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Comment

Interactive comment on “Overview of the O3M SAF GOME-2 operational atmospheric composition and UV radiation data products and data availability” by S. Hassinen et al.

Anonymous Referee #2

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Review of the manuscript “Overview of the O3M SAF GOME-2 operational atmospheric composition and UV radiation data products and data availability”, by Hassinen et al.

This manuscript provides an overview of the GOME-2 O3M SAF products. After an introduction all the products are described with varying information content. The ground segment and potential new products are described.

General comments

Overall I find this a very hard paper to review. Partly this is because it is an overview

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paper, which generally do not provide a whole lot of new scientific information. However, I think this paper must be improved in a various ways, because currently it reads like a cut-and-paste work. I think that the audience for which the paper is intended has not been properly defined. Different audiences could for example be: 1. users that are new to GOME-2 products and need a starting point; 2. policy makers that have funded the mission and need a concise overview; 3. scientific data users that need information on data products they use; 4. scientists that need a paper to refer to. I think that the manuscript has the potential to serve the audiences 1 and 2.

Once the authors have defined the audience, they should revise the entire paper to ensure that it serves that audience. This includes improving the consistency between different parts of the paper.

The number of acronyms in the paper is way too large. For each acronym that is used it should be checked if it adds anything to the paper (for example acronyms that used only once are not too useful), and if the acronyms is used consistently throughout the paper. Given the large number of acronyms, I propose to make a separate section at the end of the paper where they are all described.

In some parts of the paper there are reference to the MACC II project. I propose to update these to point to CAMS. Also, GMES should be updated to EU Copernicus

I think the manuscript could be improved with the corrections a native English speaker. (For example “quarantined” in line 15 on page 6995.)

Manuscript organization

I propose to modify the organization of the paper as follows: Include section 7 into section 4. Rationale: section 4 describes the ground segment; it is logical that it also covers data dissemination.

I strongly advice to place the ozone profile product description (section 5.2) directly after the total ozone description (5.1.1).

I advice to write a new section on data users. This is now covered in the introduction, but deserves to be described in more detail. Maybe statistics on the data use can be added.

A section shall be added that describes where the Level 2 requirements for GOME-2 can be traced to.

I propose to organize section 5 differently by simply using one subsection per product. Now there is a very long section 5.1 with many shorter subsection for the column trace gas products, followed by section 5.2 – 5.5 for the other products.

Specific comments

Section 1. The first sentence should be revised. While I understand what the message is, I don't think it is properly worded.

Page 6996 lines 1-9. Here several reference need to be added to high-level requirement documents, e.g. Copernicus, IGACO, GCOS, etc.

Page 6996 lines 10-23. The introduction heritage missions is far too limited. The introduction should also include a description of and references to the TOMS and SBUV missions, the OMI/Aura mission and the Copernicus Sentinel 4/5/5p missions. This puts the GOME-2 missions into perspective.

Page 6997. I propose to remove the description on the data dissemination because it is described in a separate section.

Page 6998. Delete the detailed information on who develops the IASI product. The point here is that IASI products will be add, not who makes them.

Section 2. Page 6998. I find a reference back to the old science objectives papers of GOME very weird. These papers are 20 years old. In the mean time our insights have changed. Moreover measuring a set of trace gases is not a scientific objective (page 6998, line 25); these are observation requirements that follow from the science

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objectives. In addition there is a big difference between the GOME and GOME-2: a scientific mission versus and operational mission. I don't even know if the operational GOME-2's have a set of science requirements. Thus, this section is really confusing to me and needs strong revision. Maybe the whole part on scientific objectives should be deleted.

Page 6999 line 3-8. This is introduction. If the authors want to keep it, it should be moved to the introduction.

Page 6999 line 9-15. References shall be added to papers or technical reports that provide technical details on the instrument.

Section 3

Section 3 in its present form is too short to keep as a separate section. However, I think it should cover more information (see below).

Page 7000 line 9. Here a reference is made to a paper that is not yet published. This shall be replaced by a traceable reference.

In section 3 description shall be added that describes the Level 1B data quality of GOME2A and B. In section, for several products instrument degradation is mentioned to have a large impact on data quality. This could be a short summary of the Munro (2015) paper.

In section 3 the current Level 1B version should be given.

Section 4 This section starts with a description of the ground segment. I propose to include here also the data dissemination section (now section 7).

Although I understand the text on page 7000 line 11 to 24, figure 1 confused me a lot. This seems to be a flow chart, but without further description it is not clear to me. The entities described in the text are not shown in this figure. I propose to delete this figure, because for me it has no added value.

Also the validation methods are very briefly described. Given the importance that such processes are for an operational mission, I think the authors could describe this in more detail. I checked the website that is given, and was only to find recent comparisons with ground stations for a few products. Most the validation reports are several years old. What is the strategy for validation and quality control? How often are analysis made and reports issued?

Page 7001 lines 9-11. I don't understand this sentence. Without context I can only guess what "user services of climatological proxies" are, and similarly for BEAT. I think this sentence can be deleted and otherwise it should be expanded and references added.

Section 5

Table 1 provides key information for this paper and should be expanded. I propose to rotate it 90 degrees such that it can hold more columns. Information to be added: -The current version of the processor to which the validation examples apply. -The spectral ranges used for the retrieval -Application area (e.g. climate change, air quality, ozone monitoring, aviation safety, etc.) -Main reference -Internal products, e.g. cloud products. -In separate the rows the planned products fro CDOP 3.

It is not clear that "High res. Ozone" and "Low res. Ozone" refers to ozone profile products. From the product name it should be clear that this is about ozone profiles.

Some product names contain information on the dissemination, e.g. "Off-line UV index", "NRT UVI Clear". Why put this information in the product name when there is a separate column for this information?

On one row "Absorbing Aerosol Index" is used and in the next "AAI". Please make the table consistent.

Footnote 1: the resolution is not well described. This table is for the entire data record and not for the current situation. The baseline resolution is 80x40 km² for GOME-2.

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Since recent years GOME2A measures at 40x40 km².

The background of the target accuracy is not discussed in the manuscripts. What are the references to the observational requirements? How is target accuracy defined and how is it verified? Is it applicable to single measurements or to an ensemble? This should be discussed in a lot more detail in section 5. Note that only for a few data products described in section 5 the validation results are compared to these accuracies.

Some of the target accuracies seems strange to me. For example the combination of an accuracy for a total NO₂ column of 3-5 10¹⁴ and a total column of 20% seems an impossible when the trop column is several times 10¹⁶. A target accuracy for the LER of 0.04 seems way too relaxed. For most surfaces this is an error of more than 100%. Why is the target accuracy for low res ozone different from low res ozone?

Section 5.1

I propose to include the information of table 2 in table 1 and delete table 2.

The sentence that the new version will be implemented this fall doesn't add anything to the manuscript, so I propose to delete it. Furthermore, information on processor versions can be included in table 1.

Section 5.1.1 I have my doubts if the part on ENSO/NAO is suitable for this paper (page 7003 and 7004). First of all there is no introduction on what these are, even the acronyms are not explained. Thus, a lot knowledge is required to understand this paragraph. Furthermore, the lack of correlation with the NAO index is not discussed. The authors should either expand this part a lot, or decide to leave it out. I am in favor of the latter.

The last part of this section describes the users. As described above, my advice is to describe the data users in a separate section for all the data products. The text provide here already contains a good basis to do that.

Section 5.1.2

Why is the MOZART-2 model used for NO₂ AMFs and the IMAGES model for formaldehyde?

Figure 5 shows an average tropospheric NO₂ column. I don't like the use of the non-linear color scale for this figure. The text focuses on the high values in China, but due to the choice of the color scale this is one red blob without any variability. Also, depending on the target audience (see general comments), one should be very careful in the use of non-linear scales.

In many cases there are strong NO₂ variations over land-sea crossings (e.g. India), also in regions with far less emissions. What is the reason for these?

Page 7005, lines 5-10. This is about data users. I advice to move this to a separate section.

Page 7005, line 21. On the validation website I could only find validation data up to the beginning of 2014. This is not very recent for an operational mission.

Figure 6. What do the error bars represent? This figure could be further improved by using box-whisker plots.

Figure 6 doesn't compare the same period for GOME-2A and GOME-2B. Given these different periods, can the conclusions on the bias be drawn?

Page 7007, line 2. The term "urban effect" is misleading. This effect is due to a representation error and should be referred to in that way.

Figure 7. Panel a is way to small. Panel b: why are the symbols in red? I would opt for a more neutral color for these plots. Panel 7 c: the last part of the plot is very hard to read (when there are 4 datasets instead of 2). I propose make a zoom of this period in another panel.

Figure 7c: this plot contains monthly means. There are several months with larger differences between GOME2A and MAXDOAS. For example December 2009, February

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2010. In these cases GOME2A seems to be way off. Describe in the text the reason for these discrepancies and how the use of these data by users can be avoided.

Section 5.1.3

The chemical formula of formaldehyde that is most commonly used is CH₂O. Sometimes HCHO is used. Why do the authors use H₂CO? I think this is confusing for potential users to see all these different chemical formula's used for the same species. I advice not to use H₂CO and change to either CH₂O or HCHO throughout the manuscript.

Page 7007, page 25. As before I advice to describe the main data users in a separate section and to delete it form the product description.

Section 5.1.4 Page 7009, lines 5-10. This is an introduction on the role of SO₂ and needs a few references. In addition, the role of sulfate aerosols in human health is not mentioned.

Page 7009, lines 10, Fig 10. The text mentions that the Figure 10 shows global SO₂ missions. However, what is shown are regions where GOME-2 has detected SO₂ concentrations above a certain threshold. There are certainly more SO₂ sources than shown in the figure. I find figure 10 not clear. There are color used, but a color scale is missing. For example over the Beijing area I see blue colors, but the anthropogenic emissions are yellow according to the caption. Also, both in print and on-screen the black background doesn't work. In addition from the caption and the text it remains unclear what is presented (variable, mean/median/max value, time period, etc.).

Page 7010, line 11. Add a version number to the OMI/Aura SO₂ data product.

Section 5.1.5

Fig 13. This figure is way too small. Fig 13a. Add error bars in the plot indicating the variability (i.e. standard deviation of the mean). Fig 13b. The difference between the light and dark green is not very cleat. Why not use the same colors in the left and right panels? Also, I am in favor of adding error bars showing to indicate the uncertainty of

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the individual data points.

Section 5.1.6 Page 7012, line 5-9. This introduction on water vapor contains some strange claims: water vapor contributes to the energy balance? I think what is meant is that water vapor is an important greenhouse gas (as stated later-on). Also the growth of aerosol particles is a function of the relative humidity, where temperature also plays a crucial role, as for cloud formation. These lines should be rephrased carefully and references need to be added.

Page 7013 line 1-2. Using the O2 or O4 as a proxy for the light path, does this mean that the same vertical profile is assumed in calculating the AMFs? This seems a very crude assumption.

The product and intended use is not very clear for this product. It is claimed that it is especially useful for long time series, but it is not explained why. Also, there are many water vapor products from different wavelengths regions. What makes this product unique? From the references that are cited I get the impression that these are mostly connected to the data product producers, hence the user community of this product seems to be very small compared to those of other water vapor products. Since this is an EUMETSAT mission, how is this product appreciated within EUMETSAT?

Section 5.2 Page 7014, line 12. The authors mention only the vertical sampling, however also the vertical resolution of the product shall be described, because I suspect that this is not the same as the sampling.

Figure 16. The units in this figure shall be changed to either VMRs or number densities. DU per layer is a bad unit because it depends on the thickness of the layers and should not be used. Also, the horizontal axis should run from the south pole to the north pole, so please reverse it.

Caption Figure 17: ozone sondes are not ground-based measurements. What are the two red vertical lines? Please refer to GOME2A and GOME2B instead of METOP

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A and METOP B, to be consistent with other figures. Add a second vertical scale to indicate the pressures.

For Figure 17 The GOME2A and GOME2B comparisons are very different, what is the reason for this? Also GOME 2B seems to be worse than GOME2A, while GOME2A has a lot more degradation?

Figure 18. I advice to use different vertical scales for each of the subplots, or to increase the figure size.

Section 5.3. This section is very short. It would be good to add a discussion on the performance of GOME2A and GOME2B in the overlap period.

Section 5.4. References need to be added to the mentioned GOME and OMI heritage products. The described method has a strong heritage to the OMI method, please mention this.

Section 5.5 Page 7018, line 20. There is a forward reference. This is not acceptable, please delete. Page 7019, line 7. Add a reference to the most recent validation paper.

Section 6. Page 7020, line 4-11. The discussion on definition of the tropopause is far too detailed and also incomplete. I think this part should be deleted.

Add new products to the Table 1.

Section 7 Section 7 should be shortened and included in section 4. Preferable there should be a pointer to one website where all the technical details can be found. All these details do not belong in a scientific paper, because they will not be sustainable in the future. Table 2 should be deleted because (1) it contains very little info and (2) this technical info doesn't belong in a scientific paper. Please take my general comments on the target audience into account when doing the rework on this part.

Section 8 The discussion section starts with a series of very general statements, which are not backed up by references. Please rewrite this section with a clear objective in

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mind. What are the messages that I should read here? What are the conclusions and what are the recommendations?

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