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Interactive comment on "AerGOM, an improved algorithm for stratospheric aerosol extinction retrieval from GOMOS observations. Part 1: Algorithm development" *by* Filip Vanhellemont et al.

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Comments on the review by Anonymous Referee #1 of the paper: "AerGOM, an improved algorithm for stratospheric aerosol extinction retrieval from GOMOS observations. Part 1: Algorithm development." by Vanhellemont et al.

We would like to express our sincere gratitude to Referee #1 for the thorough reading of the article. We realize that for most scientific researchers the available time is very limited; the considerable effort of the referee is strongly appreciated by us.

1. General comments

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Discussion paper

Referee#1: This paper describes the AerGOM algorithm which is used in GOMOS aerosol extinction profile retrievals. The paper briefly describes the previous IPFv6.01 operational algorithm, describes the new features exercised in the AerGOM algorithm, and presents several Figures illustrating the new algorithm. A companion paper (Robert et al. 2015) discusses data validation in more detail. Users of satellite data products benefit from algorithm discussions in AMT papers. The subject matter is worthy of publication as an AMT paper. The paper should be published after revision based upon the reviewers suggestions.

Author response: We are very pleased that the referee considers the paper worthy of publication in AMT. We hope that we have responded adequately to the referee's comments, and that the requested revisions are sufficient.

2. Major comments

2.1

Referee #1: This reviewer feels it is fair to separate the algorithm discussion and data validation in two separate papers. A combined paper would likely be too long.

Author response: Yes, we estimated the length of a combined algorithm/validation paper and it was found to be much too long. Furthermore, some data users are potentially less interested in the specifics of a retrieval code. These are the reasons why we published both topics separately.

2.2

Referee #1: It is requested that a 3rd column be placed in Figure 5 which gives the base-10 logs of the positive portions of the extinction profiles. This will give the reader a better visual impression of the data. Also, it is appropriate to discuss in the text why the extinction values diverge so readily at altitudes below 20 km in Figure 5.

Author response: Agreed. Concerning the divergence of extinction values below 20 km: it is caused by increased optical extinction at lower altitudes (due to longer optical

paths and denser atmospheric layers), and the presence of tropospheric clouds.

Author's changes in manuscript: A 3rd column with AERGOM aerosol extinction profiles on a logarithmic scale (base10) has been added in Fig. 5, and the figure caption has been changed accordingly. Furthermore, a discussion on the increased variability of the profiles has been added: "We also observe a larger spread of the aerosol extinction profiles at lower altitudes (below about 20 km) for both retrieval algorithms. The most important reason for this increased variability is not related to retrieval methodology, but to the limited signal-to-noise (S/N) ratio of a stellar occultation experiment. Indeed, at lower altitudes, stronger optical extinction occurs due to longer optical paths and denser atmospheric layers; measured signals become comparable to the instrument noise levels. The altitude region where this happens depends of course on the stellar properties (mainly magnitude). Furthermore, the presence of clouds in the troposphere contribute to the increased variability that is observed."

2.3

Referee #1: It is also requested that the correlation coefficients of the GOMOS and SAGE II time series of the AerGOM panels be stated either in the panels or stated in the figure caption of Figure 7. The phrase "seems to be very good" (Page 16, line 4) needs to be reinforced by a quantitative value.

Author response: We agree. Giving numerical correlation values makes a more convincing case. We have calculated correlation coefficients (IPFv6.01 vs. SAGEII and AERGOMv1.0 vs. SAGEII), and the results clearly show a significant improvement for the AERGOM data, with correlations that are almost 10 times larger at higher altitudes.

Author's changes in manuscript: We have added the correlation coefficients in the title of every subplot (Figure 7), and a sentence in the Figure caption: "Correlation coefficients are also indicated in the subplot titles". Furthermore, we have added the following discussion on the correlation coefficients: "This is confirmed when we inspect the correlation coefficients (also given in Fig. 7). Although relative aerosol

extinction contributions at the considered wavelength of 386 nm are weak, correlation coefficients are significantly larger for the SAGE II/AERGOM case, even up to one order of magnitude at 29 km."

2.4

Referee #1: There seems to be some contradiction and confusion in the discussion of the H2O component of GOMOS observations. On Page 3, line 16, the text says that the B2 spectrometer "allows the measurement of water vapour", and on Page 12, line 1 "while the SPB1 and SPB2 data are reserved for the retrieval of O2 and H2O". Yet on page 15, line 26 "Finally, SPB2 data were not used (since all wavelengths are affected by water vapor, a species that is currently not retrieved by AerGOM),..". It may be helpful to replace "allows" by "allows (in principle, but not currently exercised by AerGOM)" on page 3 to avoid confusion. Are the other bands influenced by H2O transmittance? If so, how is H2O treated by AerGOM?

Author response: We agree that the discussion on SPB2 data is confusing. The situation is as follows: these measurements are available, and the AerGOM code is constructed in such a way that we can use these data, but unfortunately AerGOM is not able yet to do H2O retrievals (which are very complicated and need special treatment), as is already mentioned on page 15, line 26. All SPB2 pixels have contributions from water vapour. That is why we currently do not use these measurements. The measurements of the other spectrometers (SPA, SPB1) contain negligible H2O contributions, so there is no problem there. In the future, we will try to do H2O retrievals as well; at the same time this will enable us to extract the aerosol content from the SPB2 data. Concerning the suggestion for the text replacement on page 3: we think it is not a good idea to mention AerGOM here, since the section (2.1) covers the instrument, while the retrieval codes are introduced only further down the text. Instead, we propose to add some clarification in section 3.5 (Transmittance data).

Author's changes in manuscript: We added the following text at the end of section 3.1:

"Due to the difficulty of finding SPB2 spectral pixels without H$_2$O absorption, and the fact that AerGOM is at present not able to perform H$_2$O retrievals, SPB2 data are currently not selected for the retrievals. This situation will likely change for future AerGOM data versions."

3. Minor comments

3.1

Referee #1: There are many places in the text in which the English can be improved. I offer some suggested revisions.

Author response: Agreed. None of the authors are native English speakers, so suggestions are very welcome.

Author's changes in manuscript: See below.

3.2

Referee #1: Page 1, line 8. "Then, the discussion of the AerGOM.."

Author response: This is not necessary anymore; at the demand of Referee#2, this part of the abstract has been removed.

3.3

Referee #1: Page 1, line 18. "most instruments use the Sun as a light source, .."

Author response: Agreed. The rule is still unclear to us, but we follow the suggestion of the referee.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.4

Referee #1: Page 2, line 8. "remains a problem, though the associated residual scin-

tillations have been adequately characterized in a statistical analysis (Sofieva et al., 2010). The random nature of these perturbations.."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.5

Referee #1: Page 2, line 12. "problem was identified.."

Author response:Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.6

Referee #1: Page 2, line 27. "Finally, the AerGOM aerosol/cloud .."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.7

Referee #1: Page 2, lines 28 – 30. Place these sentences "It should be mentioned .." at the end of the paper. The last paragraph on page 2 should focus on telling the reader the structure of your paper.

Author response: Agreed.

Author's changes in manuscript: We have deleted the two sentences from the introduction, and added a slightly changed version at the end of the paper (conclusions): "Finally, it should be mentioned that a new algorithm has been developed for the in-

version of aerosol/cloud extinction spectra to particle size distributions. We will also discuss this algorithm in a separate publication."

3.8

Referee #1: Page 3, line 2. "instrument and measurement principles are described. . ."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.9

Referee #1: Page 3, line 17 "characteristics are summarized .."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.10

Referee #1: Page 4, line 5. It may be helpful to inform the reader that the selection of stellar temperatures includes most stars i.e. "ranging from 3000-30,000 K (i.e. most stellar spectral types)".

Author response: Agreed. The temperature range covers most types of commonly used spectral classification systems.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.11

Referee #1: Page 4, line 12. "can be found in Kyrölä et al. (2010, 2012)".

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.12

Referee #1: Page 4, line 26. I am not familiar with the "refractive dilution physics". Please add a sentence or two to clarify.

Author response: Agreed.

Author's changes in manuscript: We have removed the phrase between brackets: "(due to the divergence of light rays)" and added the sentence: "The phenomenon is caused by the altitude gradient of the air refractive index and consists of the spreading of light rays (divergence) and an associated decrease in light flux."

3.13

Referee #1: Page 5, line 23. Spell out the DOAS abbreviation.

Author response: Agreed.

Author's changes in manuscript: We added the abbreviation between brackets: ". . . in a DOAS-like manner (Differential Optical Absorption Spectroscopy)".

3.14

Referee #1: Page 6, line 2. "with the NO3 and βaer,500 vectors representing.."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.15

Referee #1: Page 6, line 23. "and are used as the transmittance data source .."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.16

Referee #1: Page 6, line 26 "found in Bertaux et al. (2010).."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.17

Referee #1: Page 6, line 26 "extinction validation results are presented by .."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.18

Referee #1: Page 6, line 29 "fact that IPFv6.01 GOMOS .."

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the suggestion of the referee.

3.19

Referee #1: Page 7, 1st line. "found further in Figures 5, 6, and 7 (discussed below)".

Author response: Agreed.

Author's changes in manuscript: The text has been changed according to the sugges-

tion of the referee.

3.20

Referee #1: Page 7, line 9 The phrase “all convariances are retained by the solution” may be better than “all covariances remain in the system”.

Author response: Agreed.

Author’s changes in manuscript: The text has been changed according to the suggestion of the referee.

3.21

Referee #1: Page 7, line 11 “of the solution”.

Author response: Agreed.

Author’s changes in manuscript: The text has been changed according to the suggestion of the referee.

3.22

Referee #1: Page 9, line 5. Define Nair.

Author response: Agreed, this we forgot to do.

Author’s changes in manuscript: We added: “with Tair the transmittance by neutral air having SGD Nair”.

3.23

Referee #1: Page 11, line 15. “spectra and fits are..”

Author response: This change is not necessary anymore. The sentence has been removed, and a new paragraph has been added here, following a comment by Referee#2.

3.24

Referee #1: Page 12, line 2. “this is regrettable”. Since the SPB2 data, however, is not used, the sentence is superfluous.

Author response: Agreed concerning the word choice. However, we do intend to use SPB2 measurements for future AerGOM data versions, so we prefer to leave the discussion on SPB2 in the article, and just state that it is presently not used.

Author’s changes in manuscript: The text has been changed according to the suggestion of the referee.

3.25

Referee #1: Page 12, line 6. State the date, latitude and longitude of the spectra in Figure 4.

Author response: Agreed.

Author’s changes in manuscript: We added date, latitude and longitude in between brackets to the caption of Figure 4.

3.26

Referee #1: Page 12, line 10. Replace “interest) plenty of information is present” by “interest) since a very useful range of transmittance is present”

Author response: Agreed.

Author’s changes in manuscript: The text has been changed according to the suggestion of the referee.

3.27

Referee #1: Page 15, line 29. Does the data set refer to all spectra and retrieval values? Clarify by stating in ( )’s e.g. (spectra, columns, retrieved profiles) what quantities are in the 74 Gb of disk space.

Author response: Agreed.

Author's changes in manuscript: We have added the quantities in brackets: "The resulting AerGOM v1.0 data set (profiles for gas SGD and local densities, aerosol SAOD and extinction coefficients, retrieval errors, ancillary data and inversion statistics) occupies . . ."

3.28

Referee #1: Page 15, line 9. Are the 115 extinction selected throughout all years of the data, and at a variety of latitudes? Please clarify.

Author response: The data were randomly selected within a time window that covers the simultaneous operation of GOMOS and SAGEII. Furthermore, we excluded polar regions since comparisons for Polar Stratospheric Clouds observed by different instruments are notoriously difficult (due to different observational directions). Although not strictly necessary for this Figure, we restricted the time window and latitude range since we use the same data further down the text for initial GOMOS/SAGEII comparisons.

Author's changes in manuscript: We clarified the situation by adding the time/latitude window between brackets: " . . . 115 randomly chosen aerosol extinction profiles (in a window from April 2002 to April 2005, between 60°S and 60°N), . . ."

3.29

Referee #1: Page 17, Figure 6. There is overlap in my copy of the paper between the 10-3 and 10-4 y axis labels and the panel titles. Eliminate this problem by redoing the graphs.

Author response: Agreed.

Author's changes in manuscript: We avoided the overlap by expressing extinction on the y-axis in units of 10-4 km-1.

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Discussion paper