

Review of the revised manuscript by Martinsson et al.

I thank the authors for their detailed response and for the revised manuscript. In this new version, the authors have addressed most of my previous concerns in a satisfactory way and the manuscript has improved. I recommend publication after minor revision, provided that the following targeted changes are made.

Thank you for your efforts.

1. Sect. 2.2, abstract and conclusions: definition of background aerosol

The background definition is now much clearer. However, I suggest that the authors consistently refer to it as an “operationally defined background” or “background estimate” at the first mention in the abstract and in the conclusions. This would remind the reader that the quantity is derived from the minimum aerosol load observed during the CALIOP period, rather than representing a strictly unperturbed physical background. The present explanation in Sect. 2.2 is satisfactory, but this nuance should be preserved when the result is summarized elsewhere.

OK, we have added the word “estimated” in both the abstract and conclusions.

2. The discussion of wildfire-driven stratospheric perturbations could be slightly better connected to the broader literature on the major PNE and ANY events. Around l.38–54, where the role of wildfires and the importance of the Australian event are introduced, the authors may consider adding a few representative references, e.g. Peterson et al. (2019), Khaykin et al. (2018; 2020), Ohneiser et al. (2021) and related work.

We have added four references, but chose some of them differently to broaden the scope.

3. Sect. 3.3, l.406–411: seasonal background signal

The revised discussion of LMS seasonality is improved and sufficient for the scope of the manuscript. I only suggest polishing the sentence at l.409–411: “In addition to the size of the LMS, seasonality of the backscattering intensity is connected to a variability in aerosol load.” This sentence is important but awkward. A clearer formulation would be: “The seasonal variation of background backscattering in the LMS therefore likely reflects both the seasonal variation of LMS volume and true variability in aerosol loading.” This would make the intended interpretation more explicit.

Thank you, we use your well formulated sentence.

3. Sect. 3.5, l.580–592: RF estimate

The remaining RF estimate in Sect. 3.5 is acceptable, but it should be explicitly described as a first-order or illustrative estimate. I suggest replacing wording such as “This simplified estimate of the global stratospheric yearly average total effective radiative forcing...” with “This simplified, order-of-magnitude estimate of the global yearly average effective radiative forcing...”. The paragraph should also state clearly that this estimate does not account for aerosol absorption, latitude, vertical distribution, or differences between volcanic sulfate aerosol and wildfire smoke.

We have added “order-of-magnitude”. We explain that the relation used is not designed for absorbing wildfire aerosol, and we clearly refer to the source (Schmidt et al., 2018) where the background of the relation between AOD and RF is clearly described.

4. Sect. 4, l.704–715: CALIOP versus solar occultation

The discussion is now more balanced than in the previous version. I suggest a final wording adjustment to emphasize complementarity rather than priority of one technique over another. The sentence at l.712–713, “Now is the time to better sort out differences between lidars and solar occultation measurements,” could be softened, for example as: “Future work should better reconcile lidar and solar occultation records and exploit their complementary strengths.” Also, at l.713–714, “needs to be re-evaluated.”

Thank you, we have changed according to your suggestions.

5. Conclusions, l.674–695: interpretation of BDC transport

The conclusions are improved, but some statements still read as background interpretation rather than direct conclusions of the study. In particular, the paragraph discussing dBD/sBD transport and Brewer–Dobson circulation should distinguish more clearly between what is directly derived from the CALIOP analysis and what is inferred from established knowledge of stratospheric transport. The sentence at l.691–692, “the tropical dBD air that after poleward followed by downward transport...”, is grammatically unclear and should be rephrased.

Thank you, we have changed the formulation to “Above that layer a broad band with high aerosol load was found which we identify as the tropical dBD air that is transported polewards and downwards resulting in high aerosol load in the sBD and LMS at mid and high latitudes.”.