Anonymous Referee #1

We appreciate the suggestion from the referee. Reviewer reports are marked in black font, our responses are marked in black bold font, and the changes to the revised manuscript are marked in blue bold font.

The authors carefully respond to my comments and revise the manuscript. In the revised manuscript, the WDM-NCU scheme is introduced in more detail. We appreciate the efforts made by the authors, although we still have some new questions:

We greatly appreciate the care taken by the reviewer in evaluating the manuscript. We believe the actions we have taken to address the comments have substantially strengthened the revision of the manuscript. Our bolded responses appear below the reviewer comments.

1. If I understand correctly, when nucleating, a CCN particle will become a liquid droplet whose radius is five times larger than the CCN particle. As the radius of CCN particles ranges from 0.001 to 20 um, it means a CCN particle with the radius of 20 um will become a liquid particle with the radius of 100 um. That is to say, a large CCN particle will directly become a rain drop immediately after nucleation! It is impossible! There must be an upper limit on the radius that the newly nucleated particles will be.

   Response: According to Lee and Baik (2018) and Kogan (1991), the maximum radius of aerosols is 2 μm and 7.6 μm, and after activation, the activated CCNs will turn into about five times radius droplets. In WDM6-NCU, to consider the effects of more giant CCNs, the maximum radius of aerosols is set as 20 μm. Regarding the effects of giant CCNs (GCCNs), Posselt and Lohmann (2008) also depicted the process that GCCNs are directly activated to raindrops. On the other hand, we agree with the opinion of the referee that there must be an upper limit or the smaller growth rate for the CCNs with the radius larger than 7.6 μm. In this research, there are almost without CCNs larger than 2 μm (Fig. 5 in the manuscript). In addition, we check the size distribution of the liquid bin (Fig. 1A: the unit is percentage) which shows that nearly no CCNs are directly activated to raindrops. In the future, an upper limit or the smaller growth rate for the CCNs with the radius larger than 7.6 μm will be added in WDM6-NCU. We greatly appreciate the suggestion of the referee.

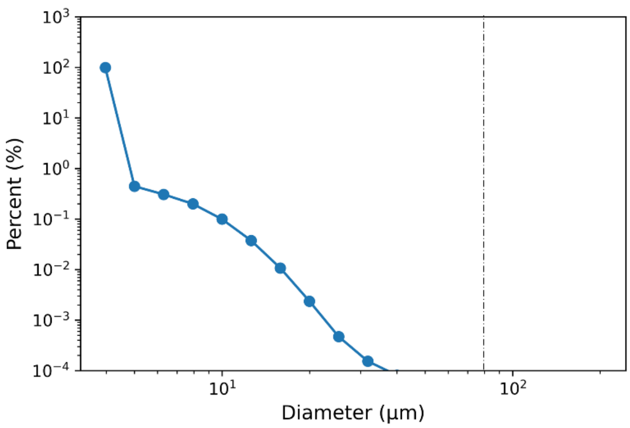

Figure 1A: the size distribution of liquid bin 10 min after cloud seeding. The black dashed line presents the diameter that separates cloud and raindrops.

2. Based on your description in the revised manuscript, it seems that only the nucleation process is calculated using the BIN part of the scheme, the mass and number concentration of the newly nucleated particles are added to the BULK part of this scheme and all the other warm rain processes are calculated in the BULK part. In the BIN part, it is true that "large CCN becomes larger liquid particle". But as you only add the mass and number concentration of the newly nucleated particles to the BULK part, it ("large CCN becomes larger liquid particle") may not be true, since the particle size distribution (PSD) of liquid water in the bulk part may deviate from the that in the bin part. You should compare the PSDs in these two parts after nucleation to see whether the parameterized PSDs in the BULK part are close to that in the BIN part.

   Response: This study attempts to extract the realistic and detailed cloud seeding information, which can be applied for the BULK part (activated CCN number concentration and mixing ratio), from the BIN part. We understand the differences between BIN and BULK parts and agree that the PSD might be different between these two parts. Figure 2A presents the PSD in the BULK part before and after the activation from the BIN part. Figure 2A shows that the BIN part PSD information will be evenly allocated to bulk parts and described by the gamma function. In the future, we should think about how to conserve more PSD information from the BIN part to the BULK part. We appreciate the suggestion of the referee and revise the manuscript:

   Line 106: "Therefore, this scheme can reveal the fact that large CCN becomes large cloud droplets in the bin part, …"

   We integrate the above suggestions and add some information to the discussion of the manuscript:

   Line 281: "Regarding the WDM6-NCU scheme, there are still some areas that require improvement. First, in the bin part, to consider the effects of giant CCNs, the maximum radius of aerosols is set as 20 μm which is different from the 2 μm setting in Lee and Baik (2018) and 7.6 μm in Kogan (1991). Although, in this research, there are almost without CCNs larger than 2 μm (Fig. 5), and nearly no CCNs are directly activated to the raindrops. It might be more reasonable that an upper limit or the smaller growth rate for the CCNs with the radius larger than 7.6 μm are defined in the WDM6-NCU. Second, for the connection between the bin and bulk parts, WDM6-NCU can extract the realistic activated CCN number concentration and mixing ratio from the bin part that can be applied to the bulk part. However, the information of droplet size distribution (DSD) might be different between the bin and bulk parts. In the future, an upper limit or the smaller growth rate for the CCNs with the radius larger than 7.6 μm will be added in WDM6-NCU, and we should think about how to conserve more DSD information from the bin part to the bulk part."

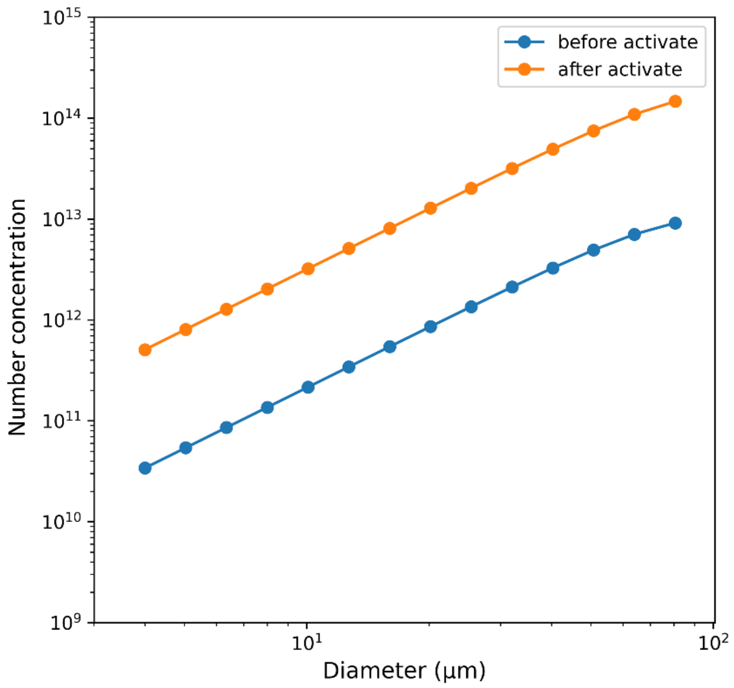

Figure 2A: The PSD in the BULK part before and after the activation from the BIN part.

3. Line 21. "Taiwanese government" is not a globally accepted term, and I don't see the necessity of using "Taiwanese government" here, please reword.

   Response: We followed reviewer's suggestions to revise the manuscript.

   Line 21: "…, which prompted the government to identify methods to address water scarcity problems with utmost urgency."

Reference:

Kogan, Y. L.: The simulation of a convective cloud in a 3-D model with explicit microphysics. Part I: Model description and sensitivity experiments, Journal of the Atmospheric Sciences, 48, 1160-1189, 1991.

Lee, H. and Baik, J.-J.: A Comparative Study of Bin and Bulk Cloud Microphysics Schemes in Simulating a Heavy Precipitation Case, Atmosphere, 9, 10.3390/atmos9120475, 2018.

Posselt, R. and Lohmann, U.: Influence of Giant CCN on warm rain processes in the ECHAM5 GCM, Atmospheric Chemistry and Physics, 8, 3769-3788, 2008.