

Reply to reviewer #2

We thank Reviewer #2 for a careful reading of our manuscript, for catching oversights and unclear statements and giving suggestions on wording. In the following we address his/ her comments and indicate how we have changed the paper according to these recommendations.

General Remarks

Please shorten the sentences overall, it would significantly improve the readability of the document.

We have proofread the entire manuscript and tried to shorten the sentences which seemed too long and, sometimes, confusing for the reader.

Errors are better presented on a relative scale (i.e. as percent) and not on an absolute scale.

We agree with the Reviewer and modified panel d of Figure 1 and 2 replacing absolute errors with percentage errors.

Aura-MLS is referred to before you actually spell it out, and then you spell it out twice (in the end of sect. 1 and beginning of sect. 4).

We thank the Reviewer for pointing out this oversight. We fixed it.

You use high/low and positive/negative bias the same way, meaning more or less the same thing. Is there an actual difference? If not, be consistent and use only one of them.

There is no difference between the two terms. We accepted the Reviewer's suggestion of using only one of them (positive/negative) and changed the manuscript accordingly.

Quite often you speak about the atmosphere as the true atmospheric profile, atmospheric state or similar. If you refer to the actual atmosphere, just using "atmosphere" is enough in most cases.

The first time we preferred to use the whole expression "true atmospheric profile" to stress the difference between the actual atmospheric profile and the retrieved profile (according to the nomenclature in Rodgers (2000)). However, in the remaining part of the manuscript we followed the Reviewer's suggestion and just used "atmosphere".

In text

p. 2980:

l. 8 Aura-MLS, see general remark.

Please, see reply to Reviewer's general remarks.

l. 11 "to be the larger of", this is a new expression to me.

We checked it and confirm that this is a used expression.

p. 2981:

l. 23 The microwave spectroscopy - Microwave spectroscopy

Done.

p. 2984:

l. 1 atmospheric pressure profile allows - atmospheric pressure allows

Done.

p.2985:

l. 5 - 9 Are there baseline artifacts or not in the GBMS spectra? Please rephrase and explain more clearly.

In order to address this Reviewer's comment we rephrased as follows: "In 2009, during the first measurement campaign, the observed spectra showed baseline artifacts due to a temporary malfunction of the beam balancing system. Such artifacts rendered the uncertainties in the retrieval of the weak and complex HNO_3 spectra exceedingly high, and these data were therefore discarded for the comparison with MLS data. Baseline issues do not affect any other GBMS spectra and are unique to the 2009 campaign."

l. 9 Remove "As for O3 measurements

Done.

p. 2986:

l. 2 the true atmospheric profile - the atmosphere

Please, see reply to Reviewer's general remarks.

l. 2 information that is added to x_a - No information is added to the a priori. The resulting profile is a combination of the a priori and the measured spectrum.

As the reviewer states, the retrieved profile is a weighted average of the information coming from the a priori profile and from the measurements. By the above sentence we meant that the a priori information is available before the measurement is carried out. In this sense, the information coming from the measurement is "added" to x_a . We rephrased this sentence and now it reads "The relative weight of the a priori profile and of the measured spectrum depends on the physical (forward) model included in \mathbf{K} , as well as on the error covariances \mathbf{S}_ε and \mathbf{S}_a (in particular on the ratio \mathbf{S}_ε to \mathbf{S}_a rather than on their absolute values)".

p. 2987:

l. 13 following - according to

Done.

l. 18 retrieval, cannot - retrieval cannot

In our opinion the comma is correct here. We did not remove it.

l. 19 achieved – carried out

Done.

l. 20 employed – as

Done.

p. 2988:

l. 29 Please explain data scaling procedures

Data scaling procedure is extensively described in Parrish et al. (1988). We feel that repeating this description here would be of little purpose, given the intent of this paper (present GBMS stratospheric O₃ and HNO₃ measurements obtained at Thule during the last three winters and assess their accuracy through comparisons with correlative Aura MLS observations). Moreover, in the previous review, the Associate Editor suggested us to further reduce the section on the observational technique. For these reasons we decided to avoid any description of scaling procedure and to refer to previous publications.

p. 2989:

l. 16 Remove “lack of resolution”

Done.

l.17 of the true atmospheric state - see general remark, atmosphere is enough

Please, see reply to general remarks.

l.18 what do you mean by “original profiles”?

We mean “the actual atmospheric profiles”. We changed the wording from “original” to “actual”.

p. 2992

l. 19 - 22 Please rephrase

We rephrased the paragraph as follows: “*Being in near-polar orbit, Aura MLS provides each day closely spaced observations near high latitude sites. This intercomparison work can therefore count on a satisfactory number of daily MLS observations near Thule to be matched to GBMS measurements. The Arctic stratosphere during winter/spring periods is often characterized, however, by particularly patchy distributions of chemical compounds. This condition could spoil comparison results if stringent coincidence criteria (both spatial and temporal) between the two datasets were not implemented*”.

p. 2994

l. 4 On l. 22 you describe the process as convolving - why not use that term here as well?

We followed the Reviewer’s suggestion and replaced the word “*smoothed*” with “*convolved*”.

l. 15 It is quite useless information that the “absolute difference” decrease, the relative difference is of much larger importance. See general remark concerning absolute/relative errors.

We removed this part of the sentence.

p. 2997

l. 25 This is consistent . . . - Please explain more clearly.

We changed the wording to “*This can be explained with the changes made in the meantime in both the GBMS and the MLS retrieval algorithms*”.

Figure 1 and 2

Please use frequency instead of channel number in panel 1 (the retrieved spectrum).

Due to its double side band mixer, each spectrum observed by the GBMS is a superposition of two spectral windows of the same width and located at an equal distance in frequency (the IF) below and above the local oscillator frequency. Therefore, each point of the GBMS spectrum corresponds to 2 different frequencies. That’s why we have always plotted GBMS spectra versus channel numbers (see also previous publications using GBMS datasets). However, in order to remind the reader of the frequencies observed, we added the information on the spectral pass band and lines observed in the captions of the two figures.

Figure 8

Please use smaller symbols.

We realized that the figure was a bit unclear. The big crosses in Figure 8 (and 5) are not symbols. They are vertical and horizontal error bars that represent MLS and GBMS uncertainties. We added this information in the captions. We also modified the figures adding small circles as symbols.