Responses and Revisions to Comments

Dear reviewer

Thanks for your reviewing and valuable comments of our manuscript entitled "***A global estimate of monthly vegetation and soil fractions from spatio-temporally adaptive spectral mixture analysis during 2001–2022***". We also appreciate you for providing insightful feedback and comments to strengthen our manuscript.

We have revised our manuscript with considering each detailed suggestion that you have graciously provided. And we have enhanced the accuracy validation of the product.

The following is a point-by-point response to the questions and comments delivered in your letter. For your convenience, revisions made by the authors have been highlighted in red color in the both response and revised manuscript, which could be easily checked. We hope that our revisions and responses can satisfactorily address all the issues and concerns.

Referee #1

This is an extensive revision. It reads much better. Thanks for addressing my comments. The accuracy of this product remains a major concern, and I don't think that has been well demonstrated.

The advantage of this dataset is offering various surface fractions. I thus urge the authors to compare green vegetation fractional cover (or fractional NPV, not the sum of fractional PV and NPV in Figures 3, 4, and S5) of this dataset vs. that of present products. Especially in the evaluation of the accuracy of fractional NPV, because knowledge of NPV is essential for all terrestrial ecosystems, and its fraction estimates are a highlight of this work.

Thank you very much for your valuable suggestions, and we agree that the estimation of NPV fractions is one of the key highlights of this paper. This product offering surface fractional PV and NPV is important for accurately characterizing vegetation structure. Therefore, we are in favor of your suggestion to validate and compare PV and NPV abundance values with that of present products, separately.

(1) We have already carried out a comparison of PV and NDVI in Figure 4a. The results indicate a strong positive relationship between PV fraction and NDVI ($p<0.01$). Yet, this correlation becomes less pronounced when PV exceeds 50%, suggesting an evident saturation effect within NDVI.

(2) We also included an experiment of comparing LAI, a parameter that characterizes the structure of green foliage, with our estimated fractions of PV (page 12, line 284-285; page 16, line 353-356). The comparison results further demonstrated that linear relationship also exists in the relationship between PV and LAI, but a non-

linear turning point occurs when PV exceeds 70% (Fig. 4c). Such relationship is generally consistent with the results of previous research on the relationship between LAI and FVC, which manifests as a broom shape with distinct confidence interval values distributed along the FVC gradients[1]

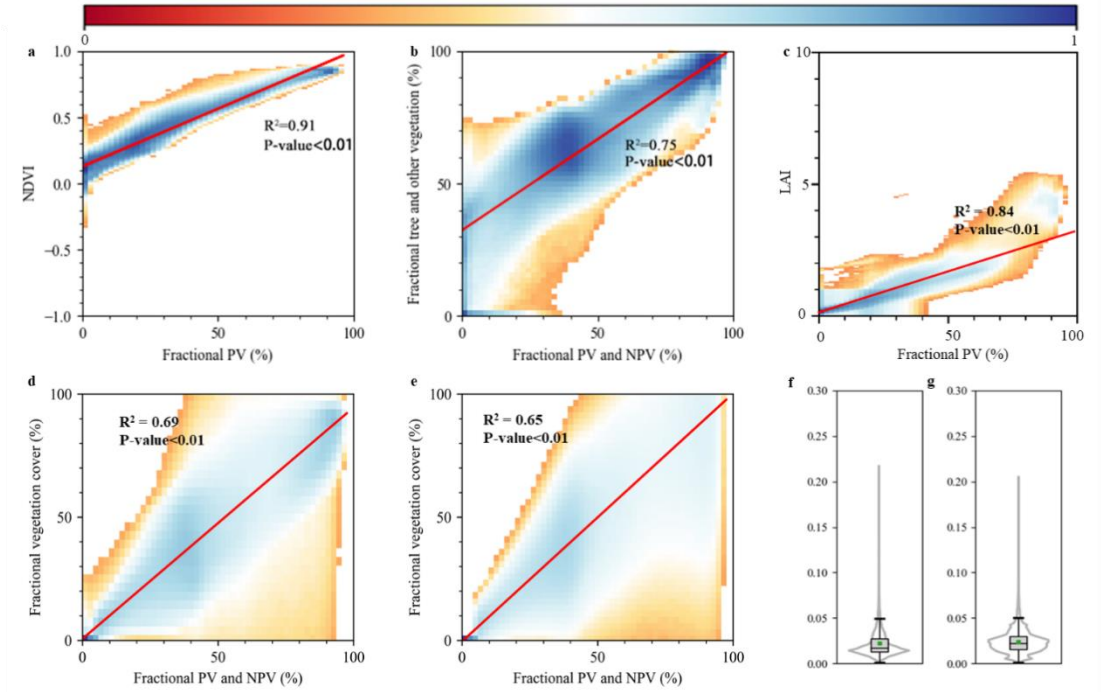

Figure 4: Comparisons with other datasets and traditional spectral mixture analysis models. a, b, c, d, e, the bi-dimensional histogram of fractional endmembers and other dataset with bin size of 2%, including fractional PV against NDVI (a), fractional PV and NPV against fractional tree and non-tree vegetation of MOD44B vegetation continuous fields product (b), fractional PV against LAI (c), fractional PV and NPV against GLASS fractional vegetation cover product (d), fractional PV and NPV against fractional vegetation cover of GEOV Fcover product (e); **f**, **g**, the boxplot and violin plot for average of monthly $RMSE_{sma}$ for two fixed endmember spectral curves using fully constrained linear spectral mixture models, including (e) average of all spectral spectra for each endmember and (f) existing spectral spectra from Small and Sousa (2019).

(3) Due to the lack of suitable existing datasets, it is difficult for us to compare NPV with existing data products. But we have already demonstrated the mapping validity from detailed spatial distribution of NPV in typical regions, when we compared that to Google Earth images (Fig. S6). The current lack of fractional NPV products highlights the need for ongoing development in our future work, and more detailed comparison and validation experiments of NPV are needed for improving the

[1] Fang, H., Li, S., Zhang, Y., Wei, S., & Wang, Y. (2021). New insights of global vegetation structural properties through an analysis of canopy clumping index, fractional vegetation cover, and leaf area index. Science of Remote Sensing, 4, 100027.

accuracy, feasibility and validity. This view has been highlighted in Discussion (page 24, line 490-494).

"Given the importance of NPV in ecological research, undertaking separate validation and comparisons between PV and NPV represents a critical foundational effort. While detailed maps of a representative region illustrate the reliability and advantages of our NPV estimation over other products (Fig. S6), the current lack of equivalent products highlights the need for ongoing development. Enhancing quantitative comparison efforts will be essential to bolster the feasibility, accuracy and validity of our NPV product in future studies."

Lines 79-80: The dimidiate pixel model is also important for satellite-derived FVC products.

Thank you very much for your suggestion. We have added information about the progress in dimidiate pixel model and relevant literature in the Introduction section (page 3, line 79-81).

"These products primarily integrate and utilize data from different spectral bands and sensors, employing methods including machine learning, radiative transfer model and dimidiate pixel model (Baret et al. 2013; Yan et al., 2021; Zhao et al., 2023)."

Lines 80-81: The meaning of NPV, which is considered a key quantifiable variable for terrestrial ecosystems, should be supplemented to emphasize the value of this work.

Thanks for your valuable, we agree that NPV (Non-Photosynthetic Vegetation) is a crucial highlight of this work. Therefore, we have provided a detailed description and introduction of NPV in the Introduction Section, outlining its significant role in ecological research and the value of our work(page 3, line 82-86).

"In ecological studies and remote sensing, non-photosynthetic vegetation including stems, branches, and other plant structures primarily serve ecosystem functions other than photosynthesis, such as support and storage. Therefore, understanding the distribution and characteristics of non-photosynthetic vegetation is important for a comprehensive analysis of ecosystems and land cover, especially in drylands (Guerschman et al., 2009)."

We also improved discussions of NPV in Discussion Section to emphasize the value of this work (page 21, line 458-461)

"The NPV component is a vital element in arid ecosystems and represents a crucial part of vegetation biomass. Our dataset, by finely characterizing NPV, not only aids in understanding the evolving features of vegetation structure under photosynthetic and non-photosynthetic interactions (Guerschman et al. 2015), but also contributes to a more accurate quantification of global biomass in arid land systems (Smith et al. 2019)."

Referee #3

I appreciate the author's effort in incorporating my comments and suggestions. Overall, my concerns were well organized and addressed.

Thank you for acknowledging the efforts to incorporate your comments and suggestions. I'm glad to hear that your concerns were well organized and addressed.

Referee #4

Dear authors, After checking the response as well as the revised manuscript, I think this paper can be accepted now. Thanks!

Thank you for reviewing the response and the revised manuscript. We appreciate your positive feedback and are pleased to hear that the paper can now be accepted. Your input has been valuable in improving the quality of the manuscript.