Response to Referee #1

General comments:

"Please clarify whether the new Nevzorov probe featuring a 12 mm cone was developed within your study presented in the manuscript. If so, I consider that as an advantage of your work. Please provide details about the geometry and design of the probe then. If not, please provide information about the producer and whether there were any tests or experiments involving this probe preceding yours."

The sensor head with the 12 mm cone was not developed as part of this study. Instead, it was developed by Environment and Climate Change Canada and manufactured by the Canadian company SkyPhysTech Inc. Prior to this study it has been tested in the Altitude Icing Wind Tunnel of the National Research Council of Canada and was flown during the In-cloud Icing and Large-drop Experiment (ICICLE). As far as we are aware, there have been no publications so far that detail the performance of the Nevzorov probe during these tests. We added the information about the manufacturer and the testing to the manuscript. Furthermore, we added an image which depicts the geometry of the new sensor head.

"Specifically for the purpose of measuring SLD, Environment and Climate Change Canada (ECCC) designed a Nevzorov sensor head with a second, larger total water content (TWC) collector cone with a diameter of 12 mm, which was subsequently produced by the manufacturer of the Nevzorov probe, the Canadian company SkyPhysTech Inc. The new sensor head was tested by ECCC in the Altitude Icing Wind Tunnel of the National Research Council of Canada (Oleskiw et al., 2001; Orchard et al., 2018; Orchard et al.,2019) and employed during the In-cloud Icing and Large-drop Experiment (ICICLE) flight campaign (Bernstein et al., 2021).

Apart from the larger diameter, the interior of the new 12 mm cone also differs from that of the standard, 8 mm Nevzorov cone. In order to increase the heated surface area and to prevent splashing and bouncing of particles, the inside of the 12 mm cone was given a bell-shaped form, such that the cone attains a depth of approximately 14.5 mm. At the inlet, the angle between the interior wall and and the frontal area is 30°, the same as for the 8 mm cone (see Fig. 1). An additional advantage of the new cone is the larger sample area, which provides provides better sampling statistics."

"Section 2 introduces two research projects and three wind tunnel facilities. In my opinion, the information about the facilities is very important in this manuscript. Therefore, the section should focus primarily on the facilities participating in the current study rather than on the scope of broader projects. I suggest emphasizing the capabilities of the wind tunnels which justify their choice in the light of the objectives of this study and the differences between the wind tunnels which explain the advantage of using three facilities instead of one."

We added information on how we selected the participating wind tunnel facilities. More information on the facilities itself can be found in the corresponding publications, e.g. Ferschitz et al. (2017), Breitfuss et al. (2019), Lang et al. (2021) for RTA, Herman et al. (2006) for Collins and Bansemer et al. (2018) and Knop et al. (2021) for the BIWT. Due to confidentiality reasons, we are unfortunately not able to publish additional information on the spray systems of the individual tunnels.

"We selected these three IWTs for this study, because taken together they are able to produce a very large range of icing conditions with distinctively different spray systems (e.g. rotating nozzles for the production of freezing rain at RTA (Breitfuss et al. 2019)). The usage of three wind tunnels also helps us to mitigate the influence of possible biases that are just present in one facility. Another criteria for the selection of the wind tunnels was the requirement to have DSDs available for all test points.”

“Please explain the choice of conditions for your test cases. As stated in section 4, many of them lie outside the range specified in Appendix C and Appendix 0 and some even feature above-zero temperatures. Is such a choice motivated by the limitations of the droplet generation systems, the limitations due to sampling statistics, the intention to explore the region outside Appendix 0 to allow for a possible extension of icing safety standards in the future?”

The IWT campaigns were part of EU-projects that have the goal to test and characterize newly developed sensors (SENS4ICE) and to develop tools for the 3D simulation of SLD and snow icing conditions (ICE GENESIS). DLR was tasked to validate the wind tunnel conditions through measurements with the Nevzorov (and in some tunnels also with the CCP). Generally, the wind tunnel owners aim at creating realistic icing conditions. Most of the SDS test points were therefore intended to cover the Appendix C icing envelopes. A few of the test SDS test points at larger MVD (e.g. Collins test points C19-C30) were run specifically to characterize the collision efficiency of the Nevzorov probe. The choice of FZDZ and FZRA conditions was mostly dictated by the droplet spray systems of the wind tunnels. The generation of FZDZ and FZRA was developed or improved as part of the Sens4Ice and ICEGENESIS projects. The ultimate goal of the wind tunnel owners is to produce icing conditions that fall into the region of Appendix O. However, the large amount of water contained in SLD makes it very difficult to adhere to the LWC requirements of Appendix O while preserving uniformity (in space and time) of the droplet spray. The examined test points represent the conditions which were regarded as the most suitable under consideration of the low LWC – spray uniformity tradeoff by the wind tunnel owners. We added this information to the manuscript. Above zero temperatures were used in a few cases to avoid ice accretion and thereby make the most economic use of the wind tunnel time, as the droplet spray is assumed to be independent of temperature. Nonetheless, even above zero temperatures can be useful for icing applications, for example if the freezing of raindrops on a structure that is colder than zero degrees is investigated.

“The SDS conditions were selected in a way that large portions of the Appendix C icing envelopes were covered. Additional SDS test points at MVDs beyond 40 µm were measured in order to characterize the collision efficiency of the Nevzorov probe at larger droplet sizes.

The FZDZ conditions vary significantly between the tunnels. The examined FZDZ test points represent the set of conditions which were attainable with the spray system of the tunnel and regarded as suitable under consideration of the trade-off between low LWC and preservation of icing cloud uniformity.”

“MVD is not a particularly meaningful measure in the case of bimodal DSD, as you pointed out in section 7. Therefore, I suggest additionally including (e.g. in Table 3, at least for bimodal cases) the parameter you actually used to distinguish between FZDZ and FZRA, i.e. the diameter corresponding to the position of the maximum of the largest mode in LWC distribution. For unimodal cases, it is presumably close to MVD because the only mode is obviously the largest one. However, for bimodal cases it might give useful information concerning SLD in the DSD.”

We added the diameter that corresponds to the position of the maximum of the large droplet mode to Table 3 for the bimodal cases.

See Table 3.

“Figures 5, 6, 8. The range of the vertical axis is inappropriate for the presented results. Please refine the range accordingly so that the differences in position between the datapoints are visible.”

We adjusted the range of the vertical axis for the figures mentioned.

See Figures 6, 7, 9.

Specific Comments:

“Line 11. The sentence implies that the form of the curve was experimentally derived. I suggest mentioning that a specific function was assumed.”

We added the information that a specific function was used.

“…we experimentally derive a collision efficiency curve that is based on a suitable functional form for the new 12 mm cone…”

“Line 113. Did you actually use Eq. (3) instead of Korolev’s value? Please specify.”

The value from Eq. 2 and 3 was used, we added an explanatory sentence to the paragraph.

“… is indeed an underestimate for IWT conditions, hence L* is determined from Eq. (2) and (3) in this study.”

“Line 124. Which particular collection efficiencies from the literature did you use for the 8 mm cone in your analysis? Please specify and provide relevant references.”

We used the curves from Strapp et al. (2003) to correct the 8 mm TWC cone measurements. We applied the correction from the curve which matched the actual tunnel velocity best, i.e. for the measurements at 40, 60 and 67 ms^{-1} we used the curve for 67 ms^{-1}, for the measurements at 85 ms^{-1} we used the curve for 100 ms^{-1}. We added this information to the manuscript.

“Collision efficiency curves of the 8 mm cone have been published by Strapp (2003) for velocities of 67 and 100 m/s based on a 2-D fluid simulation. We use the curve for the velocity value which matches the actual tunnel velocity best to correct the 8 mm cone measurements.”

“Section 4.1 and 4.2. At RTA, there were multiple reference instruments applied to measure LWC and DSD. How are those measurements combined to produce final estimates? With a similar procedure as you described for CDP and CIP? And what sampling statistics is considered sufficient while selecting the threshold size (line 180)? Did you follow any method described in the literature?”

RTA produced its size distribution from the mean of the cumulative distribution that was calculated from the Malvern probe data and the cumulative distribution that was computed from the FCDP-2DS-PIP combination. For the CDP-CIP combination we required that at least one particle of a size bin is measured every five seconds, otherwise we considered the particle count in this bin to be too small and switched to the CIP size distribution. Assuming Poisson statistics and the minimum time of 1.5 minutes that was used to record a size distribution, this yields a maximum uncertainty of 24% in that respective bin. In most cases, size distributions were recorded over at least four minutes, which reduces the maximum uncertainty in the last bin of the CDP due to sampling statistics to 14%.

“Section 4.3. As far as I understand, the estimated uncertainties of LWC measurements are valid only in the size range corresponding to Appendix C conditions, i.e. small droplets. Did you find any quantitative information about the uncertainties in SLD conditions?”

Unfortunately, we are not able to quantify the uncertainties in SLD conditions. Referring to an extended discussion of the uncertainties of the Nevzorov probe, that we now included in the Appendix, we note, that neither the intrinsic uncertainties of Nevzorov probe nor the uncertainties in the convective heat loss term depend on the type of droplet spray that is produced. Errors related to the collision efficiency of droplets will even be smaller in SLD conditions than in SDS conditions, because the collision efficiency of SLD is essentially 100%. In our opinion, there are two factors that increase the uncertainties in SLD conditions: First, the effect of droplet splashing is unknown. The Nevzorov sensors were designed to mitigate splashing effects. On the basis of high-speed camera images, Korolev et al. (2013) claim that the amount of ice particles which bounce from the 8 mm cone is small. The design of the new 12 mm cone is even better than that of the 8 mm cone for retaining ice particles and droplets. All this suggests, that the influence of droplet splashing effects is rather small, but at this point we cannot quantify the exact magnitude. The second source of uncertainty is caused by high frequency flutter of the sensor head around its axis of rotation, which was observed to be significantly stronger during SLD conditions with high LWC than in SDS conditions. This flutter led to (very short term) deflections of the sensor head of up to ±20°. The change in sample area caused by the flutter is however just a few percent.

Appendix A:

“In SLD conditions, further measurement uncertainties are introduced due to the possibility of droplet splashing. However, the Nevzorov sensors were designed to mitigate splashing effects. On the basis of high-speed camera images, Korolev et al. (2013) claim that the amount of ice particles which bounce from the 8 mm cone is small. The design of the new 12 mm cone is even better than that of the 8 mm cone for retaining ice particles and droplets. This suggests, that the influence of droplet splashing effects is rather small, but at this point we cannot quantify the exact magnitude. A second source of uncertainty in SLD conditions is caused by high frequency flutter of the sensor head around its axis of rotation, which was observed to be significantly stronger during SLD conditions with high LWC than in SDS conditions. This flutter led to (very short term) deflections of the sensor head of up to 20°. The change in sample area caused by the flutter is however just a few percent. We note that the previously mentioned uncertainty sources, which affect the Nevzorov probe in general, are not increased in SLD conditions compared to SDS conditions. In fact, the uncertainty of the collision efficiency in SLD conditions is very close to zero, as the collision efficiency of SLD is essentially 100%.”

“Line 191. I assume here you give an estimate of the uncertainty of LWC measurements with a 8 mm collector cone. Please clarify.”

The ±15% provided in the text were a rough estimate for both the LWC sensor and the 8 mm cone that was estimated on the basis of the convective heat losses that we observed and the accuracy estimates from the manufacturer of the probe. In response to your comment we performed a more thorough estimation of the measurement uncertainties, which can now be found in the Appendix.

“We performed a detailed investigation of the error sources in the Nevzorov probe measurements in Appendix A. The uncertainty values strongly depend on LWC, MVD, temperature, airspeed and the sensor that is considered. For the SDS measurements presented in this study, the uncertainties of the 8 mm cone and the 12 mm cone can be expected to be below ±11% and ±15% once the MVD exceeds 20 µm. Measurements of the LWC sensor are estimated to be accurate within ±15% for MVDs between

10 and 20 µm. We note that our uncertainties are in fairly good agreement with those stated in (Korolev et al. 1998b)."

"Section 4.4. The number of test points documents extensive experimental work. Please consider whether it would be helpful for the reader to conceive the range of conditions explored if the test points and the regimes (SDS, FZDZ, FZRA) are illustrated in a figure, e.g. a scatter plot LWC vs. diameter of the largest mode (the parameter mentioned above in general comment #4 which you used to distinguish between FZDZ and FZRA). The overall LWC limits of Appendix C and Appendix 0 can then be marked for the respective regimes."

We thank the reviewer for this suggestion, we added a plot which depicts the different test points as a function of LWC, MVD and the icing regime.

See Figure 4.

"Lines 258-259 and Fig. 4. What collision efficiency correction did you use? Please provide a reference. Is such a selection of the sensor depending on MVD recommended in existing literature? If so, please cite a relevant source."

We used the collision efficiencies from Langmuir et al. (1946) for the LWC sensor and from Strapp et al. (2003) for the 8 mm TWC cone. An explanation regarding the applied collision efficiencies has been added to section 3. The justification for using the LWC sensor up to an MVD of 20 µm is derived from Schwarzenboeck et al. (2009) which states: "A maximum in $\varepsilon_{LWC,droplets}$ is reached roughly around 20–30 μm, indicating that droplets smaller than 20–30 μm partly tend to curve around the LWC sensor, whereas larger ones impact with decreasing efficiencies related to a loss in droplet mass. $\varepsilon_{LWC,droplets}$ rapidly starts to decrease (with increasing droplet size) beginning at droplet sizes beyond 30–40 μm."

"Table 5. Providing a 2 sigma interval is rather unusual. Typically, just 1 sigma is reported and it is understood in the context of estimated standard deviation of the distribution of the results. This remark regards reporting of uncertainties and does not interfere with the point you make in line 285 where even the 3 sigma test criterion can be applied."

We now report the 1 sigma interval for the parameter D_0.

See Table 5.

"Line 286. Please specify explicitly how you calculate LWC_12. Is it just measured LWC multiplied by a factor f(MVD) or does the computation involve DSD spectrum?"

The collision efficiency used for LWC_{12} was computed using the full DSD. We added a sentence which clarifies this.

"For all measurements the collision efficiency was computed using the full DSD."

"Line 304. How do you know that droplet coincidence was present? Is it simply implied by the high droplet concentration?"

Droplet coincidence was detected through an analysis of particle transit times. We added a section in the Appendix which describes the analysis that we performed.

See Appendix B.

"Section 7. I suggest modifying the section title to mark contrast to section 6, e.g. ‹Application of collision efficiencies in bimodal SLD conditions› or similarly."

We changed the section title as you suggested, thank you for the nice proposal.

See Section 7.

"Lines 350-354 and Figure 8. Please specify explicitly whether those results were obtained by applying the MVD approximation or by resolving the entire DSD."

Again, the full DSD was used to compute LWC_{12} and LWC_8. A sentence clarifying this was added to the paragraph above.

"As a consequence of the findings presented above, we use the full DSD as input to the collision efficiency function when computing LWC_{12} and LWC_8 in bimodal distributions."

"Table 6. The values of epsilon_12 are not explained and commented on in the text. Do they result from the integration of DSDs multiplied by collision efficiency curve or represent a value f(MVD) of MVD approximation? If the latter, please explain why they do not agree with Fig. 4."

The values of ε_{12} are derived using the full DSD. We modified Eq. 9, so that this is apparent now.

"… multiplied by the overall collision efficiency of the 12 mm cone (ε_{12}), see Eq. (9)."

Minor issues:

"Please ensure the consistency and specificity among symbols.

- K is used for thermal conductivity and the droplet inertia parameter.
- T is used for temperature and test points.
- Droplet diameter is denoted by d and D.
- S is used for sensor surface and sum of squared residuals."

- TP is now used to denote the test points.
- RSS is now used to denote the sum of squared residuals.
- The symbol for the velocity in Eq. 7 and 8 was changed from V_∞ to U to be consistent with Eq. 4 and 6.
- The droplet diameter is now uniformly denoted as d.
- The thermal conductivity of air is now denoted as kappa.
- The collector sensor sample area is uniformly denoted as S_c.

“Line 9. Please rewrite the sentence so that it is clear whether Hotwire is a part of the Nevzorov probe or a separate instrument.”

“We obtained a comprehensive data set of measurements from the LWC, 8 mm cone and 12 mm cone sensor of the Nevzorov probe and from the tunnel reference instrumentation”

“Line 33. “than” is missing.”

Corrected.

“and those with an overall MVD larger than 40 µm …”

“Lines 34 and 36. I assume “they” refers to the last citation given in the text. Then another citation at the end of the sentence is confusing. Please be specific about which reference you mean.”

Lines 34 and 36: The publication “Characterization of Aircraft Icing Environments with Supercooled Large Drops for Application to Commercial Aircraft Certification” by Cober and Isaac (2012) is largely based on the FAA report “Data and Analysis for the Development of an Engineering Standard for Supercooled Large Drop Conditions” by Cober et al. (2009) and the statements in lines 30-37 can be derived from either publication. We agree with the reviewer that the citations in lines 35 and 37 were confusing and hence removed them, now it should be clear that the findings originated from the 2009 FAA report by Cober et al.

The references in lines 34 and 36 were removed.

“Line 86. “PSD” was not defined. I suppose you mean “DSD” here.”

Yes, this should read DSD.

“…in combination with the DSD measurements…”

“Line 94. There should be a dot instead of a colon or a part of the sentence is missing.”

We replaced the colon with a dot.

“… the Nevzorov contains two types of sensors. Collector sensors are …”

“Line 117 and Eq. (6). Please use either S_c or S for the collector sensor area.”

S_c is now used for the sensor sample area.

“Here, W denotes the water content of the air, S_c is the sensor sample area, …”

“Lines 173 and 176. I suppose “from” is not needed.”

We removed “from”.

"The CDP detects droplets in the size range 2-50 µm and outputs data in bins with 1-2 µm bin width. We applied a size binning for liquid droplets based on a laboratory calibration to the lower end of the CDP size range in order to consider ambiguities caused by the Mie resonances (Lance et al., 2010; Rosenberg et al., 2012).

The CIP measures particles in the size range 15-950 µm with a size resolution of 15 µm."

"Table 3. The last FZDZ record for BIWT. Should the temperature be +5 deg or a star is erroneously given here?"

The temperature was -5°C, the star was erroneously given and has been removed.

"Line 250. According to Table 4, Group 1 contains measurements from two wind tunnels. Please clarify."

Group 1 contains measurements from two wind tunnels as stated in Table 4. The sentence in line 250 has been corrected.

"Group 1 contains measurements at 40 m/s from Collins and the BIWT, Group 2 contains measurements at 60 and 67 m/s from Collins and RTA and Group 3 contains measurements at 85 m/s from Collins. The measurements in Group 2 differ in airspeed by 7 m/s. We group these measurements together because we assume that the gain in accuracy of the collision efficiency curve that we obtain from using more measurements outweighs the inaccuracy that we induce by not differentiating between the air speeds."

"Line 278. Just an integer index j is enough to denote the test points. The summation goes then from j=1 to n. "

Changed.

See Eq. 11.

Response to Alexei Korolev (Referee #2)

1. "One of the problems of microphysical measurements in icing wind tunnels is the spatial nonuniformity of sprays across the test section. This may result in biases of MVD and/or LWC measurements conducted by different instruments if their sampling volumes are positioned at different locations. To mitigate this problem, researchers usually attempt to mount instruments in the same location when conducting comparisons of different instruments or calibrations. The authors briefly mentioned this problem. However, it is not clear what was the of the spatial inhomogeneity of the wind tunnel sprays and what was its effect on the biases of the Nevzorov measurements. Did authors attempted to estimate LWC biases between the LWC, TWC8 and TWC12 Nevzorov sensors due to the sensors spatial separation, by moving the Nevzorov sensor up and down (right and left)? Do you have any estimates of spatial inhomogeneity for each wind tunnel? Such discussion would be beneficial for the paper."

We generally attempted to measure the droplet spray at the same position with all sensors. However, as you mention, this is not possible for all the Nevzorov sensors, due to their spatial separation. At the BIWT, we therefore performed traverse measurements to find an area with a homogeneous spray distribution. The area that we determined (which extended from the lowermost Nevzorov sensor to the uppermost Nevzorov sensor) had an LWC homogeneity of ±3% in bimodal conditions. Collins also provided information on its tunnel inhomogeneity which shows that within the area spanned by the Nevzorov sensors, both the small droplet spray and the FZDZ spray are uniform within ±10%. For RTA, uniformity measurements presented in Breitfuss et al. (2019) and further internal tunnel calibrations show that LWC deviations in the center of the tunnel cross section where the Nevzorov sensors were positioned are no larger than ±5% for both FZDZ and FZRA conditions.

"Further uncertainty is introduced into the measurements due to the different mounting positions of the instruments. Differences in the mounting positions are especially problematic when the spray homogeneity is poor, as is often the case in SLD conditions (Ferschitz et al., 2017; Orchard et al., 2018). In this study, we generally attempted to measure at the same position with all our instruments. However, this was not always possible, either due to constraints from the wind tunnel or due to the inherent spatial separation of sensors on the same instrument, e.g. on the CCP, the CDP and CIP sample volumes are separated by approximately 13.5 cm and on the Nevzorov probe the LWC sensor and the 12 mm cone are positioned approximately 2 cm above and below the 8 mm cone respectively. In the BIWT, we established from traverse measurements in bimodal conditions, that the LWC in the area where the Nevzorov sensor head was placed was homogeneous within ±3%. The CIP sample volume was positioned in the same area. The CDP was positioned outside of this area, but we assume that the small droplet spray that is measured by the CDP is evenly distributed across the wind tunnel cross section. At Collins, the Nevzorov probe was mounted horizontally in the wind tunnel, such that all its sensors measured at the same height. Collins provided information, that the SDS and the FZDZ conditions are uniform within ±10% in the area spanned by the Nevzorov sensors. Due to mounting constraints in the wind tunnel, the measurement location of the Nevzorov was 45 cm downstream of the WCM-2000 calibration position. Assuming Stokes law, the sedimentation of a 100 µm diameter droplet over this distance is just 0.2 cm, but for a 400 µm diameter droplet it is almost 3 cm. The sample position may therefore have had a minor influence on the measured LWC at Collins. For RTA, uniformity measurements presented in Breitfuss et al. (2019) as well as further internal tunnel calibrations show that LWC deviations between the locations of the Hotwire, the 8 mm cone and the 12 mm cone are no larger than ±5% in FZDZ and in FZRA conditions."

2. "It would be relevant indicating that the sensor head employed in this study was designed by the Environment and Climate Change Canada (ECCC) and manufactured by SkyPhysTech Inc. This sensor was tested by ECCC in the NRC AIWT wind tunnel and then used during the InCloud ICing and Large drop Experiment (ICICLE) flight operation for characterisation of icing cloud environment."

We agree that information on the manufacturer and testing prior to our study is important and we added the provided information to the manuscript.

"Specifically for the purpose of measuring SLD, Environment and Climate Change Canada (ECCC) designed a Nevzorov sensor head with a second, larger total water content (TWC) collector cone with a diameter of 12 mm, which was subsequently produced by the manufacturer of the Nevzorov probe, the Canadian company SkyPhysTech Inc. The new sensor head was tested by ECCC in the Altitude Icing Wind Tunnel of the National Research Council of Canada (Oleskiw et al., 2001; Orchard et al., 2018; Orchard et al.,2019) and employed during the In-cloud Icing and Large-drop Experiment (ICICLE) flight campaign (Bernstein et al., 2021)."

3. “It appears that the authors refer to the LWC sensor as “Hotwire” throughout the text. In fact, “hotwires” are a class of sensors/instruments used for measurements of condensed water content. However, the term “hotwire” is equally applicable to the 8mm and 12mm cone TWC sensors as well. For that reason, statements, like “…*for the Hotwire and the 8 mm cone*…” sound confusing. It would be reasonable to use conventional names of the hotwire sensors, i.e. “LWC sensor” when applied to a cylindrical hot-wire sensor, and “TWC 8mm (or 12mm) cone” when talking about the TWC 8mm (or 12mm) hotwire cone sensors.”

We agree that the name “Hotwire” is misleading and replaced the term by “LWC sensor” throughout the text.

4. “Line 178: Korolev at al. (1998a) was focused on studies of the formation of diffraction images of spherical particles in OAPS. However, it did not discuss size corrections of out-of-focus droplet images. This problem was studied in Korolev (2007). Therefore, Korolev at al. (1998a) should be replaced by Korolev (2007). (Korolev, A. 2007: Reconstruction of the Sizes of Spherical Particles from Their Shadow Images. Part I: Theoretical Considerations. *Journal of Atmospheric and Oceanic Technology,* **24**, 376–389. https://doi.org/10.1175/JTECH1980.1)”

Thank you for pointing this out, we changed the reference according to your suggestion.

5. “Page 6: It is worth mentioning that the average value L*=2580 J g-1 in Korolev et al. 1998a was obtained for a different set of ranges of temperatures and pressures as compared to this study.”

We added a sentence that explains that the value of 2580 J/g was derived for aircraft measurements where different temperatures and pressures prevail.

“Korolev et al. (1998) state a value of 2580 J/g as a good average for the value of L*, however this value was suggested for aircraft measurements where temperature and pressure differ from that in an IWT.”

6. “It is worth providing a brief geometrical description of the Nevzorov TWC 8mm and 12mm cones, i.e. inverted cones with the apex angle 60deg and the depths of the cones (~7mm and ~10.4mm).”

We added a figure which details the dimensions of the new Nevzorov sensor head.

See Figure 1.