

Reply to Reviewer 2 (Marloes Penning de Vries)

We would like to thank you very much for your kind review and comments. We have addressed your comments as follows (reviewer comments are in red, authors comments are in black beneath the corresponding reviewer comment):

First: the dependence of AOT retrieval on viewing angle. The effect of parallax on a plume of moderate altitude is mentioned, but the strongly elongated light path due to large viewing (and/or solar) angles is not discussed. This, I imagine, is a significant issue for regions at the edges of the geostationary field of view.

We agree that viewing angle is a significant issue for geostationary retrievals, as the effects of parallax and rayleigh scattering become pronounced towards the edges of the field of view and lead to large uncertainties on any retrieval. However, the ORAC algorithm takes into account the path length due to viewing angles when carrying out a retrieval. More information can be found on this in the published works discussing ORAC, e.g: Prata et al., 2022, McGaragh et al., 2018, Poulsen et al., 2012 and Thomas et al., 2009. For the purposes of this study, we aren't concerned by these effects as we focus on high AOT tropospheric plumes that occur towards the centre of AHI's field of view. However, the effects from high solar zenith angles can be seen towards the beginning and end of the day in Figure 5, where the uncertainties on ORAC retrievals begin to grow, but are a known issue with no obvious solution.

Second: the authors state that at higher AOT the retrieval depends more on the assumed aerosol parameters (particle size distribution, refractive index) than for smaller AOT. The ORAC algorithm performs very well for the Tumbarumba station, but then it makes use of the aerosol parameters derived from Tumbarumba AERONET data. How does this translate to a global algorithm? The implication appears to be that extreme AOT values can only be retrieved from satellite if the aerosol parameters are accurately known for the region (or even fire event) in question. I'd like to read the authors' view on this point. Because although they stress that their algorithm is scientific and not operational, it may be assumed that they, or others, will continue the advancement of aerosol algorithms towards routine monitoring of even extreme biomass burning cases.

We have had a similar discussion amongst ourselves on this topic which we did not believe was suitable to go into the manuscript, but we are more than happy to discuss this issue in this reply.

The results of the sensitivity analysis do suggest that accurate optical properties are needed to carry out accurate retrievals of extremely high AOT plumes. In theory, this would mean that for accurate retrievals across the globe, we would need to know the specific optical properties for each event, which is not always practical. If there were an AERONET site nearby that captures the plume, optical properties could be

derived using the technique we have employed in this study. However, for the majority of events, we are unlikely to have this information. Therefore, moving towards more specific optical property models could be a more practical approach, e.g. for Australia, deriving look-up tables (LUTs) for biomass-burning (BB) events for grassland, scrubland, tropical forest and temperate forest could be more appropriate than using simple Australia-wide BB LUT. These would be based on climatologies of the specific types of events, limiting the number of LUTs needed in an operational retrieval algorithm and producing time series data that is unbiased.

However, reprocessing BB events with specific optical properties and comparing them to the data produced using the more practical approach would be an exciting area of research to assess the applicability of BB LUTs in a global context.