EGUsphere, referee comment RC1
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Comment on egusphere-2022-438

Duncan Watson-Parris (Referee)

Referee comment on "Incorporation of aerosol into the COSPv2 satellite lidar simulator for climate model evaluation" by Marine Bonazzola et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-438-RC1, 2022

The authors present a significant addition to the COSPv2 satellite simulator package to include the simulation of CALIOP aerosol retrievals from model variables. Previous work has shown the importance of considering the detection sensitivity of CALIOP when comparing with modelled aerosol backscatter and extinction and this work provides a neat model-agnostic solution. This is a valuable contribution which has been well validated and I feel is suitable for publication in GMD after some amendments.

My main concerns with the current presentation of the manuscript is that the numbered variable (SR_0, 1, etc) names make reading and following the text very difficult, especially in legends and captions. I would strongly suggest that these are renamed to something more easily understandable such as SR_noclouds, SR_detectable, etc. both in the paper and in the code (if applicable). My second main concern is that I can't find this code contribution in the COSPv2 codebase linked to in the manuscript. Has this been merged into the code? I would appreciate visibility of the code (the specific files / commit) in order to provide a more detailed review.

The only major scientific comment I have is that I seem to remember the CALIOP aerosol detection threshold depends on the presence of cloud. I.e., if there is thin attenuating cloud aloft, or a thick layer of low cloud this would change the detection threshold. As far as I can see this isn't accounted for, which is understandable since it may not be easy to quantify (and models won't suffer from it), but it should be mentioned as a possible source of discrepancy in the combined EXT_3 variable.

While generally well written and structured the introduction is missing some citations and a bit more context (detailed below). Also, the discussion section contains results on the effect of cloud screening, on page 18 through to line 18 on page 21, which should please be moved to the results section (or in an Appendix).

Minor comments

- P2L24-25: Please rephrase, perhaps you mean 'variety of aerosol research questions'.
- P2L24-25: Please provide citations rather than a URL.
- P2L31-35: Citation needed
- P2L35-37: Citation needed
- P3L6-8: Citation needed
- P3L8: This doesn't make sense and needs rephrasing
- P3L17: Add a full stop after 'model' to break up this long sentence?
- P3L36: "(from the cloud lidar simulator but not only)" -> (from not only the cloud lidar simulator)
- P4 Figure 1 caption: Everything after the first sentence should be in the main text rather than the caption.
- P4L18: Please provide citations for the Rayleigh scattering expressions
- P5L19: 'simple' -> 'single'
- P5L29: Is this every radiation timestep or every model timestep? Please clarify
- P5L42: Does this interpolation also work for models on pressure levels?
- P7L20: Please place the Figure 1 caption text here.
- P7L24: 'model+aerosol' -> model and aerosol
- P7L43: Citation
- P9L4-5: Setting the SR=1 is equivalent to setting the aerosol backscatter to zero which may be a reasonable assumption but should be done carefully – particularly when averaging over large regions of tenuous aerosol (see e.g., Watson-Parris et al. 2018). Please make this assumption explicit in the text.
- In addition to using more descriptive variable names (especially in figure titles), please also use the full model name in the figure legends (e.g. Fig. 10)
- P22L17: -> …modes has been used interactively for almost two decades…
- P23L16: As a co-author, presumably Nick doesn't need to be acknowledged ï□□