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## Interactive comment on "Multi-scale Measurements of Mesospheric Aerosols and Electrons During the MAXIDUSTY Campaign" by Tarjei Antonsen et al.

## Anonymous Referee #1

Received and published: 29 November 2018

This manuscript is about the interpretation of rocket-borne charged particle measurements by Faraday cup detectors and related plasma instruments. The authors go into great detail discussing the signals detected on different electrodes of the instruments. I regard the resulting step-by-step interpretation of the detected signals as sound. However, it does not make this paper easy to read. There is more focus on understanding what the instruments are seeing than on drawing actual geophysical conclusions. This is in line with a number of earlier publication about the interpretation of similar charged particle measurements from sounding rockets. It is certainly important to understand this kind of particle measurements in more detail. However, from a reader's perspective one would hope that at some point focus would shift towards the "bigger picture",

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i.e. the geophysical conclusions that can be drawn from these measurements.

I therefore very much would like to encourage the authors to clearly state in the paper: What are the geophysical research objectives that motivate this paper? What are the new findings of this paper, as compared to earlier publications in the field of charged particle detection? How does this paper bring us closer to drawing conclusions about the geophysics of mesospheric ice and smoke particles? As an example, I would like to point out the last paragraph of the introduction (starting from page 2, line 28). This paragraph very much reads like a Results or Summary section. I would rather like to see that the authors in this part of the introduction clearly state the geophysical questions to be addressed by these rockets flights and by the sets of instruments. Later in the paper, the authors should then return to these questions and state what answers have actually been found ("closure").

As part of providing a "bigger picture", I would like to see several points to be discussed more deeply:

- Several identical detectors (2x DUSTY, 3x MUDD) are flown on each of the two rocket payloads. Comparing their measurements, an important conclusion is that aerodynamic effects are important for the rocket-borne measurement of (small) particles. This is not a new conclusion. Is it possible to make use of having several identical detectors: Can this be used to correct for the aerodynamic effects? Or can this be used to obtain concrete geophysical conclusions? In particular, I wonder about the goal of measuring variability on very short horizontal scales (comparable to the distance of the detectors on the front deck of the payload), as stated e.g. on page 2, lines 30-34. Can this goal be achieved, or is this made impossible by the aerodynamic effects? Much of the discussion in the remainder of the manuscript seems to indicate that the use of several identical detectors does not help us to overcome the aerodynamic obstacles or to arrive at new geophysical conclusions.

- While a major focus of the paper is on understanding the detector signals, still only a

subset of all available measurements (2 payloads carrying 2x DUSTY, 3x MUDD and various plasma probes) is discussed. It would be good to add some statements about those detector signals that are not discussed explicitly. Are they consistent with the major findings of the paper, or are there more aspects?

- A number of issues are not answered as they are "beyond the scope of the current paper". Examples are found ion page 16, line 9-13, page 25, line 15-18, page 25, lines 27-3, and page 26, line 3-4. What is the way forward here? What kind of additional studies would be needed (or are possibly planned)?

I have one other major concern about the paper: A major point of the paper is a detailed comparison of in-situ rocket measurements and simultaneous radar measurements from the ground. In general, the discussion of the various PMSE proxies in section 4.4 is very instructive. However, in order to draw conclusions, it is essential to discuss the actual overlap of the two measurements. Considering the differences in measurement volumes is essential e.g. for the discussion of the PMSE proxies. Given that the radar measurements, is it really possible to draw detailed conclusions about how well different PMSE proxies (based on the rocket measurements) describe the edges of the PMSE region (based on the radar measurements)? The manuscript mentions that the radar data are obtained "along the rocket trajectory" and with an integration time of 2 minutes, but nothing is said about the actual size of the measurement volume over which the radar averages at the altitude of the rocket measurements. Please add this information and a discussion on how this affects the conclusions.

Minor comments:

Abstract: Mention in one of the first sentences that this paper is about sounding rocket experiments.

page 1, line 3: remove comma after "10 cm"

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page 1, line 5: When using the word "anti-correlated", make clear: anti-correlated to what?

page 1, line 14: Considering the size range of smoke particles in the mesosphere, I suggest to replace "from nanometer sized" with ""from sub-nanometer sized".

page 1, line 13: What is meant by "lowers the nucleation threshold"? Threshold in terms of what? A nucleation threshold is usually expressed in terms of temperature. In that sense, this sentence's statement that "low temperature lowers the nucleation threshold" does not really make sense.

page 1, line 19: make clear that this refers to the mesopause region "in summer"

page 2, line 1: Add a comma after "balloons".

page 2, line 1: "... rocket probes are..."

page 2, line15: It is not good style to have a headline numbered 1.1 when there is no 1.2.

page 2, line 28: add space before "MAXIDUSTY"

page 1, line 30: Change the format of the citation. Instead of "(see (Havnes et al., 1996))", write "(see Havnes et al. (1996))" or better simply "(Havnes et al., 1996)". Check also the remainder of the text for similar issues with the citation format!

page 2, line 32: define "very short length scales"

page 3, line 29: Some explanation should be added: Why can secondary charge production on G1 (and G0) be neglected when secondary charge production on G2 is a dominant process?

page 3, line 29: "is" should be "it"

Section 3: Information about the payload attitude is central to this discussion. Information about the rocket spin rate ( $\sim$ 3.8 Hz) and about the angle of attack should be

provided earlier in this section. Also the mentioning of "precession" is confusing: The fact that there is an angle of attack is independent of the question whether there is precession or not. However, if there is precession, the angle of attack will vary periodically over time. Is there such a variation of the angle of attack because of precession? This would be important information for the interpretation of the dat. Please clarify this.

Section 3: The radius determination from the charged particle measurements is central to this discussion. This refers to the manuscript Havnes et al. in this special issue. Is there a reference to an accepted paper by now? If not, the basic ideas behind this size analysis method should be re-stated in the current paper.

Figure 7: Are the large particle sizes shown around the edges of the PMSE layer (z<84 km and z>88 km) real? Or is this an artefact of the size analysis method. What are the uncertainties of this size analysis (error bars) as a function of altitude?

page 7, line 18: remove "ratio between"

Section 4: While the design of the DUSTY detector has been described in detail in this paper, can you provide a reference about the design of the MUDD detector?

page 11, line 22: "reveals" instead of "reveal"

page 15, line10: "This, of course meaning..." is not good grammar and should be changed.

page 19, line 30: "accordingly" should be replaced e.g. by "according to"

page 25, line 2: It is not clear what is meant by "yield a large spread" and "horizontal gradients". Please clarify. Does this refer to variations on the scale of the rocket diameter?

page 25, line 27: "which" should be "where"

page 25, line 30: "... from the front of the payload to the top deck." Clarify: do you mean between the shock front and the top deck?

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page 26, line 24: "show" should be "shows"

page 26, line 32: "it" should be "its"

page 26, line 31-32: This sentence is unclear and probably grammatically wrong. Please rewrite.

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