This manuscript proposed an efficient method to produce the 10-m global impervious surface areas (GISA-10m) based on the existing ISA maps, Sentinel-1/2 images, and OSM data. Compared to existing global GISA products, GISA-10m can provide higher spatial resolution while keeping higher accuracy. The inter-comparison with existing datasets demonstrated the superiority of GISA-10m. Analysis of ISA on rural and urban areas further revealed the urbanization level and landscape of different countries in more details. In particular, an interesting point of GISA-10m is that it is able to delineate the area of roads across the world, making GISA-10m valuable for relevant urban studies. In general, this manuscript is well presented and makes novel contributions. However, some issues should be clarified to improve this manuscript. Specific comments include the following aspects:

1) In Section 3.1.3, the authors used 200 trees for training the random forest classifier, while the effect of the number of trees is not analyzed. Besides, the key parameter, e.g., the number of features used for training each tree, is not clarified. Please provide this information for better understanding.

R: Thanks for your comments. We analyzed the effect of the number of trees on the accuracy of global ISA mapping, using 30 mapping grids (hexagons with sides of two degrees) from global urban ecological regions (see Section 5.2 for details). The results showed that the overall accuracy was low and unstable while the number of trees was less than 20 (Fig. R1). As the number of trees increased, the mapping accuracy increased and stabilized around 200 trees. Therefore, we used 200 trees for each random forest model in GISA-10m.

In terms of the features used to train each tree, the random forest uses a random subset of features to reduce the correlation between trees. In general, the diversity of trees can be increased when fewer features are used for training each tree (Breiman, 2001). In GISA-10m mapping, we set the number of features used for each tree to the square root of the total number of features, as suggested by Liu et al., (2020).

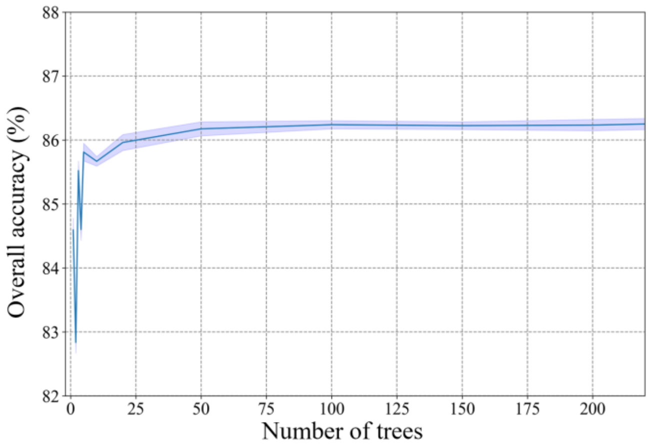

Figure R1. The overall accuracy as a function of number of trees.

Reference:

Breiman, L.: Random forests, Mach. Learn., 45(1), 5–32, doi:10.1023/A:1010933404324, 2001.

Liu, H., Gong, P., Wang, J., Clinton, N., Bai, Y. and Liang, S.: Annual dynamics of global land cover and its longterm changes from 1982 to 2015, Earth Syst. Sci. Data, 12(2), 1217–1243, doi:10.5194/essd-12-1217-2020, 2020.

2) Line 90: do you mean by "operating by"?

R: Corrected.

3) Line 103: relevant reference should be provided to support “the terrain distortion caused by the combination of two orbits”.

R: Added.

4) L120: it should be "Landsat 8".

R: Corrected.

5) L121: I found both "GLCFCS" and "GLC_FCS" in the manuscript. Please explain.

R: Thanks for pointing out this issue. "GLCFCS" and "GLC_FCS" both refer to the Global Land Cover with Fine Classification System generated by Zhang et al (2021). We have checked it throughout the manuscript.

Reference:

Zhang, X., Liu, L., Chen, X., Gao, Y., Xie, S. and Mi, J.: GLC_FCS30: global land-cover product with fine classification system at 30 m using time-series Landsat imagery, Earth Syst. Sci. Data, 13(6), 2753–2776, doi:10.5194/essd-13-2753-2021, 2021.

6) Line 201: the original OSM data are provided in vector form. When this data was converted to 10-m raster, whether the majority rule was applied? The majority rule refers to “a pixel (10m × 10m) was labelled as ISA if more than half of its area was cover by ISA, otherwise it was identified as NISA”. Please clarified this issue.

R: Thanks for your comment. Usually, we have to rasterize the raw vector data into a higher resolution (i.e., less than 10 meter), before the majority rule can be applied. This was extremely time-consuming and computationally intensive when it is applied to global ISA mapping at 10-m. Therefore, we extracted the geometric center of a vector as the sample point, rather than converted it to a raster. In such way, the amount of training samples can be guaranteed while the computational cost was reduced. Moreover, we removed buildings with area less than 100 m^2 (~ a Sentinel pixel) to ensure the reliability of the sample, since the training sample extracted from the geometric center may be NISA (Non-ISA), when the area of a building is smaller than a Sentinel pixel.

7) L295: why the total number of visually interpreted samples was 10800 when 200 samples were selected in 59 grids? Please check.

R: Thank you pointing out this issue. It should be 11,800.

8) Section 3.3: it is better to move this section to Section 5.1, since the detailed discussion has been presented in Section 5.1.

R: Thanks for your suggestion. Section 3.3 has been moved to Section 5.1.

9) Figure 6: is it possible to compare the continental accuracies of other datasets presented in Table 3? The comparison at continental level may give a clear difference of different datasets.

R: Much obliged. We compared the overall accuracy of different datasets across continents. The results showed that the average overall accuracy of GISA-10m is more stable across six continents, and exceeded the existing datasets in Africa, North America and Europe. In addition, it was found that the performance of GHSL2018 and GLCFCS was relatively unstable in South America and North America, respectively.

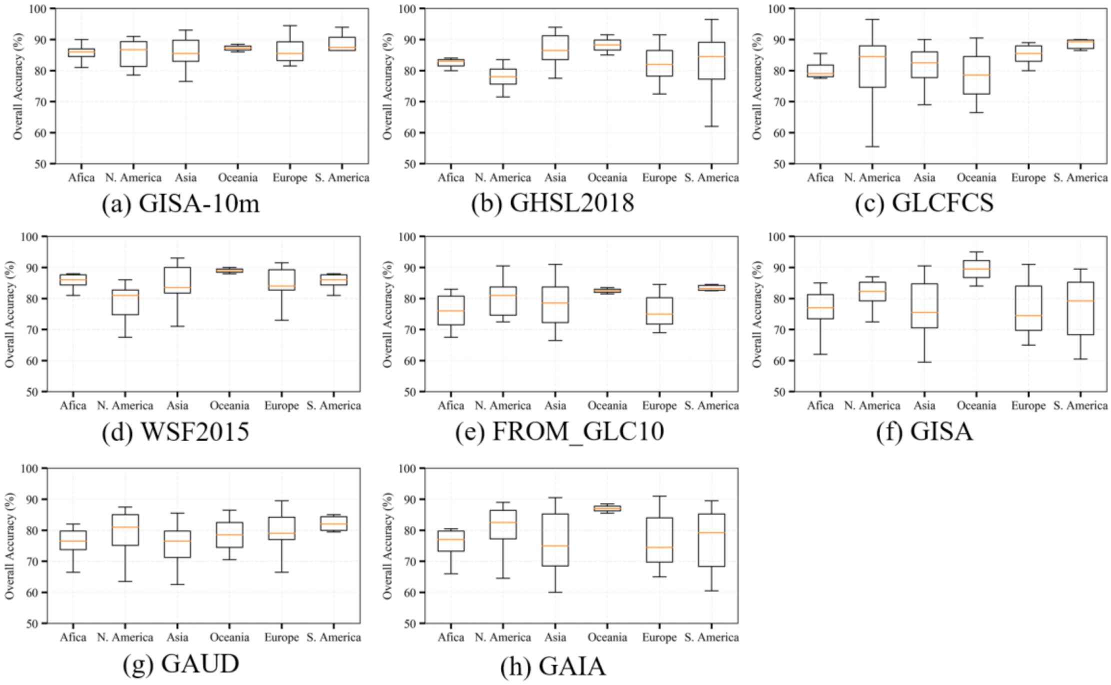

Figure R2. Box plots of overall accuracy for GISA-10m and existing datasets in the six continents.

10) Figure 8: not much information in it.

R: According to your comment, Figure 8 has been moved to the supplements.

11) Figure 11: it is better to use (a), (b), (c) to distinguish each subgraph.

R: Thanks for your suggestion. Label has been added to each subgraph (Fig. R3).

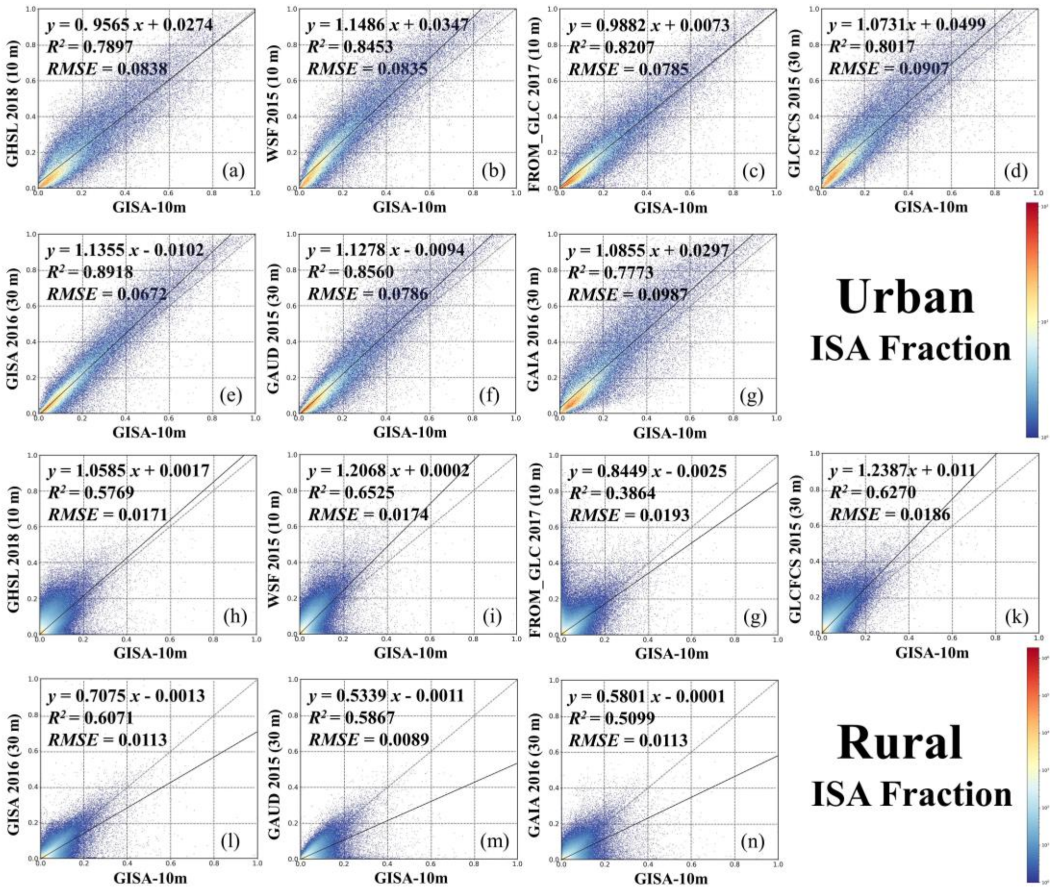

Figure R3. Scatterplots of urban and rural ISA fraction between GISA-10m with GHSL, WSF, FROM_GLC10, GLCFCS, GAUD, GAIA, GISA, respectively. ISA fraction was calculated within a 0.05° by 0.05° spatial grid.

12) Figure 17: this figure is not clear enough for presenting 30 grids. It is suggested to add legend and put this figure to the supplementary materials.

R: Thanks for your suggestion. We have added a legend to the figure (Fig. R4) and put it in the supplementary materials.

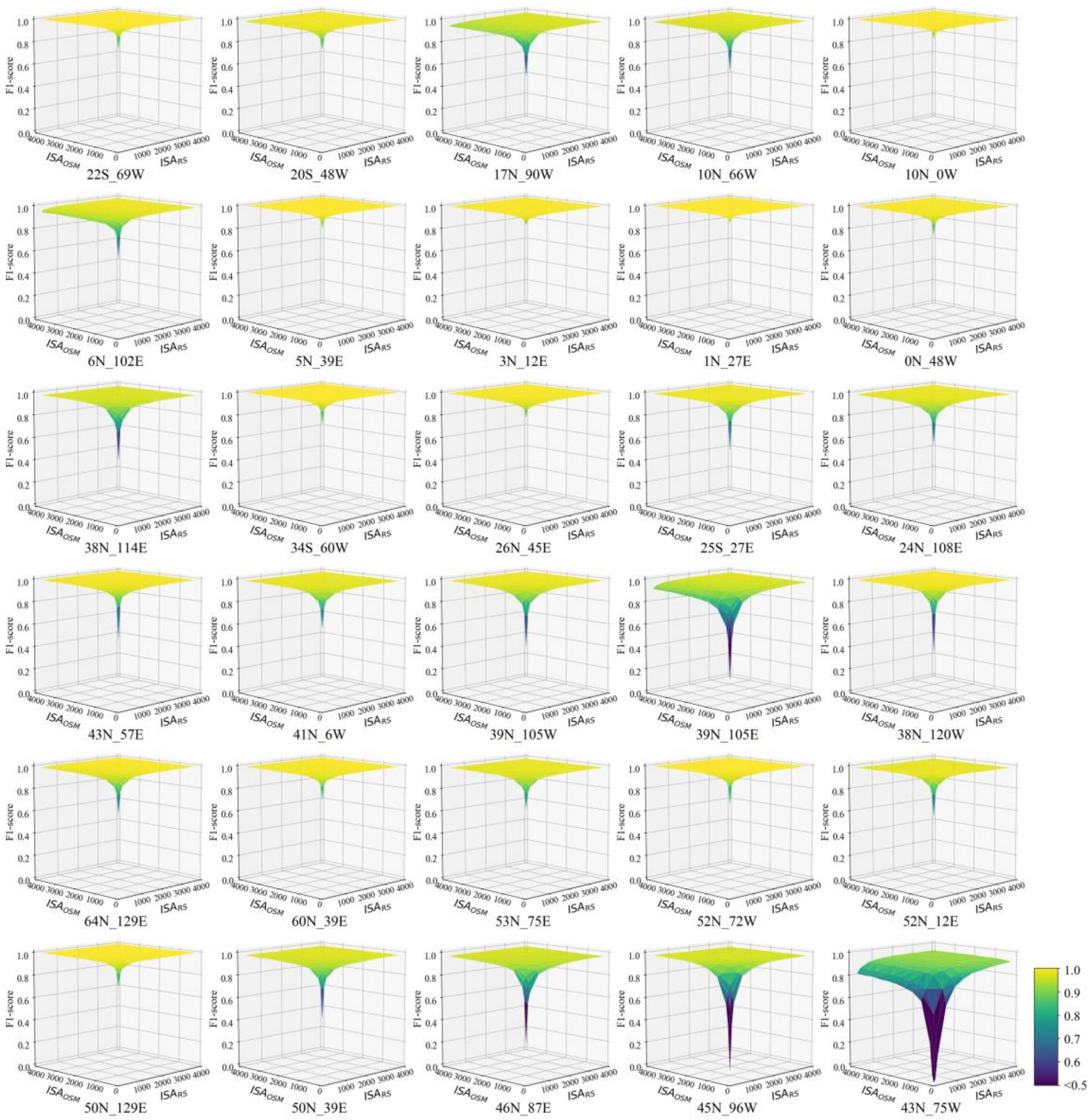

Figure R4. The F1-Score as a function of ISARS and ISAOSM samples in the randomly selected 30 global grids.

13) Line 372: “extracted” or “detected”?

R: Corrected.

14) Table 9: whether test samples used in Table 9 are from visually interpreted samples? Please clarify this.

R: Thank you for your comments. The test samples used in the Table 9 were the visually-interpreted samples described in Section 3.2. Accordingly, the relevant statement has been revised as: "*Various combinations of the ISA_{RS} and ISA_{OSM} training samples were tested at the global scale using the visually-interpreted samples from Section 3.2 (Table 9)*"