Dear Editors and Reviewers:

Sincere thanks for the evaluation of this work again and your valuable comments and suggestions for improving this manuscript. We carefully considered the suggestions and made some changes to the revised manuscript (essd-2023-467). Here we submit the revised version, which has been modified according to the comments from the reviewers.

We attach the detailed item-by-item response to all comments and suggestions for the evaluation. Our responses to the comments point-by-point are included below in blue. The corresponding changes in the revised manuscript are shown in purple.

Yours sincerely,

Zhao Zhang and co-authors

Reviewer #1:

I appreciate the authors' efforts in addressing my previous comments and those from the other reviewers. The manuscript has shown improvement in presentation. I have one additional comment regarding the revised manuscript: the added section titled "4.1 Our Advantages and Potential Applicability" might make more sense if integrated with the analysis comparing different data products/methods, rather than as a standalone section.

Response: Thank you for your suggestion. We integrated with the analysis comparing with others for both products and methods (**Lines 420-444**). We have added a comparison of the ChinaSoyArea10m with other products in Section 4.1. Additionally, on the basis of the advantages of the methodology, we combined the comparison with other commonly used methods to make the content of this section more complete. It now read as:

4.1 Our advantages and potential applicability

We proposed a new framework (RASP) to identify annual dynamic of soybean planting areas over larger regions and produced the longer-term series of soybean maps (ChinaSoyArea10m) across mainly planting areas in China from 2017 to 2021 at the first time. The accuracy of ChinaSoyArea10m is acceptable (R^2 ~ 0.85) at both county- and prefecture-level, with relatively less R^2 than GLAD (R^2 = 0.93 at prefecture-level), but higher than CDL (R^2 = 0.53 at county-level). Compared with existing products, ChinaSoyArea10m accurately depict the soybean with more spatial and temporal details as well.

The methodology developed for identifying soybean planting areas indicate several notable strengths that make it an attractive option for wide application. Firstly, it operates independently, without extensive ground samples required. The conventional supervised approaches like random forest (RF) and long short-term memory (LSTM) depend on quantities of observations, with much money, time, and labor consumed. In this context, both transferable learning model and our RASP methods (combing unsupervised learning with statistics) indeed provide huge potential for crop mapping. However, transferable models are suitable for areas or years with similar cropping patterns. In areas with diverse and complex cropping patterns, it is a challenge to apply the supervised model trained in limited areas or limited years into others (Wang et al., 2019; Ma et al., 2020). In contrast, our strategy leverages a specific, pre-existing set of samples to stably differentiate soybean characteristics from other crops, which can accurately map annual dynamics without updated requirement in annual samples. Consequently, this method significantly weakens limitations in crop classification during years without specific samples, enabling crop mapping consistently and continually.

Another key advantage of our spectra-phenology integration approach is its quick applicability over larger areas, coupled with excellent spatial scalability. It can self-adopt to different environments by considering phenology information. Compared to methods that rely on composite indicators and specific thresholds, our approach simplifies the requirements for inputs and experienced judgements. The only inputs required are the phenological information of soybeans and the number of other primary crops during the same growing season in the targeted area. This allows to classify crop swiftly and efficiently without additional inputs for background knowledge or setting complex thresholds. The input of phenological information in each prefecture enhanced the zonal adaptive assessment of soybean growth status across various areas, thereby facilitating crop classification. This innovative approach ensures its applicability into other soybean-producing areas, showcasing its potential for broader implementation.

Reviewer #2:

I have just a few minor comments and suggestions on the revised manuscript.

(1) Why is the total number of Sentinel-2 observations and clear observations in 2017 much lower than in the other four years? It looks strange because the whole country had much lower data availability.

Response: Thank you for your question. The fewer observations in 2017 was due to Sentinel-2B launched in March of that year. Prior to March, only Sentinel-2A was operational, resulting in a 10-day revisit period. Once Sentinel-2B was stably operational and began providing data, the revisit frequency improved to every five days in many areas, increasing the number of observations. We have supplemented the reasons for data availability in Section 4.2 of revised MS (Lines **465-466**).

"Obviously, the total number of images available in 2017 over the study areas was significantly fewer than those of other years, because the second satellite Sentinel-2B only commenced operations and started providing data after March of 2017 (Fig.10a1-e1)."

(2) Unsupervised classification and cluster assignment is still not very clear to me. Line 296-297, What do you mean by 'using key phenological information as input features'? My understanding is that phenological information is not directly used as features for classification. Also, six bands and two indices were used for classification. When DTW is used, do you calculate the DTW values between each indicator with the corresponding soybean curve and average the eight values? Or do you simply make the decision based on the minimum DTW values among the eight indicators? Need more clarification.

Response: Thank you for your suggestions.

For Q1, we are sorry for the confusion expression. We identified key soybean growth stages (VGP, RGP) using phenological records and selected the spectral features and vegetation indices from these periods as input features. Specifically, within the VGP, we used 2 SWIR bands and the SIWSI index, and within the RGP, we used 3 RE bands, 2 SWIR bands, NIR bands, and the TCARI index. All there were clearly showed in Figure 2 of the MS. We have updated the descriptions in the MS accordingly (**Lines 296-297**).

"We used the detailed phenological records at AMSs to identify soybean growth periods and selected the spectra and vegetation indices within specific growth periods (VGP, RGP) ~~key phenological information~~

as input features."

For Q2, we calculated the DTW distances for these 8 features and used the averaged DTW distance for all features to assess the similarity degree with the standard curve. Based on the DTW distance of their standard curves for each crop category and soybean, the cluster with the minimum distance among all categories is selected as soybean. We have clarified the details in the Cluster assignment section in the MS (**Lines 305-311**):

"We then used dynamic time warping (DTW) method to measure the similarity between each cluster's eight features involved in classification and the soybean standard curves. We averaged the data of 30% samples in each sub-zone to establish the standard curves, reducing the impact of regional phenological variations. The time coverage of Zone I-IV was set to April-September, May-October, June-October, and August-November, respectively, which are corresponding with the soybean growing season. The cluster with the minimal average of 8 DTW values was identified as the soybean cluster."

(3) Considering the different cropping patterns of the major crops in each zone, it is better to add the time series profiles of major crops at different zones to present the separatability of the clusters. Could be included in the supplementary documents.

Response: Thank for your suggestion. Indeed, cropping patterns vary across regions. We analyzed the spectral and vegetation indices characteristics of major crops in each zone, selecting those that grow in the same season as soybeans (Fig. S2-S4). We observed distinct differences in the SWIR1, SWIR2, and SIWSI indices between soybean and rice during their early growth stages. In the mid and late growth phases, the EVI, NIR, Red Edge2, and Red Edge3 values were significantly higher in soybean compared to other crops. These consistent differences support the applicability and potential repeatability of the selected features across various regions. Figures S2-S4 have been added to the supplementary materials and referenced in the revised manuscript (**Lines 281-282**).

"All these spectral-phenological characteristics are also applicable to soybeans planted in other sub-zones (Fig. S2-S4)."

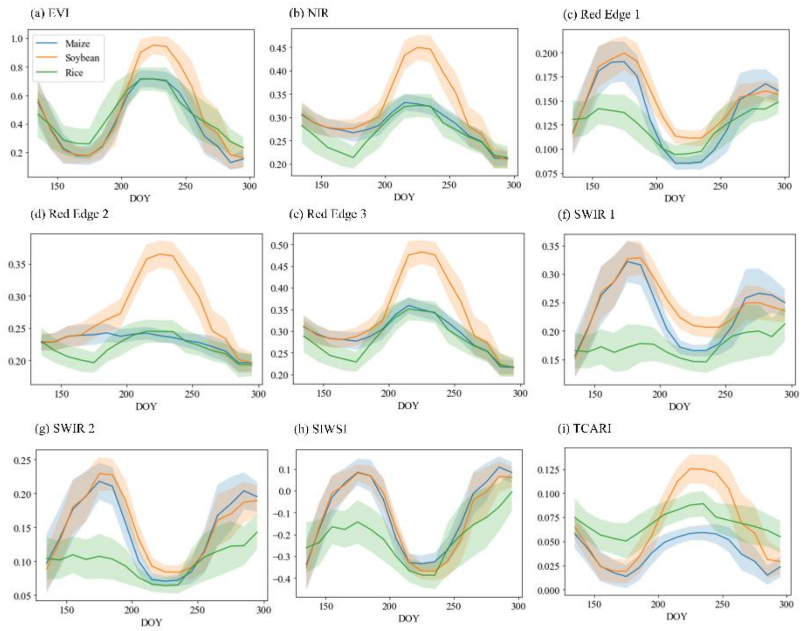

Figure S2. Temporal profiles of (a-i) for major crops in Zone II.

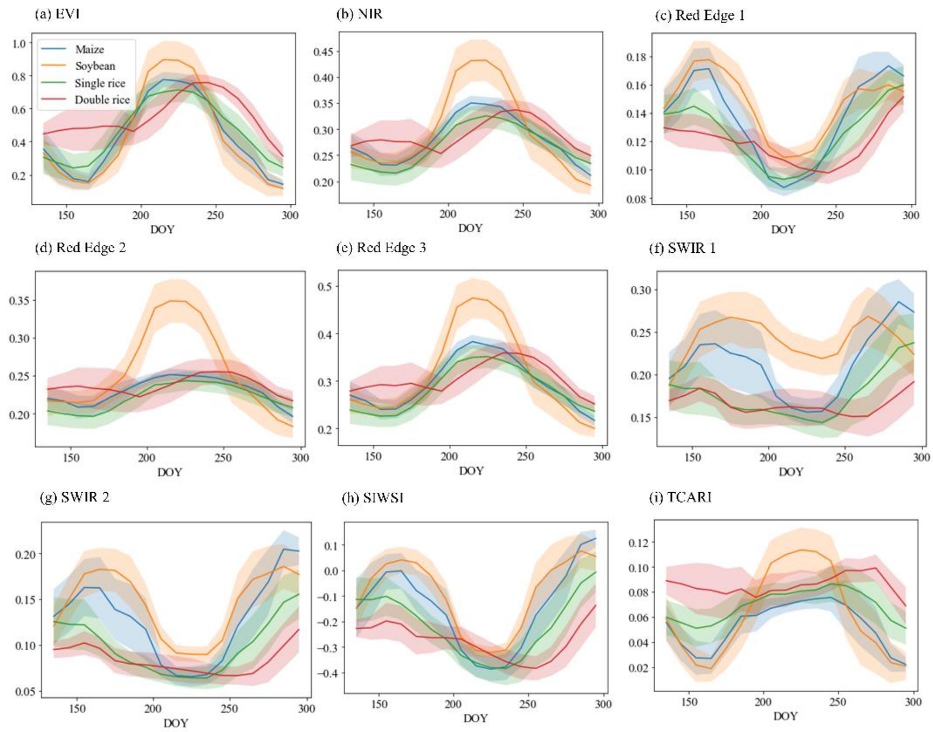

Figure S3. Temporal profiles of (a-i) for major crops in Zone III.

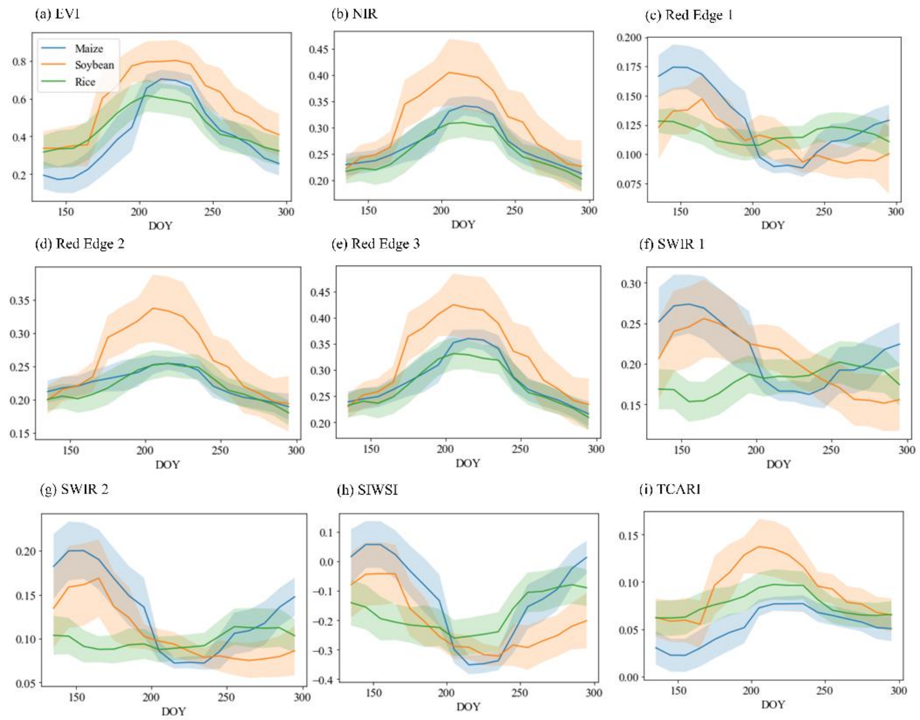

Figure S4. Temporal profiles of (a-i) for major crops in Zone IV.