Referee Comment for

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Improved consistency in solar-induced fluorescence retrievals from GOME-2A with the SIFTER v3 algorithm
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Anema et al. present results from an update to their Solar-Induced Fluorescence of Terrestrial Ecosystems Retrieval (SIFTER) v3 algorithm applied to observations from the GOME-2A sensor, together with extensive comparisons to the previous SIFTER v2. Updates include the use of the latest level 1 GOME-2A radiance product, improvements to better account for instrument degradation, and changes to background ("zero offset") and latitudinal bias corrections.

Space-based measurements of Solar-Induced Fluorescence (SIF) have become established data products and are routinely observed from sensors including GOME, SCIAMACHY, GOME-2, GOSAT, OCO-2, TROPOMI, and OCO-3, with a combined data record that goes back to 1995. SIF is a highly challenging measurement to make from space, and updates and improvements to existing data products are highly welcome to reduce data uncertainty and enhance data consistency and accuracy.

Anema et al. demonstrate extensively and convincingly that their v3 SIFTER results present an improvement over the SIFTER v2 product in terms of consistency. However, they do not present any evidence about either version's accuracy. The only comparisons to non-SIFTER data are shown in Figure 13: scaled results from SIFTER are plotted against GPP measurements from FluxSat and FLUXCOM-X products to show that seasonal and inter-annual variations in GPP are reproduced by SIFTER SIF v3 better than v2. This is not evidence for the accuracy of the new version, only for its consistency.

A wide range of independent satellite-based SIF data products have been publicly released, including that of OCO-2 starting in September 2014 providing about three years of temporal overlap with GOME-2A. While the basic scope of this paper as a "algorithm modifications and product improvement" doesn't have to change, I feel strongly about the need to include, at the least, a comparison plot with independent SIF observations for a perspective on where the SIFTER results fall in relation to data from other instruments. As has been the case for a long time now with minor trace gases like BrO, H2CO, or C2H2O2, SIF is no longer a "first observation" type of measurement, and new data products should be benchmarked against published data records that have been accepted as the current standard. This is not to suggest that existing records are necessarily correct or that deviating new results are necessarily wrong. SIF in particular is a challenging observation to make, and "dissenting opinions" only help to move the state of these measurements forward. In this particular case, the seasonal peak SIF values shown in Figure 11 appear to be 20-40% higher than those reported from other satellite sensors, for essentially all vegetated regions. That warrants an explanation as to possible sources for these differences and the confidence in the results.

To enhance the scientific significance of this study, while keeping its focus as an algorithm paper, I recommend the following modifications to the manuscript:

- Streamline the discussion of the differences between v2 and v3, which can be presented in considerably abbreviated form without sacrificing insights into the modifications.

- Add a comparison plot to an independent space-based, non-SIFTER SIF data product (e.g., the biomes in Figure 11 could be augmented with data from another satellite instrument or instruments) and a brief discussion of how the data products relate to each other.

After those modifications, the paper should be submitted for re-review.

The following comments are more detailed and editorial in nature and may help the authors during the revision of the manuscript. They are mostly intended as suggestions rather than mandatory points to be addressed, though several issues will benefit from clarifications.

Introduction:
suggest to include this paper for OCO-2/3 SIF reference
Global GOSAT, OCO-2, and OCO-3 solar-induced chlorophyll fluorescence datasets; R. Doughty et al., Earth Syst. Sci. Data, 14, 1513–1529, 2022 https://doi.org/10.5194/essd-14-1513-2022

Figure 1:
"different hues of grey" isn't working well; would suggest "orange", "light red", "dark red" or something similar, to show pre-6.3.3 processor version. Alternatively, time frames of each processor version should be included either in the figure description or indicated in the plot (shading, lines, etc.) to give the reader an idea which processor version was used when.

The mid-2013 drop must be the change in throughput related to the switch to narrow swath. But why exactly does the reflectance drop? Should that not be taken care of by updates to the radiometric calibration? The atmosphere doesn't change with the switch to a reduced swath, and vicarious calibration or cross-sensor radiometric comparisons (MODIS, etc.) should provide information on the actual radiance levels.

How do the 740 nm R3 reflectances in this figure relate to the equivalent 747 nm R3 reflectances in Figure S2 that show a smooth transition across the switch to reduced swath?

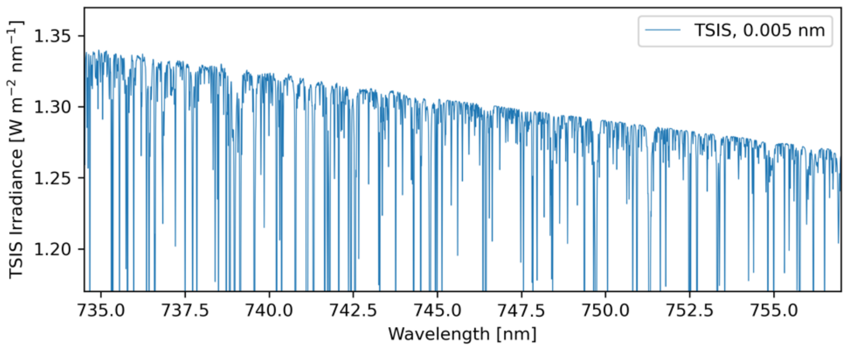
Figure 2:
Why are post-2013 reflectances not shown? Would it be instructive to limit pre- and post swath reduction reflectances to the extend of the reduced swath?

Figures 3&4:
These could be combined, since they are principally showing the same thing; as for visual cosmetics, discrete color levels (12?) might introduce some structure into the monotone Figure 4.

Figures 6,8,9:
Those panels could be combined into a single figure (with shared x-axes to save vertical space).

Figure 7:
The SIFTER 3 ILS is lost in the line width, to the point that the visual effect is somewhat strange; suggest to reduce line thickness (or switch v2 and v3 thickness), and/or include a zoom of, e.g., the 741-742 nm region.

For general information: The TSIS solar reference spectrum is becoming more widely adopted as the standard irradiance reference; absolute radiometric levels differ slightly from Chance/Kurucz (see image below). https://lasp.colorado.edu/lisird/data/tsis1_hsrs_p1nm



Zero-Level Offset Adjustments:
First, for reference: practically every existing SIF retrieval approach neglects the effect of inelastic Raman scattering on the Fraunhofer lines. This introduces an error in SIF retrievals that, while negligible over high-SIF biomes, disproportionally affects low-SIF regimes and, with that, necessarily zero-level offset corrections. A study to quantify this effect is currently under review (and thus not available to the authors of this manuscript).

SIFTER v3 switched to including fully cloudy pixels for background correction, which means more implicit variability of rotational Raman scattering in the background references. More clouds will mean less atmospheric Raman scattering, hence less reduction in Fraunhofer line depth and thus less "erroneous SIF" over non-fluorescing surfaces. Does this conform with the change in background correction values shown in Figure S7? That figure is a little hard to interpret (and it may also benefit from a tightening of the plot range to ±0.5 or ±0.4).

Figure 10:
Is the the latitude-dependent ILS is known, or can it be derived from in-flight spectra? Would that help with the latitude-dependent offset correction?

General:
Ever so often, use "allow" instead of "enable"

Line 73:
Check the font – is it "oh cee ell oh" or "oh cee eye oh"? (OClO or OCIO)

Line 88:
proceeded → performed

Line 90:
Are there any details on this “drop of throughput”? Specifically why does it affect the reflectances?

Line 133:
“narrow swath” and “nadir static” supposedly are a special observation modes?

Equation 1:
by itself, this doesn’t provide much information that couldn’t be conveyed by text alone. Can the full equation be provided?

Line 162:
“Scanner Angle” (and “Scanning Angle” or “Scan-Angle”) → “Scan Angle”

Line 165:
“sensor-switch” supposedly is the change to the reduced swath? That term is a bit confusing, “swath reduction” would be better.

Line 171:
post-sensor switch → post sensor-switch

Line 182:
“relative filling-in of solar Fraunhofer absorption lines” → “reduction of solar Fraunhofer line depth in the radiance spectra”
that makes it clear in which spectra this is happening, and it also makes it intuitive that the overall effect is SFLs showing up as enhancements (peak)s in the I/I0 reflectances, from a combination of SIF and inelastic Raman scattering.

Figure 8a:
Absolute uncertainties remain the same, thus relative uncertainties increase by 15% - does that hold true in general?

Line 282:
Can a reduction from 0.068% to 0.063% in RMSE really be considered “substantial” or “significant”? While that is indeed a reduction of ~10% in relative RMSE, what are the corresponding values in terms of absolute radiance (~?x10-4)?