Sensitivity Experiment

In the previous study, it is found that both the supercooled water content and supercooled layer thickness in the convective regions are significantly greater than those in the stratiform regions, potentially resulting in markedly different riming characteristics of ice particles compared to the stratiform regions. To better understand and explore the impact of supercooled water content and layer thickness on the riming growth of ice particles, sensitivity experiment is also added.

In the experiment, supercooled water content and supercooled layer thickness are set to 50% higher and 50% lower respectively. The result for region A (moderate cloud regions), B (convective regions) and C (stratiform cloud regions) is shown as Fig. 18.

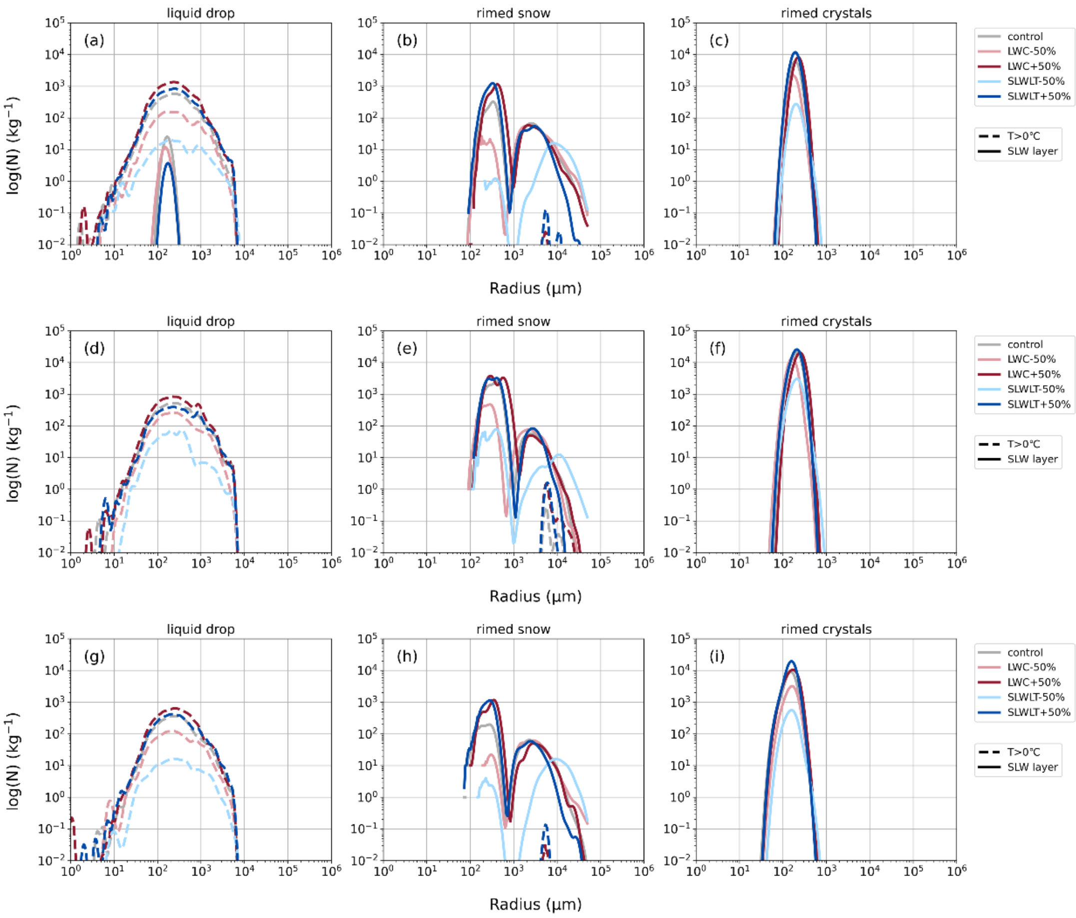

Figure 18 The liquid drop, rimed snow and rimed crystals spectra for (a)-(c) region A, (e)-(f) B and (g)-(f) C in the sensitivity experiment. Results with different control variables are represented in different colors. Dashed and solid lines indicate averages within the layer temperature above 0 ℃ and the supercooled liquid water layer (SLW layer), respectively. The vertical axis denotes the logarithm of number density, and the horizontal axis denotes particle radius.

It shows that both the increase and decrease of supercooled water content and the thickness of the supercooled layer have impacts on rimed snow and rimed crystals. When both increase, rimed snow in the 100–1000 μm range increase, while those with maximum radius larger than 1000 μm decrease in size and number concentration. The number concentration of rimed crystals also shows a slight increase. The effect of increasing supercooled water content is more significant than that of increasing the supercooled layer thickness, and the enhancement of rimed snow and rimed crystals is greater in region C than in region B, and greater in region B than in region A. This indicates that SR are more sensitive to such increases than CR.

Conversely, when the supercooled water content and the supercooled layer thickness decrease, the overall number concentrations of rimed snow and rimed ice crystals decline, while the maximum radius lager than 1000 μm increases, suggesting the presence of more large-sized rimed snow particles. This may be due to the suppression of the Hallett–Mossop secondary ice production process, especially when the supercooled layer becomes thinner.

Overall, variations in supercooled water content and supercooled layer thickness significantly affect the size distribution of ice-phase particles. Specifically, when both parameters increase, the spectrum of rimed snow shifts toward larger diameters, whereas decreases in either parameter lead to the opposite trend. Regarding supercooled water content and supercooled layer thickness, SR and CR are more sensitive to increases in the former than in the latter but are more sensitive to decreases in the latter than in the former. In addition, CR is generally more sensitive to such variations than SR, and rimed snow is more sensitive than rimed crystals.