Review of "Impact of 3D Cloud Structures on the Atmospheric Trace Gas Products from UV-VIS Sounders – Part I: Synthetic dataset for validation of trace gas retrieval algorithms" by Emde et al.(AMT-2021-336)

This paper is one of a set of three interconnected papers that discusses a) a publicly available synthetic dataset of 3D radiances, b) the sensitivity of vertical column density NO_2 retrieval errors near box-clouds and observations, and c) 3D cloud biases and metrics. The reviewed paper is part a) of the full set of papers. The remote sensing community can obtain and use the synthetic dataset of 3D radiances by accessing a Zenodo web site.

The authors have responded adequately to the comments and suggested revisions to the original paper.

The paper should be published following minor suggested text changes.

General comments

The paper contains very informative Figures. I especially like Figures 3,4,5 which looks at 1D and 3D calculations for idealized clouds.

The realistic LES cloud scene is well chosen to illustrate the complexity of actual atmospheric scenes.

The paper forms a carefully written series of three papers which will be well received by the remote sensing community.

Minor suggested changes to the text

Page 2, line 9 change to "and it was found that cloud"

Page 2, line 12 change to "or photon path length correction"

Page 2, line 13. Provide several references where the three effects ae included in operational cloud correction methods.

Page 2, line 20 change to "studies have shown that 3D cloud"

Page 3, line 4 change to "box-clouds. Yu et al (2021) systematically analyzes the VCD retrieval error in terms of the following"

Page 3, line 9 change to "using both synthetic and"

Page 3, line 11 change to "the first part of the synthetic data"

Page 3, line 25 change to "as Lambertian or by a Bidirectional"

Page 3, line 31 change to "and always agreed well to other participating radiative transfer codes"

Page 4, line 17 change to "DOAS technique (Platt, 2017):"

Page 4, line 28 change to "MYSTIC calculates layer-AMFS'

Page 5, line 1 change to "partial column density (of NO_2) for layer"

Page 5, line 20 change to "atmosphere of Anderson"

Page 5, line 22 change to "cm^2, with most of"

Page 13, line 4 change to "with the 1D cloud layer included"

Page 13, line 12 change to "or by gas molecules"

Page 16, line 5. Define the H-metric and provide a reference.

Page 17, line 6 change to "to figure out which type of "

Page 17, line 18 change to "and it was found that SZA"

Page 23, line 13 change to "region of the O_2"

Page 24, line 17 change to "to ensure that the LES"

1. Does the paper address relevant scientific questions within the scope of AMT? yes
2. Does the paper present novel concepts, ideas, tools, or data? The box-cloud and LES 3D calculations are fairly unique
3. Are substantial conclusions reached? Substantial conclusions are mainly contained in the 2nd and 3rd papers of the three paper set. The discussion in the reviewed paper presents very informative graphs and text which will be helpful to educate the remote sensing community.
4. Are the scientific methods and assumptions valid and clearly outlined? Some additional sentences could have been added to the text to clarify some of the methods. The text does have adequate referencing.
5. Are the results sufficient to support the interpretations and conclusions? yes
6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? yes
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? yes
8. Does the title clearly reflect the contents of the paper? yes
9. Does the abstract provide a concise and complete summary? yes
10. Is the overall presentation well structured and clear? The paper is well organized.
11. Is the language fluent and precise? Yes (with the exception of a few sentences)
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? yes
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? The paper is long enough, so additional text could become burdensome.
14. Are the number and quality of references appropriate? yes
15. Is the amount and quality of supplementary material appropriate? yes