Response to Review#2
Title: “Bridging the spatial gaps of the Ammonia Monitoring Network using satellite ammonia measurements”
Authors: R. Wang et al.

We thank the reviewer for the helpful comments. We have revised the manuscript accordingly to help clarify and focus the manuscript. The original comments from reviewers are in *blue and italics*, our replies are in black font, and verbatim responses from the revised manuscript are in red font.

Summary

This study is well-organized and important for research community. This reviewer has two minor comments. 1）？2) can urban atmospheric NH3 prevent the previously formed NH4NO3 from evaporating? The current discussion is imbalance.

Minor comments:

Minor comment #1: *the authors should explain why only the data ended on 2018, but not 2022*

Response: IASI observations in 2020 were excluded to rule out the possible impact of the pandemic. IASI observations in 2021 and 2022 were not included because Metop-A retired in 2021.

Minor comment #2: *can urban atmospheric NH_3 prevent the previously formed NH_4NO_3 from evaporating? The current discussion is imbalance.*

Response: The equilibrium between gas phase NH_3 and HNO_3 and aerosol phase NH_4NO_3 shifts to the aerosol phase at cold temperature and high particle pH condition (Feng et al., 2020; Guo et al., 2018; Shah et al., 2018). Gas phase NH_3 also plays an important role in aerosol acidity and aerosol chemistry (Lawal et al., 2018). Zhai et al. 2021 demonstrates that gas phase NH_3 hinders the scavenging of nitrate aerosol by slowing down the deposition of total inorganic nitrate. Wang et al. 2020 shows that gas phase NH_3 and HNO_3 can nucleate directly to form NH_4NO_3 particles in cold atmospheric conditions and is likely to result in rapid growth of new atmospheric particles in winter, especially in urban environments with abundant HNO_3. Unfortunately, reliable gas phase HNO_3 data in the boundary layer are not readily available to make a full evaluation of NH_4NO_3 formation. Because trends in SO_2 and NO_x also impact NH_4NO_3 formation, it is difficult to evaluate how each city may respond to increases in NH_3 over time. We’ve added Fig. 9b and the following paragraph to discuss the NH_3’s role in NH_4NO_3 formation in urban areas in details:

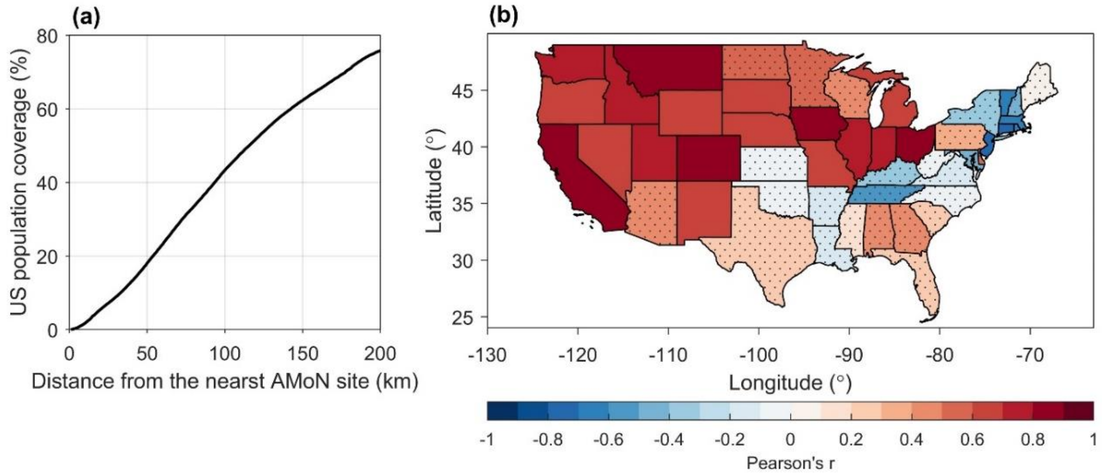

Figure 9. **(a)** Cumulative distribution of CONUS population as a function of distance from~~The population coverage of~~ the nearest AMoN site~~s~~; **(b)** Correlation between EPA NH_3 emissions and IASI observed mean NH_3 concentrations at state level during 2008 - 2018. The gray dots represent states without statistically significant correlations (α = 0.05).

Line 541 - 554: The urban environment with abundant HNO_3 and NH_3 emissions from vehicles nominally favors the formation of NH_4NO_3 over rural areas. Recent studies suggest that gas phase NH_3 hinders the scavenging of NH_4NO_3 by slowing down the deposition process of total inorganic nitrate (Zhai et al., 2021) and promotes new atmospheric particle formation by directly nucleate with HNO_3 to form NH_4NO_3 in winter in urban areas and (Wang et al., 2020). However, ultimately the sensitivity to $PM_{2.5}$ from increases in NH_3 in any urban areas will be a complex function of trends of NO_x and SO_2 as well (Feng et al., 2020). The NH_3 increase in these densely populated areas and its impact on~~ the~~ aerosol chemistry ~~need~~needs to be further addressed. For example, Fig. 9b shows the relationship between NH_3 trends versus emissions trends (EPA Air Pollutant Emissions Trends Data) on the state level. For agricultural areas with high NH_3 (excess NH_3 relative to NH_4NO_3 equilibrium), one would expect an increase in emissions to correlate very well with increasing NH_3 columns. In contrast, in areas with more NO_x, increases in emissions may result in NH_3 going into NH_4NO_3 and thereby show little or even negative correlations. To this end, Fig. 9b shows that at state level, agricultural states show strong correlations between emissions and concentrations trends, e.g., California, while the more urbanized northeast states show weak or negative correlations, e.g., New Jersey. Ultimately, co-located aerosol phase and gas phase precursor measurements are needed to fully deduce what is happening at each urban area and should be a focus of future air quality network integration.

Line 607 - 610: The comparison between NH_3 emission trends and IASI observed NH_3 concentration trends suggests that strong correlations exist in agricultural states, e.g., California, while weak or negative correlations in more urbanized northeast states, e.g., New Jersey, indicating the different contribution from emission and partitioning.

Line 43 - 45: A comparison between IASI NH_3 concentration trends and state-level NH_3 emission trends is then performed to reveal that good correlations exist in agricultural states while negative correlations in more urbanized states, suggesting the different roles of emission and partitioning in NH_3 increases.

References:

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