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Atmospheric Measurement Techniques Discussions

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Interactive comment on "A new method to infer the size, number density, and charge of mesospheric dust from its in situ collection by the DUSTY probe" *by* Ove Havnes et al.

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Overview:

The article presents an interesting method to retrieve the size, charge and number density of dust particle in the mesosphere using measurements from the DUSTY instrument, a Faraday-cup type detector flown on the MAXIDUSTY rocket in 2016. The method utilizes the current collected on the electrically biases grids to estimate the amount of secondary charge current carried by the dust particles as they collide with the grids. This secondary charge current is then used to compute the total dust density, average radius and average charges using results from previous work (Havnes and Naeshiem, 2012) as well as a charging model to provide current balance. The

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Discussion paper

results are then compared to LIDAR and onboard-photometer measurements taken simultaneously. The method is clearly explains and seems convincing.

Specific comments:

- Line 145 (page 6): Why do much of the small negatively charged fragments would be stopped by air friction? This is unclear to me, as air pressure at these heights is very low. Shock-front effects around the rocket still exist, but here were as talking about the inside of the cup.

- Line 182-183 (page 7): Why is the charge on the dust particle proportional to its radius? I would guess, for a perfectly spherical dust particle, that it should be proportional to its area (i.e. radius squared). A reference or more explanations should be added here.

- Line 236-241 (page 9): If I understand correctly the charging model aims at balancing Equation 10 by adjusting the ion density to match the electron density (measured) and dust density (also adjusted but based on measurements). However it seems to me that there are no constrain on the ion density: it would take any value to match the two others. Is this correct? Figure 7 clearly shows that the inferred dust density "compensate" for the electron bite-out, but it seems to me that this implies that the ion density does not vary with heights, and this might not be correct. Does "fixing" the ion density as a function of height (based on models for example) would not better constrain the dust density? Also, is the statement from line 238 to 241 required for the charging model to reach equilibrium? I would tend to think that the rate of electron collision should be higher than the rate of ion collision. In addition, this does not include photoelectric effects, which should affect the dust as well (charging it positively instead of negatively as for electron collision).

- Line 264 (page 10): How was the "adopted background" calculated? I'm guessing the top and middle panels of Figure 3 are already processed/corrected for several effect. A strong background trend can still be seen on G2. I'm wondering where does it come from? And why is it negative below 80 km but then positive after? The zero level of the grid is very important, as it gives the difference between received and emitted currents.

- Line 268 (page 11): In Figure 3. Where is the modulation seen in the background (i.e. below 80 and above 88 km) coming from? Is that shadowing effect due to rotation/coning of the payload affecting the photocurrent emitted by the grid and collected by the base plate?

- Figure 6 (page 15): Why is the charge of the dust always negative? Intuitively one might think the ice particle and dust from the cloud should be positively charged by the UV solar flux. On the other hand, the dust carrying secondary charges from the tribo-electric effect might be negatively charged. It seems that the model only considered negative dust (hence this results I guess), but a comment on this assumption would be good.

- Figure 7 (page 16): It would be interesting to also see the calculated ion density from the charging model in this plot. As previously commented, it seems to me that the ion density and dust density are related in the inference process.

- Lines 414-415 (page 17): The statement that small scale variation are present is not very convincing to me. Yes the LIDAR measurements shows up-down motion of the dust, but on time-scale of about half-an-hour, with spatial scale in the order of one or two km (e.g. between 9.30 and 10.00 in the top panel). Such variation would not be picked up by the rocket, which goes through the cloud in about 5 seconds. On the other hand, the argument that both instruments samples different volume is fine. From it, it might be better to argue that DUSTY picks up smaller scale variation which cannot be observed by the LIDAR.

- Line 417-424 (page 17): It seems the reference values for the secondary efficiency (ns) and radius (rd) are quite important for the model. This parts discuss the effect of changing ns from its reasonable value (50-100) to a higher value but the influence of rd is not discussed. Rd is taken as 50nm, but the LIDAR data shows a smaller average dust radius (∼20nm). What is such value is used in the model? Overall I think it would be interesting to have a figure showing the obtained dust radius, number density and charges for various combination of ns and rd, to better grasp how these assumptions might affect the results.

- Lines 435-436 (page 18): Photoelectric effect is not included in the analysis. I'm guess the design of the probe might mitigate it, as the base-plate is most likely in shadow most of the time. However a statement on how including the photoelectric effect could change the results of the analysis, or if it can be neglected and why, would be good.

Suggestions/minor comments:

- Line 91 (page 3): "...is equipped with electrically biased grids to prevent..."

- Line 93-95 (page 3): A reference would be nice to have to support the statement "The observed currents to the probe were originally..."

- Line 236-241 (page 9): Taking the electron temperature as equal to the neutral temperature (150K) is a fair assumption at these heights. However it would be interesting to see how the results (dust density, radius, charge inferred from it) is affected by 1) a overall larger temperature of the neutral (e.g. 200K) and 2) a larger temperature of electrons compare to ions (e.g. 300 K versus 150 K).

- Figure 6 (Page 15): Increasing the figure and font sizes would be good. Also, what is happening above 86 km? It is not the region of interest for this article, but I'm curious about why the measurements seems so different.

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