Referee #2

We thank Referee 2 for this review of our manuscript. Below, we address the comments with the comments of Referee 2 in bold and our reply in normal font.

Overall impression
The manuscript proposes and describes a new processing of GOME2 data that improves the SIF retrieval. The results do show convincing improvements and the description is clear and detailed. The resulting dataset will be useful for the community and this manuscript will serve as a good reference for those who need to go in the details.
I am not an expert in the actual SIF retrieval nor the GOME instruments. I must admit that this manuscript is more technical than I initially thought, and that it thus fall beyond my comfort zone in terms of technical details. Therefore I cannot pronounce myself too much on the very technical satellite retrieval details and hope that this is covered by other reviewers.
Specific points
Reply: We thank Referee 2 for these comments.

L61: Maybe state that this is FLUXCOM X-BASE products
Reply: We thank Referee 1 for this comment. It is indeed necessary to specify that we used FLUXCOM-X. We will modify line 61.

L88: Not too sure (for me) how the information on the throughput tests is actually useful for the average reader. Maybe some more context (if needed) could help.
Reply: To correct for instrument degradation, it is important to understand the various drivers of the varying degradation rate. The throughput tests played a significant role in the changing degradation rate over time and its scan-angle dependency. We acknowledge that this aspect is not made clear enough in line 88 and that this specific paragraph should be modified to highlight the different effects that contributed to the variability of the degradation impact.

L116: What seems also very clear is a downward trend after the jump. This would be good to point out (and state the reasons behind)
Reply: The clear downward trend after the jump, after ~2014, is caused by instrument degradation. This trend is mentioned in lines 115—116. We agree that it should be more explicitly stated that this downward trend is due to the instrument degradation effect. We will modify this sentence to enhance clarity.

L140: is this assumption correct given noted trend in global greening?
Reply: The impact of land-use change and other factors on the variation of the global reflectivity is studied intensively but its global impact is uncertain and contrasting results are found (Li et al., 2022). In relation to the impact of throughput loss due to instrument degradation, up to +10% in terms of reflectance (EUMETSAT, 2022), the reported geophysical trends due to e.g. greening are much smaller, with MODIS data estimating a global decrease in global albedo of 0.0004 between 2002 and 2016 (Li et al., 2018).

Therefore, such geophysical trend on the global reflectance over the studied period would be smaller than the accuracy of our method (Tilstra et al., 2012).

Fig 2: To be clear, the +0.1 should also be mentioned in the legend
Reply: We thank Referee 1 for this comment. We will include the +0.1 in the legend.

L192: for completion, please state what E0 is in Eq. 3
Reply: We appreciate the Referee's comment regarding the not-explained E_0 variable in Equation 3. E_0 is the solar irradiance, we will state the meaning in E_0 after Eq. 3.

Fig 11: I feel this visualization does not show well the actual improvements. Consider additional/complementary plots showing residuals with respect to the mean seasonal cycle, or differences with respect to one product.
Reply: SIF is sensitive to changing vegetation dynamics due to disturbances such as droughts, resulting in interannual variation in seasonal SIF (e.g., Koren et al., 2018). Residuals with respect to the mean seasonal cycle would therefore not be useful to diagnose improvements.

We agree with the Referee that showing the difference in SIF (SIFTER v2, and SIFTER v3 without degradation correction) over time with respect to the SIFTER v3 product will enhance the presentation of the improvements. We will include such plot in the supplement.

Fig 12: why these two dates, which are showing very similar information? Would it not be more appropriate to show a date after the sensor jump of 2013 to see if things hold there too?
Reply: Figure 12 shows the correlation between SIF uncertainty of SIFTER v2 and SIFTER v3 over two days in different seasons. We agree with the referee that it would be insightful to show this correlation for a later date when degradation impact is more significant.

Fig 13: it is a pity that the spatial variability is not well showcased. Could you consider adding another figure showing differences in spatial patterns over these regions (i.e. showing the actual spatial variability with maps rather than time series)?
Reply: We appreciate the Referee's comment regarding the lack of presenting spatial differences between the SIF products in this work. We agree that showing the spatial variability will provide more insight into the showcased regions, therefore spatial variability maps will be added to the supplement of this manuscript.

L398: My understanding is that FluxSAT does use some GOME2 data at some point in their processing, while FLUXCOM XBase does not at all. Please investigate/confirm is this is the case and discuss the possible repercussions (and circularity) that may come out from this comparison with SIFTER.
Reply: The Referee is right about the use of GOME-2A SIF data, specifically the SIF v27 data from NASA (Joiner et al., 2013, 2016), in FluxSat (Joiner et al., 2018). However, the NASA SIF data is only used in the FluxSat calibration procedure and not in the regression model itself, and thus we don't expect possible repercussions.

L453: It says here the SIFTER V3 data "will become publicly available", but this does not say when. It should be made available along with this manuscript.
Reply: The SIFTER v3 data will indeed be made available along with this manuscript.

What about the code? It would be good practice to provide the code used to do this processing and the analyses done within this study.
Reply: We appreciate the Referee's 2 comment. The code needed for the analysis of the SIFTER v3 L2 data will be available on request.

References

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