

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-216

Anonymous Referee #1

Referee comment on "Estimating global ammonia (NH₃) emissions based on IASI observations from 2008 to 2018" by Zhenqi Luo et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-216-RC1>, 2022

General comments:

This manuscript showcases global NH₃ emissions estimated using a top-down approach constrained by IASI observations with comparison to bottom-up estimates. The approach used here is built upon a previous study with modifications in several aspects including NH₃ lifetime calculation and local mass balance approximation. The authors address the uncertainty of emissions by performing sensitivity tests on various parameters and discuss the limitations of current emission inventories. This work shows the promise of using satellite observations to constrain NH₃ emission inventories on the global scale, as well as the need to improve emission factors used in model simulations, particularly in developing regions. Overall, the manuscript is well-written and organized. The figures are clear, concise, and easy to follow. I recommend the publication of this manuscript in ACP with some minor comments/suggestions for the authors to address/consider.

Specific comments:

Line 80: You may want to emphasize this is the reanalyzed IASI dataset as opposed to the near real time dataset.

Line 89-97: You may also want to state explicitly that you only used observations taken over land areas.

Line 103 (Sect 2.2): One major distinction between this study and Evangelidou et al.

(2021), besides modifications in the approach, is the CTM used for simulating NH₃. Can you elaborate a little on the differences between GEOS-Chem and LMDz-OR-INCA, and any outcomes they may have on the emission estimates?

Line 253-257: Are these speculations or do you have statistical evidence to support? Without seeing the inter-annual variabilities of emissions or some analyses on the NH₃/CO ratio, I am not completely sure if the positive trend in Canada can be explained by one particular wildfire season, likewise the negative trend in Russia and eastern Europe.

Line 282-285: I wonder how good the bottom-up estimates are in India and China, as you mentioned that emission factors in developing regions may not be as accurate. In Fig. 3, BUE1 in IP and EC is almost invariant throughout the whole period, which seems contradictory with the fertilizer and manure data in Fig. 4. The reason for asking this is even though the SO₂ correction largely closes the gap between BUE1 and TDE, if prior emissions are off in the first place do we have enough confidence to agree on the absolute magnitude of the emissions?

Line 332: What percentage of results or grid cells were determined as unreliable and removed?

Supplement: Table 2 should be renamed as Table S2. Also and again, I think showing the percentage of grids used may be more meaningful than just the number of grids.

Finally, the novelty of this study and why it is important should be highlighted more given the overlap with Evangeliou et al. (2021) in terms of topic, datasets, and methods. I was hoping to see a more conclusive statement on the implication of this work to the scientific community interested in NH₃ emissions. You modified the fast top-down approach proposed by Evangeliou et al. (2021), and the resulting change in emission estimates is drastic (79 vs 180 Tg a⁻¹). My takeaway from this is the emission figures one will get from models are largely subject to the method they choose and assumptions they make. Do you think this approach is scientifically reasonable enough for the purpose of deriving global emissions, or is a full-fledged inversion still necessary to obtain more accurate numbers? And how might the results change if a different satellite product is used (CrIS, for example)?

Technical corrections:

Line 30: Emissions of ammonia (NH₃) to the atmosphere have...

Line 31: such as nitrogen oxides (NO_x) and sulfur dioxide (SO₂)

Line 276: an overall decreasing trend in NH₃ emissions

Line 316: driven by the prior emissions

Line 343: NH₃ emissions from eastern China are significantly decreasing

References: I see a few citations messed up due to subscripts in the titles (e.g., line 477, line 496 and 497). Please correct accordingly.