

Clim. Past Discuss., referee comment RC2
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Comment on cp-2022-36

Anonymous Referee #2

Referee comment on "Non-spherical microparticle shape in Antarctica during the last glacial period affects dust volume-related metrics" by Aaron Chesler et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-36-RC2>, 2022

In this manuscript Chesler et al. measure the shape of dust particles in an ice core from South Pole Station and propose a correction from the commonly used spherical particle shape to calculate particle mass concentrations and fluxes. It has been known for a while that dust particles are not spherical and that the assumption has probably introduced biases in all published ice-core records based on optical techniques. Chesler et al. improve on previous work from Italy and pave the way for future works that may lead to a correction factor to be applied for Antarctic records measured using lasers. As such, it is an important step forward for paleoclimatic research and the results are in line with Climate of the Past's scope. The manuscript is solidly written with no major flaw. I therefore recommend the its publication after the issues mentioned below have been addressed.

Major Comments:

Dust in ice cores (and other paleoclimatic archives) usually produce aggregates where smaller particles stick together to form larger ones. These aggregates may have irregular and hollow shapes. Aggregates are usually broken apart using an ultrasound bath, but no such procedure was described in this manuscript. The authors mention large particles in

relationship with drill fluid contamination, but some of those may also be aggregates. If possible it would be good to get some SEM images from these sections. If not, I think aggregates and the potential effects on the presented measurements should be at least discussed. Note that this is different from the coincidence that the authors mention in line 139, which is a bit confuse. Coincidence is when for example two small particles are counted as on large one, as the authors mention in line 141, but when small particles coagulate (for example at the boundary of ice crystals) the we are talking about aggregates which is a different problem.

There is a bit of confusion on the binning and size distribution in the manuscript. In many places, the authors mention the bins of the Abakus, but in most places they seem to work with a coarse vs. fine fraction only. I think the manuscript could be made clearer about when the whole size distribution is used, and when only the coarse vs. fine fraction. Related to this, the authors use the size fraction between 2 μm and 6.4 μm for their correction. However, it is not addressed in the text how these bins are to be found in the Abakus since there is no good way to attribute a specific voltage to a specific particle size, as the calibration with spherical latex particles does not work well. This should be clarified in the text, in particular the calibration of the Abakus particle sizes.

Chapter 3.1: This subchapter is unclear. It is not clear if this comparison in Fig S4 was made using the corrected Abakus PSD or the original. Also, Fig 3 appears to show different Abakus PSDs based on corrections, but these are not discussed at all in the text. One possibility would be to merge this chapter with chapter 3.3, for example.

Minor Comments:

Line 40: The parenthesis with ~ 490 years per sample during the LGM is out of place. Put this information somewhere else.

Lines 40-41: These are not period of rapid global climate reorganization (that would be

the glacial termination), they just include some millennial scale variability, just as pretty much any other period except the Holocene.

Line 42: number of samples is missing for HS4 (n=?)

Line 70: I would say the Abakus provides theoretical millimeter-scale resolution, as the mixing of water in the tubes dilutes the original signal. Rasmussen et al. tried to deconvolute that back in the days (<https://doi.org/10.1029/2004JD005717>), but it was not really widely applicable.

Line 88: Why is the period 0-10 ka not included?

Line 92: What's the accumulation rate during the glacial?

Figure 1: Maybe add EDC or Siple Dome CO₂ to complete the record in panel B?

Line 175: Here there is some information missing. The CC is usually calibrated using commercially available spherical latex particles. How were the Abakus size bins calibrated and can they be directly compared to CC bins?

Line 188-187: Similar comment here: The Abakus size ranges are notoriously difficult to calibrate. Are the FlowCAM aspect ratios really comparable to Abakus size ranges?

Line 193: Figure S2 does not show particle counts by Abakus bin size.

Line 210: Again, how were the Abakus size distributions calibrated? Could the offset come from an uncertain coarse: fine particle size threshold?

Line 228: This is the crux of the problem. How can you be sure that length measurements of particles are equal between Abakus and DPI?

Line 251: Again, how do you know which Abakus channels corresponds to the exact sizes 2 and 6.4 μm ?

Lines 255-263: The mention of Eq.3 in the text could be a bit confusing since only eq. 3a and 3b are listed. Rephrase for clarity.

Line 286: In Figure S4 it says the slope is 1.81, not 2.3.

Line 287-288: Could we please see the histograms in the SI?

Line 295: Table 1 is first mentioned here, but appears only much further down in the document. I suggest moving it closer to the first mention.

Figure 4: The title says Particle aspect ratio as a function of time, but this is only true for panels b and d. Also, the y-axis line and title colors for Particle Concentrations and CO₂ appear to correspond to the wrong curve in the plot. The last two sentences of the figure caption are redundant.

Line 337: If you interpolated width values in bins 2.1, 2.2, 2.4, and 2.7, then why do these widths have multiple measurements and standard deviations in Figure S8?

Line 346: Closing parenthesis missing after 1c

Line 443: This last phrase should be rephrased as particle numbers were not published in Ruth et al., 2008. Although the correlation between the two was very high, that does not imply the same absolute values.