Reviewer #1:

Response: We appreciate your time and efforts to provide the valuable comments and suggestions to improve this manuscript. We have carefully addressed your comments and suggestions. To help read our responses, we labeled all the comments and suggestions at the corresponding locations and used the Track Change mode to show all the revisions in the revised manuscript. Please see our point-to-point responses to each comment and suggestion.

The preprint "Annual forest maps in the contiguous United States during 2015-2017 from analyses of PALSAR-2 and Landsat images" introduced 30 m spatial resolution forest maps for CONUS during 2015-2017 by integrating microwave data (PALSAR-2) and optical data (Landsat) using knowledge-based algorithms. The results were compared to four existing/operational forest products (GFV, VCF, NLCD, and JAXA) and FIA statistic data from USDA. The potential of PL-Forest was demonstrated by its forest area being close to the FIA-Forest statistics, but higher than GFV, NLCD, and lower than VCF. Also, PL-Forest evergreen forest showed reasonable consistency with the NLCD product.

The authors presented two main reasons for PL-Forest generation, including (1) "It is noticed that the high-spatial-resolution forest maps are relatively few for the years after 2010" and (2) "The combination of the optical and microwave data could take advantage of the optical remote sensing sensors that capture the light and forest canopy interaction and microwave sensors that capture the microwave and forest structure (tree trunk and branch) interaction without cloud contamination.", "To date, no study has combined PALSAR and Landsat images during 2015-2017 to map annual forest distributions in the CONUS". However, I think these two aspects are not significant enough to a demand for producing new annual forest maps for CONUS. First, as the authors mentioned, "In the United States, FIA and NLCD are the primary databases used by managers, researchers, and policymakers". It is because these two datasets are high quality and have been carefully examined before releasing to the public. Second, while the US can map forest annually, the forest remains stable and the NLCD production interval of 3 years (2021, 2019, 2016, 2013, 2011, 2008, 2006, 2004, 2001) is set to capture meaningful changes that occur gradually over time. If there are disturbances (e.g., wildfires), they should be captured in regional or local regions by other advanced monitoring systems in the US (Fire and Emmision monitoring) and also captured within a 3-year period of 30 m NLCD. Thus, the authors may consider to:

(1) explain why we need annual PL-Forest maps.

Response: Thanks for your comments and suggestions. We clarified this point from three aspects: First, the combination of optical and microwave data has the potential to improve the accuracy of forest maps. The NLCD dataset was generated from analyses of Landsat images. Trees have canopy (leaves), branches, and trunks. Optical data are interacted mostly with tree canopy (leaves), while L-band microwave data are interacted with tree branches and trunks. This study also suggested that the accuracy of PL-Forest maps reached more than 90%. Second, we produced annual forest maps by satellite-based approaches with comparable accuracy with FIA data, which has the potential to improve the efficiency of forest resources survey. Finally, although most forests remain stable annually, we cannot ignore the annual abrupt changes, which affects the annual forest carbon fluxes and cannot be detected by a multi-year identification. PL-Forest maps provided accurate forest information annually, which can capture the inter-annual dynamics of forests.

We revised the manuscript in Lines of 75-101 by adding detail information of FIA and NLCD data. For example, "FIA is a field survey of forest plots and reports information on the status and trends of forests in the United States. A subset of plots is measured every year with revisit intervals of 5 to 10 years depending on the state (Burrill et al. 2021; Hoover et al. 2020). The NLCD provides updated datasets continuously every about three years, which was generated by change detection algorithms for only a time period and has a certain amount of commission errors (Jin et al. 2013a)". "It remains untested about their application potential for the annual management of forest resources."

(2) describe the uncertainties in the NLCD or other Landsat-based forest products that require the integration of microwave and optical data. I believe microwave sensors will contribute more to other regions such as tropical Amazon or monsoon Asia, but still unclear in the US. This could have been paid more attention to show the advantages of involving microwave data (e.g., high-cloudy areas) compared to the use of only optical data. The authors could show some examples of uncertainties in the NLCD and better performance of PL-Forest in the results. Also, keep in mind that the combination of Landsat 8/9 or the NASA harmonized Landsat and Sentinel-2 (HLS) currently gives more opportunity to obtain good observations.

Response: Thanks for your comments and suggestions. We revised the manuscript see Lines of 90-101 following your suggestions.

First, Trees have canopy (leaves), branches, and trunks. Optical data are interacted mostly with tree canopy (leaves), while L-band microwave data are interacted with tree branches and trunks. Thus, a combination of optical data and L-band microwave data would generally better separate the forest from other non-tree vegetation.

Second, as an optical sensor, the good observations of Landsat will be affected by cloud cover. Microwave data have strong penetration, which can avoid the influence of cloud coverage.

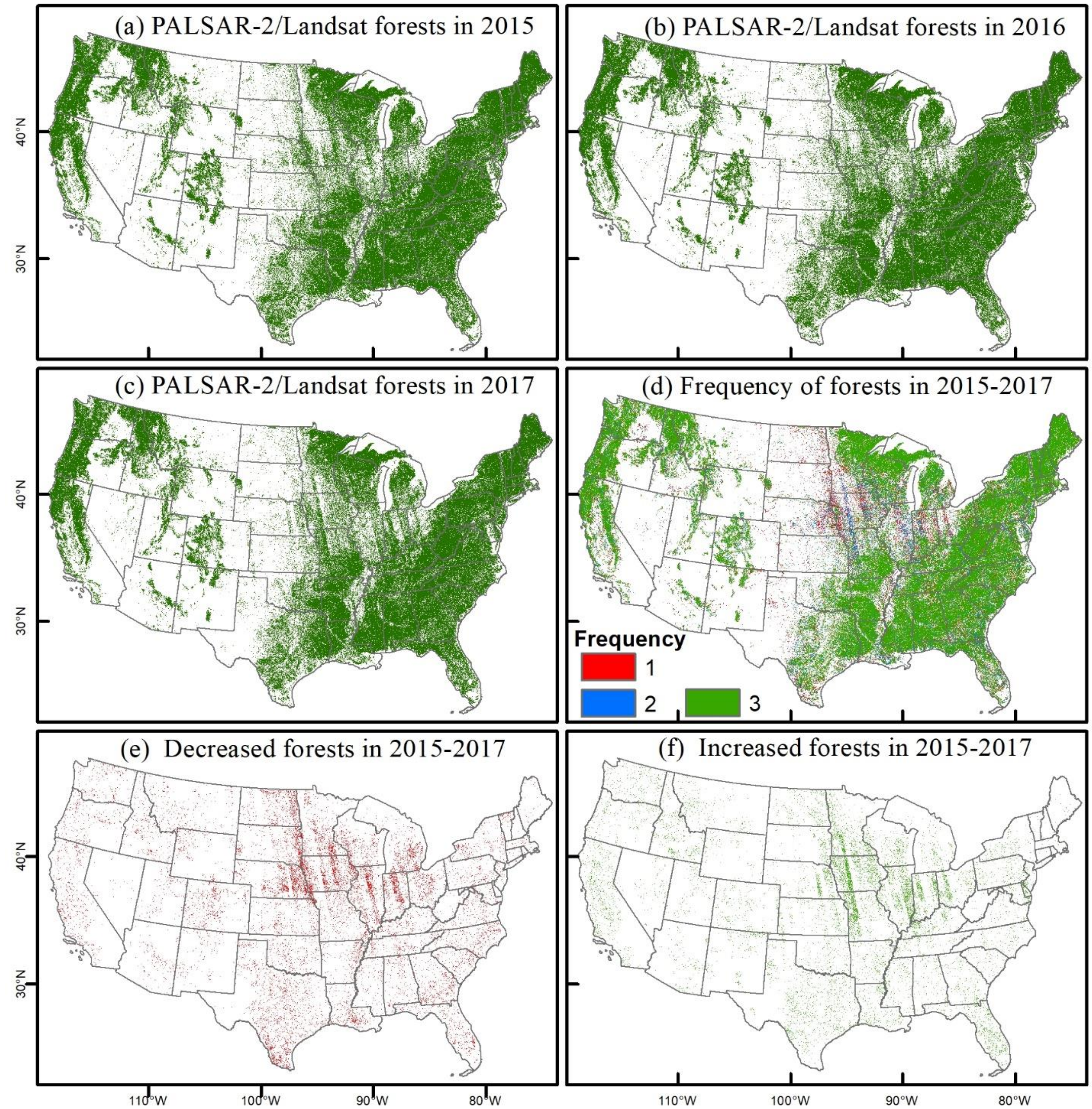
Third, PALSAR-based forest maps often have commission errors caused by buildings, rocks, and high biomass crops. As a result, the combination of the optical and microwave data could take advantage of the optical remote sensing sensors that capture the light and forest canopy interaction and microwave sensors that capture the microwave and forest structure (tree trunk and branch) interaction without cloud contamination.

Additionally, an assessment study suggested that the complementarity of optical and SAR datasets improved the discriminative properties for forest mapping compared to the individual dataset (Lehmann et al. 2015). For example, uncertainties of Landsat-based forest maps could be caused by the re-planted areas with small- or medium-size trees or regions with some vegetation types like highland scrub. These regions could be identified correctly by PALSAR data (Lehmann et al. 2015).

Improved forest mappings have been reported in a number of studies by using integrated PALSAR and Landsat data in tropical regions (Lehmann et al. 2015; Reiche et al. 2015; Thapa et al. 2014), and PALSAR and MODIS data in monsoon Asia and several sample regions of the word (Qin et al. 2016b; Zhang et al. 2019). However, it remains unclear about the potential to improve the annual forest monitoring in the CONUS.

(3) exhibit the forest decrease in the Midwest region in Fig 7.

Response: We appreciate your suggestions. We revised the figure with showing the forest loss and gain from 2015 to 2017. See Fig7e, f.


(a) PALSAR-2/Landsat forests in 2015
(b) PALSAR-2/Landsat forests in 2016
(c) PALSAR-2/Landsat forests in 2017
(d) Frequency of forests in 2015-2017
Frequency
1
2
3
(e) Decreased forests in 2015-2017
(f) Increased forests in 2015-2017
40°N
30°N
110°W
100°W
90°W
80°W

Reviewer #2:

The authors have undertaken the task of developing 30-meter resolution forest maps across the United States for the years 2015-2017. They achieved this by integrating conventional optical data (Landsat) with microwave data (Phased Array type L-band Synthetic Aperture Radar, PALSAR-2), which improved the overall accuracy of the maps. Additionally, the authors distinguished between evergreen and deciduous forests using satellite-based time series water-related indices and vegetation greenness-related indices. The accuracy of their PALSAR-2/Landsat annual forest maps was validated using fully independent datasets and compared with five existing forest cover datasets, with their results demonstrating superior performance. The authors present new estimates of forest cover and suggest that their work can contribute to more accurate forest mapping and the investigation of climate change and anthropogenic impacts on forests. The paper is well-written, the methods are clearly articulated, and the results support the conclusions drawn. However, there are several aspects of the paper's narrative that could benefit from further clarification to enhance the overall quality of the study.

Response: We appreciate your positive comments and valuables suggestions to improve the study. We have carefully revised the manuscript following your comments and suggestions. To help read our responses, we labeled all the comments and suggestions at the corresponding locations using the Track Change version. Our point-to-point responses to each comment and suggestion were shown in the following text.

1. Firstly, the paper lacks novelty, as it appears to apply a similar method to another region, in comparison to the authors' previous studies. While the study is undoubtedly important for mapping forests in the CONUS region, it would be beneficial to highlight any novel aspects beyond the geographical and temporal scope.

Response: We appreciate your suggestions. We clarified the novelty of the study in Introduction from the following three aspects.

First, high-spatial-resolution (tens of meters) forest maps are important for forest management, however, their application potential has not been tested systematically in previous studies. This study addressed this gap by comparing five widely used forest datasets and our resultant PL-based forest maps using the third-party validation samples and forest structure data from lidar observations. We clarified this point in Lines of 82-84, Page 4.

Second, the combination of optical and microwave data has the potential to improve the accuracy of forest mapping. However, previous studies were mainly conducted in tropical and monsoon Asia regions. The performance remains unclear for annual forest mapping in the CONUS and other temperate regions. This problem was addressed in this study. We clarified this point in Lines of 96-101, Page 4.

Third, previous studies mainly mapped the evergreen forests based on time series optical images across the tropical regions. However, it is unclear about the potential of time series Landsat images for improving the discrimination of evergreen and deciduous forests over the temperate regions. Therefore, this study explored the potential of time series Landsat images for mapping the evergreen forests in the CONUS (i.e., temperate regions). We clarified this point in Lines of 112-118, Page 5.

Fourth, in terms of materials and methods, we have reported a combination of optical images (e.g., MODIS, Landsat, Sentinel-2) and L-band PALSAR images in the previous studies. This study does use the same types of materials and methods to generate forest maps in CONUS, which address data, information, and knowledge gaps in the CONUS.

2. We encourage the authors to provide additional information and engage in a more extensive discussion about the uncertainties associated with their methodology and the resulting forest maps. Furthermore, the limitation of the study's focus on the 2015-2017 period restricts its ability to monitor and analyze long-term forest changes, and this should be addressed.

Response: Following your suggestions, we added more discussion about the uncertainties and limitations of this study about the method and long-term forest change monitoring in Lines of 449-455, Page 27.

"However, there could be some uncertainties and limitations when applying this approach. Firstly, although the thresholds of PALSAR-2 signatures for extracting forests were trained by numerous samples, they could be impacted by forest composition and structures (Chen et al. 2018). Thus, a careful study of the thresholds by samples of specific areas could provide more information that affect the accuracy and uncertainty of the forest maps when applying the algorithms into other regions. In addition, due to the PALSAR data are not available during 2011-2014, we cannot apply this PALSAR/optical data approach in these four years. PASAR data are available for 2007-2010, thus a combination of PALSAR (2007-2010), PALSAR-2 (2015 to present), and optical images would develop forest maps to monitor forest changes since 2007 (Zhang et al. 2019)."

3. The paper cites the existence of other studies that have used integrated PALSAR and satellite data to generate forest maps. It would be interesting to see a comparative analysis of the results from this study with those from previous efforts.

Response: To date, none of the publications have used both PALSAR-2 and optical data to generate annual forest maps for the CONUS. Therefore, we cannot compare our results directly to other publications at the CONUS scale. We added comparative analysis based on the accuracies in Results and Discussion.

See Lines of 333-334, Page 17, as "The accuracies were comparable to the PALSAR-based forest maps that were reported overall accuracies exceeding 91% (Shimada et al. 2014)."

See Lines of 444-447, Page 27, as "The integration of PALSAR and MODIS images has been demonstrated to generate improved forest maps in tropical, temperate, and boreal forests with overall accuracies above 90% (Qin et al. 2016b; Qin et al. 2017; Zhang et al. 2019). This study produced the forest maps with overall accuracy about 93% that corroborated the potential of combiningPALSAR-2 and Landsat observations to monitor the annual dynamics of forest distribution and functional types at a high spatial resolution for national or larger scales across the temperate regions."

Several specific points require attention in the manuscript:

4. On line 160, the abbreviation "TOA" needs to be explained to readers who may not be familiar with the term.

Response: Corrected as top of atmosphere (TOA).

5. The legend in Figure 4 (Line 184) should be made clearer to enhance the understanding of the figure.

Response: We revised the colors and shapes of the sample legends for different land cover types. In the figure caption, we clarified the legends of Forest_NL, Forest_BL, Forest_ML as needle-leaved forest, broad-leaved forest, and mixed-leaved forest, respectively. See Lines of 195-202, Pages 11-12.

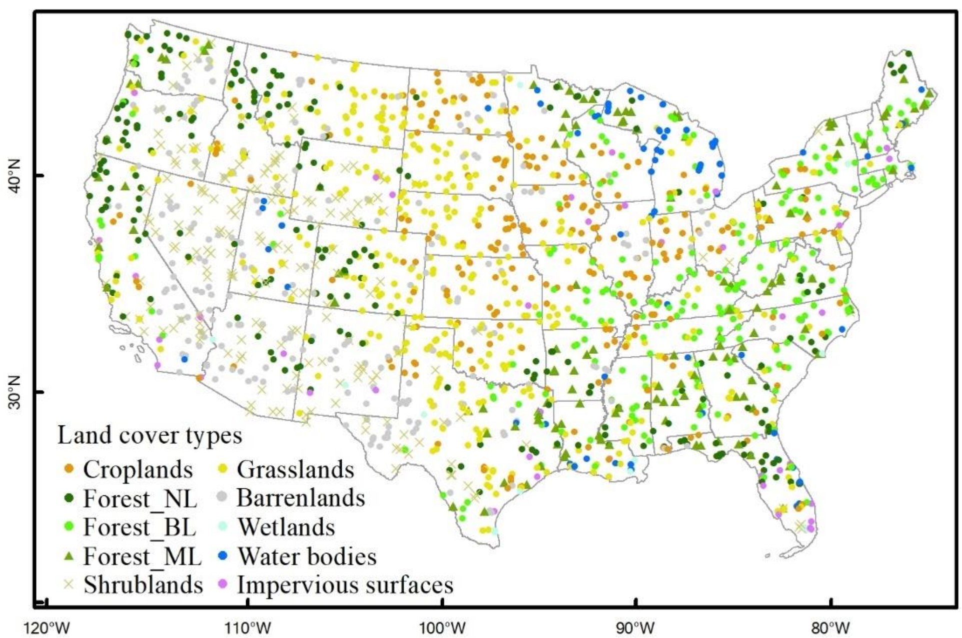


Figure 4: The land cover samples for accuracy assessment in this study. These samples were from the global validation sample set released by the third-party researchers from Tsinghua University, China (http://data.ess.tsinghua.edu.cn/) (Gong et al. 2013). They were revised by excluding the samples with land cover change according to the Google Earth images. Forest_NL, Forest_BL, and Forest_ML denote needle-leaved forest, broad-leaved forest, and mixed-leaved forest, respectively.

6. On line 336, the reference to a "stronger relationship" could benefit from additional discussion and context.

Response: Following your suggestion, we added more information in Lines of 359-362, Page 21 as "One possible explanation could be that the mixed forests in NLCD include evergreen species (Selkowitz and Stehman 2011). However, it cannot be estimated quantitatively because it is uncertain about the forest types and proportions within the mixed forest pixels (Tran et al. 2016)."

7. Overall, while this study contributes valuable insights into forest mapping, addressing these concerns and incorporating additional details and comparisons could further elevate the paper's quality.

Response: Thanks for your valuable suggestions. We have addressed the concerns and added more details and comparisons in the revised manuscript.

Reviewer3:

Summary

1. Mapping the temporal dynamics of forests at a high resolution is essential. Here Wang et al., combined the advantages of microwave and optical images, and generated high-resolution forests over continues US during 2015-2017 using an empirical threshold-based method. The manuscript is generally well organized, and easy to follow. My major concern is about its innovation. I also have few minor concerns listed as below.

Response: We appreciate your positive comments and valuables suggestions to improve the study. We have carefully revised the manuscript following your comments and suggestions point-to-point. To help read our responses, we labeled all the comments and suggestions at the corresponding locations using the Track Change version. Out responses were shown in the following text.

Specific comments

2. The major concern for me is the innovation for this study. What's the advantage of the PL-Forests data comparing to other datasets? At least not very clear for the current version. Maybe necessary accuracy comparison (e.g., Table 2) is needed to show the accuracy advantage. Or, the major advantages of the data need to be clearly demonstrated compared to at least JAXA which also covers 2015-2017 at a high resolution.

Response: We appreciate your suggestions to improve the manuscript in current version. Innovation or novelty usually includes several metrics: (1) materials (image data used), (2) methods (algorithms), (3) data products that address data gaps, (4) analyses that addresses information and knowledge gaps. Considering your comments and other reviewers' suggestions, we clarified the novelty of the study from the following three aspects.

First, although high-spatial-resolution (tens of meters) forest maps are important for forest management, their application potential has not been tested systematically in previous studies. This study made up this gap by comparing five widely used forest datasets and our resultant PL-based forest maps using the third-party validation samples and forest structure data from lidar observations. We clarified this point in Lines of 82-84, Page 4.

Second, the combination of optical and microwave data has the potential to improve the accuracy of forest mapping. However, previous studies were mainly conducted in tropical and monsoon Asia regions. The performance remains unclear for annual forest mapping in the CONUS and other temperate regions. This problem was addressed in this study. We clarified this point in Lines of 96-101, Page 4.

The major advantages of the combination data have been clarified in Introduction in Lines of 88-96, Page 4, as " The PALSAR-based forest maps often have commission errors caused by buildings, rocks, and high biomass crops. The combination of the optical and microwave data could take advantage of the optical remote sensing sensors that capture the light and forest canopy interaction and microwave sensors that capture the microwave and forest structure (tree trunk and branch) interaction without cloud contamination. Additionally, an assessment study suggested that the complementarity of optical and SAR datasets improved the discriminative properties for forest mapping compared to the individual dataset. For example, uncertainties of Landsat-based forest maps could be caused by the re-planted areas with small- or medium-size trees or regions with some vegetation types like highland scrub. These regions could be identified correctly by PALSAR data."

Third, previous studies mainly mapped the evergreen forests based on time series optical images across the tropical regions. However, it is unclear about the potential of time series Landsat images for improving the discrimination of evergreen and deciduous forests over the temperate regions. Therefore, this study explored the potential of time series Landsat images for mapping the evergreen forests in the CONUS (i.e., temperate regions). We clarified this point in Lines of 112-118, Page 5.

At last, we add the accuracy information of PALSAR-based forest products into the Results in Lines of 333-334, page 17 as "The accuracies were comparable to the PALSAR-based forest maps that were reported overall accuracies exceeding 91% (Shimada et al. 2014).".

3. Line 52-53, which year?

Response: Corrected as "estimated in 2020"

4. Line 79-80: it's hard to say 'few' since all the data except one in Table 1 have years after 2010.

Response: We revised the sentence as "However, it remains untested about their application potential for the annual management of forest resources systematically."

5. Line 90-91, since a major contribution for this study is combining the advantages of microwave and optical images for mapping forest, necessary experiments are needed to show the accuracy improvement when combining these two datasets.

Response: To clarify the contribution of this study, we revised the sentence as "However, it remains unclear about the potential to improve the annual forest monitoring in the CONUS by combining PALSAR and Landsat images".

In addition, we add the accuracy information of PALSAR-based forest products into the Results in Lines of 333-334, page 17 as "The accuracies were comparable to the PALSAR-based forest maps that were reported overall accuracies exceeding 91% (Shimada et al. 2014).".

6. Section 2.4, what's the spatial and classification accuracy for the sample data in Fig.,4?

Response: Fig. 4 show the samples of different land cover types, which were generated by the third-party (Tsinghua University) using the visual interpretation method. In this study, we double checked the samples visually based on Google Earth images. Therefore, these samples presented ground truth states that were used to validate our results in this study. We clarified this issue in the manuscript in Lines of 191-194, Page 10.

7. Line 178-179, how did you identify land cover changes? If a sample changed from other land cover types to Forest during 2015-2017, shall we keep this sample or delete it? How many forest samples before and after the removing.

Response: Due to the validation samples were generated in 2013, we double checked the samples by visual interpretation according to the Google Earth images during 2015-2017 in this study. We deleted all the samples with land cover changes including a sample changed from other land samples to forests. The forests samples changed from 706 to 652 before and after the removing. We clarified the sentence as "The samples with land cover changes were identified visually according to the Google Earth images during 2015-2017, which were removed out in this study." in Lines of 193-194, Page 10.

8. Line 201-202: since the canopy height and cover will change over time, why there is no effect of time differences? I feel confused.

Response: Since the canopy height and cover of forest may increase over time from 2003-2009 to 2015-2017 that is beneficial to forest identification in 2015-2017, this potential change could not affect the assessment results on how many forests were identified following FAO definition (canopy cover$\geqslant$10%, tree height $\geqslant$5-m).

9. Line 203-204, 'the time differences could have small effect on the assessment', what do you mean 'time differences'? if it's difference for canopy height or cover, it may not be necessarily correct.

Response: We agree with you. As ICESat data was acquired during 2003-2009, our study was conducted for the period of 2015-2017. We used ICESat data as reference to assess the forest maps in terms of forest structure features (canopy height and cover). Here, we want to clarify how much effect could be caused in our assessment results by the time differences between ICESat data and our study period.

10. Figure4, clarify what do 'NL', 'BL', and 'ML' respectively mean in its caption.

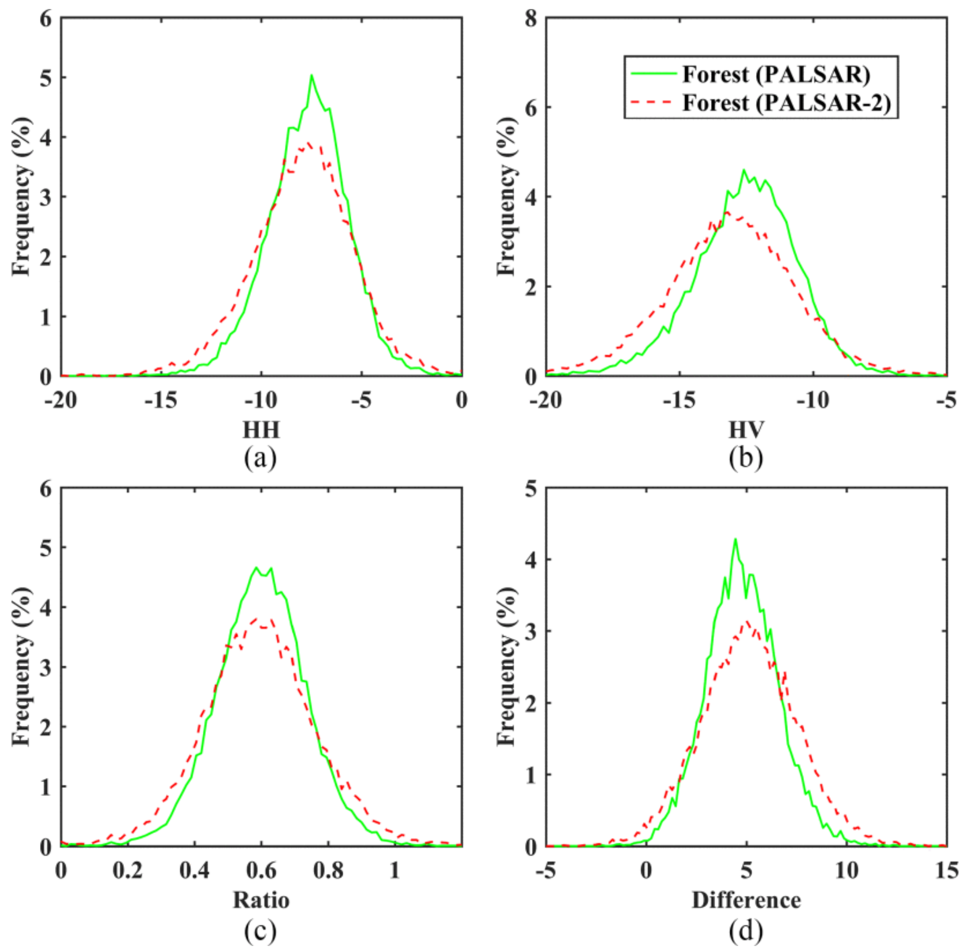
Response: In the caption, we clarified the legends of Forest_NL, Forest_BL, Forest_ML as needle-leaved forest, broad-leaved forest, and mixed-leaved forest, respectively. See Lines of 201-202, Page12.

11. Line 210: The PL-Forest map is during 2015-2017, while the GFW product is in 2010. Unless the interannual changes are ignorable, the two products cannot be compared across different years to show their definition differences.

Response: We agree with you. In this study, we did not compare the GFW and PL-Forest map pixel-by-pixel directly. We analyzed the GFW and PL-Forest maps separately based on the forest structure features from ICESat data. This analysis could improve our understanding of different products on the relationships between forest distribution and structure features.

12. Section 2.7, how to justify these thresholds are optimal?

Response: This thresholds were determined based on our previous studies on the PALSAR、PALSAR-2 signature analysis of forest and non-forest samples (See the following figure) (Chen et al. 2018). We clarified this point in Lines of 267-268, Page 15.



13. Line 265-266: why change 'NFN' to 'NNN'? why not 'FFM' or 'NFF'? similar to 'FNF'

Response: We changed "NFN to NNN"and "FNF to FFF"considering that forests cannot disappear and appear within one year for a specific pixel. This unreasonable time series is more likely caused by noise. Therefore, we conducted a logical consistency check on our resultant maps to reduce the uncertainties. However, for the cases of "FFN or NFF", we have no information to reject the change in the 3rd year for "FFN" and the change in the 2nd year for "NFF", and these two cases may happen in real world. Thus, we did not change these sequences in the 3-year logical consistency check.

14. Line 265-266: such rules seem very empirical. How many or what a percentage of pixels show a ‘NFN’ or ‘FNF’?

Response: The logical consistency check was conducted on the resultant maps as a post-processing process to reduce the uncertainties. The proportion of the pixels was small less than 1%. This post-processing approach was widely used in previous studies (Chen et al. 2018, Qin et al. 2016). We added references into the manuscript in Line of 281, Page 15.