Response to comments on egusphere-2025-4942 Submitted 06 Oct 2025

Anonymous Referee #2

Referee comment on "**Cross-calibration of GOME and SCIAMACHY Spectrometers Enhanced by Polarization Monitoring Devices Data**" by Owda, A., Coldewey-Egbers, M., Slijkhuis, S., Lichtenberg, G., and Aberle, B., https://doi.org/10.5194/egusphere-2025-4942, 2025.

We are grateful to the anonymous referee for taking the time to review our manuscript and provide us with constructive comments. We have carefully considered all comments and suggestions and thoroughly revised the manuscript.

In this response letter, we intend to address all comments, concerns, and suggestions point by point. The response will be highlighted in blue and the corresponding modification in the revised manuscript in orange. The original comment from the anonymous referee will be in black.

General comments:

Owda et.al. describe a method to harmonize the reflectances of the spectrometers GOME and SCIAMACHY. Goal is a harmonized time-series of both instruments for reflectances. The authors uses measurements over PICS sites with co-located reflectance measurements from both instruments. The method includes utilizing the spatially higher resolved measuerments of the PMDs of both instrument to ensure homogenous scenes used for the harmonization.

In general, the paper is well written. The ideas behind the method are well described.

Long term data records are an important topic in atmospheric science. Harmonizing the data from different instrument is especially an issue for satellite based measurements. Harmonizing reflectances is a new approach to harmonize the measurements on the spectrometer level.

This paper describes a method to harmonize the reflectances of the satellite instruments GOME and SCIAMACHY. A method to harmonize the irradiance is not covered. This is not

clearly stated in the abstract (according the the abstract, the FDR4ATMOS project aims to provide also irradiance). Please clarify this in the abstract, for example in line 7: This paper presents, for the first time, the cross-calibration methodology for *the reflectance of t*he spectrometers used in the FDR4ATMOS project. You might also consider adding the term *reflectance* to the title of the paper.`

Response: Thank you very much for the general comments and the positive impression about the paper. We agree that we should highlight clearly the harmonized parameter in the manuscript. We presented only reflectance in the manuscript; therefore, we have added that clearly in the title of the paper and in the abstract as well. [Fixed]

See Title "Reflectance-Based Cross-calibration…."

See Line 8, "across-calibration methodology for the reflectance of the spectrometers."

In the introduction, I miss the motivation for the selected spectral windows. This is driven by the common spectral windows, which contain spectral absorbtions of important trace gases. I suggest adding the relavant trace gases for each band also in Table 2. [Fixed]

Response: The motivation for the selection of these ranges of spectral bands is added to the introduction. The relevant trace gases for each band are added in Table 4

See Table 4 and

Lines 81-83. "The focus of the FDR4ATMOS was on three spectral windows in the ultraviolet, visible, and near-infrared (UV/VIS/NIR), as these regions contain well-characterized absorption features of many key atmospheric trace gases (see Table 4)."

In Figure 7, transfer functions (TFs) for the whole band 4 (including O2A) are shown (dashed line). In Figure 10, only the two separate TFs outside the absorption are shown. The TF for band 4 needs some clarification:

How is the TF for the whole channel build? [Fixed]

We agree with your point of view that further clarification is needed.

We considered only the ratios from the wavelength intervals to the left and to the right of the O_2 A-band. The O_2 A-band was excluded from the derivation process of TF of Band 4 (NIR). The TF of band 4 is the average of the ratios from the left and right sides of the O_2 A-band. Fig 6(g- i) shows the left and right sides of the ratio of the O_2 A-band.

Which TF will be used for the harmonization? This is finally stated in the conclusion: `constant value for the whole band`. This needs to be clarified already here. Therefore, the whole channel 4 TFs need to be added to Figure 10, because that is the used one. [Fixed]

That is correct; we agree on that. The manuscript is modified as well.

The TF is a constant value that is used to update the whole band (including the O2 A-band). Figure 10 is corrected.

Lines 303-305. For Band 4, the TF was obtained by averaging the ratios on the left and right sides of the O_2 A-band, yielding a constant value of 0.93, which represents the TF for Band 4, including the O_2 A-band (blue dashed line in Fig. 7c).

Related to this: In Table 1, for the NIR the wavelength intervalls are given as 756–757 & 773–774 nm. These are the intervall used for the TF calculation, but the FDR4ATMOS product will contain the intervall 756-774nm including the O2A Band. Here you need to distinguish between the spectral window in the harmonized product and the windows used in your calculations. You also need to descripe the calculation of the final TF for band 4. [Fixed]

We agree. We distinguish between the spectral ranges used to derive the TFs and the harmonized ranges.

See Lines 233-235. Additionally, the note was added to the caption of Table 4

For the derivation of the TF of the NIR spectral window, the O_2 A-band is excluded due to its high atmospheric sensitivity and the resulting strong variability in the observed reflectance. Instead, the two wavelength intervals of 1 nm width located immediately to the left and right of the O_2 A-band were used to compute the TFs. The ratio measurements obtained in these adjacent intervals were averaged to derive a single wavelength-independent TF, which is then applied to the entire spectral window, including the O_2 A-band.

Specific and technical comments

Response: Thank you very much for the specific comments. We believe that your comments were very useful, and fixing these comments helps to improve the readability of the paper.

We have dealt with your comments one by one as follows:

1. **p5, l120:**

   The SCIAMACHY Level1 product does not contain cloud information. Probably, your cloud information comes from the corresponding Level 2 products. Please clarify.

   [Fixed]

   Line 124. "For SCIAMACHY, we added cloud information from Level 2 to the standard Level 1c products."

---

2. **p5, 122:**

   The cluster concept refers to a subdivision of a channel containing a specific wavelength region and detector exposure time, aiming to identify certain important spectral windows in the data.

   The goal is not to identify important windows. The goal is to optimize the data rate towards the important spectral windows:

   ..., aiming to optimize the data rate towards important spectral windows in the data.

   We have decided to take this part of the information out of the manuscript. The revised manuscript will not have any description of the cluster concept. The conversion process of Level 1b -> Level 1c was disregarded. The input for the harmonization starts with SCIAMACHY data, which is at Level 1c.

---

3. **p5, l127:**

   with the scial1c tool developed by DLR (the link to the tool is under Section 8).

   I suggest to change this to a normal reference and add the URL to the references, something like: with the scial1c tool developed by DLR (ESA, 2025c).

   [Fixed]

   We have followed your suggestion by putting the links under the references.

---

4. **p7, Fig. 2:**

   Add to the text in the building blocks the variable names used in text/formulas, just as in the first block with (R_g) and (R_s)

   - SCIA2GOME Pseudo reflectance -> SCIA2GOME Pseudo reflectance ($R_{SCIA2GOME}$)

   - Ratio of refectance (SCIAMACHY/GOME) -> Ratio of refectances (Ratio)

   - Transfer functions ... -> Transfer functions (TF) ...

   I suggest to add a block for "Outlier removal", that step is missing in the sketch.

   [Fixed]

   Fig.2 has been updated in the revised manuscript based on reviewers' and your feedback.

---

5. **p7, eq(1):**

   Please use a proper multiplication sign in equation (1), this seem to be a simple dot (.).

   Should be *cdot* in Latex math mode. Same for all further equations.

   [Fixed]

   See equation 1

6. **p7, Figure 3:**

   There is a gap between subsequent SCIAMACHY scanlines. This is not expected; there is (almost) no gap between the scanlines (similar to the two GOME ground pixels in the plot). Please check your figure.

   This gap refers to considering only forward scanning in the cross-calibration. The backscan is not considered in the cross-calibration, therefore, there is a gap between the forward scanning of SCIAMACHY.

   We have updated the caption with this piece of information.

   See caption of Fig 3

---

7. **p9, Table2:**

   This table is a duplication of Table 1, only provide and refer to Table 1.

   [Fixed]

   There was a duplicate. Tables 1 and 2 were the same. In the revised manuscript, there are no more duplicated tables.

---

8. **p 24, l397:**

   the spectral channels with strong absorption features: Only the O2A absorbtion band is excluded, so I suggest to clarify here, that the O2A window is the one excluded.

   [Fixed]

   O2 A-band was the only window excluded from the derivation of TFs.

   See Line 410-411

---

9. **p 24, l401:**

   It found that... -> It has been found that...

   [Fixed]

   See Line 415

10. **25, Section 8:**

    Instead of a list of links (with wrong indentations, use the `itemize` environment for lists), make a short text and move the links to the references. Something like:

    ***SCIAMACHY and GOME Level-1 data are available from ESA (ESA, 2025c; ESA, 2025d),* etc.**

    [Fixed]

    Instead of using links. We moved all links to the reference and cited them as you suggested.

    Section 8