

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2021-338

Anonymous Referee #2

Referee comment on "Impact of 3D cloud structures on the atmospheric trace gas products from UV–Vis sounders – Part 2: Impact on NO₂ retrieval and mitigation strategies" by Huan Yu et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-338-RC2>, 2022

The study "Impact of 3D Cloud Structures on the Atmospheric Trace Gas Products from UV-VIS Sounders - Part II: impact on NO₂ retrieval and mitigation strategies" investigates the impact of 3D cloud structures - which are ignored so far - on the NO₂ retrieval from satellite measurements. The paper is generally well written and matches the scope of AMT.

However, I see a fundamental flaw in the design of this study, as it is doing the second step before the first one:
The quantities directly affected by 3d cloud effects would be the retrieved cloud fraction and cloud height.
These quantities are generally used for calculating NO₂ AMFs, and, as far as I understand, this should not be changed according to the authors.
But then it is essential to first check how far the cloud retrievals are affected by 3D effects before analysing the effects on trace gases.

For instance, a cloud shadow causes lower reflectance. This might actually be dealt with in the existing algorithms if negative cloud fractions would be allowed. This way it might be actually quite simple to account for cloud shadow effects without introducing new concepts/quantities like CSF.
Also other 3d effects (clouds in neighboring pixels) will affect the cloud fraction and cloud height retrieved based on IPA. It would be interesting to see to which extent these "wrong" CF/CH parameters do the NO₂ AMF correction intrinsically (such as aerosol effects being partly accounted for by the cloud algorithms yielding higher CF and lower CH than "reality").

I would thus like the authors to add an analysis of 3D effects on the cloud products first. The further mitigation strategy might be different if 3D effects could already be accounted for by e.g. negative cloud fractions. In any case, the mitigation strategies cannot be discussed without knowledge on the effect of 3D cloud structures on the standard cloud products themselves.

Minor comments:

Page 1, Line 2: "generally implement Lambertian cloud models": This is not true, see for instance OCRA/ROCINN.

Page 1, Line 3: "photon path length corrections": to my understanding, the cloud algorithms interpret the measured O₂ or O₄ absorption in terms of a cloud height. This should be stated here.

Page 2, line 6: "amount of the trace gas along the average path": this sounds like the average path could be calculated and then linked to the amount of trace gas. It is rather the average absorption along light paths.

Page 2, line 19: "A simplified Lambertian cloud model is generally used": This is not true, see for instance OCRA/ROCINN.

As the remaining text might change considerably, I do not provide further detailed comments for now.