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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of sodium number density profiles in the mesosphere and lower thermosphere from SCIAMACHY limb emission measurements" *by* M. Langowski et al.

Anonymous Referee #1

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This paper describes new retrievals of sodium number densities from SCIAMACHY limb scans in the mesosphere and lower thermosphere. The paper discusses basic ideas and challenges of the retrieval, and presents results in terms of seasonal and latitudinal climatologies. For details of the retrieval algorithms, the authors refer to an earlier paper on SCIAMACHY Mg/Mg+ retrievals (Langowski et al., AMT, 2014).

I find the paper suitable for publication in AMT after some clarifications. I find the discussion of the retrieval sound, including the spectroscopy and the radiative transfer of the sodium lines. Much consideration is given to the treatment of multiple scattering (or albedo contributions). Unfortunately, not all theoretical concepts work out when it

comes to the practical retrieval. Nevertheless, the authors manage to define a useful way of handling multiple scattering.

Here are the topics that I would like to see discussed more:

Langowski et al. (AMT, 2014) is a good reference explaining the details of the retrieval algorithms used here. Nevertheless, some more information should be given in the present paper in order to make it more readable, without the need of going back to the original paper too often. Hence, I recommend the authors to add some more information about the basic retrieval ideas in the current paper, without overloading it. One important example is the discussion of smoothing and the constraint parameter (section 2.3.1, figures 3-5). It would greatly enhance the readability if more basic explanations of the smoothing and its effect on the retrieval were given in the present paper.

The handling of multiple scattering takes much place in the paper, including six figures. Sections 2.3.1 and 2.3.2 discuss two different methods. The detailed discussions in both sections are at times hard to follow. It might help the reader to give a brief summary of the methods at the beginning of each section before going into all the details.

The operational retrieval handles multiple scattering by invoking regular (lower atmospheric) SCIAMACHY scans from days before and after the MLT measurements. As the variation of multiple scattering (albedo) is strongly controled by the variability of tropospheric cloudiness, this approach would likely lead to rather large uncertainties when attempting to retrieve individual Na profiles. For the zonally averaged approach chosen here, the effect of tropospheric cloud variability may not be so critical. Nevertheless, I very much would like to see an uncertainty discussion addressing this. How much uncertainty is contributed to the retrieval by basing the multiple scattering analysis on albedo data that are not coincident with the sodium measurements?

Before the retrieval is performed, the limb radiance data are daily and zonally averaged. This raises some questions that should be discussed:

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- To what extend is the averaging necessary, given that the signal-to-noise ratio presumably is substantially better for Na than for Mg/Mg+ as retrieved in the earlier paper. Can individual Na profiles be retrieved?

- How does the averaging affect the retrieval results, as compared to retrieving individual number density profiles first and performing the averaging of the individual profiles then?

- Do individual profiles show signs of deviations from well-behaved Na profiles, such as sporadic sodium layers, that may affect the averaging?

I also have some other minor comments:

Abstract, line 9: Please state the years for which data are presented (2008-2012).

Abstract, line 11: It may be clearer to write "peak altitude" instead of "altitude".

page 7914, line 11: "seperation" should read "separation".

pag 7925, line 3: Make clearer what you mean by "four to eight individual day measurements".

page 7926, line 23: "errors bars" should read "error bars".

page 7927, line 12: "lidar's" should read "lidar".

page 7927, line 21: You might consider calling the agreement for "good" rather than "quite good".

page 7928, line 18: "at summer" should read "in summer".

figures 3 and 4: In order to mark the lines in a consistent way, you may want to change the black dashed line into a red dashed line.

figure 6: Please specify in the figure caption what wavelengths have been used here. Is it the integrated wavelength range 650-660 nm or an individual wavelength pixel?

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