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Atmospheric Measurement Techniques Discussions

Interactive comment on "Improved SIFTER v2 algorithm for long-term GOME-2A satellite retrievals of fluorescence with a correction for instrument degradation" *by* Erik van Schaik et al.

Anonymous Referee #1

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Genereral comment

The manuscript entitled with "Improved SIFTER v2 algorithm for long-term GOME-2A satellite retrievals of fluorescence with a correction for instrument degradation" by van Schaik et al. tackles some interesting technical aspects related to the GOME-2 SIF retrievals. In particular, the assessment of degradation issues is crucial for the interpretation of the resulting data set. Improvements were apparently achieved by narrowing the fitting window, resulting in a very similar retrieval set-up with respect to the NASA algorithm. Therefore, it is not surprising that the results converge, but reassuring. While the manuscript is generally well written, there are some important

corrections necessary and I recommend to add some additional analyses. My major concern relates to the end-to-end test, where the retrieval seems to perform worse than for the real data, even though the simulations are representing the ideal case (noise-free). To identify any fitting issues (over or underfitting), adding a reduced Chi square anaylsis (expected vs observed) would be necessary, at least for the real data.

Specific comments

P2L9-10 van der Tol (2014) claims that SIF is driven by CO2 concentration? This is certainly wrong, the CO2 concentration is relevant for the dark reaction of photosynthesis.

P2L22-24 overly complicated sentence. Please rephrase

P4L20 'understood' → is due to

P6L33 – P7L3 What justifies this particular interpretation? What means "and so on"? A physical meaning may be attached to the PCs, but this is not always the case. Here, all PCs show features related to oxygen and water vapour. Maybe remove this sentence?

P7L3 This sentence has a trivial meaning, masking the important details of how many components are actually required to model the transmission with sufficient accuracy and if all of the PCs are indeed needed. This is relevant, because it is known that the number of PCs has effects on the retrieval accuracy and precision, reported by Guanter et al. (2013), Joiner et al. (2013), and Köhler et al. (2015).

P7Eq2 The forward model is written in a way that assumes SIF as known. If, as claimed, there is one fitting parameter for SIF, there should be a normalized spectral shape in combination with one coefficient to fit.

P7L15 The spectral shape of SIF in Daumard et al. (2012) is based on leaf level measurements, not "spectral measurements over various vegetated fields". "...considerable uncertainty on the shape..." is inaccurate. In fact, Magney et al. (2019) showed that the spectral shape of SIF in the far-red is remarkably stable across species and envi-

ronmental conditions. However, in wavelengths < ∼730nm the shape is controlled by re-(absorption) effects, which is the origin of the uncertainty.

P7L17 The sentence about the spectral shape is misleading as the two tested spectral shapes in Parazoo et al. (2019) are very similar. The main message here should be that the fitting window ideally covers the spectral region where SIF is stable, otherwise re-absorption effects may interfere with the retrieval. However, this limits the number of spectral points, which increases the retrieval noise. Conversely, a wider retrieval window makes the retrieval less noisy, but affects the retrieved SIF magnitude (introduces a bias). The overlap with solar Fraunhofer lines does not change the retrieved magnitude, it is a necessary prerequisite. Please rephrase according to my comment.

P7L21 This sentence appears to be out of context.

P7L28 I don't understand this sentence. What means "...so orthogonality between the albedo plus two-way transmission and SIF plus one-way transmission terms is important."?

P7L30 I don't think that an "Internship Report" is a legit, citeable reference. Unrealistic albedo or transmittance values occur under "some viewing conditions" and lead to negative SIF estimates? This raises several questions and appears to be out of context, please remove this sentence entirely.

P8L20 The opening of the sentence sounds odd. Replace "our understanding" by "our assumptions to model ..."? Provide a reference for the DISAMAR radiative transfer model, the abbreviation has not been introduced.

P9Fig.2 Please check your y-axis, spelling and unit. What does absorption > 1 mean? Explained variances could be added.

P10L9 This sentence is odd. First, "spectra" is misleading, because PCs are compared. Second, it should be self-explanatory that a radiative transfer model is able to "capture the various relevant atmospheric processes".

P10L11 The informative value of comparing PCs from observations and simulations is not obvious to me. The sign could be flipped, higher order PCs explain only a fraction of the variance and might occur at different positions (e.g. PC#3 from simulations could be PC#5 in observations). Would you clarify what this comparison should tell the reader and why it deserves a Figure? Furthermore, why should we expect the PCs to be similar if the real measurements include noise while the simulations seem to be noise-free?

P10L20 As there is no word about noise in the simulations, I have to assume that they are noise free, in which case the poor retrieval performance shown in Table 2 is surprisingly disappointing. Without noise, the RMSE could be zero.

P12-13 Even though it is interesting to explore alternative ways to identify poor retrievals, the authors should consider to use the reduced Chi square instead. The reduced Chi square would reveal any deficiencies in the retrieval set-up.

P13L9-21 This paragraph reveals that there is a serious issue when modeling water vapour absorption. This is an idealized scenario in which 65% of the retrievals are flagged as poor. From my perspective, this is far from being acceptable.

P14L21 Is there a reference to justify that the Saharan desert has a "dynamic range" of water vapour in the first place?

P15L5 "but not dramatically so"? This seems to be a bold claim.

P17L15 Could you elaborate on the exact mechanism by which the slit function introduces a bias or is this hypothesis purely based on the latitudinal offset?

P18L5 Could you add a Figure to illustrate the bias correction? I am particularly interested to see if a linear fit with radiance levels is justified.

P18L10 Does this sentence mean that you apply a daily and monthly bias correction? Please clarify.

P18L22-26 Again, it is not appropriate to cite an “Internship Report” which is not publicly available.

P20L1 Could you explain how the degradation relates to the different L1 processors? Please discuss what kind of effect could potentially result from the change in L1 processors.

P21L11 Again, “Internship Report”

P21L14 Is there a reason to assume that the uncertainty is driven by the SIF signal level? It should be driven by the radiance level. Please add (or replace) the uncertainty vs radiance level in Figure 6.

P22L6 Replace “yields” by values. How come that the filter rejects suddenly only 5-10% of the measurements? This is better than in all of the experiments.

P27Fig.9 The Amazon time series still shows a significant SIF decrease after 2013. Even though the reliability for the later period is already extensively discussed, are there other potential sources for artificial trends?

P27L6 I see this as an overstatement. No retrieval algorithm has been developed, but different parameters have been optimized.

References:

Guanter, L., Rossini, M., Colombo, R., Meroni, M., Frankenberg, C., Lee, J.-E., & Joiner, J. (2013). Using field spectroscopy to assess the potential of statistical approaches for the retrieval of sun-induced chlorophyll fluorescence from ground and space. Remote Sensing of Environment, 133 , 52–61.

Joiner, J., Guanter, L., Lindstrot, R., Voigt, M., Vasilkov, A., Middleton, E., Frankenberg, C. (2013). Global monitoring of terrestrial chlorophyll fluorescence from moderate-spectral-resolution near-infrared satellite measurements: methodology, simulations, and application to GOME-2. Atmospheric Measurement Techniques, 6 (10), 2803–

2823.

Köhler, P., Guanter, L., & Joiner, J. (2015). A linear method for the retrieval of sun-induced chlorophyll fluorescence from GOME-2 and SCIAMACHY data. Atmospheric Measurement Techniques, 8 (6), 2589–2608.

Magney, T. S., Frankenberg, C., Köhler, P., North, G., Davis, T. S., Dold, C. (2019). Disentangling changes in the spectral shape of chlorophyll fluorescence: Implications for remote sensing of photosynthesis. Journal of Geophysical Research: Biogeosciences.

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