Supplementary Information

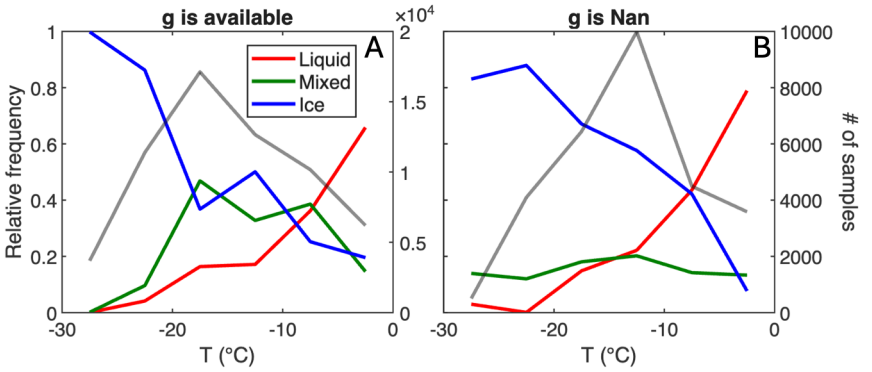


Figure S1: Normalized cloud phase occurrence frequency for liquid, mixed and ice phase samples when the asymmetry parameter from the Polar Nephelometer is available (A) and not available (B). Results are shown for different temperatures binned at 5°C.

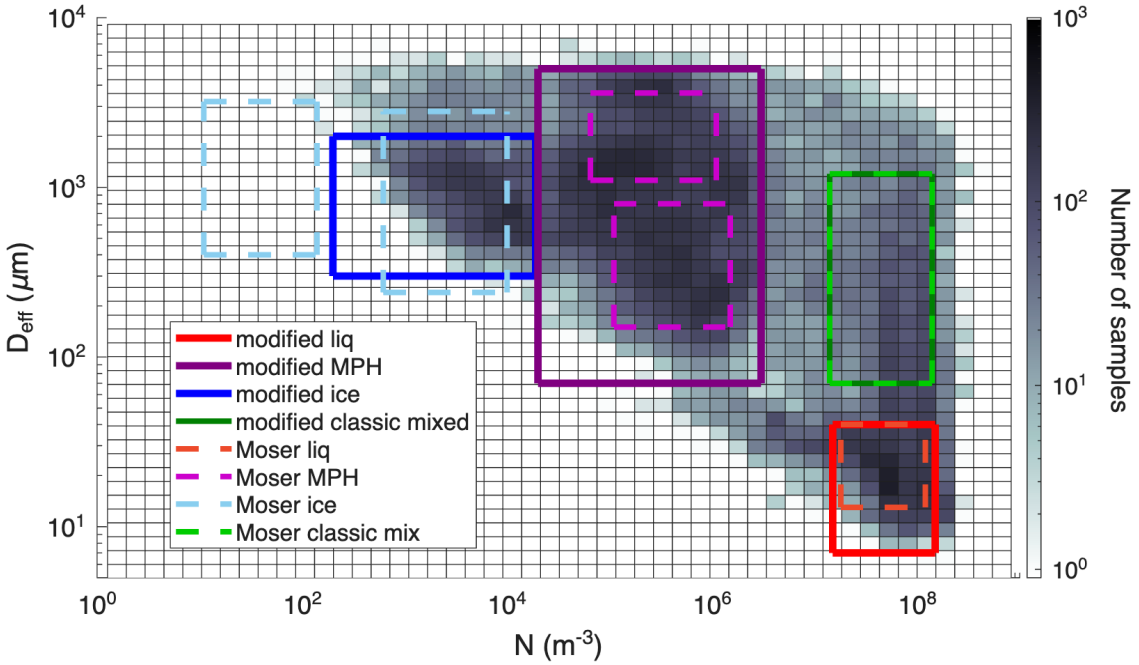


Figure S2: Joint histogram of 1 Hz cloud samples relating total particle concentration (N) and the effective diameter (D_{eff}). Samples within the colored boxes having solid lines are labelled as their respective cloud phase types used in this study (red boxes: liquid phase; green boxes: mixed phase; ice phase: blue boxes). Boxes with dashed lines show samples bounded following Moser et al. (2023, 2026). Note that the purple mode is

mixed phase haze (MPH), reclassifying a mixed phase category following Moser et al. (2026).

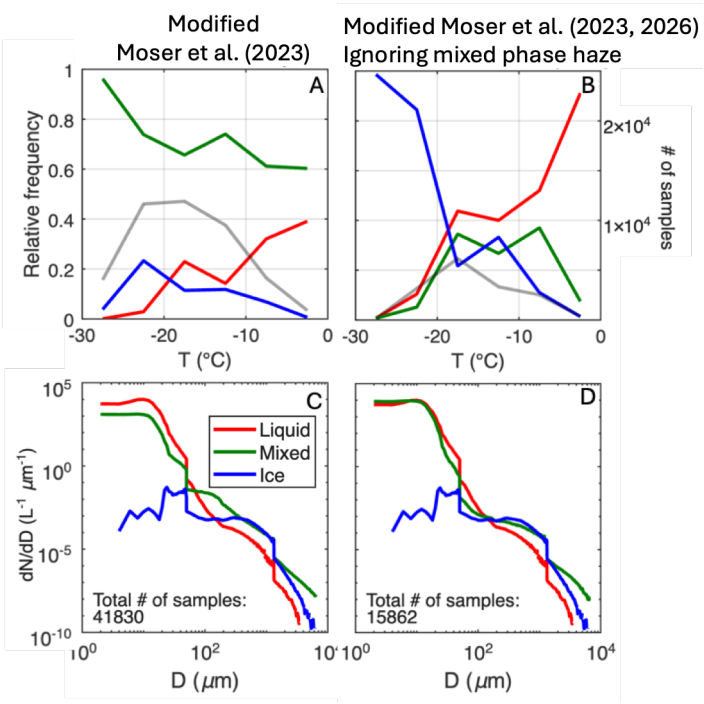


Figure S3: Columns are similar to those in Figure 4 in the main text, except the left column is the modified Moser et al. (2023) which considers mixed phase haze as mixed phase (rather than ice). The right column is similar except mixed phase haze samples are ignored (i.e., ignoring modes 2A&B in Supplementary Figure 2).

Moser et al. (2026) distinguishes the mixed phase samples from the green box and the purple box in Figure S2. The former is associated with what he calls “classical” mixed phase clouds, whereas the latter refers to what is defined to be “mixed phase haze.” This mode consists of ice crystals and the presence of small, deliquesced aerosols. Due to its distinct characteristics, alternative approaches of evaluating the Moser et al. (2023) are

provided here. Panels A&C consider this MPH category as mixed phase, following Moser et al. (2023). Panels B&D remove the mixed phase haze samples altogether.

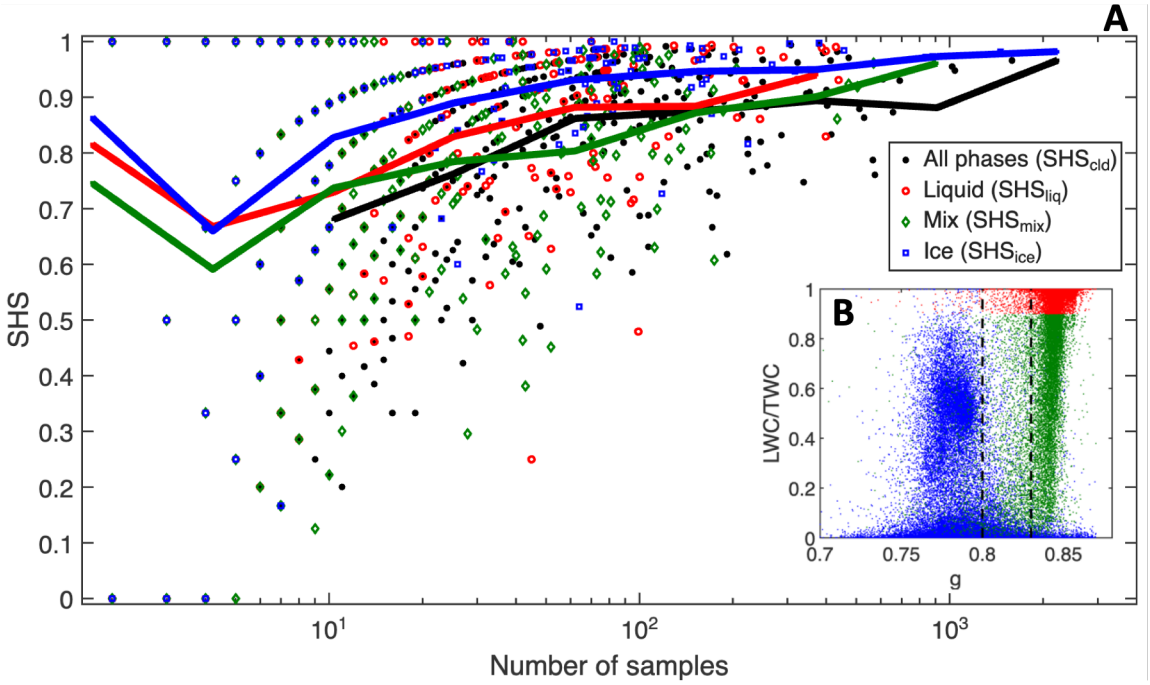


Figure S4: A) Similar to Figure 5B, but the proposed methodology has an additional condition which converts mixed phase samples having LWC/TWC>0.9 to liquid phase. B) Similar to 3C, but converting the mixed phase samples with LWC/TWC>0.9 to liquid phase.

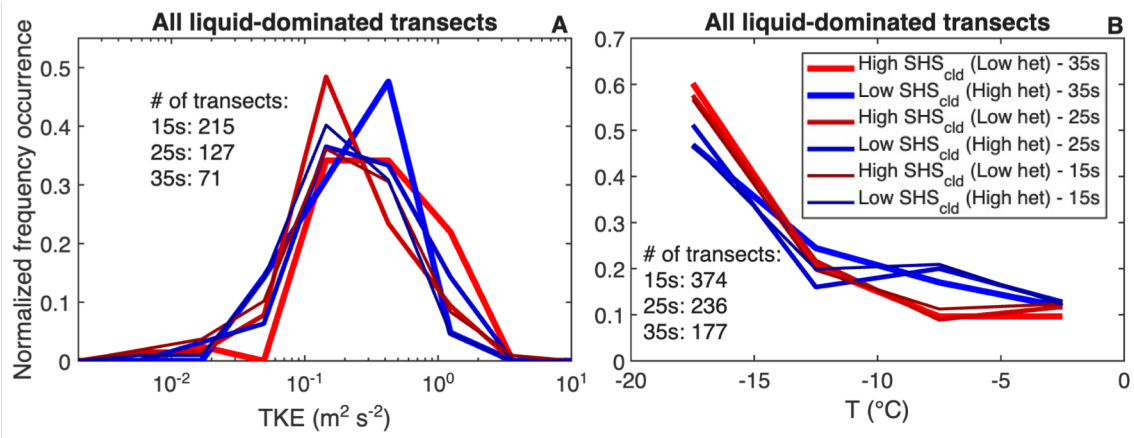


Figure S5: Similar to Figure 12A&B, except results are shown for measurements determined at coarser length scales. Results are restricted to temperatures within -20°–0°C. The exact methodology is shown as below:

1. Find all transects having identical cloud phase occurrence frequencies.
2. Separate these transects into those with high spatial heterogeneity (*SHS*<50th percentile) and those with low spatial heterogeneity (*SHS*>50th percentile). Collect the transect averaged temperatures and *TKE* measurements computed over the entire transect.
3. Repeat steps 1. and 2. for all possible combinations of cloud phase occurrence frequencies, and display the results as normalized frequency distributions.

Bibliography:

Moser, M., Voigt, C., Jurkat-Witschas, T., Hahn, V., Mioche, G., Jourdan, O., et al. (2023). Microphysical and thermodynamic phase analyses of Arctic low-level clouds measured above the sea ice and the open ocean in spring and summer. *Atmospheric Chemistry and Physics*, *23*(13), 7257–7280. https://doi.org/10.5194/acp-23-7257-2023

Moser, M., Voigt, C., Eppers, O., Lucke, J., De La Torre Castro, E., Mayer, J., et al. (2026). The Arctic Low-Level Mixed-Phase Haze Regime and its Microphysical Differences to Mixed-Phase Clouds. *Atmospheric Chemistry and Physics*, *26*(3), 1867–1887. https://doi.org/10.5194/acp-26-1867-2026