https://doi.org/10.5194/essd-2025-94
Response to Reviewer 1 Comments:

This paper produced a long-term SIF dataset (LHSIF) from 1995 to 2023. This topic is of significant importance for global-scale carbon simulation and vegetation studies. I think the datasets preprocessing procedures are solid. However, there are some questions I am concerned, especially about the reliability of the inter-annual trend in the SIF data from 1995 to 2000.

Response: We sincerely thank the reviewer for recognizing the significance of our work and the robustness of the preprocessing procedures. We fully understand the reviewer's concern regarding the reliability of the inter-annual trend in the early part of the time series (1995–2000). In response, we have added a dedicated discussion in the manuscript to clarify the limitations and uncertainties associated with this period. Please see below for detailed responses. Reviewer comments are shown in black, authors' responses in blue, and the corresponding revisions to the manuscript in purple.

There are many spelling errors in sentences throughout the paper. I listed as much as I could found. Please double check to avoid such errors and also try to avoid using 'Figure.... illustrated...' as the begining of a paragraph in the result section. Following a logical writing orders is necessary.

I recommend minor revision and here are some comments I wish the authors could give explanations before accepting this paper for publication.

Response: We sincerely thank the reviewer for the detailed and constructive comments. We have carefully reviewed the entire manuscript to correct the identified language issues and have revised or rewritten problematic expressions accordingly. Detailed responses to each comment are provided below.

Specific concerns and suggestions are outlined as follows:

Comment 1： You didn't mention how do you do quality control for GPP provides by FLUXNET. Did you use the quality flag data of "GPP_DT_VUT_REF" during SIF production?

Response: Thank you for this comment. In the previous version of our manuscript, we selected GPP data that were neither missing nor equal to -999 for comparison. In the revised version, we have incorporated an additional quality control step by using the "NEE_VUT_REF_QC" field as a filter. Specifically, only GPP data points with QC values greater than 0.7 were retained to ensure the reliability of the data used for SIF product validation. Corresponding descriptions have been added to Section 2.5.4, as follows:

2.5.4 Ground-based observations

Ground-based SIF and GPP observations were integrated into this study to validate and enhance the interpretation of satellite-derived datasets. Specifically, FLUXNET GPP observations were employed, which are based on in-situ measurements from a global network of flux towers distributed across diverse ecosystems (Pastorello et al., 2020). FLUXNET sites with more than five years of data were grouped into climate zones and vegetation functional types (see Fig. S1 for site distribution and types). The field "GPP_DT_VUT_REF" was used. **To ensure the quality of the GPP data used for validation, only GPP records with the quality flag greater than 0.7 (Verma et al., 2015) were retained in this study.**

The correlation between SIF and GPP was further improved after applying quality filtering. The corresponding figure has been updated accordingly (originally Figure 10, now revised as Figure 11).

3.3Validation and comparative analysis

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In addition to long-term satellite products, ground-based observations were also incorporated for comparison.

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The relationships of LHSIF and AVHRR NDVI with FLUXNET GPP are illustrated in Figure . The LHSIF product shows a strong ability to track GPP, especially for cropland and mixed forest types (Fig. 11a). In contrast, NDVI consistently exhibits lower R^2 values (Fig. 11b) and a more pronounced nonlinear relationship with GPP due to saturation effects. Apart from a few groups in the Southern Hemisphere (such as grasslands in tropical and arid areas), where only a small number of sites are available (see Fig. S1), SIF outperforms NDVI in most cases.

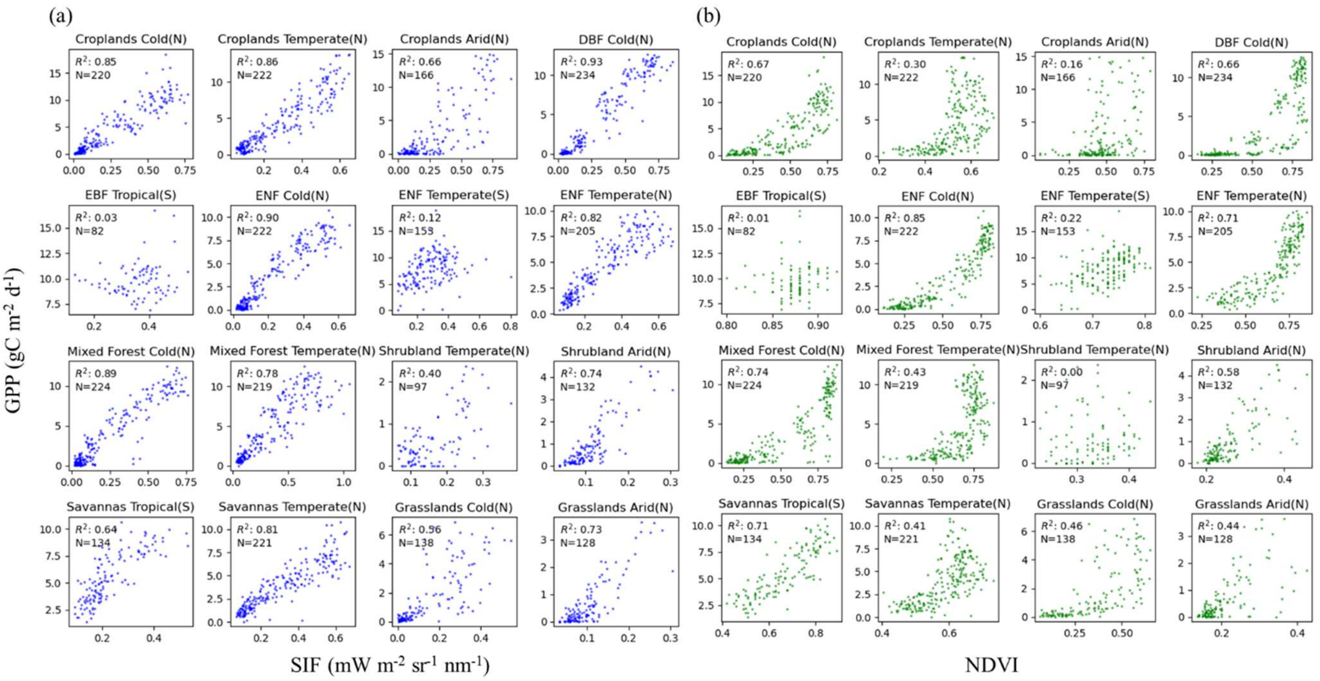

Figure 11. Comparison of long-term relationships between SIF vs. GPP and NDVI vs. GPP at FLUXNET sites. Only those flux tower sites that have accumulated over a decade of data were chosen and subsequently categorized according to their respective climate zones and vegetation types.

Comment 2： I am concerned whether the interannual trend in SIF before 2000 is true or reliable. For example, in Figure 7, we did not see much difference in yearly maximum global-averaged SIF based on the SIFu or SIFc from 2000 to 2023. The large discrepency mainly occurs in year 1995 to 2000, when SIFu is significant higher than the SIFc with a significnatly decreasing trend (mainly provided by GOME?). However, there exists larege discrenpency between SIFu and SIFc before 2000. How could you convience the readers that such inter-annual trend in SIF in year 1995 to 2000 is reliable? There is no validation of this trend from 1995 to 2000 as far as I can see in the paper.

Response: Thanks for this thoughtful comment. We appreciate the concern regarding the reliability of the interannual SIF trend prior to 2000. First, we would like to clarify that our normalization approach adjusts only the overall scale of the datasets based on their statistical relationships during the overlap period. It does not impose artificial changes on the original temporal trends.

To further investigate whether the decreasing trend during the early GOME period (1995–2000) is attributable to sensor degradation, we examined long-term reflectance at pseudo-invariant calibration sites (PICs) located in the Sahara and Arabian deserts (Fig. R1).

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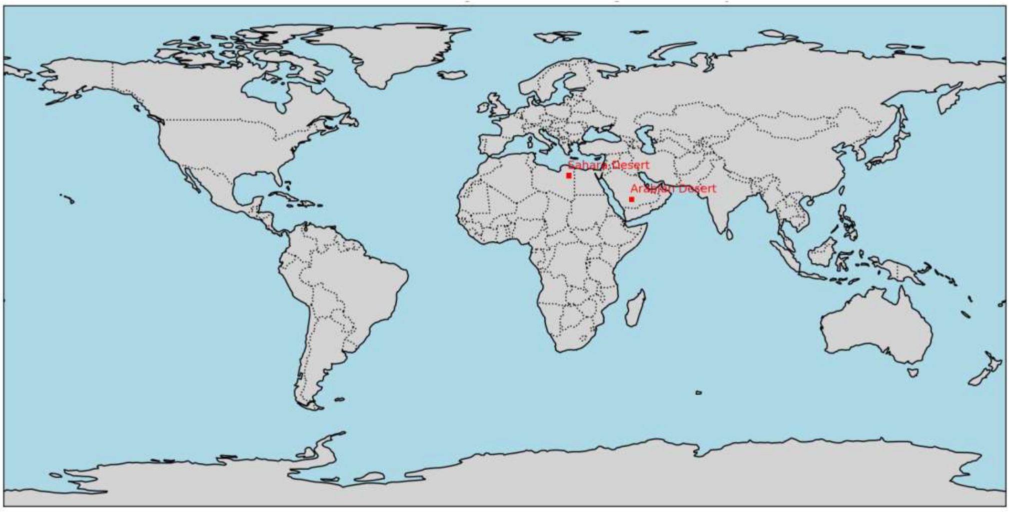

Figure R1 Locations of the PICs used to evaluate GOME sensor stability.

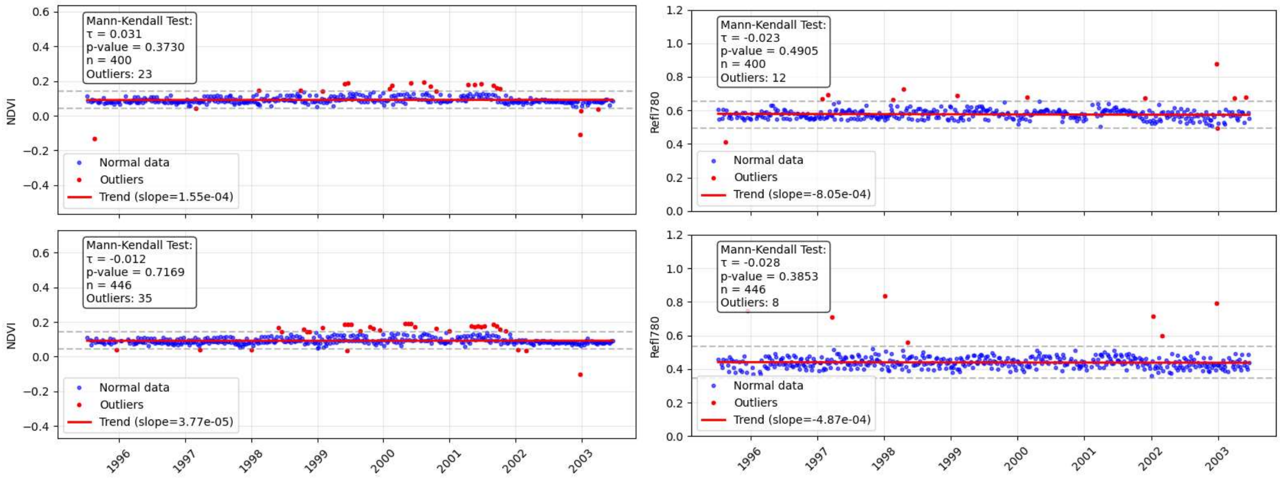

Figure R2 Long-term trends of GOME 780 nm reflectance and NDVI over the PICs.

As shown in Fig. R2, no significant decline was found in the GOME NIR-band (780 nm) reflectance or the NDVI. These results suggest that the GOME sensor did not exhibit obvious degradation in reflectance at relevant wavelengths. Therefore, we did not apply an artificial trend correction to the GOME SIF record.

However, since GOME and SCIAMACHY share only a six-month overlap period, such a short duration may introduce uncertainties in the normalization process. We have added an evaluation of this issue in the discussion section and included a note to caution readers about the potential uncertainties associated with this period of the dataset. The added description is as follows:

4.1 Improvements in cross-sensor harmonization

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Secondly, our harmonization strategy uses GOME-2A as the reference sensor. Its extended data record (2007–2021) provides over five years of overlap with both SCIAMACHY and OCO-2, allowing us to perform a single-step normalization for each. This approach helps reduce the uncertainty propagation associated with multi-step corrections. In contrast, the LT_SIFc* product uses GOME as the benchmark, relying on only a six-month overlap with SCIAMACHY and then sequentially calibrating SCIAMACHY and GOME-2A, which may accumulate uncertainties.

To quantify the impact of overlap duration on harmonization uncertainty, we performed normalization experiments using 6-, 12-, and 24-month overlap periods between GOME-2 and OCO-2. Each experiment

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was repeated 10 times to assess the variability of the resulting harmonized time series.

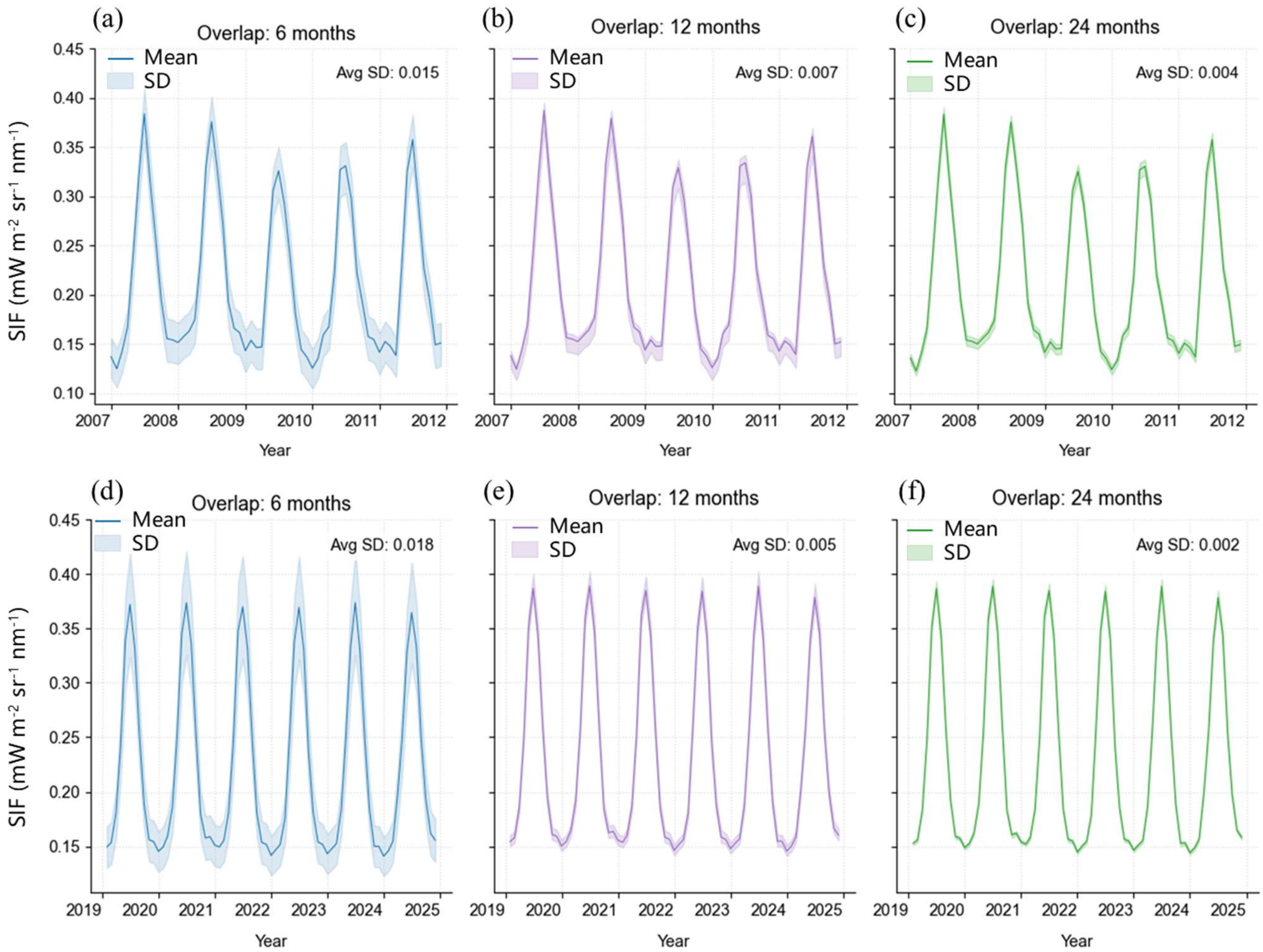

Figure 13. Normalized SIF time series using different overlap durations: 6 months (first column), 12 months (second column), and 24 months (third column) from SCIAMACHY (top row) and OCO-2 (bottom row). The shaded areas represent the standard deviation (SD) across multiple experiments, with units of mW m^{-2} sr^{-1} nm^{-1}.

The results show that a six-month overlap leads to a higher standard deviation in SIF time series compared to longer overlaps. As the overlap period was extended from 6 to 12 months, the standard deviations of the normalized SIF series decreased from 0.015 to 0.007 mW m^{-2} sr^{-1} nm^{-1} (SCIAMACHY) and from 0.018 to 0.005 mW m^{-2} sr^{-1} nm^{-1} (OCO-2), representing a reduction of over 53.3%. **These results confirm that short overlap periods increase normalization uncertainty and highlight the robustness of our chosen strategy, which avoids using GOME as the baseline. Nevertheless, users should be aware of the potential uncertainties in the early portion (from 1995 to 2003) of the LHSIF record.**

Comment 3： Line 21: You should better change a word to substitute ‘tool’ in line 21. How could a dataset be a tool? How about “Therefore, the long-term harmonized SIF dataset with a fine 0.05° resolution is valuable for estimating global photosynthesis over extended periods.”

Response: Thanks for this comment. We have revised the sentence according to your advice.

Comment 4： Missing space in multiple places in sentences.

Response: Thanks for this comment. We have thoroughly reviewed the manuscript and made corrections.

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Comment 5: Line 22: Missing space: "The LHSIF dataset is available at https://doi.org/10.5281/zenodo.14854185 (Zou et al., 2025)."
Response: Thanks for this comment. It has been corrected.

Comment 6: Line 138: There should be a comma in"0.5°×0.5°, and 1°×1°".
Response: Thanks for this comment. It has been corrected.

Comment 7: Line 144: GPP (Berry et al)
Response: Thanks for this comment. It has been corrected.

Comment 8: Line 153: Missing space : 2 m.
Response: Thanks for this comment. It has been corrected.

Comment 9: Line 154: Missing comma: f(NIRv), f(VPD), and f(AT),
Response: Thanks for this comment. It has been corrected.

Comment 10: Line 159: "L-BFGS-B" algorithm (Byrd et al., 1995)
Response: Thanks for this comment. We have added a space before the citation.

Comment 11: Line 167: Two balnk spaces here. "0.05° , were"
Response: Thanks for this comment. It has been corrected.

Comment 12: Line 445: Missing space before the reference.
Response: Thanks for this comment. It has been corrected.

Comment 13: Incomplete sentence in Line 267: "The temporal and spatial distributions of the spatial downscaling residuals were analyzed (Fig. 4). The residual was calculated as the difference between ? As shown..."
Response: Thanks for this comment. The missing explanation has been added as follows:

The residuals are calculated as the difference between the reaggregated SIF (SIF_reagg) and the original SIF (SIF_original).

Comment 14: L353: Please do grammer check and change this sentence to: "To highlight the overall correlation, the data in June for these two sites were removed from the scatter plots."
Thanks for this comment. We have revised the sentence according to your advice.

Comment 15: Line434: Upper foot label for m-2 in "residual less than 0.05 mW m-2 sr-1 nm-1".

Response: Thanks for this comment. It has been corrected.

Comment 16: Line 303: please add an 'and' in "0.05; and significant increase".

Response: Thanks for this comment. It has been corrected.