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Comment on acp-2021-549

Anonymous Referee #1

Referee comment on "An Ensemble-Variational Inversion System for the Estimation of Ammonia Emissions using CrIS Satellite Ammonia Retrievals" by Michael Sitwell et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-549-RC2>, 2021

This paper intensely has investigated the inversion of ammonia emissions with CrIS satellite products and GEM-MACH model with an Ensemble-variational technique. The ammonia emissions are highly uncertain but are crucial to PM formation, which is quite important to model prediction. This study carefully examined the sensitivities of the inversion technique to the results and quantitatively evaluated the performance with and without updated results. I believe this is a very nice example of applying an inversion technique with useful satellite retrievals to evaluate current ammonia emissions.

General comments

- I am not sure why the author spent much effort about the difference between log-space and linear-space $H(\text{observational operator})$ to justify the 'hydride' technique. Is that because of the scientific importance? If that is the efficient approach, then 3.3 should be shortened and briefly explain the benefit of the compromised approach. (Those descriptions and testing results are too technical to this journal)
- I understand why the column comparisons with the averaging kernels for this work. But if the operator has higher sensitivities with the vertical profile, is that any possibility to compare the satellite data and model at a specific level only with the highest sensitivity (such as 700hPa or near-surface levels only)?
- The author has to comment more about the reason for GEM-MACH performance before and after the inversion since readers do not know much about the potential weakness or biases of the generic model performance. We don't determine the meaning of changes by this work well.
- The ammonia has a relatively short lifetime and the author claimed that the ammonia concentrations have increased. How is the degree of underestimation of NH_3 emissions and the trends over the other continents? The comparison of this work to other regions(or studies) will be informative as well.