) RAL and their corresponding co-located NDACC and TCCON mtCH4 timeseries. Overall, on average, both LMD and RAL underestimate 5 the long term trend. Also immediately apparent is the far greater standard deviation on the trend for LMD, compared to RAL, indicating stronger station-to-station variability.

p28, l26
Table 5 --> Table 6
p29, l8
initial a priori profile --> a priori profile
Section 7

p30, l9-10
'not insignificant (but not impossible either)'
Is this means that significant and possible? There are many unclear expressions throughout the paper.

Reworded: Changing the CAMS UTLS transition region resulted in significant changes in the observed biases with HIPPO. However in most cases, the biases increased instead of decreased and in the rare cases the comparison improved, upward shifts of up to 4 km of the transition region were required.

Section 8
p31, l14
discrepancy --> discontinuity
p31, l17
Where the value '1.3 ppb' come from? ('1.1 ppb' maybe come from 15.2 – 14.1 in the Table 4 but I couldn't find 1.3 ppb.)

This was an error, the phrase has been reworded: For AirCore these differences in stdv are small (15.2 ppb for LMD vs. 14.1 ppb for RAL).

p31, l24
the long-term stability --> the long-term trend
p31, l27-28
'The L1 … now using.'
Is this for the newer version than RAL v2.0 that wasn't analyzed in this paper? If so, please clarify it.
Instead of this information, you should describe the result with discontinuity correction.

Only a very preliminary analysis of an intermediate update was performed. We removed this sentence to avoid confusion.

p32, l3-4
'Improvements … reduced.'
Is this also for the newer version? Are you already analyzed it?

See above

Figure 1
There are 'AirCore' mark in the Atlantic Ocean. What is this?

Unfortunately, in the AirCore datafile one entry was tagged with the wrong geolocation. This has been fixed. No impact on our further AirCore analysis was observed.

Figure 3 caption
'for the -20° to 20° …'
The latitudes should be -60° to 60° and there are 4 graphs, not two.
Figure 6 caption
The last three rows --> The last two rows
Figure 8 caption
RAL (b) RAL_LMDavk (d) --> RAL (b), and RAL_LMDavk (d)
between LMD and RAL_LMDavk (e), between RAL and RAL_LMDavk (f)

--> between LMD and RAL_LMDavk (e), and between RAL and RAL_LMDavk (f)
Figure 12 caption
2013 timeserie. --> 2013 timeseries.
Figure 13 right figure
Is the dashed line correct? You changed x-axis and y-axis but the dashed line doesn't so change.
Figure 13 legend
(+6.7 ppb discontinuity corrected) --> remove or (no data after May 2013)
N is the number … --> now N isn't written in the figure. Please remove.
The colored dotted --> The dotted (now the line is black.)
'with forcing the fit to go through (0,0)'
Is it true? It looks only y=x line.

It is indeed a y=x line, this has been corrected

Figure 14 axis titles
CH4 --> mtCH4 is better
Figure 14 right figure
The dashed line also should be checked.
Figure 15
The positions of the left figures are wrong.
The dashed lines in the right figures also should be checked.
Figure 15 caption
Same as the comments for the Figure 13 caption
Figure 22 caption
There is no description for the CAMS_LMDavk.

CAMS_LMDavk corresponds with CAMS model data at Boulder smoothed by the LMD weighting function.