

## ***Interactive comment on “Global height-resolved methane retrievals from the Infrared Atmospheric Sounding Interferometer (IASI) on MetOp” by Richard Siddans et al.***

**Anonymous Referee #2**

Received and published: 20 January 2017

General comments:

The authors have applied height-resolved methane retrievals to IASI using a modified N<sub>2</sub>O correction scheme. Given the global coverage and long-time series for IASI, improvements in IASI results will lead to significant scientific advancements.

The abstract states that the scheme is novel in the use of "precisely fitting measured spectra in the 7.9 micron region to allow information to be retrieved on two independent layers centred in the upper and lower troposphere" and "making specific use of nitrous oxide (N<sub>2</sub>O) spectral features in the same spectral interval to directly retrieve effective cloud parameters to mitigate errors in retrieved methane due to residual cloud and other geophysical variables" were both previously done by Worden et al. (2012). The

C1

statement that this is novel should be removed. The authors could state that they have developed a novel variant of N<sub>2</sub>O correction.

The abstract and conclusion gives only errors for the column. The abstract and conclusions should give the errors for the new vertically resolved quantities. In the conclusions, if errors are also given for column CH<sub>4</sub>, these should be compared to current IASI CH<sub>4</sub> products.

P8 L20. The article states that the averaging kernel and predicted errors are more accurate in the new scheme versus previous methods where N<sub>2</sub>O is retrieved and then used to correct CH<sub>4</sub>. To make this claim, comparisons of results, averaging kernels, and predicted errors need to be shown between the method where N<sub>2</sub>O is fixed versus retrieved, at least for a few cases. The results where N<sub>2</sub>O is retrieved must include the retrieval of cloud parameters to make it a fair comparison, as the previous scheme this tries to improve on, e.g. Worden et al. (2012), retrieves cloud parameters jointly with N<sub>2</sub>O and CH<sub>4</sub>.

The title of the article is "Global height-resolved methane retrievals..." and yet most of the results shown are column results. Comparisons to TCCON and GOSAT are of limited interest to this paper because they are not vertically resolved. The only reason to compare the total column is if the new retrieval improves over the current IASI column. If this is the case, both new and current IASI CH<sub>4</sub> results should be shown.

HIPPO is primarily over ocean. The authors need to validate the height-resolved CH<sub>4</sub> over land.

Specific comments:

P.2 Line 18. The word "also" is confusing and should be taken out.

P2 L32 "Sophisticated use" is not a useful description of what the authors are doing. I would reword this to something like, "Use of an fixed N<sub>2</sub>O volume mixing ratio values,

C2

based on ACE climatology described in Section XX, to retrieve cloud parameters in the CH<sub>4</sub> spectral region."

P5 L16. The description of the N<sub>2</sub>O a priori definition is sufficiently important to the paper that it should be in its own sub-section so that readers can easily find it. It should not be under the heading "forward model".

P3 L13 "coupled to sophisticated modelling...". The use of the word "sophisticated" is not useful. Something like, "coupled to modeling of N<sub>2</sub>O based on the ACE climatology, parameterized by latitude, pressure, and date, as described in Section ##." Please remove all other instances of the word "sophisticated".

P3 L12 "described by Kulawik 2006 and Eldering 2008, however this uses a much wider spectral range (8-15 microns)" It's not obvious from the above cited papers, but although the cloud parameters are initially estimated using 8-15 microns, cloud parameters are then retrieved in the windows used for each retrieved species. For methane, the windows are 7.5-8.4 microns.

P3 L6-15. It appears N<sub>2</sub>O is set and then not retrieved. Could you state this explicitly? It's currently confusing to the reader what you are doing.

P5 L29. "Column average mixing ratios from retrieved methane profiles are positively biased compared to independent measurements by approximately 4%, with a systematic height-dependent structure in the profile." It needs to be clarified what is being compared to and a citation or reference to a later section needs to be given.

P5 L31. I'd cite the Alvarado, 2015 paper for TES biases.

P5 L31. The TES bias in Alvarado, 2015 is twice as much in the upper troposphere as lower. MIPAS does not see into the lower Troposphere. If IASI sees a 4% bias in the lower Troposphere and no bias in the upper Troposphere, this result is somewhat different from previous results.

P9 L30. Since IASI columns are being compared to GOSAT and TCCON, it is important

C3

to show the column averaging kernel and compare to that of GOSAT and TCCON (e.g. see Boesch et al. (2011), figure 13). The values in Fig 1 of 0.15 or 0.2 impossible to compare the sensitivity of the column averaging kernel.

P10 L 22 and Figure 4. Please define the DOF's for the column averaging kernel. I don't think a single parameter quantity, e.g column amount, can have degrees of freedom above 1, by definition. Can you show the sum of the trace of the averaging kernel for the CH<sub>4</sub> profile, and/or the DOF for the lower and upper partial columns for CH<sub>4</sub>.

P10 L18 As discussed in general comments, to support the assertion that you have height resolved methane retrievals, in addition to the 6-12 km results, 0-6 km or 3-6 km comparisons to MACC need to be shown.

P18 L16. The HIPPO comparisons in Figs 14-15 of 0-6, 6-12 and total column are good. The biases are summarized in the text. Please also mention the standard deviation in the text, abstract, and conclusions.

Conclusions. The conclusions only discuss results for column CH<sub>4</sub>. As the paper is on height-resolved methane retrievals, the discussion needs to emphasize results for height-resolved quantities of 0-6 km and 6-12 km.

Figure 6. Show MACC with the IASI averaging kernel (Eq. 12) for day and night. In particular, I'd want to see that the day/night differences seen in IASI are due to sensitivity not variations in CH<sub>4</sub>.

Figure 9-10. Show comparisons for 0-6 km also.

Figures 11-14. These figures are column-based and do not support the validation of height-resolved methane retrievals. If the assertion is that the full-column retrievals are also improved, results should be compared to current IASI CH<sub>4</sub> retrievals. Otherwise results should focus on height-resolved validation.

C4

