Response to Anonymous Referee #3

First of all, we thank the referee for submitting helpful and productive comments and annotations, which have led to improvements and clarifications within the revised manuscript, which we submit with this review response.

We have prepared a revised manuscript that addresses the questions and comments of all referees. Furthermore, below we explicitly respond to each of the items raised in the comments of anonymous referee #1. These comments are indicated in *italics,* whereas the author's response is presented in blue. Changes in the manuscript are given in green. The differences are also highlighted in separate PDFs with track changes enabled. All line and page numbers refer to the AMTD manuscript, and not the revised manuscript.

Review of Schrod et al. A view on recent ice-nucleating particle intercomparison studies: Why the uncertainty of the activation conditions matters

This manuscript addresses the uncertainties associated with in situ ice nucleation measurements based on a review of a number of intercomparison studies made over the last ten years. It illustrates how temperature uncertainties can be the result of the large spread in the range of ice nucleation measurements. They calculate these estimated uncertainties as a function of temperature and determine an error Factor (EF). This EF is then evaluated using a number of commonly used parametrizations from the literature. This paper is well written and pleasant to read. It is a very important topic to address and this work will likely contribute to the motivation to generating new measurement guidelines and approaches when comparing instruments.

> We thank the reviewer for their assessment of our manuscript. We do hope that researchers will consider our findings in upcoming instrument intercomparisons or instrument characterizations in general.

However at the end of the manuscript, the impression is that, the current uncertainty in ice nucleation measurements is so great that we cannot rely on these measurements when interpreting particle ice-nucleating properties.

> This is not what we aimed to relay as the message of the manuscript. Rather, we mainly wanted to make researcher more aware of potential uncertainties in their measurement data (e.g., see last paragraph). If temperature uncertainties are large, measurement errors may impede the reliability of the INP data. We hope that our raised questions did not come off as too negative. In fact, we feel that the community is moving forward in great strides, considering the development of new instruments, a larger coverage of observational data in space and time, and more consistent intercomparisons, which we also note in lines 210-211. We still think that raising questions can help the community identify problems and move towards answering unresolved issues.

It would be a useful addition to this manuscript to include a list of recommendations that can be brought forward into future measurements. The community is already striving to reduce the uncertainties in the measurements.

- *Are there some methods that have shown to have smaller uncertainties and more reliable measurements?*
- *Should the community compare similar instruments (same make/model) and avoid comparing different types of ice nucleating measurements?*
- *How can these temperature measurements be improved?*

Adding a list of recommendations could be a great idea. Our final sentence does already recommend to diligently and conservatively characterize temperature (and ice supersaturation) uncertainties in INP instrumentation, which, as the reviewer correctly says, the community of course is already trying to accomplish anyway. Although interesting questions for sure, we don't feel that the three suggested bullet points are a good fit to finishing off of the manuscript however, and we prefer to reply here to reviewer 2 instead.

- We do not intend to evaluate the performance of individual methods or instruments. What we can say from our literature analysis is what is presented in Fig. 1 and Tab. S1: Generally, researchers stated lower temperature uncertainties for DFCS instruments. As we have listed in Section 2, there are arguments that the temperature (and supersaturation) uncertainty may be larger in online INP instruments. As all instruments have strengths and weaknesses, we do not think, however, that one type of instrument is more reliable than another. Having a plethora of methods seems like a great way to tackle the complex study of atmospheric ice nucleation.
- We think that there is merit for both suggestions. When comparing two very similar instruments (maybe even of the same make), you could focus on small details of the general performance, activation conditions measurements, INP counting algorithms, etc. Comparing multiple different methods is also very valuable, when it is assured that they measure the same thing (i.e., both immersion freezing INP concentration at -25°C and water saturation). Consistency of results among multiple independent methods with different working principles gives good confidence in the reliability of the data. Also the strengths (e.g., explorable temperature regime, time resolution) of one instrument may complement the others weaknesses and vice versa.
- We feel that this question is difficult to answer in a general way, as it very much depends on individual instrument specifics. Thus individual research group would know best, how to improve their own instrument. The best advice we can give generally, is what researchers will already know: Make as much measurements of the activation conditions as possible. Make sure that your measurement best represent the conditions where the ice crystals are formed. Do frequent calibrations of your sensors. Be conservative, when estimating uncertainties.