Response to Referee #2

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We thank the reviewer very much for the detailed and valuable comments. We believe that addressing the issues raised by the reviewer will considerably improve the quality of our manuscript. Please see our response to each comment below (in blue).

This manuscript presents an overview of Global Estimates of Surface Reactive Nitrogen Concentration and Deposition Using Satellite Observation. The authors discuss recent advances of estimating surface Nr concentration and deposition, present a framework of using satellite data to estimate surface Nr concentration and deposition, and summarize the existing challenges for estimating surface Nr concentration and deposition using the satellite-based methods.

The manuscript is clearly written and logically organized. It provides sufficient and up-to-date literature citations. Listed below comments and suggestions for changes are relatively minor, but should be carefully considered. I recommend publication after addressing following comments:

1. L290: It is unclear to me how the vertical resolution of GEOS-Chem can resolve the vertical gradients that are likely to exist in source regions. The authors should clarify these several issues: (1) the vertical structure of the model, (2) the measurement characteristics of the surface observation (including height), (3) how this information is used to calculate surface concentrations.

IASI NH_3 retrievals are column data that has no vertical profile information. We gained surface NH_3 concentration by using modeled NH_3 vertical profiles from GEOS-Chem including 47 layers. We constructed the Gaussian model to fit the 47 layers' vertical NH_3 concentrations, which can generate the continuous NH_3 profile. Hence, based on the constructed the Gaussian model, we can obtain satellite-based

NH_3 concentration at any height. More importantly, the constructed the Gaussian model has general rules, appropriate for converting satellite columns to surface concentration simply. Please refer to the Sect. 3.1 for more details.

2. Fig. 10b: It is true that NH3 can be more accurately retrieved in one region than another depending on the thermal contrast. But it is not clear to me why this would be so much better in China than that in the US? I guess it is also just a matter of detection limits? It could also be related to more reliable simulation of mixing, depending on sufficient observational input into the parent weather model. Please clarify this issue.

We agree with you that the accuracy of IASI-retrieved surface NH_3 concentrations in different regions is highly linked with the thermal contrast (TC) and the simulation of NH_3 mixing from GEOS-Chem. The accuracy for satellite estimates over different area is related to the thermal contrast. The lowest uncertainties occurred when high columns and high TC coincide. In case either of them decreases, the uncertainty will gradually increase. In case both the TC and column are low, all sensitivity to NH_3 is lost. When high TC and high NH_3 columns (high HRI) occurs, the major contribution to the uncertainty results from the thickness of the NH_3 layer, the surface temperature as well as the temperature profile (Whitburn et al., 2016). We have added following text for clarification in the Sect. 4.2: “Higher correlation over China than other regions for the satellite estimates is linked to the detection limits by the instruments and thermal contrast (Liu et al., 2019).”.

3. L531: For the estimated ammonia deposition, its uncertainties from remote sensing and models should be discussed more in this manuscript.

We have added the following text for further describing the uncertainties in the Sect. 4.2:

“The satellite NH_3 retrievals were affected by the detection limits of the satellite

instruments and thermal contrast. Higher accuracy could be gained with higher thermal contrast and NH_3 abundance. Instead, the uncertainties of NH_3 retrievals would be higher with lower thermal contrast and NH_3 abundance."

4. title: I suggest to change the satellite observation to "satellite retrievals" since IASI NH3 data were not a direct satellite observation but a reanalysis data using the statistical methods.

We have revised it as suggested.

5. L30: The abbreviation must be defined for the first occurrence.

We have removed these abbreviations.

6. L137: Replace ACTM with Atmospheric chemistry transport model

We have revised it as suggested.

7. L306: Added the references of the equations.

We have added the reference as suggested.

8. L333: Added the references of the equations.

We have added the reference as suggested.