This study combined Landsat, Sentinel-2, and MODIS images to generate a global cropping intensity map at a spatial resolution of 30 meters between 2016 and 2018. This study also validated the cropping intensity map using thousands of pixels from time series satellite images and currently available PhenoCam data. Then this study compared the resultant cropping intensity map with other cropping intensity datasets. This is nice work. The writing and the logic of this manuscript are good. However, I have some comments which may help the authors improve this study.

Response: We would like to thank the Referee for the constructive suggestions that help significantly improve the research and the quality of this work. We revised the manuscript according to these comments and provided our detailed responses point to point to address all the issues raised.

*1 Page 1 Line 34-35: This study did not do the relevant analysis to support this conclusion.

Response: Agreed and modified. We changed the sentence in the **Abstract** to: "As the first global coverage, fine-resolution CI product, GCI30 is expected to fill the data gap for achieving sustainable development goals (SDGs) by depicting worldwide diversity of agricultural land use intensity."

*2 Page 2 Line 14: Here is the definition of cropping intensity. What is the continuous cropping type you mentioned in the manuscript?

Response: Thanks for raising the issue on clarification. We provided the definition of "continuous cropping" in **Section 2.3.1** because it is analogous to other CI categories including single cropping, double cropping, and triple cropping. In our manuscript, continuous cropping is defined as cropping systems having short growing period (CI > 3 for this study) or exhibiting a lower degree of seasonality (e.g., tea plantation).

*3 Page 3 Line 6: You may need to highlight why you combined Landsat, Sentinel-2 and MODIS data somewhere in the Introduction section.

Response: Agreed. We added a sentence in **the last paragraph of the Introduction Section** to explain the reason of the combination of multiple data: "We integrated the full archive of Landsat, Sentinel-2 and MODIS data from 2016 to 2018 for constructing seamless spectral time series in order to capture the full cropping cycles, which is the key for CI identification by segmenting growing and non-growing periods."

*4 Page 3 Line 15-25: According to your Google Earth Engine code, this study included forest, water, and urban mask to help integrate the cropland layer. But I did not find any description in this section.

Response: Thanks for pointing out this issue. As you mentioned, the initial version of our GEE code utilized some global urban, forest and water products help mask non-cropland extents (See our RSE paper for more details, C. Liu et al., 2020). However, for this study of GCI30 producing, we improved the procedure of non-cropland masking by using an ensemble of multiple land cover/cropland layer products. In particular, the demo code is located in U.S., where the CDL dataset was used. We have updated our GEE code accordingly which is open to all and available at https://code.earthengine.google.com/3572b843c607c25ba9be876e6f73948e

Reference: Liu, Chong, Qi Zhang, Shiqi Tao, Jiaguo Qi, Mingjun Ding, Qihui Guan, Bingfang Wu, et al. 2020. "A New Framework to Map Fine Resolution Cropping Intensity across the Globe: Algorithm, Validation, and Implication." Remote Sensing of Environment 251: 112095. https://doi.org/10.1016/j.rse.2020.112095.

*5 Page 4 Line 4-5: Why not using surface reflectance data?

Response: We used top-of-atmosphere (TOA) reflectance because of two reasons. First, within the GEE storage, the Sentinel-2 TOA data have longer temporal coverage (since 2015) than the surface reflectance (since 2017). Moreover, the inter-calibration approach harmonizing Landsat and Sentinel-2 (Chastain et al. 2019) was based on TOA data. As a result, TOA rather than surface reflectance data were used.

Reference: Chastain, Robert, Ian Housman, Joshua Goldstein, Mark Finco, and Karis Tenneson. 2019. "Empirical Cross Sensor Comparison of Sentinel-2A and 2B MSI, Landsat-8 OLI, and Landsat-7 ETM+ Top of Atmosphere Spectral Characteristics over the Conterminous United States." Remote Sensing of Environment 221: 274–85. https://doi.org/10.1016/j.rse.2018.11.012.

*6 Page 4 Line 16-17: Landsat and Sentinel-2 are TOA data, and MODIS data are surface reflectance (SR) data if my understanding is right. The reflectance values from TOA data and SR data should be very different, especially when including the blue band to calculate EVI. Which version of MODIS data are used?

Response: 1) Indeed, we only used the MODIS surface reflectance (SR) data (MOD09A1) to generate LSWI layer. The MODIS NDVI/EVI is not used to generate vegetation indices. The MOD13Q1 NDVI/EVI product was used but cannot be directly combined with Landsat and Sentinel-2. We added sentences in the revised manuscript explain how the MODIS data were harmonized and integrated with fine resolution imagery as follows: In particular, the coarse MODIS datasets were resized to 30-m using the bicubic interpolation method. Then an empirical linear function was built for each pixel to bridge the data records of MODIS and Landsat/Sentinel-2, and missing data gaps were filled with the resampled, transformed MODIS data (labelled as MODIS modelled). If there is no valid data from either Landsat/Sentinel-2 or MODIS, temporally adjacent (within 48-day) cloud free LANDSAT/Sentinel-2 observations were used to determine the filling value (labelled as interpolated). 2) For all MODIS data, we used the Collection 6 version MOD13Q1 NDVI/EVI and MOD09A1 to derive LSWI data.

*7 Page 5 Line 1-2: More details are needed for the data gap filling and smoothing. The integrated data is 30 meters, but what is the temporal resolution?

Response: Agreed and modified. We added description of data gap filling and smoothing in the revised manuscript. The temporal resolution (16-day) was also given. The text is revised to: "After gap-filling, a weighted Whittaker smoother (Kong et al. 2019) was further adopted to smooth the gap filled time series data. We assigned different weights (1, 0.5, 0.2) to Landsat/Sentinel-2 original observations, MODIS modelled values and interpolation values, respectively. Finally, a dataset of smoothed, seamless image time series of vegetation indices was generated at a spatial resolution of 30-m with a temporal interval of 16-day."

Please see the last paragraph in **Section 2.1.**

*8 Page 5 Line 14: what is the size for these samples?

Response: Thanks for this comment. The spatial size of RDsat is 30 m × 30 m.

*9 Page 5: Line 25: How did you separate flooded and non-flooded croplands?

Response: Thanks for the comment. For this study, the flooding/non-flooding information is derived from our cropland extent map. More specifically, ChinaCover and SERVIR land cover products have paddy rice included in their classification systems. Please refer to the Table S1 in the supplementary document. This also explained why the flooding specific method was only applied in China and Lower Mekong River basin.

*10 Page 6 Line 1: Why did you choose the 50% of the NDVI amplitude?

Response: This is a good point! We use 50% amplitude because it is in the middle of peak and dent, which maximize the relative distance from the selected point to each. More importantly, it was also adopted by a previous study (Bolton et al. 2020) for separating growing/non-growing periods. We added the reference in the revised manuscript.

Reference: Bolton, D.K., Gray, J.M., Melaas, E.K., Moon, M., Eklundh, L. and Friedl, M.A., 2020. Continental-scale land surface phenology from harmonized Landsat 8 and Sentinel-2 imagery. Remote Sensing of Environment, 240, p.111685.

*11 Page 7 Figure 2: This figure is not clear to me. Could you please the ticks for the x-axis?

Response: We modified Figure 2 in the revised manuscript.

*12 Page 8 Line 9-25: A brief introduction of these products is needed. Or you can move Table 2 here and add the two phenology datasets in the table.

Response: Agreed and modified. We moved Table 2 (as Table 1 in the revised manuscript), offering information of each product.

*13 Page 9 Line 14-25: Could you explain why the underestimation and overestimation happened based on those samples (RDsat)?

Response: Thanks for this comment. We added further discussion of potential drivers shaping such a bias distribution using RDsat as follows:

The negative errors could possibly be due to the complexity of some special cropping systems that cannot be fully accounted by our CI mapping method. For example, inter/mixed cropping may lead to shallow troughs in NDVI time series, which makes the 50% NDVI amplitude rule less reliable (C. Liu et al. 2020).

These positive biases could be attributed to the fallow strategy adopted in some Europe countries (Estel et al. 2016). During a fallow cycle, there may exist weeds which are falsely identified as one solid cropping cycle.

Please see the revised text in **Section 3.1**.

Reference:

Estel, S., Kuemmerle, T., Levers, C., Baumann, M. and Hostert, P., 2016. Mapping cropland-use intensity across Europe using MODIS NDVI time series. Environmental Research Letters, 11(2), p.024015.

*14 Page 10 Figure 4: I could not see the cropping cycles dots.

Response: Thanks for this comment. For Figure 4, we use the size of dot indicating the actual total number of cropping cycle(s), and the color representing the prediction biases. Therefore, each point in the map is a combination of two features: different sizes and different colors. We reclarified this in the figure caption.

*15 Page 11 Figure 5: The colors for different cropping intensity types are too close. Please modify the colors.

Response: Agreed and modified.

*16 Page 14 Line 2: Why excluding the continuous cropping pixels?

Response: The continuous cropping pixels were excluded for mean/std calculation because it will bring in additional uncertainties. According to its definition as added in the last paragraph in Section 2.3.1, there is no explicit CI value for some continuous cropping systems like evergreen cash crops. Therefore, this special cropping type should be removed before statistical analysis.

*17 Page 14 Line 19-20: Why “Wu et al (2018) might overestimate the annual harvest area and …”?

Response: Thanks for your question. We realized that we only described the higher CI from Wu et al (2018) but did not explain the reason. We have now revised the manuscript and added an explanation as follows: Wu et al. (2018) might overestimate the annual harvest areas and accordingly overestimate the cropping intensity because they ignored the presence of fallowed cropland. Each pixel of cropland was assigned to either a single cropping or double cropping category which will result in a higher CI.

*18 Page 14 Table 2: Please cite the relevant references. FAO data in 2010 is used for comparison, and the FAO data in 2016-2018 should be better for comparison.

Response: Thanks for your comments. We do agree that the FAO data in 2016-2018 should be better for comparison with GCI30 to avoid the uncertainty resulted from temporal differences. However, the FAO data is coming from published paper (Siebert et al. (2010) which used the statistical data up to 2010. Therefore, we did not use FAO data in 2016-2018 for comparison. As cropping intensity derived from FAO data is only the statistical information at global or a certain administrative unit, in our revised manuscript, we dropped the CI using FAO data and focused on the comparison with other products from both statistically and spatially aspects at global scale.

*19 Page 15 Line 7: MDC12Q2 should be MCD12Q2.

Response: Agreed and corrected.

*20 Page 16 Line 4: This study "provides insight only into the current actual cropping intensity (Page 17 Line 18)" instead of "agricultural land use management".

Response: Agreed and modified. We changed the sentence to: "As a global 30-m product, GCI30 depicts the worldwide diversity of agricultural land use intensity in a spatially explicit manner that has not been fully revealed by existing studies or datasets." It was added to the beginning of **Section 3.4**.

*21 Page 16 Line 7: I agree that the GCI30 generated by this study reduces uncertainties caused by the mixed pixel effect. However, suppose you would like to say you generated a more accurate global CI estimation. In that case, you need to do accuracy assessment for each cropping intensity product based on their specific definition and the same set of ground reference samples.

Response: Agreed. We rewrote this sentence as: "Given the CI distribution with a fine spatial resolution, GCI30 is associated with reduced uncertainties caused by the mixed pixel effect".

*22 Table S1: You may add the spatial resolution for each product.

Response: Agreed and added. Please see the revised Table S1.

*23 This manuscript is too long and could be shortened.

Response: Thanks for your suggestions. We agree that the manuscript is relatively long. However, the length of our manuscript is reasonable if we compare with some published papers on ESSD. We keep the manuscript long because of two reasons.

1) Our manuscript is the first manuscript describing the global pattern of cropping intensity at 30m resolution. We documented the full methodologies and spatial pattern and statistical characteristics of the derived GCI30 product.

2) We used a couple of pages to compare GCI30 with the existing research and products from both statistical and spatial aspect to make it clear the advantages of our product.

Nevertheless, the authors went through the revised manuscript and dropped the redundant sentences or reorganize the wordings to improve the readability.