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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effect of biological particles and their ageing processes on aerosol radiative properties: Model sensitivity studies" *by* Minghui Zhang et al.

Anonymous Referee #1

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General comments: Overall, this paper is a useful study that investigates the relevant optical properties of biological aerosol particles. They provide some excellent comparison tests of which parameters and processes are important, and provide a framework for understanding these findings.

Major comments:

1. The authors frequently talk about how they do not intend this paper to be a comprehensive literature review (e.g., lines 137-140), yet it is still important that they cover the range of values that are found in the literature. Specifically, I would like to see an inclusion of more up to date information on pollen and fungal spore rupture (see next

comment)

2. The authors do not provide equal weight to the physical ageing via rupture of biological particles such as fungal spores and pollen. Physical ageing processes are noted, but they have not done the appropriate literature review to accurately capture how some types of biological particles may change. This represents an important atmospheric secondary process that can change both the size distribution as well as potentially the optical properties. This should be mentioned in the introduction when discussing "physical transformations" around line 100, and more specifically throughout the paper, particularly for including observed size distributions and their influence the optical properties. Pollen rupture is mentioned briefly on lines 168-169 and as a single referenced line item in Table 1, but this underestimates this process based on the long list of epidemiological literature on this process (e.g., Suphiolglu et al. 1992; Grote et al., 2001; Taylor et al. 2002; Taylor et al. 2004). More recently, fungal spores have been shown to rupture as well (Lawler et al., 2020; China et al., 2017), and this has not been mentioned at all in the text nor in Table 1. Overall, the authors spend a lot of time on the chemical processing (e.g., nitration) and its impacts, but very little on this physical process.

3. Overall, the sensitivity studies described are useful, but there was little discussion of box model results. Specifically, more detail on the following would enhance the paper: a. lines 367-369 – why does the absorption coefficient increase at the higher wavelengths? b. Figure 6 – large changes with refractive indices (no surprise) but hardly any discussion in the text of what changes are important c. Figure 7: why are the nitrated changes in scattering large at smaller wavelengths?

4. The ranking in Figure 11 is potentially useful but ultimately confusing. Please revise the accompanying text to make this figure more clear – right now the discussion is scattered and it would help to clarify this figure more, as it is ultimately very useful.

Minor comments: 1. The acronym used in the paper is inconsistent with the literature on *primary* biological aerosol particles (PBAP) not BAP. While they do talk about some secondary processing of the aerosols, the origin of the particles is still primary (as opposed to secondary formation), and consistency with prior work is helpful.

2. Line 57 – is the Londahl et al. 2014 the correct reference here? This seems to be an error.

3. Line 58 – Myhre et al. 2013 is not in the reference list.

4. Line 98 – Pollen can also nucleate ice – see Diehl et al. 2001

5. Line 181 – missing word between "that" and "might"? Can't tell what this sentence is supposed to say.

6. Table 2: missing many references on the rupture of pollen. I actually think that these numbers are incorrect and very much mis-represent the range of potential sizes (see refs Grote, Taylor, Suphioulglu for a few; listed below). Also, you are missing the rupture of fungal spores (China, Lawler; see references below). Also missing the fact that the hygroscopicity of pollen may change on rupture (not just from oxidation).

7. Lines 283-284: The text should more clearly state that certain classes of PBAP are excluded based on the 0.5-2.8 micron size representation.

8. Line 342: Fungal fragments could also be on the order of this size. . .

9. Lines 360-363: This line downplays the potential importance of non-spherical particles. The true atmospheric range of moisture conditions is not enough to say what is more likely, therefore this speculation should be removed and it would be better to discuss what types of uncertainties non-spherical particles would include.

10. Figure 3: the caption states that there is an a/b panel to capture scattering and absorption, yet only the scattering is shown.

11. Line 392: "very small PBAP" could also be pollen or fungal fragments. Please see literature suggestions in the major comments.

12. Line 422: I think this is supposed to be S15 and S16?

13. Line 471: what is delta_mBAP? First use, please define. (perhaps including S13, S15 and S16?)

14. Table 3: last row – is dm_aged the same as dm_nitrated? Different terminology than Table 2.

15. Also in Table 3 – what is the dm actually referring to? Hard to tell from comparing with Table 2.

16. Lines 495-298: Could be compared with the observed values of Sc from Steiner et al. 2015

17. Line 500 – The missed rupture literature could also be important here. Physical processes like rupture could create many more hygroscopic particles.

18. Lines 568-571 – overall, these changes are really hard to see in the figure. Is it possible to overlay Figures 9a/b so they can be more directly compared?

19. Lines 630-632: What is the reference for this sentence "However, as it has been shown that at many locations NBAP/Ntotal is approximately constant. . .." – this is not true for fungal spores and pollen. The emissions of these types of PBAP are very spatially and temporally heterogeneous, and tend to be more event-based than consistent.

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