Response to Editor:

Thank you for your careful consideration of the referee comments. I find that the revisions have largely addressed the referee comments and am happy to accept the paper for publication following attention to the following comments. Line numbers refer to the track changes version of the manuscript.

Response: We appreciate that the editor and reviewers recognize our efforts and thank you for your thoughtful suggestions and insights, which have helped improve this manuscript substantially. The detailed responses are listed as follows.

1) lines 29-30: To my understanding, NH_3 reacts with oxidized organics within the condensed phase under atmospheric conditions, but I am unaware of atmospherically relevant reactions with alkanes. The cited manuscript does not support that reaction either. Please clarify.

Response: We agree with the comment and apologize for this mistake. We revised this sentence as follows:

"For example, in China, the contribution of agriculture-related NH3 emissions to SIA and $PM_{2.5}$ is 29% and 16%, respectively (Han et al., 2020). This fine particle formation has led to substantial health and economic costs (Paulot and Jacob, 2014)."

2) Line 107: These reports need to be better documented/referenced. Depending on the number, citation in the paper may not be appropriate, but the SI or an archived document may be sufficient.

Response: We sincerely thank you for providing this valuable comments. As suggested, we added one section (Section S1) and a table (Table S5) to state the main data sources of the fertilization application timing and frequency for the three main crops: rice, maize, and wheat. Most of the collected reports/websites were published by the national or provincial governments in 2016.

3) Please increase the text size in Fig. 3.

Response: As suggested, we increased the text size in Fig.3.

"

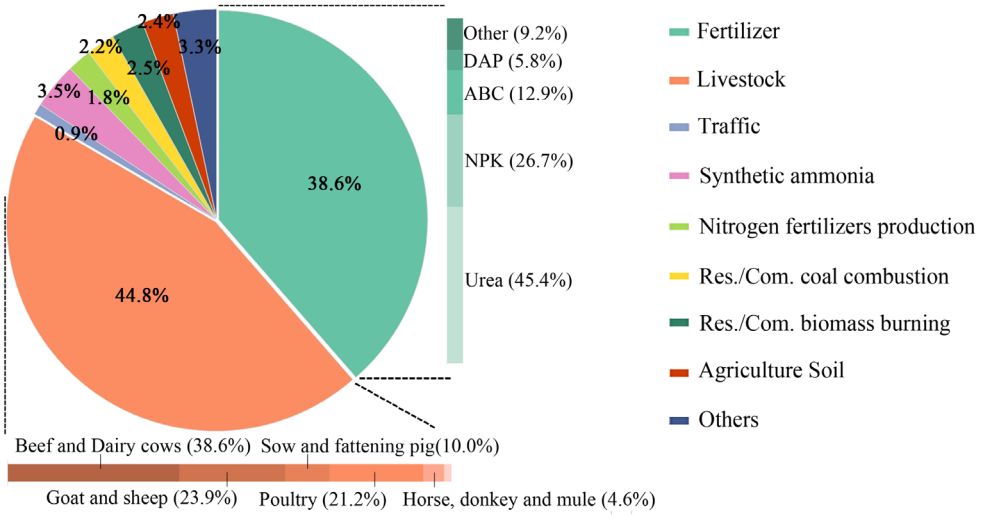

Fig. 3. Contributions of different sources (%) to NH_3 emissions in mainland China (2016)."

4) Table 4: Why are some numbers in bold?

Response: Thanks for pointing it out. The R^2 values in bold represent improved monthly NH_3 emission trend in our inventory compared to that of the MEIC inventory in the corresponding regions. We also explained it in the Note.

"Note: R^2 value was obtained by fitting the 2016 monthly values between IASI satellite observations and the NH_3 emissions from two inventories (MEIC and our study). The R^2 values in bold represent improved monthly NH_3 emission trend in our inventory compared to that of the MEIC inventory in the corresponding regions."

5a) Sect 3.4.3: Please comment on the y-intercepts of the trend lines between the simulated measurements and ground based concentrations as well. There appears to be a significant positive intercept suggesting overestimation despite the slope near one. To me this suggests that the variation in spatial distribution is perhaps better than the absolute concentrations. The MEIC comparison also shows a positive y-intercept so it is not clear if it is a true underestimation of emissions (line 396).

Response: We sincerely thank you for providing this critical comment. We believe that positive intercepts mainly resulted from simulation results that overestimated the NH_3 concentrations at relatively low values (Fig. 7(b)) (e.g., the simulation for January). However, the MEIC inventory may have underestimated the NH_3 concentration in areas with a high emission density (e.g., the simulation for the North China Plain in July). We changed the relevant sentences as follows:

"The y-intercepts of the trend lines between the ground observations and the simulated measurements using MEIC and our inventory were respectively 5.0 and 4.0. Positive intercepts mainly resulted from simulation results that overestimated the NH_3 concentrations at relatively low values (Fig. 7(b)) (e.g., the simulation for January). However, the MEIC inventory may have underestimated the NH_3 concentration in areas with a high emission density (e.g., the simulation for the North China Plain in July)."

5b) Sect 3.4.3: Lines 392-395: I assume that the R^2 and slopes reported are the comparison when all months are included, but this is not explicitly stated. Are there differences if months are compared individually? Please clarify.

Response: Thanks for your valuable comment. In the revised version, we compared the R^2 and slopes obtained by fitting the ground-based observations with NH_3 concentrations simulated using MEIC and our inventory of January, April and July, respectively. We found similar results for the spatial accuracy of our inventory, which were better than that of the MEIC.

"For each month, we found similar results for the spatial accuracy of our inventory, which were better than that of the MEIC. The R^2 values and slopes obtained by fitting the ground-based observations with the NH_3 concentrations simulated via the MEIC yielded an R^2 of 0.18 and slope of 0.54 in January, R^2 of 0.01 and slope of 0.11 in April, and R^2 of 0.21 and slope of 0.28 in July, which were significantly lower than those obtained by fitting the simulated NH_3 concentrations using our inventory and the ground-based observations (R^2 of 0.27 and slope of 0.68 in January, R^2 of 0.23 and slope of 0.70 in April, and R^2 of 0.53 and slope of 0.87 in July)."

5c) Figure 7b: I find it difficult to tell the different months apart in this graph and this makes it challenging to assess differences between the months. I suggest considering different symbols rather than different sizes or adding plots to the SI that shows the months individually.

Response: Thanks for your comment. As suggested, we used different symbols to represent the ammonia concentrations in different months.

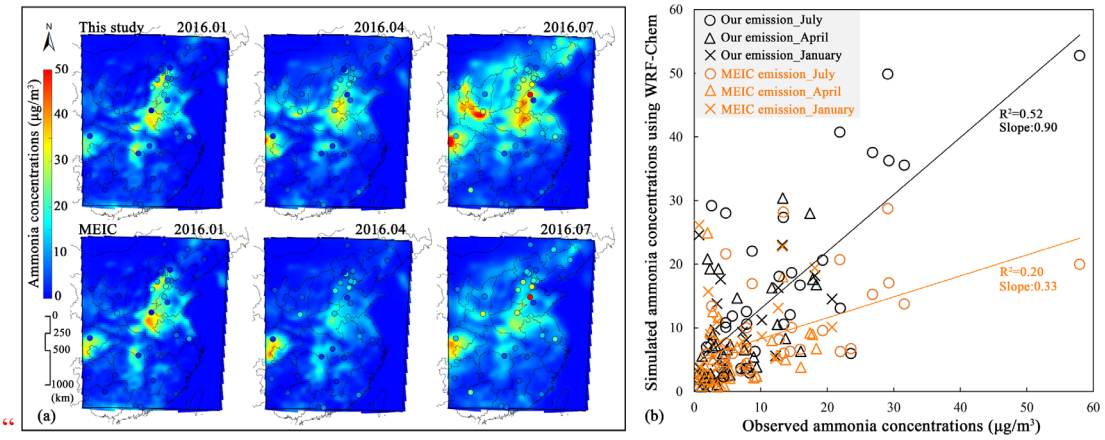

Fig. 7. (a) Spatial distribution of NH_3 concentrations in 2016, from this study and the MEIC inventory. (b) Correlation between simulated NH_3 concentrations, from different emission inventories, and ground observations obtained from AMoN-China."

6) Fig 8: Please use the same color scale for all plots or explicitly call the reader's attention to the fact that they vary.

Response: Thanks for your kindly comment. The values of NH_3 VCDs in different months vary greatly. In order to better present the spatial distribution of NH_3 VCDs, different color scales are used for different months. In the figure caption, we added one sentences to emphasize the difference in color scale.

"Fig. 8. The spatial distribution of IASI NH_3 VCDs and NH_3 VCDs from WRF-Chem based on the two inventories in January, April, July, and October (2016). Different color scales represent different months to indicate the spatial distribution of the NH_3 VCDs."

7) Figs. S1 & S2: Please increase resolution and font size. The color scale values are not legible.

Response: We revised the Fig. S1 and Fig. S2 based on your suggestion.

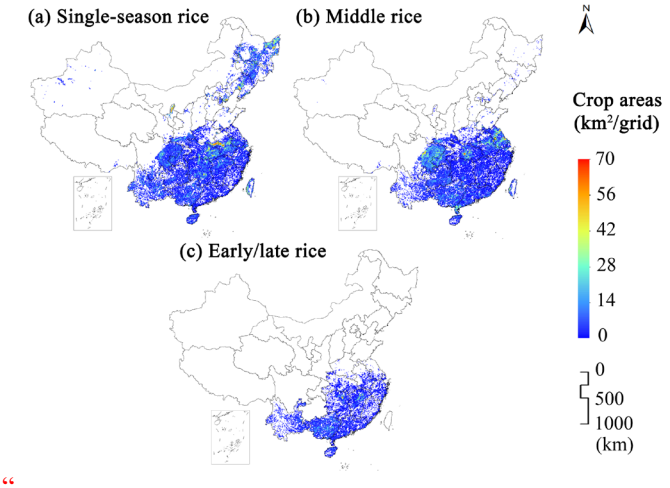

Fig. S1. Spatial distribution of single-season rice, middle rice and early/late rice.

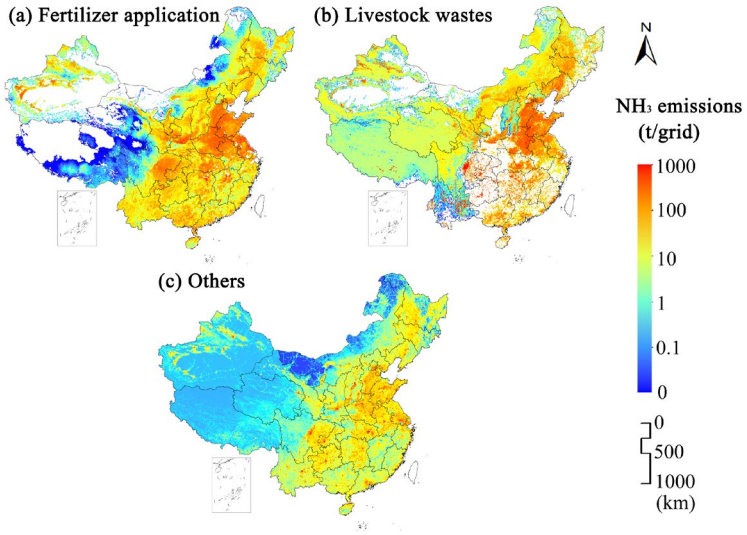

Fig. S2. Geographical distribution of NH_3 emission from fertilizer application, livestock wastes, and others in mainland China (2016)."

8) Fig. S3: please explicitly draw the reader's attention to the fact that the range on the plots varies.

Response: In the figure caption, we added one sentences to state the range on the plots varies.

"Fig. S3. Comparison between IASI-based VCDs and simulated NH_3 VCDs obtained in this study and MEIC, for January, April, July, and October. The range of the axes on the scatter plots for the different months is not the same."

9) I urge the authors to consider, but I do not require, depositing at least some parts of the data in a public data repository to foster accessibility and citation. Please see this website for the data policy: https://www.atmospheric-chemistry-and-physics.net/policies/data_policy.html

Response: Thanks for your comment. We have made our gridded ammonia emission inventory publicly available based on your suggestion. The gridded ammonia emission inventory is archived on Zenodo (https://doi.org/10.5281/zenodo.5516929). The relevant sentences in the *Data availability* were also updated.