Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC3
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Comment on amt-2021-129

Anonymous Referee #1

Referee comment on "Impact of 3D radiative transfer on airborne NO_2 imaging remote sensing over cities with buildings" by Marc Schwaerzel et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-129-RC3, 2021

This paper describes the influence of 3D radiative transfer and shadowing on airborne NO2 retrievals, using a case study over Zurich. The paper is well-organized, concise and easy to follow. I have a couple of general and specific comments. After those are addressed I would recommend it be published in AMT. The study results are interesting but I am not sure how the results can be transferred over to a practical application in retrievals; however, it will be a good reference for the impacts of 3D radiative transfer on these kinds of measurements.

General comments:

I find the description of the motivation to be unconvincing. The authors point to possible 3D effects as being responsible for the discrepancy between high resolution airborne NO2 maps over urban areas and city-scale urban models, and point to Figure S1 for an example. First, to drive home the need for this study, it would be good to see the motivating figures in the main paper instead of the supplement. To me, the observed and modeled NO2 maps look so very different that I doubt the source of the differences is entirely or even primarily 3D radiative effects. I would suspect issues with the model like inaccuracies in mixed layer height, transport, emissions, and chemistry, or issues with surface reflectance and profile shapes in the retrievals. For instance, there are what look like three plumes in the southwest corner of the map which actually look quite well-represented. Why are these represented fairly well but other plumes are not? It may be that 3D effects are the main reason for observed/model discrepancies, but the current example is unconvincing.

The study's motivation would be more convincing if: 1) The new calculations were actually applied to APEX data to calculate new AMFs, perhaps at the end of the paper, and the new maps showed better agreement with the model or improvements in resolution, or 2) a simulation were done using the GRAL NO2 columns to simulate airborne measurements that use 1D radiative transfer, and these simulations were found to show significant smearing. Even if this is not possible, I would suggest leaving out the example figure, and be more nuanced in the motivation, i.e., along the lines of "we explore 3D effects as a possible contributor to smearing…". The later results will show whether or not they are significant.

My second general comment is that it would be nice to see some discussion of the practical implementation of these calculations. Is it too computationally intensive to use

for actual campaign AMF calculations? How would a more realistic albedo field change the results?

Specific Comments:

Line 3: It's unlikely that the entire cause would be 3D radiative transfer effects. Should qualify with wording like "3D radiative transfer effects may contribute to this discrepancy due to…."

Line 152: Can you give an estimate (maybe in results section) about how much the results would change for shorter wavelength fitting windows? Shorter wavelengths are used in almost all other airborne and satellite instruments that measure NO2, so this would be most interesting for the majority of readers who do not use APEX data.

Technical Comments:

Some mixing of verb tenses in paper. For example, in abstract say "We compute.." then next sentence says "We found…"

Line 63: I'm a bit confused at the wording of this sentence. Should it be "The model, however, is able to …"?