We thank the reviewer for the helpful observations and suggestions which have considerably improved the manuscript. We have also taken the opportunity to further refine the text for minor grammatical and typographical issues.

Reviewer 2:

I appreciate the improvements of the manuscript. After rereading the manuscript I do, however, have a few comments.

I noticed that neither the title nor the abstract mentions what kind of ice crystals are captured and characterized for roughness. It is also not necessarily clear from the context, so maybe a mention of "atmospheric cloud ice crystals" or something to this effect would be appropriate.

Response: We have revised both the title and the abstract to explicitly include the term atmospheric, ensuring that the focus of the study is immediately clear to readers.

I still have trouble understanding how the roughness of ice crystals obtained with the optical profilometer compares to the literature values and how it can be used for deriving optical properties of ice crystals. First, the authors do not cite any other values of roughness measured in previous studies. Instead, they more or less put aside all previous measurements by stating "Direct measurement of the surface roughness of ice crystals has been elusive, ..." (line 79 of the revised manuscript). Elusive or not, roughness of atmospherically relevant particles has been measured for mineral dust grains, as cited by the authors (Collier et al., 2016) and for ice crystals grown in SEM (Magee et al., 2014, Butterfield et al., 2017). Second, and most importantly, the dimensional roughness parameters defined in the manuscript by equations 2 and 3 cannot be compared to any previous measurements or to the values used in the optical simulations, because this is not how roughness of ice crystals is represented in light scattering models.

To simulate scattering of light by ice crystals with rough surfaces, roughness has been introduced either as a variation of tilt angles of the patches (facets) on the ice crystal surface, a method originally introduced by (Cox and Munk, 1954) and afterwards extensively used by modelling community (e.g. Yang et al., 2013), or by defining "the correlation length which describes the dominant spatial frequencies, and a standard deviation, which describes the variation in height" (Collier et al., 2016; Ulanowski et al., 2014). I am puzzled why authors have chosen a different, rather technical definition of roughness which is hardly applicable for optical calculations, but the measurement data is undoubtedly still available! With the 3D surface profiles of the formvar replicas and the full analytical power of modern computer software, I am sure this will be a simple exercise to derive one or both roughness metrics from the profilometer data.

I have partly addressed these issues in my review of the original manuscript, but the authors rebutted with the argument that the study is a "proof of concept". From my point of view, however, the "concept" includes showing that the method allows measurements of the parameters needed for optical simulations, as mentioned by authors several times in the manuscript, and I strongly encourage the authors to perform such calculations. Roughness metrics derived in this way would be directly comparable to the data from previous studies and with the values used in optical simulations, thus immediately increasing the potential impact of this manuscript.

For the same reasons the sentence (lines 75-77) “The roughness values obtained from the sand grains were found to be similar to those retrieved by SID-3 for ice crystals, making sand a suitable medium for capturing roughness then applied to scattering models” is misleading because it implies that the roughness (as defined by equations 2 and 3) has been retrieved for both particle types from the SID-3 measurements. This is not so. In fact, the conclusion of roughness similarity between the mineral dust grains (“sand”) and ice crystals has been drawn by comparing diffraction patterns of both particle types measured with SID-3 instrument (Ulanowski et al., 2012; Ulanowski et al., 2014) and then, based on this observations, the roughness parameters obtained from the AFM measurements of “sand” particles (Collier et al., 2016) have been used to model the optical properties of ice crystals. Even then, the surface roughness parameters used in these studies were defined differently: as a combination of a correlation length and standard deviation of heights, both values not directly comparable to definitions given in (Gadelmawla et al., 2002). It is also important to keep in mind (and this is explicitly mentioned in (Collier et al., 2016)) that the similarity of the “scattering pattern derived roughness” holds only for similarly sized grains.

Response: We would like to clarify that we have already taken steps to make this connection explicit in the revised manuscript.

- In lines 68–79, we now provide a fuller discussion of previous studies, citing roughness observations for mineral dust grains (Collier et al., 2016) and for ice crystals measured in SEM (Magee et al., 2014; Butterfield et al., 2017). This section was specifically revised to acknowledge and frame our work within the context of existing literature.
- In lines 95–96, we explicitly state that the profilometer approach can yield roughness metrics directly comparable to those used in optical scattering studies, namely correlation length and height standard deviation (σ). This clarifies that our method is not limited to purely technical roughness descriptors but can provide parameters in the same form as those adopted in previous optical modelling work.
- Finally, in lines 315–326, we present our dimensionless results which was produced by following Collier et al. (2016) and normalized to λ = 532 nm in a table and explicitly compare these values with those reported in prior studies, noting that they fall within the ranges used in light scattering simulations (e.g. Collier et al., 2016; Butterfield et al., 2017).

Together, these additions demonstrate that our measurements are not only proof-of-concept but also provide parameters directly comparable with established metrics, thereby addressing the reviewer’s concern regarding applicability to optical calculations.

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