The manuscript is sometimes imprecise on whether ice particles or dust particles or large dust particles are at focus.

The present work deals with both ice particles and mesospheric smoke particles, referred to as the so-called "mesospheric dust particles" when speaking about both in order to avoid repetitions. Such clarifications will be made in the revised version of the manuscript.

Line 28+ : The PMSE / radar physics are not sufficiently (e.g. turbulence, bragg scale structures) or imprecise described (" wavelength of scattered radars"), particle size might not play a direct role here.

Following the referee comment, the following description has been added to the manuscript : "*PMSE are strong coherent radar echoes that can be observed from around 30 MHz to 300 MHz and sometimes at even higher frequencies (see, e.g.* Rapp and Lübken 2004, Latteck et al. 2021*). The echoes occur at structures in the electron number density that arise from the interplay of atmospheric turbulence and the ice particles. The turbulence spatially structures the ice particle distribution, the charging of the ice particles in turn influences the electron density."*

Line 36: It is mentioned that built-in dust probes are the only way for in-situ composition measurements of these particles, however an honorable mention of mass spectrometers is justified given the fact that mass spectrometers are flown into this atmospheric region since many decades.

A mention of the mass spectrometers has been added to the manuscript where the achievements and the limitations associated to these instruments are described.

Line 46 - 51: The goal for the paper should be described more precise, large dust, large MSP, ice particles, MSP in ice particles? IP abbreviation not introduced.

The present work deals with both sole MSP and MSP embedded in ice particles that are referred to as "ice particles" in that case. IP meant ice particles and this abbreviation will be removed in the revised manuscript.

Figure 1: The simplified drawing for the instrument in the simulation omits the lid completely. It seems as if the lid could have a significant impact on the flow and potential shadowing for certain angles of attack, especially for low apogee (low speed) mission profiles where the angle of attack is higher.

The drawing is indeed simplified because our study cannot consider the influence of the surrounding instrument payload since this is unknown. The angle of attack is also an unknown. We will describe these limitations of the study in the revised manuscript.

Line 74+: The mentioned pressure valve function is unclear: if the instrument opens after nose cone ejection and closes at apogee, how does it maintain the pressure at nose cone ejection in the instrument? Why is it needed at all?

The valve is needed because the pressure in the MESS instrument is reduced before launch. This is to make sure that pressure in the instrument correspond to the ambient pressure when it is opened. Sudden change of the pressure could damage the collection grids. Similarly, the pressure must be adjusted before opening the instrument after recovery. This will be mentioned in the modified text.

Further if the pressure valve is venting the instrument during flight, the "air cushion" formed by the trapped air inside the funnel is considerable smaller as simulated in section 4.1 ?

The valve is solely used for pumping before launch, not during the flight in order to avoid such an unwanted "air cushion". We will modify the manuscript to make this clear.

Line 91: Since it is very unlikely that dust particles, sublimate through background gas collisions, the author means ice particles?

It is indeed a priori very likely that only the ice particles sublimate and the MSP don't sublimate. However, the heating due to the collisions with the background gas is modeled for both ice particles and MSP since the heating may have an influence on the composition. It is a posteriori confirmed by the simulations that only the ice particles sublimate and the MSP don't sublimate, although these latter are heated up to temperatures of about 1000 K.

Line 133: The Knudsen number cannot characterize the mesosphere, as it is a relation between the environment and the length of a characteristic structure (payload or instrument).

The Knudsen number is indeed defined for a given characteristic length. It was implicitly assumed that the characteristic length is the one of the instrument. This is explicitly mentioned in the revised manuscript.

Figure 2: little difference between the 2 panels in the figure, maybe possible to improve.

The two panels aim at illustrating the difference in the fragmentation model for ice particles smaller or larger than 6 nm. For ice particles smaller than 6 nm, only one larger fragment is considered after the collision while for ice particles larger than 6 nm, a 1nm-size MSP is considered in addition to the large fragment. The figure is modified in the revised manuscript to make the difference between the two panels clearer.

Section 3.3: If the section only treats ice particles, this should be made more clear.

Section 3.3 describes the fragmentation model that only applies to the ice particles indeed. This is made clearer in the revised manuscript.

Line 168: the current atmospheric model is called NRLMSISE-00. The given reference is outdated and the name is insufficient but the value seem legit.

We thank the referee for this update. The name of the model is accordingly modified in the revised manuscript.

Figure 3 – 6 : While one figure nicely shows how the shock is formed around the instrument it is quite difficult to assess the simulation results for their numbers, e.g. the number density inside the funnel. A summary plot of a point in the funnel or at point of interest would probably be of more value and reduce the number of figures with rather similar appearance.

In the revised manuscript, an additional plot showing the evolution of the density along the central axis on the instrument for the different altitude and rocket speeds has been added and commented. In order not to overload this section with too many figures, Figure 4 is kept in the main text and Figures 3, 5 and 6 are moved to a new appendix.

Figure 7: The figure is supposed to show particle trajectories from the simulations. As it appears the particle size only gives very trivial cases of a ray-like behavior and does not show how e.g. a particle is trapped or subjected to background collisions.

Figure 7 aims indeed at illustrating the typical trajectory in the instrument. The trapping coming from the reduction in speed and the stop due to the drag force can be seen when the trajectory ends in the middle in the instrument. The background collisions can hardly be seen through the trajectories. The collisions lead to a heating of the particles. For ice particles, the heating leads to a melting of the ice and the ice particles become smaller and, as a consequence, more sensitive to the drag force. For MSP, there is no melting and the MSP trajectories are not affected by the heating.

Line 224: How is the given conclusion be drawn from Figure 7?

This conclusion is made given the trajectories. It is deduced that some particles can be completely slowed down to eventually float in the instrument given the trajectories that ends in the middle of the instrument. It is deduced that other particles can reach the collection area given the trajectories finishing at the bottom of the funnel, corresponding to a height of 6 cm from the bottom of the instrument. The bottom of the funnel corresponds to the entrance of the collection area. Such clarifications will be made in the manuscript.

Line 232: If an initial ice particle splits several times to finally create remnants all below 0.8 nm and thus ultimately is removed from the simulation, would that not remove quite a lot of potential MSP? i.e. underestimate the total collected amount?

It is correct that the current fragmentation model can lose track of a lot of potential MSP if the initial ice particle splits several times. However, such a splitting only happens during a collision with a funnel wall. According to the simulations, the ice particles collide with the funnel walls no more than twice. After two collisions, they are small enough to get efficiently slowed down and eventually float in the instrument. As a consequence, the fragmentation model should not lead to an underestimation of the total collected amount.

In section 4.6 it would be nice to see the assumed particle densities, at least by pointing to a certain figure or maybe even from a reprint of the underlying densities, to evaluate the numbers. Maybe include the ideal case if any particle entering the funnel would be collected, even if the results have a large uncertainty.

The MSP profiles were taken from Baumann et al. 2013 Figure 5. The number density of ice particles is taken from the Kiliani et al. 2015 paper Figure 8. We are aware of the uncertainties and will present an improved estimate. In the revised version we include a new estimate of the collected MSP made during a master thesis project at UiT. With this update, the values are different but remains of the same order of magnitude. We are discussing this with former master student H. Greaker who will be added as a co-author in the revised version.

Line 384: The tilt under an angle of attack can be easily simulated with DS2V using 2D flows, why would you need 3D?

2D simulations can indeed simulate small angle of attack (a few degrees) but it is expected that it does not significantly change the results. For larger angle of attack leading to significant modifications of the results (45 degrees for instance), 3D simulations are required since it becomes necessary to include the lid, the other instruments located next to the MESS instrument and the overall shape of the rocket payload, which is out of the scope of the present work.