Dear Authors and Colleagues

Thank you for your contributions! Thanks for the authors for the replies to the reviews of your paper and for the revision.

Your published forest maps of CONUS represent a useful data set and in your ESSD manuscript you show a range of comparison with other data products, from in situ to other remote sensing derived data sets. The manuscript, the data description and data publication do not yet fulfill the requirements of ESSD and improvements are needed. A major revision of the manuscript and a minor revision of the dataset publication is needed.

Response: Thanks for the efforts from editors, reviewers, and colleagues to provide valuable comments and suggestions to improve the manuscript. We revised the manuscript and dataset carefully following the comments and suggestions in this revision. To help read our responses, we labeled all the revisions in the numbers of Lines and Pages using the Track Change version. Please see our point-to-point responses to each comment and suggestion.

1. You describe three annual CONUS forest maps 2015,2016, and 2017 and you propose that based on your method more yearly products could be produced. ESSD is not publishing papers on remote sensing methods, the focus of an ESSD manuscript needs to be on the usability of the data sets that are described.

On the positive side, what is well done in your manuscript,

i) you are providing assessments, cross validation and intercomparison with a wide range of products, detailed descriptions and data visualisations

ii) that the value of your product is in representing a high-quality robust CONUS forest cover product for 2016 (cross-checked with 2015 and 2017, i.e. your data publications are three annual maps that you keep, but the maximum value of your data publication lies in the 2016 most robust assessment of forest cover)

Response: We appreciate your suggestions. Following your suggestions, we edited the text with the focus of describing the usability of the data sets throughout the manuscript in this revision.

For example, in the abstract, we revised the implication of this study as "The comparison of the most widely used forest datasets offered insights to employ appropriate products for relevant research and management activities across local to regional and national scales. The generated datasets in this study are available at https://doi.org/10.6084/m9.figshare.21270261 (Wang, 2024). The improved annual

maps of forest and evergreen forest at 30-m over the CONUS can be used to support forest management, conservation, and resource assessments." in Lines of 45-55, pages 2-3.

2. Recommendations to the authors – can you change some aspects of discussion and conclusions accordingly, also slightly change the focus of the title

Response: Following your suggestions, the title has been revised to "Annual maps of forest and evergreen forest in the contiguous United States during 2015-2017 from analyses of PALSAR-2 and Landsat images".

In Discussion, we highlighted the intercomparison of this study in Lines of 539-541, Page 37 as "This study provided a comprehensive assessment by intercomparison with the widely used forest products using the FAO forest definition and the Lidar-based forest structural data (CC, CH) as references. The comparison between forest datasets suggested …"

In Conclusion, we focused on the forest, and evergreen forest products, and the comparison study. The manuscript has been revised in Lines of 621-635, Page 40, as "This study integrated microwave (PALSAR-2) and optical (Landsat) images and produced annual forest maps in 2015-2017 for the CONUS at 30-m spatial resolution with an improved accuracy. Furthermore, we generated the annual 30-m evergreen forest maps in the CONUS, which can be used to investigate how climate change and human activities affect these forest types in the CONUS. In addition, following the FAO's forest definition, we compared the widely-used Landsat-based, PALSAR-2-based, and PALSAR-2/Landsat-based forest cover products on the characterization of forest structure metrics (CC and CH) by using the ICESat LiDAR tree structure datasets. We also compared the satellite-based forest cover products and the FIA statistical data on the forest area estimates. The comprehensive intercomparison with a wide range of products provides insights to apply appropriate products for relevant research and management activities."

3. i) The wide availability of forest and land cover maps based on satellite data provides more information for users than ever before. However, it is challenging for users to understand the differences in the forest products and decide which data to use for a specific application. Your manuscript can support the understanding of different forest products. Could you therefore in some cases even discuss in more detail why some products align in some ways and differ in others with your product and FIA estimation.

Response: We appreciate your suggestions. In the Discussion, we explained the reasons for the better accuracy of PALSAR-based forests than the Landsat-based forest products and the potential applications in Lines of 555-558, Page 37 as "One of the reasons for the improved accuracy could be attributed to the utilization of L-band PALSAR-2 images that (1) are less affected by atmospheric conditions, clouds, and cloud shadows than optical data, and (2) have stronger penetration capability into forest canopy with more sensitivity to forest structure."

Lines of 562-564, Page 37 as "In addition, GFW-Forst 2010 and Landsat VCF-Forest 2015 present the forest cover in the CONUS in the years of 2010 and 2015. The inconsistent time with the FIA-Forest in 2017 may contribute to some discrepancies between them that are difficult to quantify."

Lines of 576-578, Page 38 as "It also suggested the potential of integrating FIA data and PL-Forst products to support the FAO's Global Forest Resources Assessment at the national scale."

4. ii) Provide more details and regional assessments on your CONUS forest cover products for 2016. E.g, how about the performance in mountainous terrain? Can you cross check with fire scar products -does this make sense?

Response: Following your suggestions, we added a detailed assessment of the forest cover product in 2016 about the performance at regions with different elevations and the burned areas.

The results have been added to the manuscript in Lines of 414-423, Pages 21-22 as "In detail, the accuracies of the PALSAR-2/Landsat forests in 2016 have been estimated at different altitudes of 0-500m, 500-1000m, 1000-2000m, and 2000-4000m (Tabel 3). Results showed that the areas with altitudes lower than 2000m have user's and producer's accuracies greater than 88%, and overall accuracies greater than 91%. The areas with altitudes higher than 2000m have slightly lower user's (78.3%), producer's (76.6%), and overall accuracies (87.8%). Additionally, we examined the potential of the PALSAR-2/Landsat forests in 2016 to exclude the impacts of the burned area by overlying a MODIS burned area product and the forest map (Fig. 8). The results showed that there were 6,845,692 pixels covered by burned area and 713,003 pixels were identified as forests in the resultant PALSAR-2/Landsat forest map in 2016 with a proportion of about 10.4%. But this number may not accurately represent the commission error, as the burned forest may not be fully dead and could regrow again."

Table 3. Accuracy assessment of the annual PALSAR-2/Landsat forest map in 2016 (PL-Forests) with different elevations based on the validation samples (Fig. 4). The User's (UA), Producer's (PA), and Overall (OA) accuracy is shown.

Elevation	PL-Forests Classificatio	Reference Forests	Non-	Total	UA	PA	OA
0-500	Forests	441	58	499	88.4%	94.0%	91.2%
	Non-	28	555	583	95.2%	90.5%	
	Total	469	613	1092			
500-1000	Forests	70	6	76	92.1%	90.9%	95.9%
	Non-	7	234	241	97.1%	97.5%	
	Total	77	240	317			
1000-2000	Forests	52	7	59	88.1%	88.1%	96.4%
	Non-	7	321	328	97.9%	97.9%	

	Total	59	328	387			
2000-4000	Forests	36	10	46	78.3%	76.6%	87.8%
	Non-	11	115	126	91.3%	92.0%	
	Total	47	125	172			

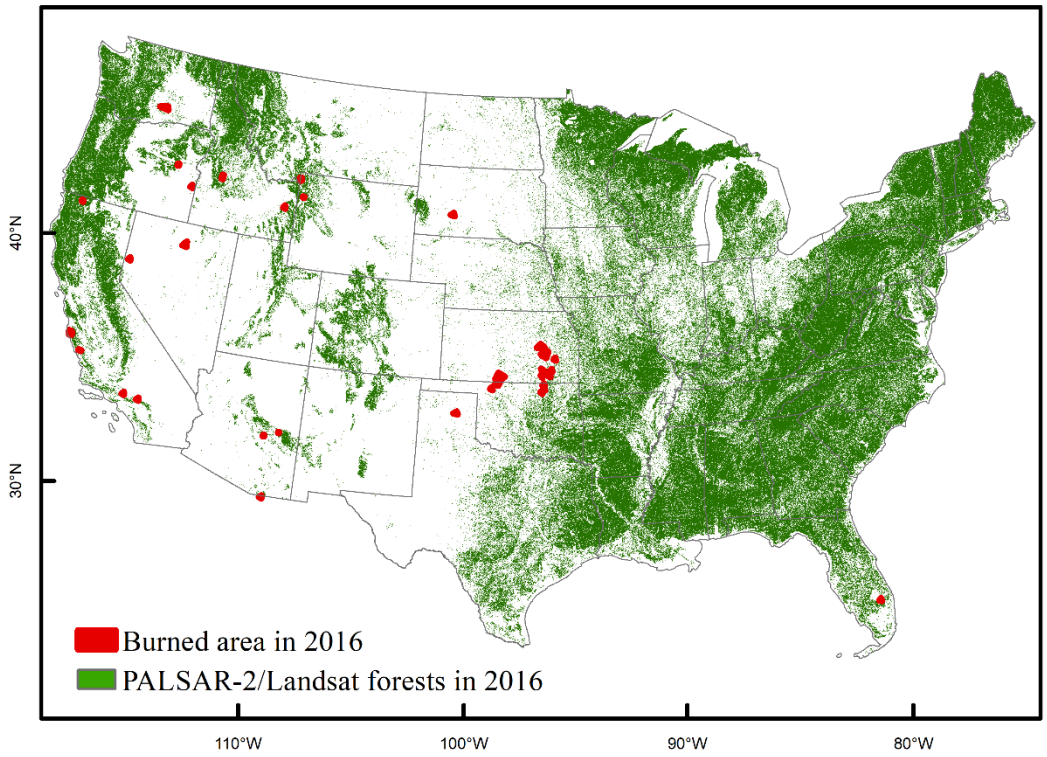

Figure 8: Distribution of burned area overlaid with the PALSAR-2/Landsat forests in 2016. The burned area in 2016 was generated from the MODIS Burned Area Monthly Global 500m products (MCD64A1.061). If a pixel was burned in any month, the pixel was considered a burned area in 2016.

5. Can you carefully formulate what is included in the evergreen forest class, do you include evergreen needle-leaf and evergreen broad-leaf? What is included in the deciduous forest class?

do you also include summergreen needle-leaf, e.g. larch?

Response: We clarified the definition of the evergreen forests in this study in Lines of 368-373, Pages 19-20, as "Thus, evergreen forests refer to the forest land having green leaves throughout the year, with tree canopy height greater than 5m and tree canopy cover larger than 10%. In this study, both the forests and evergreen forests include natural and artificial forests that meet the requirements (Qin et al., 2024). Meanwhile,

the evergreen forests include needle-leaf and broad-leaf forests that meet the requirements based on the greenness signature observed by the satellite images."

Reference:

Qin, Y., Xiao, X., Tang, H., Dubayah, R., Doughty, R., Liu, D., Liu, F., Shimabukuro, Y., Arai, E., and Wang, X. J. E. S. S. D.: Annual maps of forest cover in the Brazilian Amazon from analyses of PALSAR and MODIS images, Earth Syst Sci Data, 16, 321-336, 2024.

6. In general, figures and tables: explain all abbreviations in figure and table captions please enhance your writing style and consider professional proofreading - Sometimes sentences are not complete and remain unclear, e.g. p.15 'It is still unclear that the performance of the integrated datasets for monitoring the annual dynamics of forest distribution and forest functional types over the temperate regions.' Throughout your manuscript, standardize your terms, reuse the same term for forest, non forest and the two forest classes you create, e.g., Table 2: the term 'Nonforests ' does not exist, in most cases in your sentences, the use of 'forest' is more appropriate than 'forests', Figure 8 naming and abbreviations not consistent, and in general not consistent throughout the text. Try to avoid in general sentences such as … JAXA forests identified, … JAXA forests missed ... pixels, i.e., describe your products using a language without attributing actions to them. Avoid to imply human-like qualities to non-human subjects. "The resultant PL-Forest maps (forest and non-forest) in 2015-2017 were validated by the validation samples generated by the third party" – in a scientific manuscript do not use the term 'third party', use a reference or author and oral communication

Response: We appreciate your suggestions. (1) All the abbreviations in figures and tables have been explained in the captions. We also revised the abbreviations in Figure 6, Figure 9, Figure 10, Figure 11, and Figure 12 to make them consistent with the text.

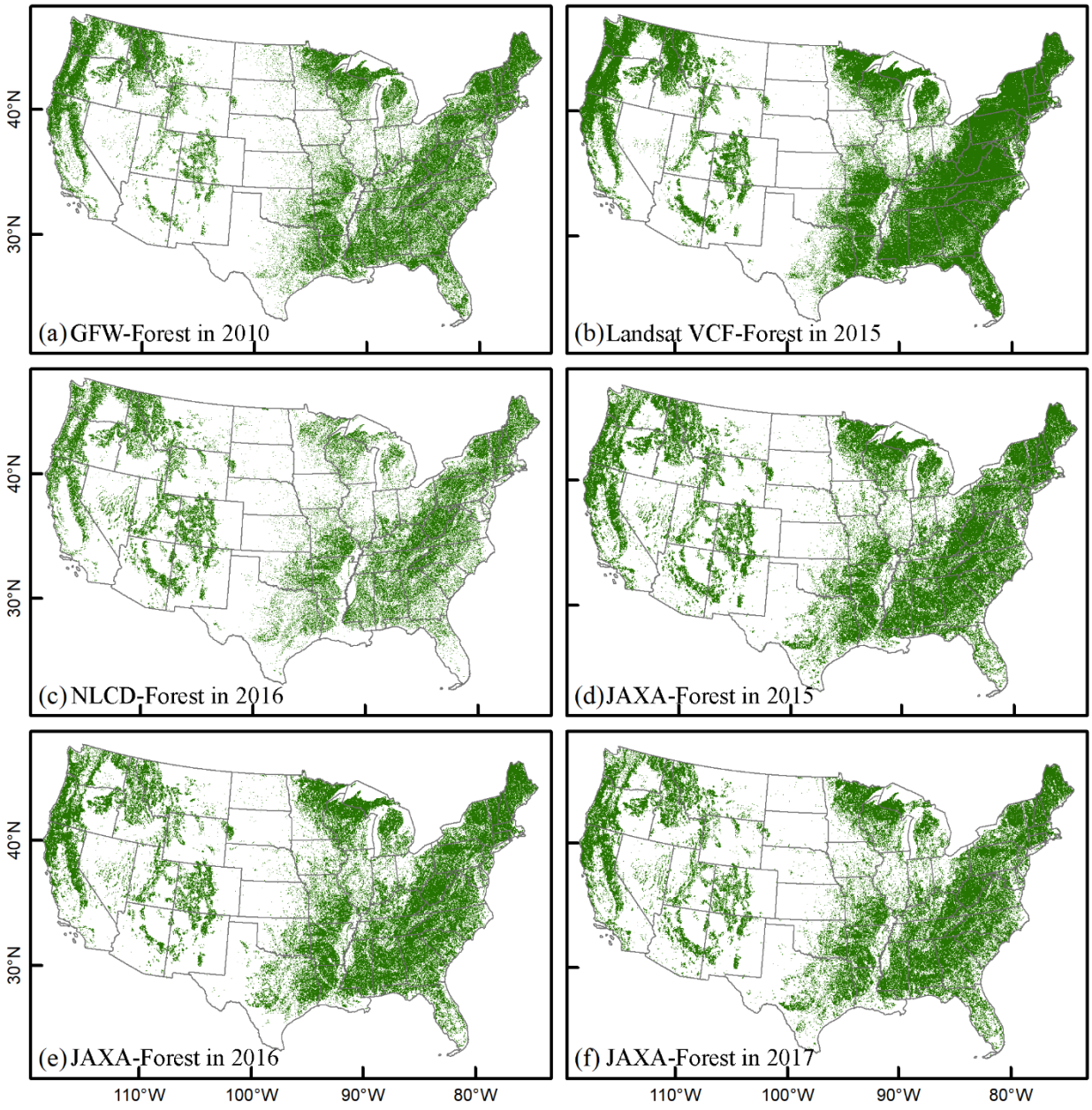
40°N
30°N
(a) GFW-Forest in 2010
(b) Landsat VCF-Forest in 2015
(c) NLCD-Forest in 2016
(d) JAXA-Forest in 2015
(e) JAXA-Forest in 2016
(f) JAXA-Forest in 2017
110°W
100°W
90°W
80°W

Figure 6

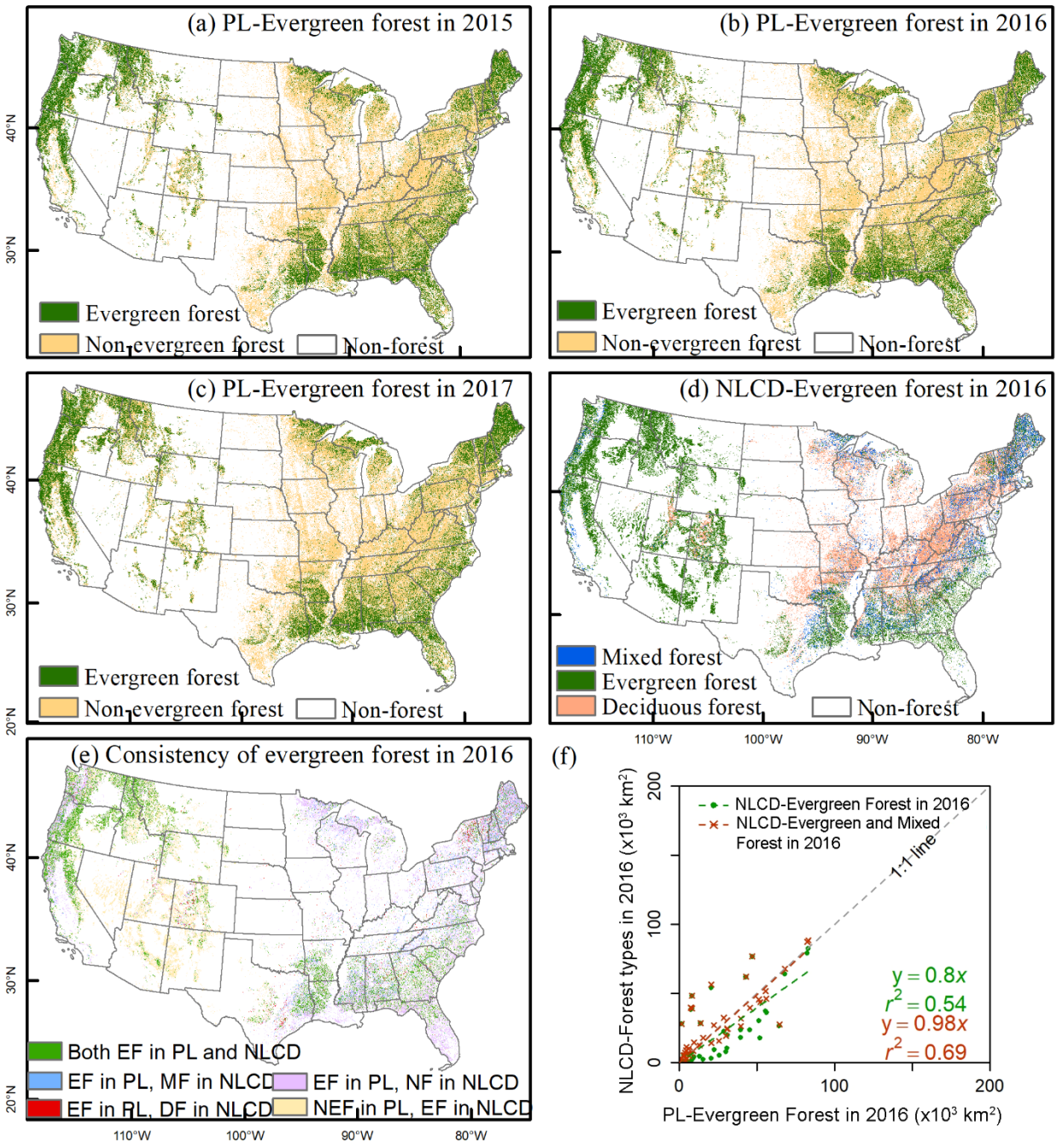
(a) PL-Evergreen forest in 2015
Evergreen forest
Non-evergreen forest
Non-forest
(b) PL-Evergreen forest in 2016
Evergreen forest
Non-evergreen forest
Non-forest
(c) PL-Evergreen forest in 2017
Evergreen forest
Non-evergreen forest
Non-forest
(d) NLCD-Evergreen forest in 2016
Mixed forest
Evergreen forest
Deciduous forest
Non-forest
(e) Consistency of evergreen forest in 2016
Both EF in PL and NLCD
EF in PL, MF in NLCD
EF in PL, NF in NLCD
EF in PL, DF in NLCD
NEF in PL, EF in NLCD
40°N
30°N
20°N
110°W
100°W
90°W
80°W
(f)
NLCD-Evergreen Forest in 2016
NLCD-Evergreen and Mixed Forest in 2016
1:1 line
y = 0.8x
r2 = 0.54
y = 0.98x
r2 = 0.69
NLCD-Forest types in 2016 (x10³ km²)
PL-Evergreen Forest in 2016 (x10³ km²)
0
100
200

Figure 9

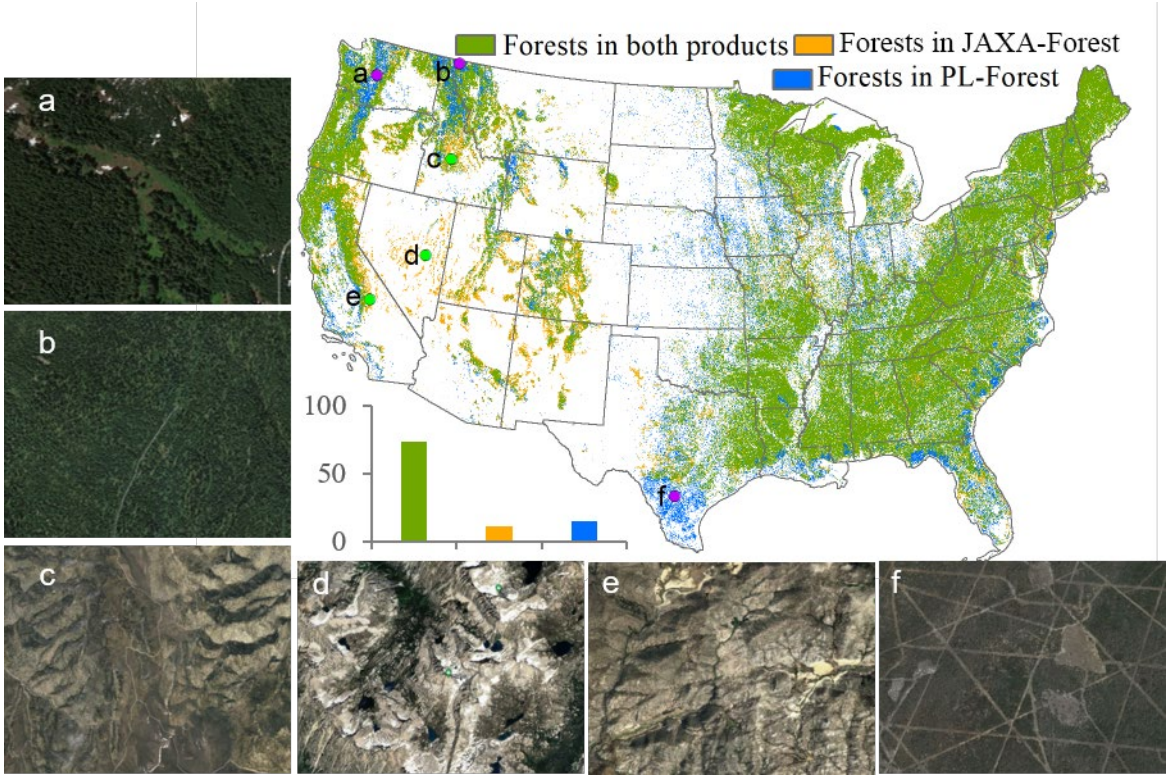
Forests in both products
Forests in JAXA-Forest
Forests in PL-Forest
a
b
c
d
e
f
100
50
0

Figure 10

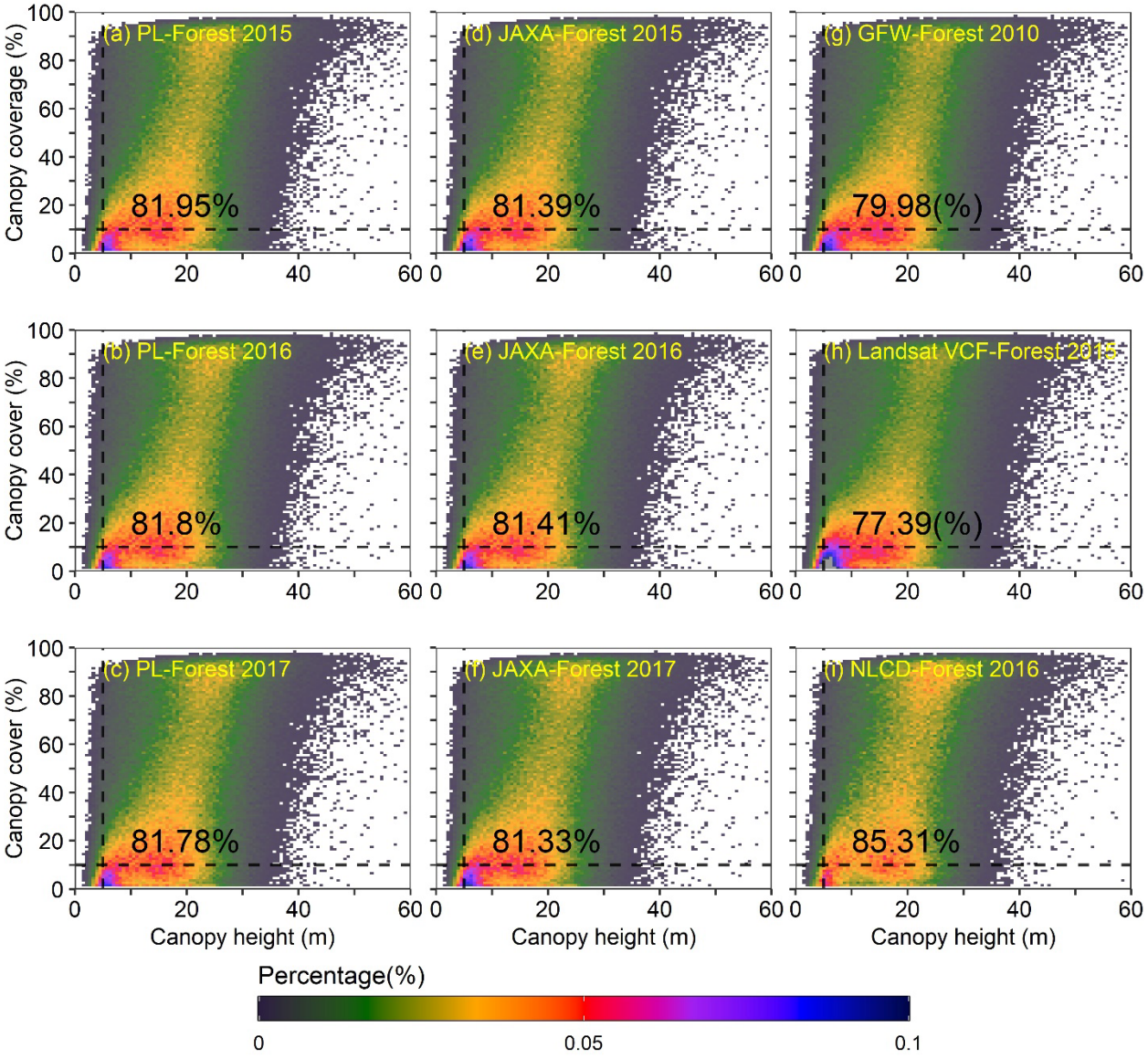
(a) PL-Forest 2015
81.95%
(d) JAXA-Forest 2015
81.39%
(g) GFW-Forest 2010
79.98(%)
(b) PL-Forest 2016
81.8%
(e) JAXA-Forest 2016
81.41%
(h) Landsat VCF-Forest 2015
77.39(%)
(c) PL-Forest 2017
81.78%
(f) JAXA-Forest 2017
81.33%
(i) NLCD-Forest 2016
85.31%
Canopy coverage (%)
Canopy cover (%)
Canopy height (m)
Percentage(%)
0
0.05
0.1

Figure 11

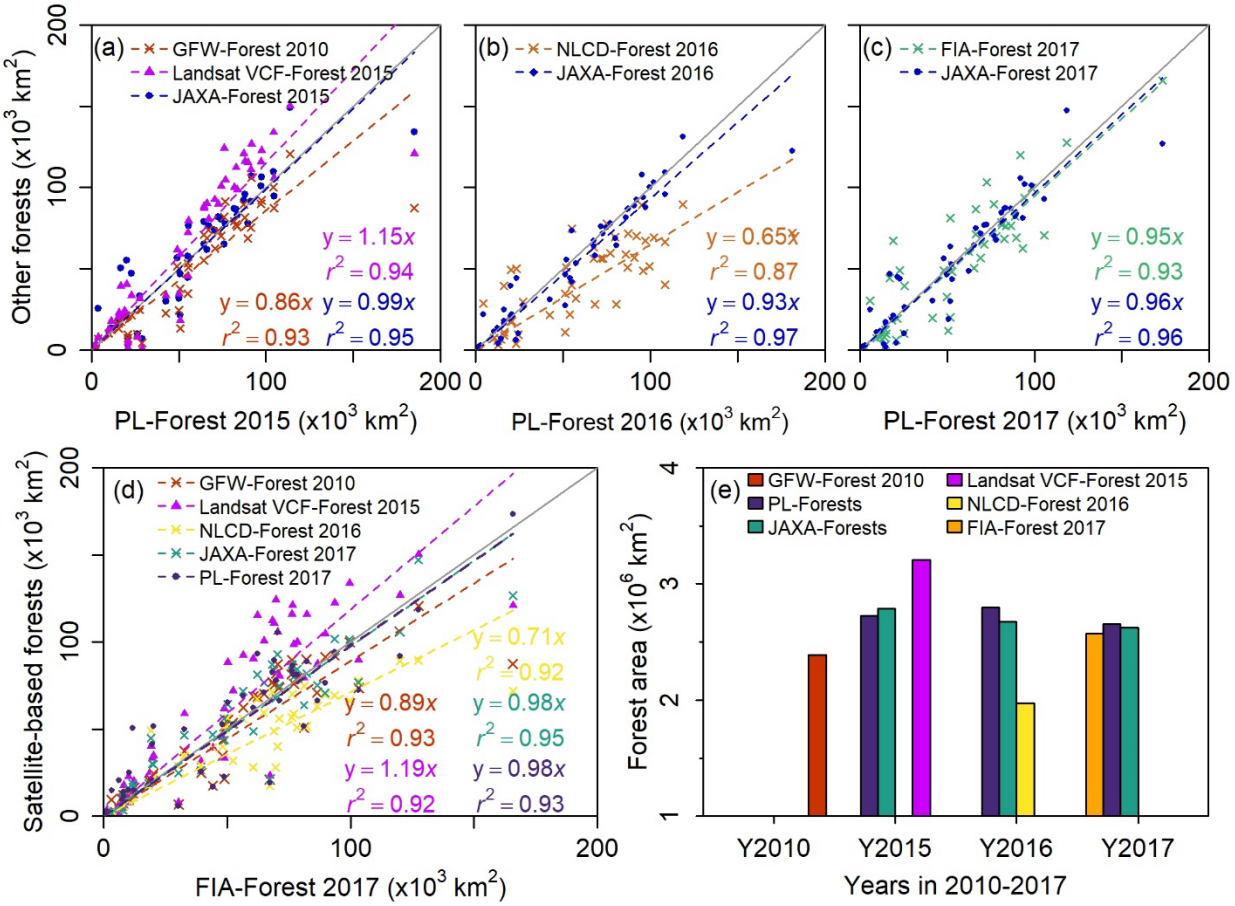

Figure 12

(2) The terms have been standardized throughout the manuscript and figures. For example, Nonforests have been revised as non-forest, and forests were revised as "forest".

(3) The sentences of the manuscript have been revised carefully. The revision includes unclear sentences and general sentences throughout the manuscript.

(4) The term "third party" has been revised using a reference or the author in the manuscript.

7. In general, Please provide more information related to your replies to the reviewers also in your manuscript text. e.g, Reviewer 3 asked 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. Your new sentence in the manuscript text: "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." This sentence remains very unclear, Please put sentences in the manuscript text in with more detail e.g., Reviewer 3 asked

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. Your new sentence in the manuscript text: ”We recognize the time difference between the ICESat data (2003-2009) and the PALSAR-2 data (2015-2017), which may affect the assessment, dependent upon the land use change. ” This sentence remains unclear, Please put a sentence in the manuscript text in with more detail, e.g. is there a consequence, can you estimate the magnitude? E.g. areal change due to fire scares?

Response: Following your suggestions, we added more information related to the replies to reviewers into the manuscript.

For the first question from Reviewer 3, the sentence has been revised in Lines of 229-235, Pages 11-12, as “As the validation samples were generated in 2013, in this study, we double-checked the land cover types of all the samples by visual interpretation of the Google Earth images during 2015-2017. We deleted those samples with land cover changes (e.g., from forest to non-forest or from non-forest to forest), and thus, a total of 652 forest samples were kept for this study.”

For the second question from Reviewer 3, the manuscript has been revised in Lines of 254-268, Page 13, as “This is the only available dataset that can be used to assess the structural characteristics of the forests extracted by the forest cover products in the study period of 2015-2017. The image acquisition years differ between the ICESat data (2003-2009) and the PALSAR-2/Landsat data (2015-2017), which may cause small uncertainties in the assessment results. A pixel has three scenarios in terms of forest or not in these two time periods (2003-2009 vs 2015-2017): (1) as forest in both 2003-2009 and 2015-2017, (2) as forest in 2003-2009 but not in 2015-2017 (forest loss due to deforestation), and (3) as forest in 2015-2017 but not in 2003-2009 (forest gain due reforestation or afforestation). For those pixels that were forest in both 2003-2009 and 2015-2017 (Scenario #1), as the canopy height (CH) and canopy coverage (CC) of a forest stand are likely to increase over the years, using CH and CC data in 2003-2009 may underestimate the number of pixels meets the FAO forest definition. For those pixels that were forest only in one period of 2003-2009 or 2015-2017 (scenario #2 or #3), they were not evaluated in the assessment. In addition, the differences in image acquisition years would not affect the results of inter-comparison between different forest cover products. ”

Details

Introduction

8.We propose that you (shortly) introduce the CONUS forest types

Response: Following your suggestion, we have introduced the spatial distribution of the CONUS forest types from both biome and tree species levels in Lines of 65-70, Page 4, as "The forest biomes are dominated by the northwestern rocky mountain and Pacific coast evergreen forests, the eastern deciduous and mixed forests, and the southeastern coastal plain evergreen forests (Cooperation, 1997). The Forest Inventory and Analysis (FIA) program, managed by the U.S. Department of Agriculture (USDA) Forest Service, identified 142 forest types (by major tree species), which were aggregated into 28 forest groups across the USA (Ruefenacht et al., 2008)."

References:

Commission for Environmental Cooperation (1997). Ecological regions of North America: toward a common perspective.

Ruefenacht, B., Finco, M., Nelson, M., Czaplewski, R., Helmer, E., Blackard, J., Holden, G., Lister, A., Salajanu, D., & Weyermann, D. (2008). Conterminous US and Alaska forest type mapping using forest inventory and analysis data. Photogrammetric Engineering and Remote Sensing, 74, 1379-1388

Cooperation, C. f. E.: Ecological regions of North America: toward a common perspective, The Commission1997.

Chapter 2

9. 2.2. HH, HV .. and 2.3. vegetation indices …introduce abbreviations the first time you use them Can you include more information on FIA data in chapter 2.6 or in a separate small subchapter – on data from field inventory and upscaling to forest area, e.g. in table 1 there is no minimum height threshold does this mean that also areas with trees < 5 m height are included ?

Response: The abbreviations of HH, HV and Vegetation Indices have been revised as full name in the first time. See Lines of 194, Page 10, and Lines of 213-214, Page 10. We also double checked the manuscript following the rule in this revision.

We added more information on the definition of forest land and the accuracy of FIA data in a separate subchapter of "2.7 Forest cover data from in-situ field inventory for inter-comparison" in Lines of 290, Page 14

As "The definition of the forest land condition is: larger than 0.4 ha (1.0 acre) in size, greater than 37m (120.0 feet) in width, at least 10% canopy cover by live tally trees of any size at present or in the past (Burrill et al., 2021). Forest land also includes (1) the transition zones, such as areas between forest and non-forest lands that meet the minimal tree canopy cover and forest areas; (2) the strips of trees in roadside, streamside, and shelterbelt, must wider than 37m (120 feet) and longer than 111m (363 feet) continuously; (3) the unimproved roads and trails, streams, and clearings in forest areas if they are less than 37m in width or less than 0.4 ha in size. Forest land does not include tree-covered regions in agricultural production settings like orchards or urban areas like city parks (Burrill et al., 2021). The accuracy standard for forest area in the FIA program is to meet the mandated sampling error no more than 3% error per 1 million acres of timberland (Burrill et al., 2021)."

References:

Burrill, E. A., DiTommaso, A. M., Turner, J. A., Pugh, S. A., Menlove, J., Christiansen, G., Perry, C. J., and Conkling, B. L.: The Forest Inventory and Analysis Database: database description and user guide version 9.0.1 for Phase 2, U.S. Department of Agriculture, Forest Service, 1026 p, 2021.

10. P8 L167 please explain the symbols in the equation you show in your text – is there a reference?

Response: The symbols were explained in the text. The reference was added. See Lines of 199-203, Pages 10.

The revision is that "The HH and HV bands were converted from the amplitude values into gamma-naught backscattering coefficients in decibels (γ°) using the equation (1) (Chen et al. 2018; Shimada et al. 2009; Shimada et al. 2014).

$$\gamma^\circ = 10 \times \ln DN2 + CF \quad (1)$$

where γ° is the backscattering coefficient using dB as the unit; DN is the digital number of the amplitude images like HH or HV band; and CF is a calibration factor with a value of -83 dB."

References:

Chen, B.Q., Xiao, X.M., Ye, H.C., Ma, J., Doughty, R., Li, X.P., Zhao, B., Wu, Z.X., Sun, R., Dong, J.W., Qin, Y.W., & Xie, G.S. (2018). Mapping Forest and Their Spatial-Temporal Changes From 2007 to 2015 in Tropical Hainan Island by Integrating ALOS/ALOS-2 L-Band SAR and Landsat Optical Images. Ieee Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 11, 852-867

Shimada, M., Isoguchi, O., Tadono, T., & Isono, K. (2009). PALSAR Radiometric and Geometric Calibration. IEEE transactions on geoscience and remote sensing, 47, 3915-3932

Shimada, M., Itoh, T., Motooka, T., Watanabe, M., Shiraishi, T., Thapa, R., & Lucas, R. (2014). New global forest/non-forest maps from ALOS PALSAR data (2007-2010). Remote Sensing of Environment, 155, 13-31

11. Introduce FQ LSWI e.g. in a sentence, and as equation before using it in 2.8 L295 (FQLSWI)

Response: Following your suggestion, we clarified the information here in Lines of 358-367, Page 19, as "The green leaves of evergreen forests have positive LSWI values all year round and relatively high EVI in winter and/or dry seasons, and thus the seasonal profiles analysis of LSWI and EVI was used to identify evergreen forests (Qin et al., 2016). The same approach was used to generate the annual maps of evergreen vegetation by the criteria of pixels having (1) LSWI≥0 for all the good observation images in a year and (2) a minimum EVI (EVI_{min}) no less than 0.2 identified as evergreen cover. This rule can be characterized by the frequency of LSWI≥0 ($FQ_{LSWI\geq0}$) for all the good observations in a year and EVI_{min} using the decision thresholds ($FQ_{LSWI\geq0}$ = 100% and $EVI_{min} \geq 0.2$). Here, the $FQ_{LSWI\geq0}$ was calculated by the number of observations with LSWI≥0 ($N_{LSWI\geq0}$) over the number of good-quality observations (N_{GOBs}) in a year for individual pixels (EQ. 4)."

12. Can you define what forest types you include in your product, natural, managed and plantations?

Response: The definition of evergreen forests and the forest types included in the forests and evergreen forests have been clarified in the manuscript, in Lines of 368-371, Pages 19-20. "Thus, the evergreen forests refer to the forest land having green leaves throughout the year, with tree canopy height greater than 5m and tree canopy cover larger than 10%. In this study, both the forests and evergreen forests include natural and artificial forests that meet the requirements (Qin et al., 2024)"

Reference:

Qin, Y., Xiao, X., Tang, H., Dubayah, R., Doughty, R., Liu, D., Liu, F., Shimabukuro, Y., Arai, E., & Wang, X.J.E.S.S.D. (2024). Annual maps of forest cover in the Brazilian Amazon from analyses of PALSAR and MODIS images. Earth System Science Data, 16, 321-336

Figures

13. Figure 2 – add source of DEM in figure caption

Response: The data source has been added in figure caption in Lines of 187-188, Page 9, as "The spatial distributions of the topography of the CONUS using the data from the U.S. Geological Survey, 3D Elevation Program 10-Meter Resolution Digital Elevation Model (DEM). "

14. Figure 7 d, frequency of forests – unit is missing, e.g. year?, add explanations of the color coding in the figure caption

Response: The frequency of forests refers to the number of the a specific pixel identified as forests in the annual PL-Forest maps from 2015 to 2017. So it does not have unit. The explanations of the colors have been added in the figure caption in Lines of 428-429, Page 23. "The colors red, blue, and green denote the numbers of a specific pixel classified as forest based on the annual PL-Forest maps from 2015 to 2017."

Data publication

15. ESSD requires an optimization of the published data sets.

Please include a read me document describing the format of the data: e.g. geotiff, which projection, band variables, units

Response: A read me document has been uploaded. The following information are included:

This dataset provides annual 30-m forest cover maps and annual 30-m evergreen forest cover maps in the Contiguous United States (CONUS) from 2015 to 2017. This dataset was generated based on the PALSAR-2 and Landsat images.

Annual 30-m forest maps in 2015, 2016, and 2017 were named as "Forest2015.tif, Forest2016.tif, Forest2017.tif", respectively. The maps are stored in a GeoTIFF formatted unsigned integer. Each map has one band using a spatial reference of GCS-WGS_1984. In the map, the pixel value of 1 represents forest and 0 represents non-forest. NoData value is 2.

Annual 30-m evergreen forest maps in 2015, 2016, and 2017 were named as "Evergreen Forest2015.tif, Evergreen Forest2016.tif, Evergreen Forest2017.tif", respcetively. The maps are stored in a GeoTIFF formatted unsigned integer. Each map has one band using a spatial reference of GCS-WGS_1984. In the map, the pixel value of 1 represents evergreen forest and 0 represents non-evergreen forest. NoData value is 2.

16. product evergreen forest is binary, does it include evergreen needle-leaf and evergreen broad-leaf? Does a product for summergreen forest exists, as you show summergreen in the figures or does the users need to construct the summergreen forest product by themselves? Could this become an additional product in your data publication?

Response: The evergreen forest included evergreen needle-leaf and evergreen broad-leaf. A product for summergreen forest was not generated in this study. To make the evergreen forest map clear, in this revision, we added the definition of evergreen forest as "Thus, the evergreen forests refer to the forest land having green leaves throughout the year, with tree canopy height greater than 5m and tree canopy cover larger than 10%. In this study, both the forests and evergreen forests include natural and artificial forests that meet the requirements (Qin et al., 2024)." In Lines of 368-373, Pages 19-20.

17. Please enhance the title – e.g. include the data sources and the region of your product and enhance the abstract.

Response: Following your suggestion, the title has been revised as "Annual maps of forest and evergreen forest in the contiguous United States during 2015-2017 from analyses of PALSAR-2 and Landsat images".

The abstract has also been revised with adding the descriptions on the datasets of the forest and evergreen forest maps, and the potential applications.