Author reply

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1 Answer to the editor

We would like to thank the editor and the reviewer for their help with improving the manuscript.
In the following we list the reviewer comments in **bold** font and our answers in normal font.

2 Answer to Reviewer 1

2.1 Specific comments

Referee comment: Lines 15 – 16 and 72 – 73: It would help to specify that the CAMS global inversion system uses surface observations and data from GOSAT.
Author's reply: We mainly compare our results to growth rates derived from CAMS/INV data based only on surface observations. To keep the abstract short we hence only mention the CAMS/INV data based on surface observations. In the introduction we mention briefly of both versions of CAMS/INV (with and without satellite data).

Referee comment: Lines 21 – 22: Consistent with the second reviewer's last comment, it might help to rephrase this sentence to clarify that the author's interesting results support past conclusions about the causes of observed methane trends rather than producing new inferences.
Author's reply: We added a sentence to the abstract to mention that our results support past conclusions about the causes of observed methane trends. However, we still want to emphasize that the discrepancy between NH and SH methane increases is a novel result of our study and, to our knowledge, hasn't been mentioned before in literature.

Referee comment: Line 116: In the response to reviewers, the authors seem to suggest that the data are averaged in two latitude bands at 60°S and 60°N, instead of one latitude band between 60°S and 60°N as suggested here. I'm assuming this was a typo, but the proper explanation should be used here.
Author's reply: We apologize for the misunderstanding in our reply. Indeed we

mean a single region between 60°S and 60°N as described in the manuscript.

Referee comment: Line 141: Many thanks to the authors for their description of how the uncertainties are calculated in the response to the reviewers! Can you mention the origin of the uncertainties used here somewhere in the text (perhaps in the section 2 data descriptions?).
Author's reply: As recommended we describe the origin of uncertainties to section 2.

Referee comment: Line 286 – 287: Thanks so much for clarifying these terms! I assume the standard deviations here to the DLM-produced uncertainties? (Can you clarify in the text, too (e.g., as "the corresponding uncertainties as given by the DLM)"?)
Author's reply: As recommended we clarified this in the updated manuscript.

Referee comment: Figure 4 and lines 330 – 337: I'm confused by this figure. What does it mean to apply zonal-first averaging to zonal growth rates? You describe zonal-first averaging as calculating the zonal average, then averaging the zonal averages globally. I assume you only apply the first step here. As a result, I'm confused by what you show in Figure 4. I'm also confused by the large differences between zonal-first averaging and full-coverage averaging at 10°S – 10°N, which seem to suggest that the standard averaging approach may be preferable. It also seems like neither averaging method recovers the full-coverage growth rate at 30°S – 50°S.
Author's reply: By zonal-first averaging we mean that the data is first averaged in each latitude "band" and then averaging all latitude band averages. Since the data is on a 2°x2° grid this means that each latitude band is a 2° band. This is what we mean by zonal bands. We understand that this was not explained sufficiently and provided some clarification in the updated manuscript. Zonal-averaging first for zonal bands hence means that (for a 20° zonal band), we first average the 2° latitude bands and then calculate the average of the 20° band from these ten averages. Zonal-averaging first can thus also be applied to 20° zonal bands.
Regarding the 10°S-10°N band we want to point out that both averaging methods are in 1σ agreement with the growth rate derived from unmasked data. It is also true that neither method recovers the full-coverage growth rate at 30°S-50°S, indicating that sampling is to sparse to recover the full information. This is why we calculate a sampling bias in the following paragraph which quantifies the difference between growth rates derived from unmasked and masked data. For the aforementioned regions this sampling uncertainty is especially high (see Tab. 1). Both averaging methods show good agreement for most bands, and some disagreement for few bands, with no clear winner. As mentioned in the manuscript, we therefore base our decision for using zonal-first averaging mainly on the fact that sampling within a 20° zonal band can still vary with latitude and zonal-first averaging is hence preferable.

Referee comment: Line 380: Is this related to the higher uncertainty for AMIs at the start/end of a time series or the higher uncertainty

for DLMs at the start/end of a timeseries? If the former, why does this explain the deviation of DLM@CAMS/INV-SURF compared to the other AMIs shown in Figure 7?
Author's reply: The latter is correct. The higher uncertainty for AMIs at the start/end of a time series is directly caused by the higher uncertainty for DLMs at the start/end of a time series. We changed this in the text.

Referee comment: Line 424: Are there no significant sub-annual variations in zonal growth rates? Figure 8 panels 30°N – 50°N, 50°N – 70°N, and 50°S – 70°S seem to suggest otherwise. (Relatedly, on line 426, you write "short-term variations between zonal bands are not detected.")
Author's reply: By sub-annual variations we actually meant variations on a monthly timescale. We clarified this in the updated manuscript.

Referee comment: Line 431: Do you mean "bands between 10°N (instead of S) and 70°N when we speak of the Northern Hemisphere"? It seems like you discuss 10°S – 10°N separately.
Author's reply: We corrected this typo in the updated manuscript.