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Interactive comment on "Particle shape accounts for instrumental discrepancy in ice core dust size distributions" *by* Marius Folden Simonsen et al.

Anonymous Referee #1

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This manuscript by Simonsen et al. is an important addition to the ice core dust community. The discrepancy between Abakus and Coulter Counter measurements of dust particle size have been discussed in the past but this study provides a clear description of the measurement differences due to the irregular shape of dust particles. More importantly, this study presents a calibration routine for adjusting the Abakus measurements thereby providing more accurate measurements and allowing for comparisons between different ice cores, and ice core lab groups. Some comments on the writing and clarity of the paper are below.

Comments: Page 1 Line 3: "depending on the type of sample." Can you be more specific here? do you mean mineral dust particles versus volcanic tephra?

Line 5: To accurately measure irregularly shaped dust particles, a calibration routine

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based on standard spheres must be used.

Line 13: The dust has several properties that provide useful information of the past:

Line 15: The observed 100-fold decrease

Page 2 Line 3-4: offering faster measurement speed Line 5: and melted upon a gold coated melt head... Line 9: The Abakus instrument measures the intensity of laser light through a flow cell filled with the sample liquid. Line 10: The Abakus therefore measures the optical extinction cross section of the particle, and can measure particles in the range of 1-15 um. Line 12-13: Can you be more specific or explain more on the depth resolution of 3 mm? Line 14: What do you mean "thicker interval"? Line 17: The SPES instrument measures the extinction cross section (also measured by the Abakus) in addition to the optical thickness of the particles (Potenza et al., 2016). Line 25: Furthermore the ADDA simulations were used to show that the Mie scattering effects on the optical extinction cross-section for spherical particles do not affect ice core dust due to its irregular shape... Line 28: The measured samples are from the Renland Ice Cap Project (RECAP) ice core drilled during the summer of 2015... Line 31: The Holocene dust, similar to the old Renland core (Bory et al., 2003), is dominated by a local East Greenlandic source. Line 33: The volume mode of the glacial dust is 2 um versus 20 um for the Holocene dust, which is likely due to the increased transport size fractionation of glacial dust (Ruth et al., 2003).

Page 3 Line 4: We show here that the non-spherical shape of the particles... Line 15: higher melt rate Line 15-16: The Abakus was connected to the CFA system with a flow rate of 2 mL/min. Line 17: remove "during the measurement campaign." Line 18: ...was clogged by a large particle and required flushing... Line 19: The Abakus was initially calibrated to the diameters of polystyrene beads of 2, 5 and 10 um.

Page 4 Line 4: I'm not sure this sentence is necessary. Line 6: The Coulter Counter measured discrete samples 55 cm in length. Line 6-7: The measured ice consisted of an outer triangular piece 3 x 1 cm in cross section, which was broken lengthwise into

smaller pieces of 10 cm. Line 10: The samples were shaken prior to measurement in the 100 um Coulter Counter. Line 13: Selected samples representative of Holocene and glacial climates were measured by the Coulter Counter for this study. Line 30: please define all parameters in the equation

Page 5 Line 1: You should provide more information about what the extinction diameter actually is before the rest of the paragraph. You talk about it more in section 3.2 but it should really be explained here. Line 2: remove "Besides," Lines 6-8: The two consecutive sentences "For each volumetric diameter, there will therefore be a probability density function of extinction diameter. When the Abakus measures a particle, it gives a specific extinction diameter with a probability given by this probability density function." seem a bit redundant and this can be shortened. Line 8-9: The broadness of the probability density function for non-spherical particles results in a smoothing of the relationship between the extinction and volumetric diameters (Figure 3). Line 9 & 11: I think the word wiggles can be replaced with "scattering" or something like that. Line 12: The average extinction diameter is higher than the volumetric diameter due to the elongated particles measured (discussed further in section 3.4). Line 18: We have measured the diameters of five different. . .

Page 6: Line 1-2: This sentence also seems a bit redundant. . . Line 11-13: To compare the simulations and the data, the average of the logarithm of the simulated optical thickness as a function of extinction cross section was calculated. This average was then used as a least squares fit to the measured data, where the aspect ratio is the variable parameter. Line 13: is the refractive index of ice core dust "n"? That you talk about on page 7 line 2? If so, you should define it here.

Page 7 Line 4: Insert period after "parabolic fit" Line 6-7: The SPES is not sensitive in the full optical thickness range for low and high extinction cross sections, which would introduce a bias when fitting to the simulated data. Line 11: We define the geometric cross section diameter of a particle as. . .

Page 8 Figure 4 caption: delete one of the “log”, should you use “logarithm” instead since you use it throughout the text elsewhere?

Page 10 Line 3-4: The discrepancy between the two instruments is systematic and exists because they measure two different properties of the particles: volume and extinction cross section.

Page 11 Line 7: . . .not the uncertainty of the mean.” Line 9-10: I’m not sure you need to include that information here, I think its more important to talk about RECAP dust provenance. Line 12: Since large ice sheets are located far from typical dust sources, the dust extracted. . .

Page 12 Line 12: Moreover, by determining the aspect ratio, a more accurate size distribution can be obtained from the Abakus data.

I think that you can add a few lines in the conclusion section about what the implications of this research are, how can this model aid in more accurately determining ice core provenance?

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