Response to referee comments

We thank the two reviewers and the editor for the precious and constructive suggestions to improve our manuscript. We carefully revised our manuscript and addressed the comments of each of the two reviewers. Please find our point-by-point response below.

Referee #1

General comments. According to the World Meteorological Organization, 2023 is the hottest year on record. Therefore, it is of great significance to develop a long-term cropland dataset to explore the climatic effects of human land use. This study reconstructs millennial cropland for Northeast China. Topics fits the aims and scope of the ESSD. The following comments and suggestions should be considered for revisions.

Response: We sincerely thank the reviewers for valuing our work. Thank you for your insightful comments which have improved our work greatly. Please find our point-by-point response below.

1. --First, why only area estimation, and no spatial reconstruction? A 5' × 5' cropland dataset is developed for Northeast China from AD 1000 to 1200 by these authors (Gridded reconstruction of cropland cover changes in Northeast China from AD 1000 to 1200. https://link.springer.com/article/10.1007/s10113-023-02118-y). But in this study, only provincial-level or county-level cropland area is available. Why? Obviously, the datasets reconstructed in this study cannot be used by climate modelers. In addition, in terms of data from 1000 to 1200 years, is there any improvement in this paper compared to the paper mentioned above (Gridded reconstruction of cropland cover changes in Northeast China from AD 1000 to 1200)?

Response: Thank you for your helpful suggestion. In this study, 1000 to 1600 corresponds to historical provincial-level administrative districts, while 1700 to 2020 corresponds to modern county-level administrative districts.

The primary reasons are as follows: First, compared to the regional existing historical LUCC gridded reconstruction results, the cropland area data of administrative

units is relatively more fundamental and reliable. Our research experiments indicate that there remains a certain degree of uncertainty in gridded reconstruction of cropland over long historical periods, even when using human factors supported by historical data in the allocation model (such as historical settlement points) (Jia et al., 2023). Long-term historical cropland gridded reconstructions need to consider using allocation methods that match the historical facts of different periods in local area. In theory, based on this dataset, researcher could even create datasets with a resolution of 1 meter or less. If climate modelers need to use gridded cropland datasets, they can easily convert our dataset into a customized grid spatial resolution dataset according to their required time range and main influencing factors (such as natural factors, human factors, etc.). For instance, some studies concluded that the HYDE dataset can be used as a map of agricultural potential and crop suitability, especially in periods before the advent of satellite imagery (Yu and Lu, 2018; Yu et al., 2021).

Second, for the 1700 to 2020 corresponds to modern county-level administrative districts, the average spatial scale of these counties in this dataset ranges between 0.5°×0.5° and 1°×1°. Theoretically, when readers use this dataset to convert it into the gridded dataset they need, the error can be controlled within 1°×1° even if they don't use natural or human factors to guide the allocation.

Third, this dataset can be applied in a wide range of scenarios (such as carbon emission and carbon neutrality, climate data construction, ecological footprint, and biological population assessment, etc.). The bilingual format and the administrative boundaries consistent with the current county-level administrative units in China also facilitate its use by scholars in the humanities and social sciences worldwide.

Realistically, compared to the primary data and reconstruction methods of Jia et al. (2023), this study directly used the results of the cropland area (1000-1200) of the above study. The main difference is that, this dataset provides provincial-level cropland area data for three time points (1000-1200) within the current administrative boundaries of Northeast China, consistent with the boundaries of the other 25 time points in this dataset. We are also very pleased to offer the reconstructed gridded cropland dataset in Northeast China from 1000 to 1200 as a reference solution for readers.

References:

Yu, Z. and Lu, C.: Historical cropland expansion and abandonment in the continental U.S. During 1850 to 2016, Glob. Ecol. Biogeogr., 27, 322-333, https://doi.org/10.1111/geb.12697, 2018.

Yu, Z., Jin, X., Miao, L., and Yang, X.: A historical reconstruction of cropland in china from 1900 to 2016, Earth Syst. Sci. Data, 13, 3203-3218, https://doi.org/10.5194/essd-13-3203-2021, 2021.

Jia, R., Fang, X., and Ye, Y.: Gridded reconstruction of cropland cover changes in Northeast China from ad 1000 to 1200, Reg. Envir. Chang., 23, 128, https://doi.org/10.1007/s10113-023-02118-y, 2023.

2. --Second, the applicability of the reconstruction method of estimating the cropland area for a small area by population. Generally speaking, estimating cropland by population is mostly applicable at continental to global scales. In the case of a small region, more other factors will affect the relationship between population and cropland.

Response: Thank you for your suggestion. The fundamental reason is that there are no direct historical records of cropland area in Northeast China from 1000 to 1600. When we selecting proxy indicators to reconstruct cropland area, the population data for this period is relatively complete and authoritative.

We acknowledge that at a regional scale, the factors affecting the relationship between population and cropland area are diverse and may change over time. Therefore, we combine historical facts (particularly from 1000 to 1600) and use the most authoritative historical population data in China: "*The History of Population of China*" (Wu and Ge, 2005a; Cao and Ge, 2005b). Based on the needs of this study, we extracted the population data (mainly divided into agricultural, non-agricultural, and military populations) that was consistent with the scope of this study area, and developed cropland calculation indicators for different historical periods corresponding to different population categories.

In several global LUCC datasets, such as HYDE, when estimating cropland based

on population, either the population indicators (e.g.: per capita cropland) remain unchanged across different historical periods; or in the uncertainty estimates, homogeneously varied it with time across the globe; or to account for their uncertainties, different population databases were used and the upper and lower ends of an uncertainty range were assessed. However, these estimation methods can still lead to errors in cropland area on a global or regional scale. Therefore, when this study used historical population data to reconstruct cropland, special attention was paid to two key points: 1) authoritative and accurate population data, and 2) cropland areas corresponding to different population categories based on historical facts (Please see Line 592-614). Thus, we believe this method is relatively applicable for Northeast China from 1000 to 1600.

References:

Wu, S. and Ge, J.: The History of Chinese Population, Volume 3, Fudan University Press, Shanghai, China, 2005a (in Chinese).

Cao, S. and Ge, J.: The History of Chinese Population, Volume 4, Fudan University Press, Shanghai, China, 2005b (in Chinese).

3. --Third, failure to evaluate the reliability or accuracy or uncertainties of the reconstructed dataset will affect the user's use of the dataset. The comparison with the global dataset does not indicate the reliability of the dataset developed in this paper, because the global dataset itself has a large degree of uncertainty. The fact that the reconstruction results in this paper are very different from the global dataset does not mean that the dataset developed in this paper is reliable.

Response: Thank you for your insightful suggestion. We acknowledge that the current paper's reliability, accuracy, or uncertainties assessments are not yet sufficiently comprehensive. We have made every effort to supplement the relevant assessments and uncertainty analysis as much as possible. Please see Line 416-625, new Fig. 7 and Table S3.

Here is the new Fig. 7:

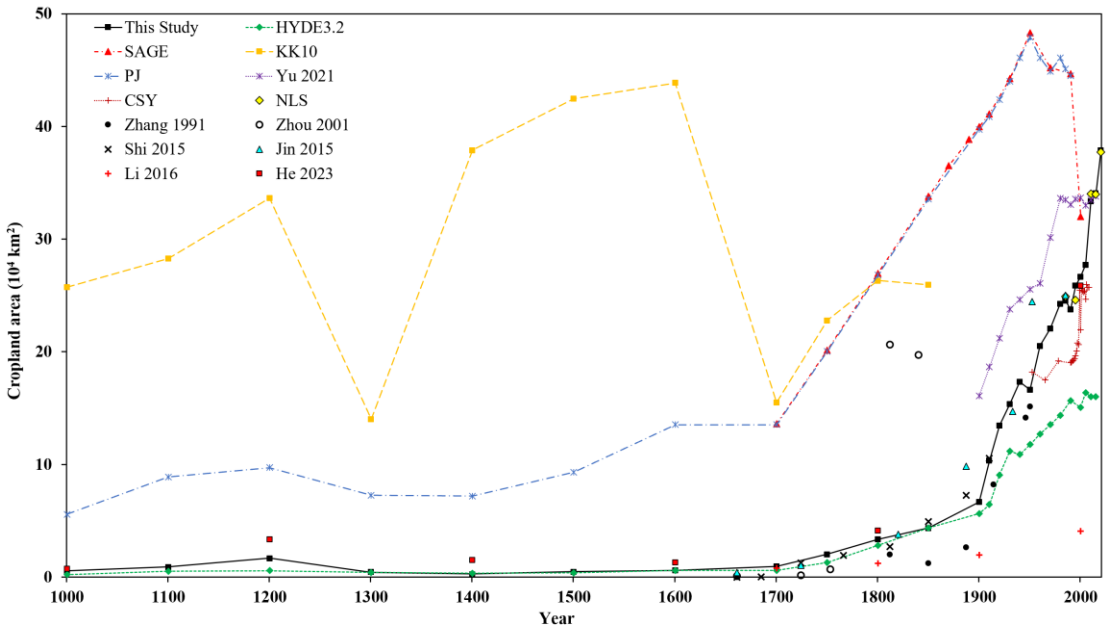

Figure 7: Comparison of total cropland area from global historical LUCC datasets, previous studies and this study in the Northeast China. CSY denotes the Chinese Statistical Yearbook; NLS denotes the National Land Survey.

4. --Fourth, writing is not done from the perspective of data development (Data description paper), it is more like a research paper. For example, the core content of the results should not be the analysis of the spatio-temporal characteristics of cropland changes, but the rationality, reliability, accuracy, and potential uses of the data products developed in this paper. More specific comments are as follows.

Response: Thank you for your insightful suggestion. We reorganized the paper to make it more like a data description paper. It mainly includes: 1. Deletion of the conclusion section (Please see Line 630-649); 2. Reorganized of introduction, results and discussion sections (Please see Line 26-74, 382-578); 3. Add the credibility assessment and uncertainty analysis (Please see Line 416-625); 4. Potential uses are added to the introduction and abstract sections (Please see Line 22-24, 38-40).

5. --Title and Introduction. Why reconstruction for 1000 to 2020 in Northeast China? More explanations are necessary. Based on Figure 5, From 1000-1700, there was only a small area of cropland in Northeast China. Line 393, In 1200, cropland fraction of

1.17%; In 1400, line 395, cropland fraction of only 0.19%. The environmental impact of such a small area of cropland is completely negligible. Based on figure 5, the topic for past 300 years (Ye, Y., Fang, X., Ren, Y., Zhang, X., and Chen, L.: Cropland cover change in northeast china during the past 300 years, Science China Earth Sciences, 52, 1172-1182, https://doi.org/10.1007/s11430-009-0118-8, 2009.) is good, but for 1000 to 2020 may be not a good research topic.

Response: Thank you for your insightful suggestion. We chose to reconstruct the cropland changes in Northeast China over the past millennium mainly for the following reasons: 1. From the LUCC projects carried out by IGBP and IHDP in the last century to the recent PAGES (The PAGES (Past Global Changes) project is an international effort to coordinate and promote past global change research. The primary objective is to improve our understanding of past changes in the Earth system in order to improve projections of future climate and environment, and inform strategies for sustainability.), LandCover6k (The goal of LandCover6k was to produce datasets on past land-cover and land-use on continental and global spatial scales that are useful for climate modeling studies on land-use as a climate forcing.) and other research projects, the importance of accurate long-term historical LUCC datasets has been emphasized.

2. The land reclamation in Northeast China exhibited a unique pattern: during the period between the two land reclamations (eleventh and twelfth centuries; from the nineteenth century to present), there was a prolonged period of nomadism in this area (Jia et al., 2023). In addition, the global historical LUCC datasets fail to demonstrate the historical fact of cropland cultivation in the study area from 1000 to 1200.

3. We want to better demonstrate the changes in human impact on terrestrial environments, ranging from near-natural original states (natural dominance) to significant alterations induced by extensive human intervention (anthropogenic dominance), particularly since the Industrial Revolution.

4. Northeast China has now become one of the most important agricultural regions in China and the world. Focusing solely on the past 300 years of research is not conductive to the exploration of long-term LUCC effects in critical agricultural areas worldwide (He et al., 2023). If feasible, we are willing to expand the dataset regarded

as "truth values" to encompass a broader historical span, thereby enhancing the credibility of historical cropland area.

References:

He, F., Yang, F., Zhao, C., Li, S., and Li, M.: Spatially explicit reconstruction of cropland cover for china over the past millennium., Science China Earth Sciences, 66, 111-128, https://doi.org/10.1007/s11430-021-9988-5, 2023.

Jia, R., Fang, X., and Ye, Y.: Gridded reconstruction of cropland cover changes in Northeast China from ad 1000 to 1200, Reg. Envir. Chang., 23, 128, https://doi.org/10.1007/s10113-023-02118-y, 2023.

6. --Data and Methods. Not clear enough. For example, Line 91-115, It only introduces population data, per household population data, and interpolates the population according to the population growth rate, and does not involve how to estimate the cropland area at all. Line 107-110 mentions how to estimate the area of cropland, but it is very simple and there is no specific method. As far as Northeast China is concerned, why such an estimate is reasonable is not explained at all. From the perspective of historical land use reconstruction, estimating cropland area based on population as a proxy is only applicable to large-scale scales such as global and continental. For example, HYDE uses population to estimate the world's historical cropland. It also makes sense to reconstruct China's historical cropland in this way. But the Northeast is only a small region of China, so there is a lot of uncertainty in the results of this estimate.

Response: Thank you for your constructive suggestion, and we apologize if this was confusing. The main algorithm applied in the Liao, Jin, Yuan, and Ming Dynasties (1000-1600) can be found in the supplementary materials.

The reason and the credibility of using population to reconstruct cropland is similar to your second question, to which we have already responded and discussed more fully in the “Uncertainty analysis section”. Please see Line 592-614. Regarding the importance of Northeast China, we added content in the “Introduction section”. Please see Line 51-74.

7. --In addition, for 1000, 1100, and 1200, what's the difference between this study and the paper mentioned above (Gridded reconstruction of cropland cover changes in Northeast China from AD 1000 to 1200).

Response: Thank you for your comment. This comment is similar to your first question. Realistically, compared to the primary data and reconstruction methods of Jia et al. (2023), this study directly used the results of the cropland area (1000-1200) of the above study. The main difference is that, this dataset provides provincial-level cropland area data for three time points (1000-1200) within the current administrative boundaries of Northeast China, consistent with the boundaries of the other 25 time points in this dataset. We are also very pleased to offer the reconstructed gridded cropland dataset in Northeast China from 1000 to 1200 as a reference solution for readers.

References:

Jia, R., Fang, X., and Ye, Y.: Gridded reconstruction of cropland cover changes in Northeast China from ad 1000 to 1200, Reg. Envir. Chang., 23, 128, https://doi.org/10.1007/s10113-023-02118-y, 2023.

8. --Line 170-197; Line 257-278. Introduce too much about the estimation methods in published papers (Ye et al, 2009; Tian et al., 2005). It needs to be drastically cut, and readers can read these papers at all. In short, the writing of the method section is too lengthy and will scare off the vast majority of readers.

Response: Thank you for your helpful suggestion, and we apologize if this was confusing. We have deleted the detailed description about the estimation methods in published papers in the main text to make the article more readable. Considering that the papers we cited in this section is not available in English, we have added these contents to the supplement material for readers who need it.

9. --Line 232. Correct negative or zero values of cropland. If the estimated results have

a negative value, then there must be a problem with the previous interpolation and fitting methods, and we have reason to suspect that all the results obtained by the interpolation are problematic. Just correct negative or zero values of cropland isn't enough, what about the other results? From this point, it can be seen that this paper needs to have an uncertainty assessment of the estimation results, otherwise readers will not dare to use this data product to carry out downstream research.

Response: Thank you for your insightful suggestion, and we apologize if this was confusing. We have reorganized the structure of the original text, and added more specific and detailed description based on careful checking and correction of the existing errors in the original text. Please see Line 211-261 and the Table S2.

10. --Results. ESSD readers are more concerned about the reliability, availability, and accuracy of data products. However, the spatiotemporal variation characteristics of cropland area are not the most important.

Response: Thank you for your helpful suggestion. We acknowledge that the current paper's reliability, accuracy, or uncertainties assessments are not yet sufficiently comprehensive. We have made every effort to supplement the relevant assessments and uncertainty analysis as much as possible. And we deleted some description of the spatiotemporal variation characteristics of cropland area. Please see Line 382-412, 416-625.

11. --4.1 comparison. The comparison with the global dataset does not indicate the reliability of the dataset developed in this paper, because the global dataset itself has a large degree of uncertainty. The fact that the reconstruction results in this paper are very different from the global dataset does not mean that the dataset developed in this paper is reliable. Line 516-517, the following statement is not acceptable "Comparative analysis with global historical LUCC datasets indicates that the results of this study are relatively credible and more rational."

Response: Thank you for your insightful suggestion. "Comparative analysis with global historical LUCC datasets indicates that the results of this study are relatively credible

and more rational." This statement is indeed inappropriate. We have deleted such statements in the original text and used more objective language to describe the differences between different datasets and analyze the possible reasons for the differences. Please see Line 416-625.

12. -- technical corrections. Figure 5, no titles for x and y axes.

Response: Thank you for your suggestion. We revised the Fig. 5 and Fig. 7.