Reviewer responses are highlighted in blue, and changes made to the manuscript are marked in red for ease of reference.

1. The novelty of the study is never stated, but to me is the geographic region of the study- few studies have been published, at least in English, of stratiform vs convective clouds in the northern China region. That said, the microphysical evolution described in the paper conforms to studies in similar cloud systems in other regions of the world, some of which the authors refer to in their intro.

1. The authors fail to relate their findings to past studies. There is no discussion section after the analyses are presented. What is unique about this study that makes it a novel contribution to the literature? How do the findings relate to past work regarding microphysical evolution in stratiform vs convective regions? This is what is missing in this paper, and should be developed if the editor decides to return the paper for major revisions.

Re: The WRF results (L. 306–340) in Sec. 4.1 have been removed from the main text and are now provided in the appendices, while the content previously in Sec. 4.2 has been merged into Sec. 4.1. Specifically, we have deleted the subsection title at L. 342 and removed the phrase "as well as the uneven vertical resolution in the WRF model" at L. 343. The numbering of Fig. 14 has been updated accordingly to Fig. 11. Specifically, we have deleted the subsection title at L. 342 and removed the phrase "as well as the uneven vertical resolution in the WRF model" at L. 343. The numbering of Fig. 14 has been updated accordingly to Fig. 11.

Additionally, we have included a new section on the sensitivity experiments, which is now designated as Sec. 4.2. Please refer to the file "SensitivityExperiment.pdf" included in the submitted ZIP package. for details. The introductory discussion of Sec. 5 Summary and Conclusion (L. 414–422) has also been revised as follows:

Current research on stratiform clouds with embedded convection is mostly based on observational data and Eulerian numerical simulations. The study on cloud physical processes often focuses on the temperature layer below 0 °C or the ML, and there is limited research that connects both the two layers and precipitation processes (Hou et al., 2021; Hu et al., 2025). As the Lagrangian method of the McSnow model has unique advantages in studying the ice-phase process (Bringi et al., 2020; Delafrance et al., 2024), demonstrating good simulation results for the microphysical evolution of ice particles. Research on the spectral parameters of ice-phase particles in stratiform clouds remains limited. Previous studies primarily focused on raindrop size distribution, such as the gamma distribution analyses in stratiform and convective regions by Caracciolo et al. (2006) and Niu et al. (2010), and the investigation of particle size evolution in cirrus and stratiform precipitating clouds by Heymsfield et al. (2002). Xiong et al. (2023) had examined the present case but using a two-parameter negative exponential distribution. Additionally, the effects of supercooled water content and supercooled layer thickness on particle size spectra have rarely been explored. This paper studies a precipitation case of stratocumulus clouds on 22 May 2017, using aircraft measurements and weather radar data. By combining the WRF-SBM and McSnow numerical simulations, a deeper understanding of the microphysical evolution of ice particles in different cloud regions of stratocumulus clouds has been achieved. The following conclusions are drawn:

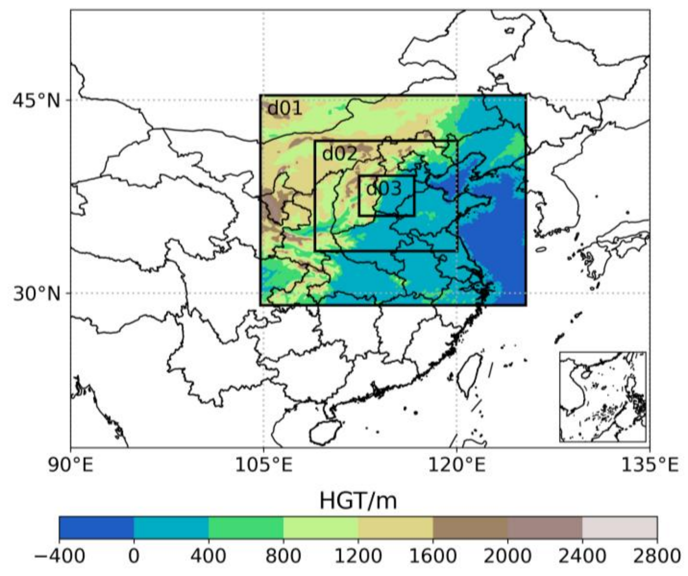
Item (2) in the conclusion (L. 434–443) has been removed, and the original item (3) has been renumbered as (2). The new item (3) has been rewritten as follows:

(3) The sensitivity experiments reveal that variations in supercooled water content (SLWC) and supercooled layer thickness (SLWLT) significantly influence the riming growth and size distribution of ice-phase particles. Increasing both SLWC and SLWLT enhances rimed snow within the 100–1000 μm range and slightly increases rimed crystal concentrations, while reducing the abundance of particles larger than 1000 μm. Decreases in SLWC and SLWLT lead to fewer rimed particles overall but favor the formation of larger rimed snow due to reduced secondary ice production. SR respond more strongly to these changes than CR, and rimed snow is generally more sensitive than rimed crystals. Gamma distribution fitting shows that spectral parameters (N_0, μ, λ) vary mainly between 2000 m and 5500 m, with N_0 highly responsive to SLWC changes. The impacts of decreasing SLWC and SLWLT are stronger than increases, particularly in SR, highlighting its dominant role in riming processes.

2. The figures need a lot of work to make them easier to understand. Specifically:

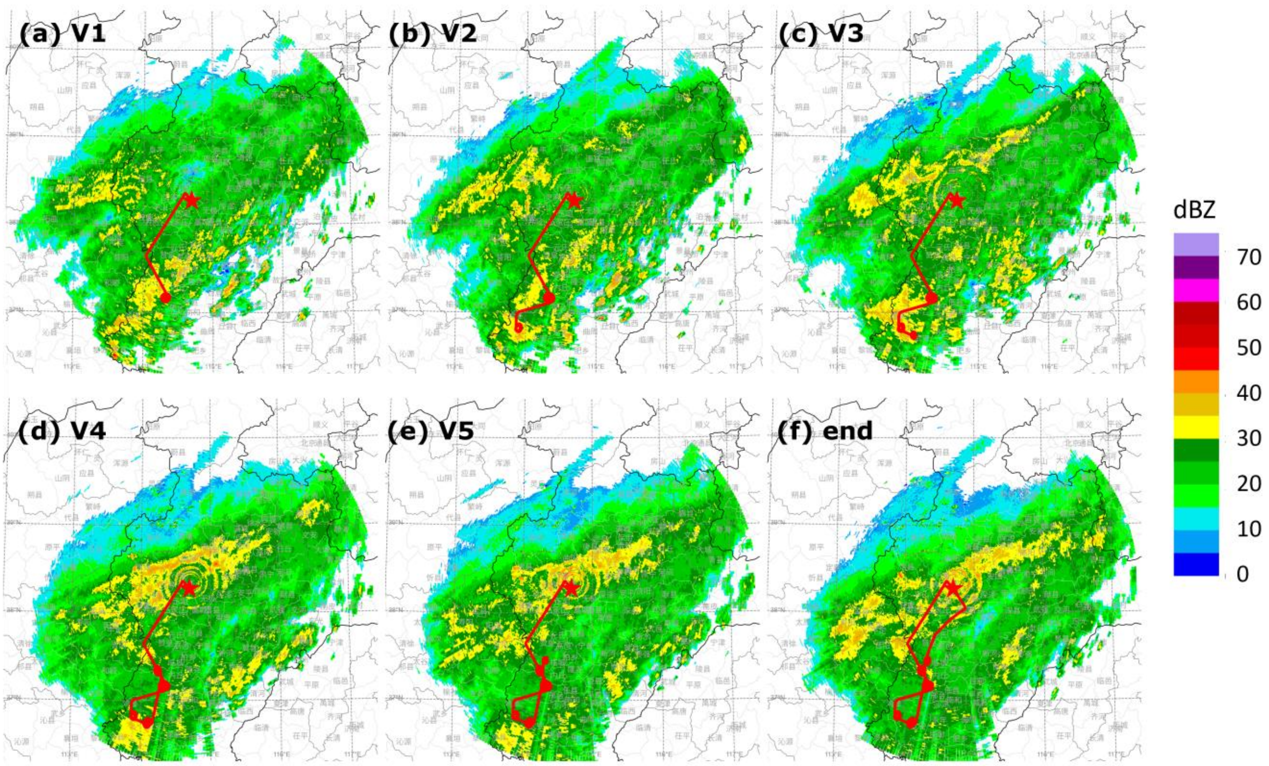
- Figure 2: An inset of where this is in China would be helpful. International readers would have no idea where this is within the country.

  Re: Fig. 2 has been revised as follows:



- The flight track is hard to see in Fig. 3, and the reflectivity scale numbers are microscopic. You only need one scale and you can make it large with readable text. A white instead of black background wound enhance the figure.

  Re：Fig. 3 has been revised as follows:



- Figure 4 needs a temperature scale. Without it, it is hard to make any sense of the other data. I can't make any sense of which dots are which on the first panel, and the data on vertical wind are all a jumble on the last panel. Why not show each spiral separately. Make a 4 by

5 panel figure. The vertical motions look pretty much the same in all spirals (+3 to -3 m/s). How do you know there was convection? I would think the vertical motions would be very different in the stratiform vs convective regions. Maybe if they were plotted separately, they might differentiate better? The table does show some differentiation, but the convection is pretty weak for a mid-May storm.

Re: Fig. 4 has been revised as follows:

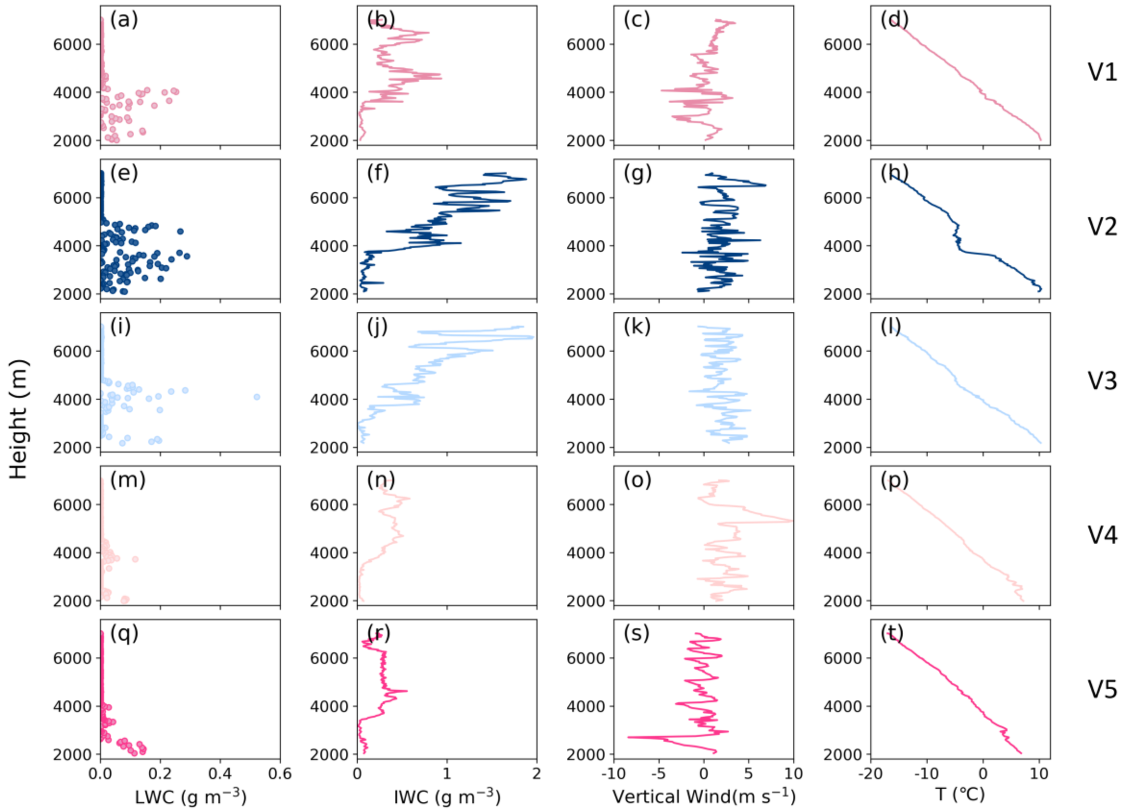
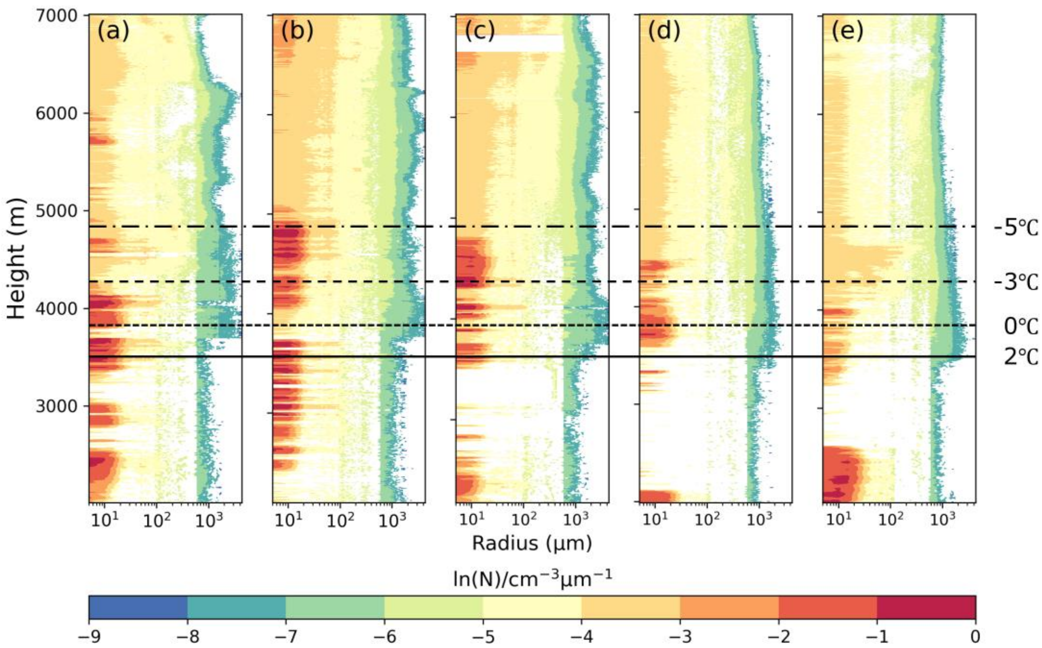


Figure 4 Vertical distributions of LWC, IWC, vertical wind speed, and temperature with height, where each column represents a different physical variable and each row corresponds to a different flight.

The primary criterion for distinguishing between the convective and stratiform regions is based on a combination of radar reflectivity and precipitation intensity, following the classification approach used in Hou et al. (2021). We acknowledge that there may indeed be potential biases in the measurement of updrafts.

- Figure 5: Radius, not Radium. Because the diagrams are small and cover 2.5 orders of magnitude on the x axis, the first four look pretty much the same to me at altitude above 2C. There is more differentiation at altitudes below 2C.

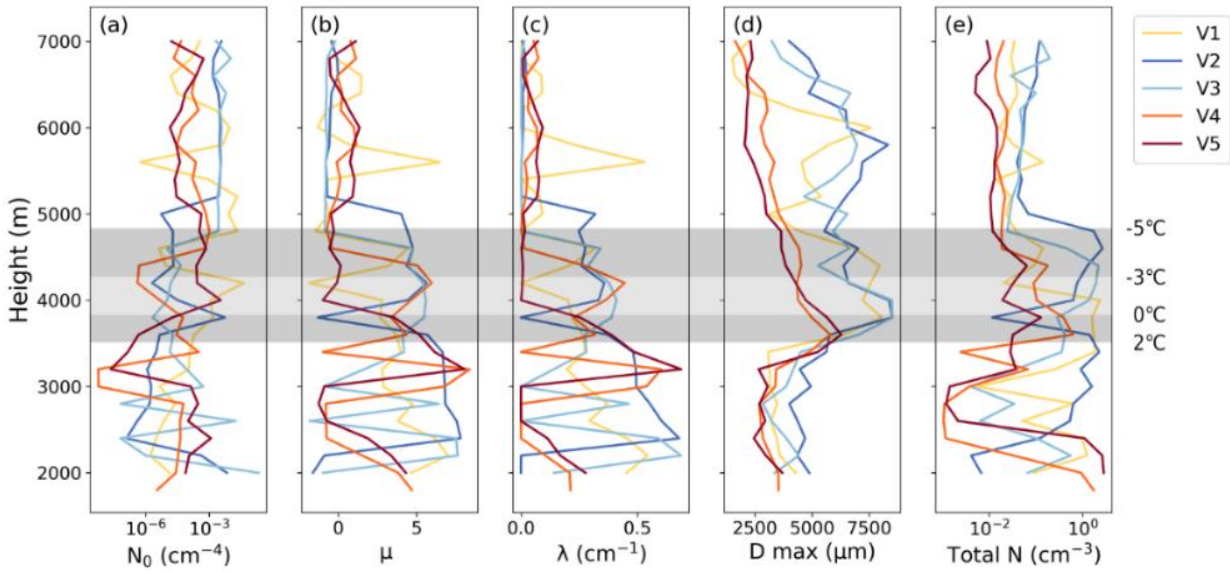
Re: Fig. 5 has been revised as follows:



We apologize for the small figures in the previous submission. This issue occurred because the images were not properly enlarged when converting the manuscript to PDF. Since observational data below the 2 °C isotherm are incomplete and not the main focus of this study, we did not conduct a further detailed discussion on this part.

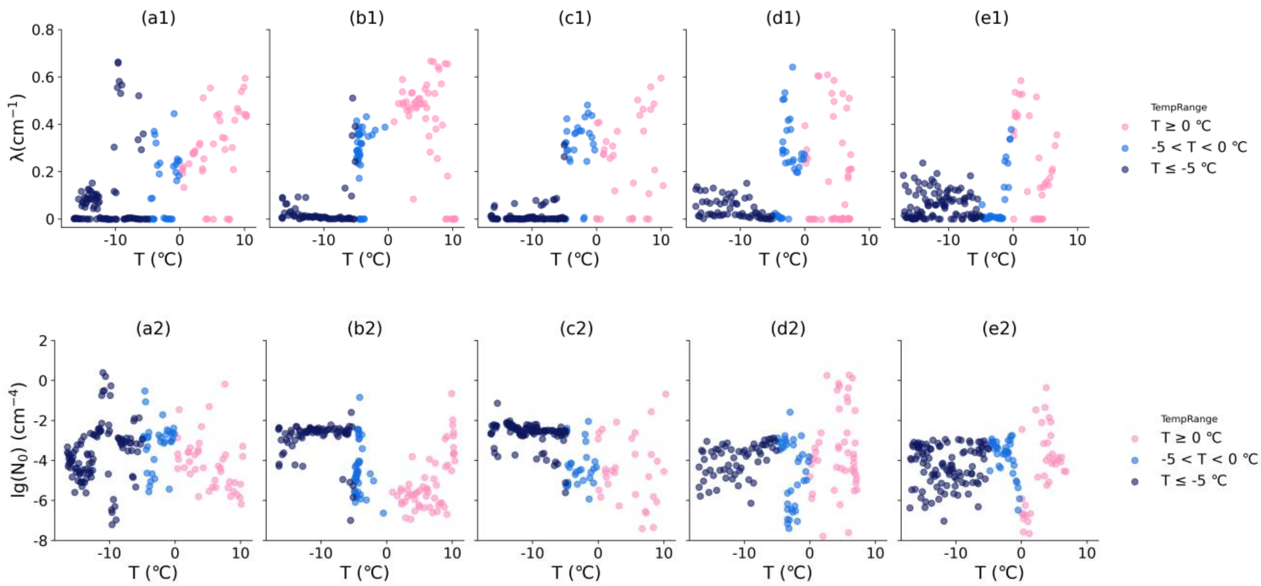
- 6: The many lines on each panel criss-cross so many times that I had a hard time making sense out of any of it

Re：Regarding Fig. 6, we could not find a better way to present the results. The gamma distribution parameters vary significantly with height, especially below the melting layer. Therefore, we have provided an enlarged version of the figure for better visibility:



- 7 shows the gamma distribution fit parameters for different points on the spiral descents for three temperature ranges. For most of the panels, the data are scattered quite a bit. Linear fit equations are given as a function of temperature in each panel for the three temperature ranges, but to me, the data are anything but linear. How good are these fits? What is the point of the fit equations if the data are not a linear function of temperature to begin with? How are these fit equations supposed to be used? There is no discussion of the application of all these fit equations. What is the point of the fits?

  Re: We agree that the spectral parameters and temperature could potentially allow for a linear fit. However, the purpose of this part of the analysis is to highlight the trend of parameter variations with temperature. Therefore, we decided to remove the linear fitting lines from the revised manuscript:



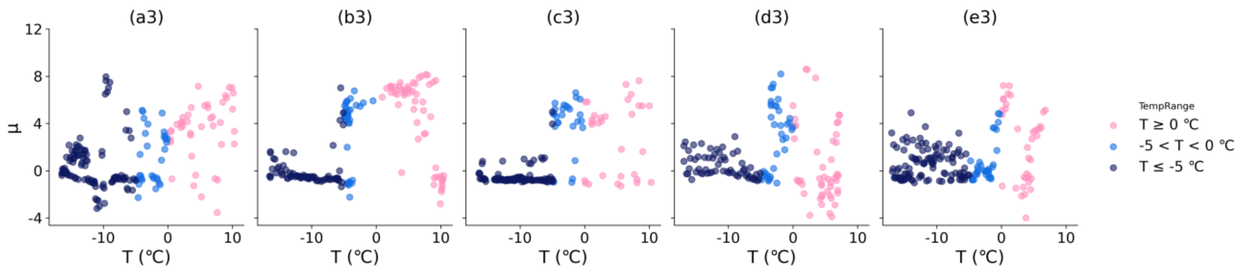


Figure 7 Distribution of the Gamma distribution spectral parameters with temperature. Each row of subplots shows the distribution relationships (scatter points) of *λ*, lg(*N₀*), and *μ* with temperature *T*. (a) to (e) represent different flights. The different temperature intervals (< 0 ℃, -5 to 0 ℃ and ⩾ 0 ℃) are represented by different colors.

In addition, we have removed the statements in L. 245 "(although the slope of the fitted line for V2 is negative, it still shows an increasing trend)" and in L. 248 "with low confidence level of the fitting"to improve clarity and consistency.

We have added an explanation at the end of L. 257:

"The relationship can provide useful references and potential applications for future improvements in parameterization, such as in refining the simulation of ice particle size distributions." to clarify the usage.

15: There are so many particle size distributions on the tiny figures, that it is difficult to make sense out of them.

Re: Fig. 15–17 have been split into four separate figures due to the structural adjustments made in the earlier sections. Their numbering has been updated to Fig. 12–15. The revised figures and their corresponding captions are provided below.

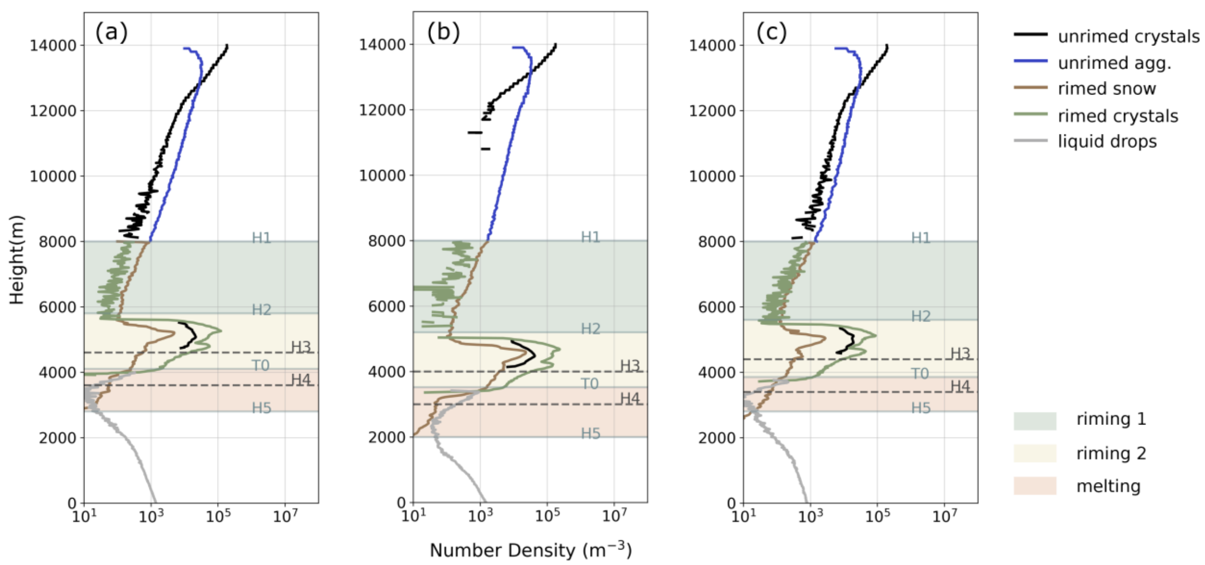


Figure 12 The vertical profiles of number concentration for the five particle types in three regions. The three height intervals defined by H1-H5 correspond to the following main physical processes: riming (H1-H2, green), intensified riming (H2-T0, yellow), and melting (T0-H5, orange).

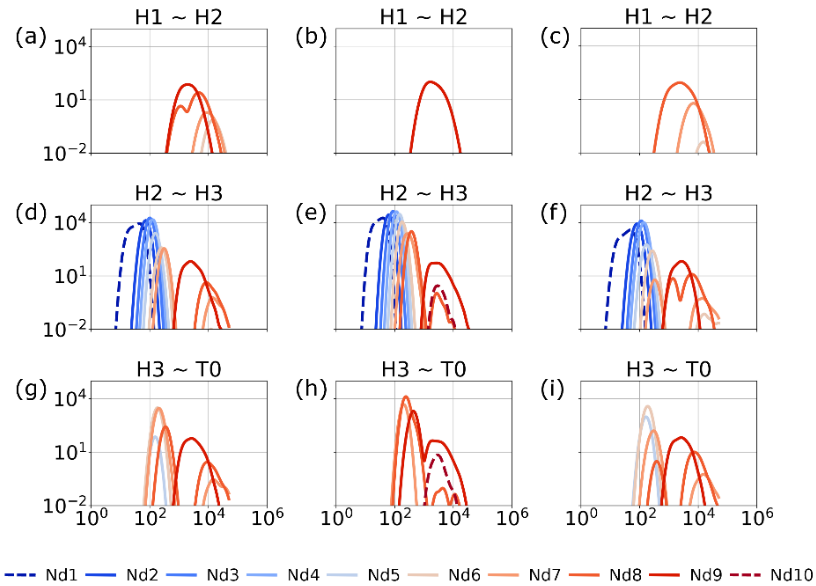


Figure 13 The particle spectra distribution within each height layer for region A, B and C (each column from left to right respectively). The subplots (a)–(c) represent the riming 1 layer (as in Fig12), while the subplots (d)–(i) represent the riming 2 layer. The spectra is categorized into 10 bins (Nd1–Nd10) based on different rime fraction, represented using different colors. The horizontal axis represents particle radius (μm), and the vertical axis represents number concentration (kg⁻¹). The rime fraction fraction bins for Nd1–Nd10 are divided as follows: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9.

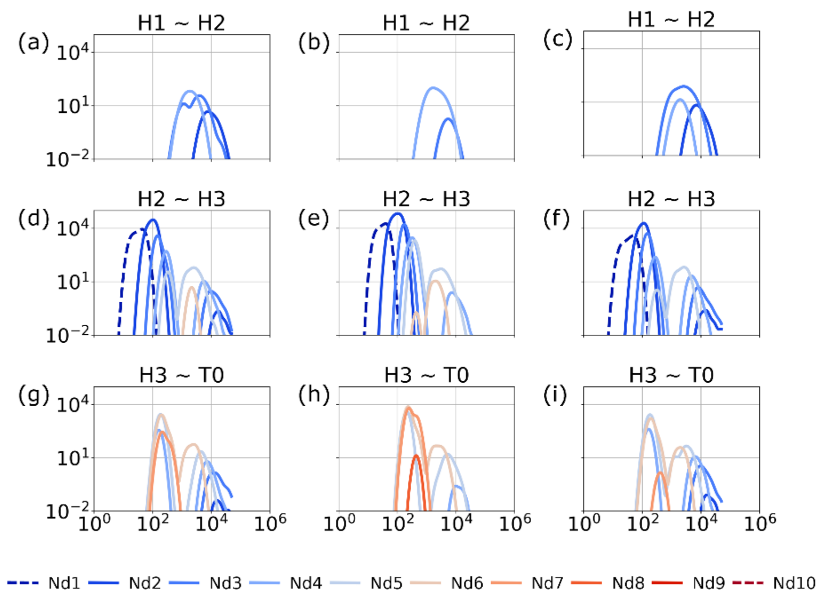


Figure 14 Similar to Fig. 13, but categorized based on different rime density: 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6 (g cm-³), respectively.

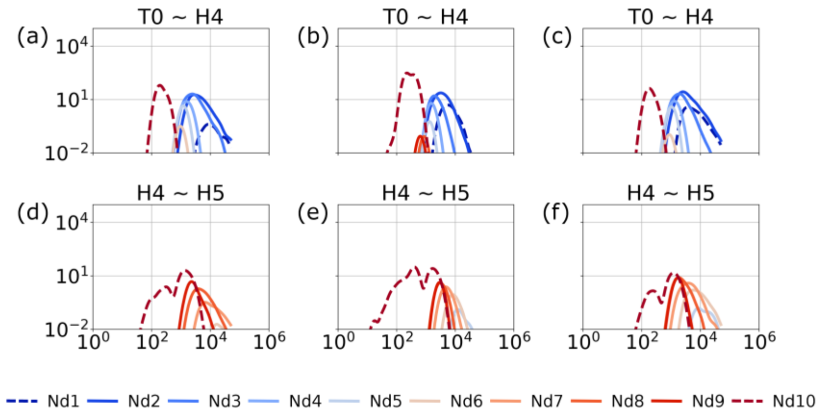


Figure 15 Similar to Fig. 13, but categorized based on different melt fraction: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, respectively. The spectrum are for the melting layer (as in Fig 12).

Line 354-360 has been revised as follows:

The McSnow simulation results for region A, B and C are shown in Fig. 12-15. Figure 12 shows the vertical profiles of number concentration for the five particle types (unrimed crystals, unrimed aggregates, rimed snow, rimed crystals, and liquid drops) in three regions. The three height intervals defined by H1-H5 correspond to the following main physical processes: moderate riming (riming 1, H1-H2, green), intensified riming (riming 2, H2-T0, yellow), and melting (T0-H5, orange). The layer from H1 to T0 is the supercooled water layer, and the region above H1 is the aggregation layer for ice crystals and snow. Additionally, H4 represents the turning height of the liquid drop curve, while H5 marks the height at which rimed snow nearly disappears. Figures 13-15 show the particle size distributions within each altitude layer in Fig. 15, where the particles are classified into ten categories (Nd1–Nd10) based on different riming ratios, rime densities, and melting ratios, respectively.

Line 370-399 has been revised as follows:

In all three regions (A, B, and C), crystal and aggregate particles formed by ice crystal collisions above H1 level fall into the supercooled water region (H1-T0), starting the riming process. Particles with a rime fraction ≤ 0.2 are classified as light rimed (Nd1-Nd2), those with a fraction > 0.8 as heavily rimed (Nd9-Nd10), and those in between (Nd3-Nd8) as moderate rimed. The decreasing number concentration with decreasing height indicates the presence of aggregation or the falling of larger particles due to riming.

Within the H2-T0 layer (about 5000 m to 4000 m in Fig. 12a), particles experience progressively stronger riming as they fall through regions with higher supercooled water content, which promotes the formation of numerous rimed crystals and rimed snow. In the H2-H3 layer, light rimed particles are mostly distributed below 1000 μm, moderate rimed particles are found at both ends of the spectra (i.e., discontinuous), while heavily rimed particles are located between 1000 μm and about 0.02 cm with continuous spectra. The highest rime density, ranging from 0.4 to 0.45 g cm^{-3} in region A, is found in particles between 1000 μm and 5000 μm. In the H3-T0 layer, lightly rimed particles decrease rapidly, whereas the rime density of particles continues to increase, reaching a maximum density of 0.45 to 0.5 g cm^{-3} in region A. Overall, across the entire H1–T0 layer, medium-sized particles consistently exhibited the highest rime fraction and the largest density.

T0 represents the 0 °C isothermal level, where ice-phase particles begin to melt, and the number of rimed particles rapidly decreases, giving rise to liquid drops. Particles with a melt fraction less than 0.1 (i.e., Nd1) are primarily distributed above 1000 μm, and the maximum size is still large. The concentration of particles with significant melting (Nd10) is high, but the spectrum remains narrow, primarily consisting of particles between 500 and 1000 μm. Near H4, there is no significant decrease in the number concentration of rimed snow, the number concentration of rimed snow does not decline substantially, likely due to aggregation processes in the middle and upper parts of the melting layer, which counterbalance the decrease in ice-phase particles caused by melting. The reduction in liquid drops in T0-H4 may be due to the collision-coalescence of smaller drops or the sedimentation of large size droplet. Finally, in the H4-H5 layer, the melting of ice particles dominates, resulting in a rapid increase in liquid drops, with all the rimed snow melting and the number of small size liquid drops increasing.

The temperature and thickness between the height pairs of H1-H5 for all three regions are provided in Table 3. Comparing the three regions, it is evident that region B, with stronger convection, has a thicker riming zone (H1-H3) and a higher number of rimed crystals and rimed snow, with the maximum rime density reaching 0.45 to 0.5 g cm^{-3} (higher than A and C), indicating a stronger riming process. This results in a thicker ML (T0-H5) in region B. For region C, located in the stratiform cloud area, has weaker riming process, with the maximum rime density of rimed particles ranging from 0.4 to 0.45 g cm^{-3}. The ML is also thinner in region C, and aggregation and riming process near H4 are less prominent (rimed snow continuously decreases). The riming and melting layers in region B are 400 to 500 m thicker than in the region C.

Overall, the figures are too small and crammed with too much information. The text on many figures is small and hard to read.

1. I had a hard time associating the three components of the study into a common theme. The relationship between the data and the modeling studies was not clear. It seemed like the three components were somewhat independent. The conclusions, for example, don't really tie the components of the study together at all.

   Re: We appreciate the reviewer's valuable comment. To address this concern, we have added sensitivity experiments to analyze the simulated spectral parameters, compare them with the observations, and further discuss the influence of supercooled water content and supercooled layer thickness on these parameters. These additions help integrate the three components of the study and present a more coherent narrative. The relevant revisions have been described in the responses above.

   In addition, the WRF model can serve as a valuable complement to the observational data by providing a complete depiction of the vertical cloud structure, including features such as higher cloud tops in convective regions and more pronounced updrafts. However, to better highlight the McSnow model results regarding the evolution of ice particles, we have reduced certain parts of the WRF-SBM simulation results in the revised manuscript and discussed the original results in the appendices. Accordingly, we have added the following sentence at the end of L.304 to clarify this point:

   "However, to better highlight the McSnow model results regarding the evolution of ice particles, the WRF-SBM simulation results are discussed in the appendices."

Other comments

Table 1: change the dash is the temperatures from -16.3-10.3 to -16.3 to +10.3 on all lines.

Re: Table 1 has been revised as follows:

	Altitude / m	Temperature / °C	LWC / g m^{-3} Avg (Q1, Q3)	IWC / g m^{-3} Avg (Q1, Q3)	Vertical Wind / m s^{-1} Avg (Q1, Q3)
V1	2011.34-7013.17	-16.4 to+10.3	0.0195 (0.0004, 0.0060)	0.34 (0.18, 0.49)	0.63 (-0.10, 1.50)
V2	2096.32-7010.74	-16.5 to +10.4	0.0414 (0.0009, 0.0650)	0.72 (0.11, 1.07)	1.95 (0.80, 2.90)

V3	2177.92-7020.79	-16.4 to +10.3	0.0206 (0.0005, 0.0026)	0.77 (0.42, 1.04)	2.12 (1.30, 3.00)
V4	1987.24-7003.82	-16.9 to +7.2	0.0083 (0.0002, 0.0048)	0.25 (0.05, 0.40)	2.54 (1.10, 3.60)
V5	2034.11-7018.39	-17.0 to +6.8	0.0085 (0.0001, 0.0012)	0.22 (0.12, 0.30)	-0.27 (-0.90, 0.72)

1. 206: What do you mean by "microphysical dynamics"

   Re: The wording has been revised to "ice-phase processes."

The evolution of the parameters in Fig. 6 seems more complicated than the explanations given. I had a hard time sorting out what the figures showed, and I'm not sure I understand it. Having all 5 spirals on top of one another and lines going back and forth with spirals crossing one another made the figure different to sort out, at least for me.

Re: We appreciate the reviewer's careful examination of Fig. 6 and understand the difficulty in interpreting the overlapping spiral cases. The relatively large variations in the fitted spectral parameters (N_0, μ, and λ) mainly arise from two factors: (1) the fitting uncertainties inherent in the gamma distribution, and (2) the presence of melting particles at lower altitudes, which causes the observed particle size distributions to deviate from an ideal gamma shape. Consequently, the parameters exhibit significant fluctuations with height, and only the overall trends can be reasonably interpreted. To improve clarity, we have added explanations after L. 239:

In addition, it is worth noting that the vertical evolution of the fitted spectral parameters shows relatively large fluctuations (Fig. 6). These variations are mainly attributed to two factors: (1) the inherent uncertainties in fitting particle size distributions to the gamma function, and (2) the presence of melting particles in the lower layers, which leads to deviations from an ideal gamma distribution.

Please check the following sentences for grammar or missing space or other characters:

1. 47, Sentence beginning L. 60, L. 82, L121,

   Re：

   · Line 47, "CRallow" -> "CR allow"

   · Line 60,

Original: “Xiong et al. (2023) also found that the melting process changed the spectral parameters the correlation between the intercept and slope parameters greatly.”

Revised: “Xiong et al. (2023) also found that the melting process changed the spectral parameters, and the correlation between the intercept and slope parameters greatly.”

- Line 121,

Original: “The combined size distribution includes particles with maximum diameters ranging from 5 to 1105 μm from 2D-S and from 1125 μm to 2 cm from HVPS as Hou et al. (2021).”

Revised: “The combined particle size distribution covers maximum diameters ranging from 5 to 1105 μm measured by the 2D-S and from 1125 μm to 2 cm measured by the HVPS, following the method described in Hou et al. (2021).”

2. 64: I think you have it backwards – Heymsfield found that at low RH, Ice particles survived to warmer temperatures. This was also found in MCSs (see papers by Grim et al. and Stechman et al.).

Re:

Original: “When the RH is too low, snow will sublimate completely once it enters the ML, whereas at higher RH levels, snowflakes can survive at higher temperatures (up to +7°C) (Heymsfield et al., 2021).”

Revised: “When the RH is below the ice-bulb threshold (RHIB), snow completely sublimates within the ML, whereas at RH levels near or above RHIB, snowflakes can survive at temperatures as high as +7 °C (Heymsfield et al., 2021).”

3. 128: There is no coefficient “a” in the equation above

Re:

Original: “The ice water content (IWC) is 125 calculated using the mass–diameter relationship from Heymsfield et al. (2010), as in Hou et al. (2021): $m(D) = 0.00528D^{2.1}$, where m is the mass of an ice crystal (in grams), and D is the maximum diameter of the ice crystal (in centimetres).”

Revised: ” The ice water content (IWC) is calculated using the mass–diameter relationship from Heymsfield et al. (2010): $m(D) = aD^b$, where m is the mass of an ice crystal (in grams), D is the maximum diameter of the ice crystal (in centimetres), and a and b are empirically derived terms. Here, a and b are set to 0.00528 and 2.1, respectively(Hou et al., 2021).”