In the following, we addressed the specific points of the reviewers. Reviewer comments are black font and our responses are blue. We also use red highlights to mark changes in the revised manuscript.
We use codes to the Reviewers' comments, for example R1C2 means Reviewer 1 Comment 2.

Reviewer #1:

Review of Zhao et al.

This manuscript proposes a new approach to estimating Fractional Vegetation Cover (FVC) across China using the MultiVI algorithm, which integrates multiple remote sensing data. The results generally have good accuracy and spatial coherence, validated through field measurements. The manuscript is well written, and the methodology is well presented. The only major issue is that this dataset is for the year 2014.

Re: Thank you for your encouragement and affirmation. Your comments helped improve our manuscript. We revised our manuscript and responded to the comments and suggestions point by point as follows.

General comments:

R1C1: Limitation of single-year data. How representative can the use of single-year data (in 2014) be for the interannual variability in vegetation and soil properties? Why didn't the authors expand the methods to more recent years?
Re: **Done.** Thank you for your valuable comment. We newly generated *Vv* and *Vs* datasets for the years 2018 and 2022, and found that the values of *Vv* and *Vs* show very small differences across different years. To address your concern regarding the representativeness of using endmember values from a single year, we have conducted a supplementary analysis and revised the main text accordingly (Section 5), including the following points:

1) The NDVI values of pure vegetation (*Vv*) and bare soil pixels (*Vs*) are primarily influenced by factors such as plant species, soil types, climate, and moisture conditions, which typically remain stable unless disrupted by sudden events like fire or land cover conversion. This inherent stability in the land surface background implies that the estimation of FVC imposes relatively low demands on the temporal frequency of endmember calibration. Furthermore, we calculated the differences between the *Vv* and *Vs* obtained for 2022 and those from 2014. The results demonstrate that the endmember values show very small interannual differences. The supplementary analysis has been added in Section 5.
2) The field validation data used in this study span from 2012 to 2022, and the results show consistent and accurate FVC estimation across multiple years, indicating the broader applicability of the 2014-derived endmembers. Moreover, using one set of *Vv* and *Vs* to calculate FVC across multiple years demonstrated a reasonable

accuracy in many other studies (Oleson et al., 2000; Zhao et al., 2023; Donohue et al., 2025).

3) MODIS sensors are known to exhibit time-dependent signal degradation, which may lead to increased uncertainty in BRDF-derived products over time. To minimize the impact of sensor degradation, we selected data from the year 2014, when MODIS data quality was relatively stable and well-calibrated.
4) We have also generated additional *Vv* and *Vs* datasets for the years 2018 and 2022 using the same methodology. These datasets are currently being prepared and are expected to be published as a companion product with the next revised manuscript.

Newly added Reference: Donohue, R. J. and Renzullo, L. J.: An assessment of the accuracy of satellite-derived woody and grass foliage cover estimates for Australia, Aust. J. Bot., 73, BT24060, https://doi.org/10.1071/BT24060, 2025.

Specific comments:

R1C2: L27: should briefly introduce the reasons for using these three regions (e.g. for validation purposes), otherwise the readers will be confused as to why only compare to these regions.

Re: **Done.** Thank you for your suggestion. We have revised the abstract to clarify the rationale for selecting the three validation regions (P1: Line 28~29).

P1: Line 28~29

"These regions include typical arid and humid zones in China, facilitating the evaluation of the algorithm's performance under diverse climatic conditions."

R1C3: L30: 'free access' to 'publicly available'

Re: **Done.** Thanks for your correction. We have replaced the phrase in the manuscript.

R1C4: L30: should add what year is the data for

Re: **Done.** Thanks for your reminder. We have clarified the year for the data.

P1: Line 30~31

"The 30 m pure NDVI maps of 2014 are publicly available at https://zenodo.org/records/14060222 (Zhao et al., 2024)."

R1C5: L93: remove 'flexibly'

Re: **Done.** The word "flexibly" has been removed accordingly.

P5: Line 93~94

"These datasets can be applied to accurately calculate FVC at various resolutions on regional or national scales."

R1C6: L113: need more details about the choice of 55 and 60 degrees.

Re: **Done.** Thanks for your suggestion. A more detailed description of this angular configuration was provided in Section 3.1.1: "This selection is attributed to its minimal influence on G(θ) and the high quality of angular remote sensing observations (Mu et al., 2018)." To enhance clarity, we have also cross-referenced this explanation at the point you mentioned (P5: Lines 113–115), allowing readers to easily locate the relevant details.

P5: Line 113~115

"All MCD43A1 data obtained in 2014 over China's mainland were used to reconstruct the ground surface reflectance of red and near-infrared (NIR) bands at viewing zenith angles (VZAs) of 55° and 60° (see Section 3.1.1 for more details on the choice of angular configuration)."

R1C7: L272: A moving window of 330x330m might oversimplify the spatial heterogeneity, how does it affect accuracy?

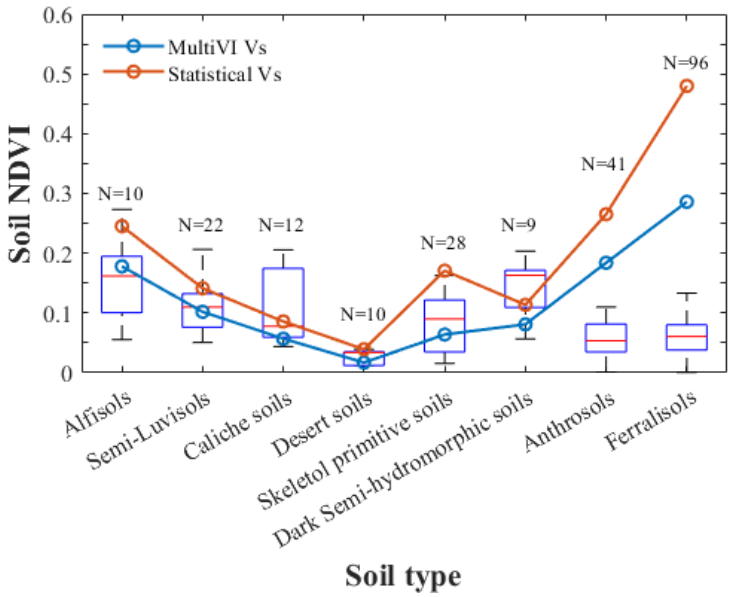
Re: **Done.** Thank you for your insightful comment. To avoid oversimplifying spatial heterogeneity, we have removed the 330 × 330 m moving window when calculate the statistical *Vv* and *Vs*. Moreover, we recalculated the statistical *Vv* and *Vs* values pixel-by-pixel using a longer Landsat time series (2010–2020) to improve their temporal stability and representativeness, as suggested by Reviewer 2. Corresponding revisions have been made in Section 3.3.1.

R1C8: Figure 6: I suggest changing the colors by using darker colors to indicate larger differences (e.g. dark blue for -0.3~-0.2, light blue for -0.1~0)

Re: **Done.** Thanks for your advice and we have revised the Figure 6 accordingly to enhance its clarity.

R1C9: L335: why compare the mean (of MultiVI) with the median (NDVI)? Why not mean with mean or median with median?

Re: **Done.** Using different statistical measures can be misleading and we appreciate your reminder. Since boxplots typically use the median as the central tendency indicator, we have updated the comparison to consistently use the median for both MultiVI and Statistical *Vs*. The median and mean values of MultiVI and Statistical *Vs* across soil types are very close (with difference values less than 0.02 in most soil types), so the original conclusions remain unchanged. Corresponding updates have been made to Figure 7 and the related text descriptions.



"Figure 7: The boxplot of the soil NDVI from the ICRAF soil library for each soil type. Each boxplot features a central red line representing the median. The N above the box indicates the number of sampling plots for each soil type. The lower and upper edges of the box denote the 25th and 75th percentiles, respectively. The whiskers are extended to the most extreme data points excluding outliers. The blue and red lines denote the median values of the MultiVI *Vs* and statistical *Vs*, respectively."

R1C10: L348: add what 'the bias' represents (it is already in Figure 8 legend, better to have it in the main text).

Re: **Done.** Thanks for your reminder. We have added a sentence in the main text to clarify the meaning of 'the bias'.

R1C11: Figure 9: there seem to be seasonal patterns for some sites by eye, and it is worth further exploration.

Re: **Done.** Thank you for your comment. We have added descriptions of the seasonal patterns observed in Figure 9 to Section 4.3, and further discussed the underlying causes of these seasonal differences in the Section 5.

"Figure 9 shows that FVC errors are generally larger during early spring and winter, particularly at low FVC values. This seasonal pattern can be explained by the sensitivity of FVC estimation to NDVI values in the 0.2–0.4 range (Montandon and Small, 2008). In this interval, small errors in *Vs* can lead to systematic overestimation of FVC, especially over grasslands and shrublands. During peak growing seasons, when NDVI values exceed 0.7, the model estimates become more stable and less sensitive to endmember NDVI values."

R1C12: L457: usually invalid values should be marked as nan, not 0 to avoid confusion with actual 0 values.

Re: **Done.** We have updated the published data by marking invalid values as NaN instead of 0 to avoid confusion with actual zero values. The corresponding description in the manuscript has also been revised.