RESPONSE TO THE REVIEWS (MANUSCRIPT ESSD-2026-192)

Dear Reviewers,

Thank you for your comprehensive and thoughtful review of our manuscript. We appreciate the time you invested in providing feedback, which has been very helpful in improving the overall clarity and quality of this research.

We have carefully considered all the points raised and have incorporated your suggestions into the revised manuscript. We believe these changes have significantly strengthened the paper and addressed the areas requiring further refinement. Our point-by-point responses are provided in the following, with referee comments in blue and our responses in black.

Kind regards,

Deniz Menekay

Point-by-point response to Referee 1's comments:

Overall this is an excellent article, paving the way for many more articles using the SENS4ICE-EU data set. In addition, the discussions of the various probe measurements and error sources can be used by researchers using other studies. The campaign used the SAFIRE ATR 42 research aircraft, collecting data with a focus on supercooled liquid water regions, with some mixed-phase and ice-only regions. Southern France was chosen as the location of the measurements because of the relatively "clean" conditions and the presence of supercooled liquid water regions. A minimum altitude of 8000 feet was chosen as a safety measure, in case the aircraft iced up and had to shed the liquid water. Fifteen flights were conducted, and the flight conditions for each are well described.

We thank you for these encouraging comments and for their positive feedback on our work. We are pleased that the reviewer found the manuscript well-written and our dataset to be of significant importance to the field.

Primary Comments

1. I did not find a discussion of the air motions. These are very important to understand the microphysical variations and the cause of the SLD.

We agree with the referee that air motions provide important context for interpreting the observed microphysical variability and the occurrence of SLD conditions. We have therefore added a new figure showing the distribution of vertical wind speed during cloud encounters and also added a short discussion at the end of Section 6.

The figure also highlights the subset fulfilling Appendix O icing conditions. The positive tail of the distribution shows that some cloud regions were associated with enhanced upward motion, which can promote condensational growth and support the maintenance of supercooled liquid water. We also note that the Appendix O subset follows a similar distribution, suggesting that SLD conditions were not limited to the strongest updrafts but occurred over a range of dynamical conditions.

2. A reference for the Robust Hotwire Probe would be helpful

A reference for the Robust Hotwire Probe was already provided in the first paragraph of Sect. 4.4, line 160. However, the previous reference was a user guide. To provide a more accessible and appropriate reference, we have replaced it with the product webpage of the WCM-3000 Robust Water Content System from the manufacturer of the instrument.

3. Figure 3 is very helpful. It would be good to show where the horizontal and vertical winds are measured.

Thank you! As the wind measurements are derived from the five-hole radome around the nose, it is a bit complicated to show on the figure. However, I added a description of how the horizontal and vertical winds are derived in section 4 (Line 98-100).

4. Line 134 with a larger sample volume. I feel the following is extremely important as it will help other researchers. I suggest showing a figure with the size and the associated sample volume for each of the probes.

We thank the referee for the suggestion. We agree that the sample volume is important for understanding the complementarity of the probes. However, we did not include a separate figure. As the depth of field is dependent on size and we used several different coefficients to define the depth of field in the CIP data analysis, a figure could be misleading and would go beyond the scope of this data description paper. We therefore revised the text to clarify that the PIP has a larger effective sampling volume than the CIP due to its wider probe geometry, and that this is particularly relevant for larger hydrometeors, which occur at lower number concentrations.

5. 225 Using 2D data analysis script. This needs to be discussed why the given script was chosen.

We have revised the paragraph to clarify the reason for using the in-house 2D particle image analysis software. The revised text now explains that the software described in Kirschler (2023) provides an extended set of image-derived particle parameters, such as Poisson-spot size, aspect ratio at each grayscale level, and particle sphericity. These parameters allow a more detailed discrimination between droplets, ice particles, and image artefacts, which is particularly important for the reliable identification of SLDs in this study.

6. Figure 5 is very helpful.

Thank you for your kind feedback!

Very minor. Line 214. Artifacts

Thank you for pointing this out. We have retained the spelling “artefacts” to maintain consistency with British English throughout the manuscript.

Point-by-point response to Referee 2's comments:

Review of "An airborne in-situ dataset of cloud microphysical properties in supercooled large droplet icing conditions" by Menekay et al., submitted to *ESSD*. This manuscript presents a valuable and rare in-situ cloud microphysical dataset collected during the SENS4ICE-EU campaign, focusing on supercooled liquid and mixed-phase clouds, including supercooled large droplet (SLD) conditions. The dataset is well-documented, adheres to FAIR principles, and has clear potential for applications in aircraft icing research, model evaluation, and sensor development. However, several methodological and transparency issues need to be addressed before the paper is suitable for publication. The main concerns relate to uncertainty characterization, the reliability of ice-phase measurements, reproducibility, and the representativeness of the sampling strategy.

We thank the referee for the positive assessment of the dataset and for recognizing its potential value for aircraft icing research, model evaluation, and sensor development. We also appreciate the constructive comments regarding uncertainty characterization, ice-phase measurements, reproducibility, and sampling representativeness.

Major Comments

1. The reported uncertainties (e.g., 10–100% for OAP counting, ~50% for sizing) are too broad and lack dependence on particle size, phase, or concentration. Furthermore, it is unclear whether the stated 20% counting uncertainty and 50% sizing uncertainty are intended as absolute values or relative errors.

We thank the referee for this comment. We have revised the paragraph to clarify that the reported uncertainty values are relative uncertainties, not absolute errors. We now also state that these values should be interpreted as representative estimates for the processed dataset rather than as size-resolved uncertainty estimates. We clarify that OAP uncertainties depend on particle size, phase, concentration, particle shape, image quality, and processing method, and that relative sizing uncertainties are expected to be larger for smaller particles and for irregular ice particles. We also gave more details on applied corrections in the previous section where data evaluation is explained.

2. Ice properties are derived from OAP images using shape-based phase discrimination, but no quantitative assessment of ice shattering effects is provided.

We agree that shattering may affect OAP-derived ice-particle properties and that this should be stated more clearly. In the present processing, no interarrival-time-based shattering correction was applied. This is because the dataset focuses on supercooled liquid and mixed-phase conditions, where small shattered ice fragments can be difficult to distinguish from real cloud droplets. Instead, the processing relies on image-based filtering, which makes it difficult to identify shattered ice fragments and make a quantitative assessment.

3. The merging thresholds (43 µm between CDP and CIP; 600 µm between CIP and PIP) are empirically chosen. A discussion is needed on how uncertainties at these size thresholds propagate into integral parameters.

We agree that the choice of merging thresholds should be better justified. We have revised the text to clarify that the thresholds were not chosen arbitrarily, but based on objective instrumental and processing constraints. The CDP–CIP threshold of 43 µm was selected because the CIP has a resolution of 15 µm, and particles smaller than three pixels are associated with larger sizing and depth-of-field uncertainties. Therefore, the lowest two CIP bins were excluded. The CIP–PIP threshold of 600 µm was selected to avoid using PIP images with fewer than six pixels, while also avoiding the reduced sampling statistics of the CIP for particles larger than approximately half of the CIP array width.

Regarding the propagation into integral parameters, the largest sensitivity at the CDP–CIP transition is expected for number concentration, because this parameter is dominated by small particles. The effect on mass-related quantities such as LWC, MVD, and ED is expected to be smaller at this transition because particle mass scales with the third power of diameter. In contrast, uncertainties at the CIP–PIP transition can have a larger influence on mass-weighted quantities and characteristic diameters, but only when a substantial fraction of the particle mass is located near or above the transition diameter. In the present dataset, the selected thresholds mainly affect the transition between probes and do not change the overall interpretation of the derived integral parameters. We have added a clarification of the threshold selection to the manuscript.

Minor Comments

1. Please provide an explanation for Figure 1(a).

“(a)” is now mentioned in the caption next to the description.

2. In Figure 2, land and ocean should be clearly distinguished, and a legend should be included.

We have increased the contrast between land and ocean in Fig. 2 and clarified the meaning of the colours in the caption. In addition, the flight track colours have been adjusted to make the individual flights easier to distinguish. The flight numbers are shown in the legend.

3. For Figure 6, please explain the reason for the sudden drop in observation counts at certain temperature intervals.

The sudden drop in observation counts at the warmer temperature intervals is mainly caused by the limited number of measurements above approximately −3 °C. In addition, Figure 6 only includes in-cloud measurements, so data points are counted only when cloud particles were detected. Therefore, temperature intervals with little in-cloud sampling, especially above −3 °C, naturally show a strong decrease in observation counts.

4. The link https://doi.org/10.17616/R39Q0T does not appear to correspond directly to the dataset described in this manuscript.

We thank the referee for pointing this out. The DOI https://doi.org/10.17616/R39Q0T refers to the HALO database rather than to a mission- or dataset-specific landing page. At present, HALO-DB does not provide individual DOIs for specific missions or datasets. To avoid ambiguity, we have revised the data availability statement to explicitly identify the SENS4ICE-EU mission in HALO-DB, including the mission number, and to list the individual dataset IDs corresponding to each data product. We believe that this provides a direct and unambiguous route to the datasets used in the manuscript despite the absence of mission-specific DOIs in HALO-DB.