

Review of the manuscript: Bender et al. (2013), “Retrieval of nitric oxide in the mesosphere and lower thermosphere with SCIAMACHY” submitted to Atmos. Meas. Tech.

by Anonymous Referee

General comments

This paper describes the retrieval of mesospheric NO from Envisat/SCIAMACHY limb measurements. The authors introduced a new retrieval algorithm that is a 3-D ray tracing using a two dimensional grid. Comparisons with the model and the NO data obtained from the Envisat/MIPAS infrared measurements are presented in order to validate the output. The content of the paper well fits with the scope of the AMT journal, and indeed the retrieval approach the authors adopted is rather unique. However, the current manuscript significantly lacks detail explanations on its retrieval algorithm, its effectiveness compared to traditional 1-D retrievals, and the methodology of the comparison with MIPAS. I think such detail information is what this journal puts more importance. Therefore I recommend this manuscript to be published in AMT only after the authors improve Sect 3 (and other related Sections) and Sect 4.4. For revising, I would like to ask the authors to consider following comments:

- Is there any motivation for employing the 2-D grid retrieval? i.e., did the authors compare the results from (traditional) 1-D vertical grid retrieval with spherically homogeneous layers?

The 2-D retrieval is motivated by the close horizontal sampling of the limb scans in particular in the northern polar region. The discussion of more benefits of the 2-D approach and a comparison study with the results from a one-dimensional retrieval was added to the paper as Sect. 4.3.

- There are several parameters in calculating the emissivity (Eq. 1). If possible, I think it's better to put the values the authors adopted in their presented work (not only putting the references).

The most important parameters used in this work are now listed in the new Table 1.

- For the retrieval algorithm description, it is unclear what kind of a priori value and its covariance were used. How did you determine R_{alt} and R_{lat} ? What value was used for S_y ? etc. It would make this paper more useful for readers if the authors provide these numbers within the text.

More detail was added, and an explicit description of the regularisation can now be found in the paper in Sect. 3.4 after Eq. (8). We list the regularisation parameters used for the retrieval in Table 3 (new).

- Also I feel a weakness in the comparison with MIPAS NO. I would like to see the

sensitivity of MIPAS NO product with its usable altitude range (as the basic information) in the text (although the authors put the reference paper). Without such information, I consider it's difficult to judge the agreement between SCIAMACHY NO and MIPAS NO. Furthermore, are there any reasons not to compare vertical profiles?

A detailed comment about the MIPAS results and their resolution was added to the paper at the beginning of Sect. 4.4, and the reason why not to compare profiles is discussed: Both instruments have different vertical resolutions, and both are broad in the context of NO vertical variability. This makes it difficult to perform suitable profile comparisons and for this reason, column comparisons have been done. This, however, implies merging two different MIPAS NO products (below 100 km using temperature retrieved at 15 μm and above from a joint T-NO retrieval at 5.3 μm) which could have different biases. Nevertheless, possible inconsistencies related to this merging are supposed to have a smaller impact on the column comparisons than the different vertical resolutions would have on profile comparisons.

Minor Comments

Title: For me the title “retrieval . . . with SCIAMACHY” sounds a bit strange: I would prefer “from” instead of “with”.

This was also suggested by the other referee, the title was changed to end in “... from SCIAMACHY limb scans”.

P 3612, Line 24: SCIAMACHY appears for the first time in the main text here. I would like to have the full spelling of SCIAMACHY here, and also one general reference for the mission or instrument will be useful.

The full spelling is given in the abstract, but it was added here again as requested. As general references there are Burrows1995 and Bovensmann1999.

P 3613, Line 3–24: Here the authors describe the development history of the SCIAMACHY since the Phase-A studies, but I'm not sure if such a detail is really needed in this paper. In my eyes, this paragraph can be much shortened.

We consider it important for the reader to understand how the SCIAMACHY MLT scans used in this study came into being. Thus we consider the history to be of relevance for the reader. With respect to the reviewer we wish to keep this brief summary of the history of SCIAMACHY and its limb observations in the manuscript.

P 3615, Line 17: “. . . to be excited first, restricts. . .”, I think this “first” is unnecessary. Changed in the updated version of the paper.

P 3616, Line 10: “The various gamma bands have different advantages and disadvantages” I think you are talking about the advantages/disadvantages “for retrieving NO in data analyses”, but it's not clear. I would suggest re-writing the sentence.

This is a valid point and ‘for retrieval’ was added to the text to make clear to what advantages and disadvantages refer.

P 3622, Line24: Is there any difference between the MIPAS retrieved temperature and that used by the authors for the SCIAMACHY analysis?

The temperatures used in this study stem from the MSIS model and are different from the MIPAS retrieved temperatures. As stated in the paper, MIPAS found large deviations in the thermospheric temperatures from the model. However, the total emission rate does not change proportionally and the limited spectral resolution does not allow us to observe changes in the individual rotation lines.

P 3623, Line 13–14: “Here, the SCIAMACHY retrieval attempts...provided by the model” I could not follow this discussion. Please explain more.

The last paragraph in Sect. 4.4 has been re-written to make the differences of the effects of the regularisations in both retrieval methods clearer and how they may affect the ratio of the vertical columns.

Figures: I would like to have minor ticks on x and y axis, particularly for Figs 6 and 7. Minor ticks were added to Figs. 6, 7, 8, and 9.