

Response to Reviewer #1

We thank Reviewer #1 for her/his very detailed and helpful comments. Please find below the reviewer's comments (black) and our responses (blue) which also indicate the changes made in the manuscript.

1. General comments

The paper is well written and gives a good overview of the re-processing of GOME data together with its in-flight performance during the entire mission. The new level 1 product and new results on the instrument monitoring are definitely worth a long publication.

I find it a very good and practical idea to include a description of the new data format in the appendix, this will give the users a good starting point.

Although the overall quality of the paper content is already high, there are a number of points where the structure and phrasing can be changed to improve the overall readability.

It is not clear, which of the new in-sights and degradation corrections are included in the re-processed data set. An overview (table or graph) of the main level 1 processing steps indicating the changed steps might be an easy remedy for this. Are all the long term monitoring drift and degradation corrections included in the (ir-)radiance data now?

New users of GOME data would be helped by a few brief explanations on the mentioned GOME specifics. Especially if this new data-set is to become a reference, the paper should be as stand-alone as possible.

For the different radiometric steps a few sentences at the beginning of Section 3 would be helpful. There you could explain that the main cause for degradation is the scan mirror, the biggest correction is done based on irradiance monitoring, then the differences between radiance and irradiance degradation are corrected for in the reflectance. Explaining the approach first and then going into the details would improve the readability of this part a lot.

Section 2 of this review lists specific comments and questions about the content and understanding of the paper. These also include the issues summarized in the general comments. Once these points are clarified, I would strongly recommend the paper for publication.

Section 3 contains suggestions where to edit the text to allow for a smoother read, minor spelling and grammar errors and formatting issues.

This review is based on the version amt-2018-118.pdf retrieved on the 4th of June from <https://doi.org/10.5194/amt-2018-118>. The earlier version (amt-2018-118-manuscript-version1.pdf retrieved on the 1st of June) was not considered.

#	Page	Line	Section	Comment
SC1	1	21	1	You could also add S5P, S5, S4. <i>Done.</i>
SC2	3	12	2.1	Is the integration time for the forward scan also 1.5 s? This is not clear from the text. <i>Yes. We made this more clear in the text.</i>
SC3	4	12	2.1	What kind of channel separator? In line 14 a di-chroic is mentioned, is a di-chroic used here too? <i>It is a channel separator prism. We added an explanation.</i>
SC4	5	5	2.2	Please add which parameters are calibrated in-flight and which are based on on-ground data only. <i>Done. In the list we indicate the in-flight calibration parameters with an asterisk.</i>
SC5	5	7-17	2.2	It would be very useful to have a flowchart showing the actual order of

				<p>the steps, also indicating which steps have been changed/improved with the new version. Maybe even show which step is based on in-flight data. The word “steps” in line 7 suggests that the list shows the order of the steps. Consider writing “the basic calibration algorithms are:” instead.</p> <p>We added two more figures (Figs. 2 and 3) indicating the processing flow for calculating the in-flight calibration parameters and the science data, respectively.</p> <p>The description of the algorithms using the on-ground calibration has been moved into a separate section (new Sec. 3).</p>
SC6	6	8/9/10	2.2	<p>Are these calibration constants then fed back immediately into the L1 processor?</p> <p>Yes, they are fed back immediately. We added this information to the text.</p>
SC7	6	9	2.2	<p>The use of the word “comprise” is confusing here. It suggests that the list is complete, that only data from dark measurements, the PtNeCr lamp and the LED is used to directly derive calibration constants during L1 processing. Is this indeed correct? I would also expect that for example transient filtering is performed for all data during L1 processing.</p> <p>Yes, this list is complete. Transient filtering is not performed.</p> <p>No changes were made in the text.</p>
SC8	6	30	2.3.1	<p>What are the other sources? What is “slow” noise? “Slow” with respect to what?</p> <p>“Additional” is not needed here. In this case “slow” means “the noise varies slowly with time and not from readout to readout”. We reformulated the sentence.</p>
SC9	6	32	2.3.1	<p>“from one typical orbit”: Isn’t this section about on-ground calibration data? Does this scaling factor ever change?</p> <p>This scaling factor has been obtained from one orbit during the commissioning phase. It has not changed since then.</p>
SC10	6	33	2.3.1	<p>So only band 1a earthshine needs this correction as all other bands and modes have a shorter integration time?</p> <p>Yes.</p>
SC11	7	2	2.3.1	<p>Are all Peltier signals involved for all detectors? Or only the Peltier belonging to band 1 a? Please clarify.</p> <p>Only the Peltier output belonging to channel 1 is used. We added the information in the text.</p>
SC12	7	6/7	2.3.1	<p>So the additional residual correction is not part of the L1 processor discussed here? Was it not feasible to include this?</p> <p>The correction is implemented in the L1 processor. We clarified this in the text.</p>
SC13	7	12	2.3.2	<p>“In-flight calibration exercise” : do you actually include in-flight calibration into the correction? The rest of the section does not suggest this. Or do you mean “in-flight correction” ? Please clarify.</p> <p>The use of the word calibration suggests calibration measurements to me, and I cannot see how that could be done in-flight.</p> <p>We replaced “in-flight calibration exercise” with “L1 processing”.</p>
SC14	7	25	2.3.2	<p>“currently” , do you expect more ghosts to become significant?</p> <p>We deleted “currently”.</p>
SC15	7	28	2.3.2	<p>Accuracy: Is this for the combined straylight or only the uniform part? I</p>

				<p>guess there must have been a discussion at some stage whether the ghost correction is useful or detrimental. You could consider adding a reference here, if there ever was any research done on this. (This is more a note of personal interest than a comment on your manuscript.) It is for the uniform part. Unfortunately, there is no reference available. It has been discussed pre-flight (1994), but we do not have more detailed information.</p>
SC16	7	10-22	2.3.2	<p>To make this section a bit clearer, I would change the order a bit: Lines 10-12, then lines 20 to mid 22, then lines 12 to 19, then from line 22 on. Done as suggested.</p>
SC17	8	14	2.3.3	<p>Do I understand this correctly: There are two BSDF steps with a different parametrization? Why are they not combined? Is that because the BSDF depends too much on the degradation? Please clarify. Yes, there are two BSDF steps. This has historical reasons. In the previous GDP version the application of a separate extraction software was required in which the second step was performed. The second BSDF step contains an improved azimuth dependence. We made this more clear in the text.</p>
SC18	8	3-21	2.3.3	<p>This part might be a better read if you state what is performed for the solar, the earthshine and the moon measurements. Or is the BSDF correction also applied for earthshine and moon? Also here a figure with the processing steps and paths might help. This section (now Sec. 3.3) has been rewritten to make this more clear.</p>
SC19	8	25-26	2.3.4	<p>I would guess that the polarization sensitivity is from on-ground calibration and that only the characterization has two main parts. This is not clear from the sentence. We split the sentence in order to make this more clear.</p>
SC20	8	31	2.3.4	<p>I assume the interpolation should be followed by a multiplication with the sensitivity? Or where does the on-ground data come back in? We added the information in line 26.</p>
SC21	9	9	2.3.4	<p>Why were the iterations made if they are not needed? Do you mean "for practical reasons these iterations.."? The iterations were made in the course of several (unplanned) reprocessings. We added this in the text.</p>
SC22	9	18	2.4	<p>Can you explain which calibration parameters are included? Alternatively you could add it to the appendix. In the appendix we added the reference to the Product User Manual (Aberle, 2018) that contains the complete list of all parameters.</p>
SC23	10	10	3.0	<p>For the different radiometric steps a few introductory sentences at the beginning of Section 3 would be helpful. Here the approach can be outlined: that the main cause for degradation is the scan mirror, the biggest correction is done based on irradiance monitoring, then the differences between radiance and irradiance degradation are corrected in the reflectance. I found myself wondering why it was done in such a roundabout way and finding the explanation pages later. To explain the approach at the beginning of the section removes this confusion. We added a brief introduction to this section (now Sec. 4).</p>

SC24	10	14	3.1	<p>1) I would make very clear here, that the degradation has been shown to be mainly/only the scan mirror and not the diffuser, otherwise the degradation correction doesn't seem logical.</p> <p>2) Furthermore it would be important to mention that it is a first order correction and differences between radiance and irradiance are corrected in the reflectance.</p> <p>1) We added a sentence and a reference here to make this more clear.</p> <p>2) We mention this in Section 'Reflectance Degradation' (former Sec. 3.3)</p>
SC25	10	26	3.1	<p>Somewhat more explanation is needed here, why does the loss of the gyroscope functionality only affect one channel? What does this functionality do?</p> <p>Our text was a bit misleading in this case. The loss of the gyroscope functionality did affect all channels. We reordered the sentences to make this more clear.</p>
SC26	11	Fig. 2	3.1	<p>From 2004 on the entire wavelength range from 450nm seems to be above 1, this is not explained in the text. Where does it come from?</p> <p>Values above 1 might be due deposits on the coatings which can lead to changes in interference patterns and to an increase in intensity (Snel, 2001). We added the explanation in the text.</p>
SC27	11	Tab. 1	3.1	<p>Could you also add the values for end-of-life?</p> <p>End-of-life values have been added (and also values for 290nm, see comments Reviewer #2).</p>
SC28	11	4/5	3.1	<p>The same degradation is applied to both irradiance and radiance? Wouldn't that only work when all degradation occurs within the common path and none in the diffuser? Has this been verified? Then it should really be mentioned here. (OK, I now see it's mentioned later in the text. I have added SC 23 and SC24.)</p> <p>Please see responses to SC23 and SC24.</p>
SC29	12	13	3.2	<p>For new users of GOME data it is not clear why a platform pointing problem would only affect one channel. Please add a brief explanation.</p> <p>See response to SC25. We reordered the sentences here, too.</p>
SC30	13	12/13	3.2	<p>So PMD 1 does not decay as bad as channel 2. Is it known why? Is it maybe related to the wavelength dependent difference between s-and p- reflectance of the scan mirror?</p> <p>We assume that this might be related to long-term changes in the mean wavelength of the PMD which is in the order of ~10nm for PMD1.</p>
SC31	15	8	3.3	<p>So there is a contribution of the diffuser after all? Or is the only difference the angle on the scan mirror?</p> <p>The only difference is the angle on the scan mirror.</p>
SC32	16	19-22	3.3	<p>Is there an explanation for the degradation getting better and worse? Have there been studies for other wavelengths too? If yes, do they show the same behaviour?</p> <p>We did not analyze other wavelengths. Degradation getting better and worse might be due to changes in interference patterns (Snel, 2001). We added a sentence and the reference.</p>
SC33	17	Fig 6	3.3	<p>It is striking that the two wavelengths appear to behave the same until 2004 and then they start deviating, is there a reason for that?</p>

				We assume that this is related to the scan angle dependence that increased over time (see Snel, 2001).
SC34	17		4.2	This section is very well written.
SC35	19	2	4.2	Which are the thermally sensitive optical elements? Does the degradation of thermally sensitive optical elements also cause the changes in the reflectance? We removed this sentence.
SC36	21	Fig. 9	4.3.1	The caption and plots' y-axes are not consistent with the unit and what is shown. I think you mean leakage signal or dark signal and not current. To make the plot a bit clearer, you could add the co-addition times in the plot or the caption. Corrected.
SC37	21	Fig. 9	4.3.1	For channel 2 in the normal scanning mode: the spread is much larger than for the other channels and modes. Is that explained? Unfortunately, we do not have an explanation for this behavior.
SC38	21	17	4.3.1	Shouldn't it be leakage signal? Yes. Corrected.
SC39	23	3	4.3.1	Is this plot representative for other channels and modes? Yes, a three-fold broadening of the distribution was also found for other bands and modes.
SC40	25	4	4.3.2	I assume the tape recorder failure changed the power conditioning? Or how can it have the shown effect? The noise level changed because of the significantly reduced number of measurements and in particular because measurements from the South Atlantic Anomaly region are missing since the tape recorder failure.
SC41	26	5	4.4	When using a monochromatic LED, the pixel response and quantum efficiency is monitored for the LED's wavelength but not necessarily for the wavelength the pixel is normally detecting. Have there ever been other measurements, for example on-ground with a white light source, to verify the results from the LEDs? Unfortunately, this has not been verified.
SC42	28/29		5	It's not entirely clear from the summary (or elsewhere) which insights from the long term monitoring of irradiance, degradation, spectral calibration have been included in the L1 processor. If they are, are they part of the calibration data or are corrections already included in the (ir) radiance? More results of the study were included in the summary in order to make this more clear.
SC43	29/30		App. A	Great idea to include the file format. Thanks.

3. Technical corrections

3.1. Definitions

Is there a reason to explicitly name the detector brand Reticon? No other brands are named as far as I could see.

No, there is no explicit reason, it is rather a 'leftover'. We replaced it with “array detector”.

Figure 11: “PDF” is not explained.
We added the explanation.

3.2. Formatting of plots

Figure 9: The y-axis says “DC”, which normally is the dark current, but the dark signal is shown.
Corrected.

3.3. Typos

For the following words, the spelling/capitalization is not consistent throughout the article:

- Sun
- Polarization Measurement Device
- The word ‘data’ is used both in the singular and the plural, please pick one of the two
- Please reconsider you capitalization, either capitalize all new abbreviations or none. For example “Focal Plane Assembly (FPA)” but “pixel-to-pixel variations (PPG) in quantum efficiency” on page 5

Spelling/capitalization should be consistent now.

#	Page	Line	Section	Comment
TC1	1	2	Abstract	Shouldn't it be “ozone and other trace gases”? Changed.
TC2	1	29	Abstract	Shouldn't it be “polarization correction, and dark current correction” ? Changed.
TC3	2	18	1	Similar changes ...[], whereas they are Corrected.
TC4	2 3	27	2.1	Full stop missing. Inserted.
TC5	4	1	2.1	It's “GOME Users” not “User's” Corrected.
TC6	4	16	2.1	To clarify: “that consists for each channel of ... “ Added.
TC7	4	22	2.1	“... and it had a repeat cycle ...” Added.
TC8	4	22/23	2.1	The sentence should also be in the past tense. Changed.
TC9	4	26	2.1	“... additional ground stations had been ..” Changed.
TC10	9	12	2.4	Was thus, not thus was. Corrected.
TC11	9	15	2.4	It has turned out ... Corrected.
TC12	9	17	2.4	Contains Corrected.
TC13	10	8	3.1	Word order: the latter serve themselves... Changed.
TC14	10	10	3.1	3rd of July

				Corrected.
TC15	11	7	3.1	3rd of July Corrected.
TC16	13	10	3.1	3rd of July Corrected.
TC17	18	5	4.2	...lines ... have Corrected.
TC18	19	11	4.2	The use of “however” is a bit confusing here, I would first state that they didn’t find a dependence on longitude and then “However they found the maxima... Reformulated.
TC19	19	13	4.2	Temperature rise not raise Corrected.
TC20	22	12	4.3.1	The second “which” is not needed. Changed.
TC21	22	17	4.3.1	The second comma is not needed. Changed.
TC22	23	4	4.3.1	..pixel the standard ... Changed.
TC23	23	12	4.3.1	Rephrase to “The most significant decrease in the number of available measurements is for the LED dark signal calibration measurements.” Changed.
TC24	25	3	4.3.2	Don’t you mean the following section ? Corrected.
TC25	27	8	4.4	The date format is different than before. Changed.

3.4. References

Page	Line	Section	Comment
33	10/11	Bibliography	Link seems to be faulty. Corrected.
33	12/13	Bibliography	Link seems to be faulty. We double-checked the link and it should be valid.

3.5. Author contributions

The authors’ contributions are not listed separately, is this intentional?
This section is optional and we would like to leave it out.