Dear Reviewer:

Thank you for careful comments. These comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied the comments carefully and have made corrections which we hope meet with approval. The Reviewer's comments are in blue and our responses are in black. Revised portion are marked in red in the marked-up manuscript. The main corrections in the paper and the point-to-point responses are as following:

Response to Reviewer #1:

Main comments:

1. The cloud droplets nucleation is a bridge connecting aerosol and cloud droplets and this is also the key of this paper. I think how cloud droplets nucleation is parameterized should be added to the manuscript or supporting material in detail.

Response: Accept. Thanks for your suggestions. In the new Thompson cloud microphysics scheme, when the supersaturation degree is greater than 0, the water-friendly aerosol can be activated as cloud droplets by equation (1):

$$Activ\_Nc = NWFA \times AF \qquad (1),$$

where Activ_Nc represents activated cloud droplets, NWFA represents the number concentration of water-friendly aerosol, and AF represents activated fraction. The activation fraction is determined by the simulated temperature, vertical velocity, number concentration of water-friendly aerosol, and pre-determined values of the hygroscopicity parameter (0.4) and aerosol mean radius (0.04 μm) by using a lookup table. This lookup table is created by the explicit treatment of Köhler activation theory using different number concentration of water-friendly aerosol (10.0, 31.6, 100.0, 316.0, 1000.0, 3160.0, 10000.0 cm^{-3}), vertical velocity (0.01, 0.0316, 0.1, 0.316, 1.0, 3.16, 10.0, 31.6, 100.0 m/s), temperature (243.15, 253.15, 263.15, 273.15, 283.15, 293.15, 303.15 K), aerosol mean radius (0.01, 0.02, 0.04, 0.08, 0.16 μm), and hygroscopicity parameter (0.2, 0.4, 0.6, 0.8) according to previous studies (Feingold, and Heymsfield, 1992; Thompson and Eidhammer, 2014). We have added these introductions of cloud droplets nucleation to the revised manuscript in Text S1.2 in supplementary material.

References

Thompson, G. and Eidhammer, T.: A Study of Aerosol Impacts on Clouds and Precipitation Development in a Large Winter Cyclone, Journal of the Atmospheric Sciences, 71, 3636-3658, https://doi.org/10.1175/JAS-D-13-0305.1, 2014.

Feingold, G., and Heymsfield, A. J.: Parameterizations of condensational growth of droplets for use in general circulation models. J. Atmos. Sci., 49, 2325–2342, https://doi.org/10.1175/1520-0469(1992)049,2325:POCGOD.2.0.CO;2, 1992.

2. Is the increase or decrease in precipitation only due to snow melting?

Response: Revised. In this study, we find that the ACI decreases the 24 h cumulative precipitation in the DA region and increases the 24 h cumulative precipitation in the DB region on 7 January 2017. As you mentioned, the changes in precipitation are not only dependent on the snow melting. Other source/sink processes (e.g., the rain collecting cloud water, the autoconversion of cloud water to from rain, and the rain collecting snow) of rainwater cannot be ignored. However, based on the analysis of the source/sink of rainwater in the cloud microphysical scheme, we think that the increase or decrease in precipitation due to the ACI is mainly caused by the melting of snow to form rain (i.e., prr_sml). The contributions of other source/sink processes of rainwater are relatively small. The followings are more detailed descriptions.

In the Thompson cloud microphysics scheme, the source/sink of rainwater is calculated by the following equation (2):

Rain tendency= prr_wau + prr_rcw + prr_sml + prr_gml + prr_rcs + prr_rcg - prg_rfz - pri_rfz - prr_rci (2),

where prr_wau is the autoconversion of cloud water to form rain, prr_rcw is the rain collecting cloud water, prr_sml is the melting of snow to form rain, prr_gml the is melting of graupel to form rain, prr_rcs is the rain collecting snow, prr_rcg is the rain collecting graupel, prg_rfz is the freezing of rainwater into graupel, pri_rfz is the freezing of rainwater into ice, and prr_rci is the rain collecting ice. All of these processes lead to changes in rainwater.

Figure S7 shows the difference in mean hydrometeors mixing ratio and rain tendency processes between the E2 (ACI) and E1 (NO-ACI) experiment. In the DA, the largest contribution to the decrease in precipitation is the prr_sml, followed by the prr_rcs and other processes (Figure S7 (c)). In the DB, the largest contribution to the increase in precipitation is also the prr_sml, followed by the prr_rcw and other processes (Figure S7 (d)). In summary, the increase or decrease in simulated precipitation due to the ACI is mainly caused by the melting of snow to form rain (i.e., prr_sml), followed by other source/sink processes of rainwater. We have made corresponding corrections for accurate descriptions in Text S2 in supplementary material.

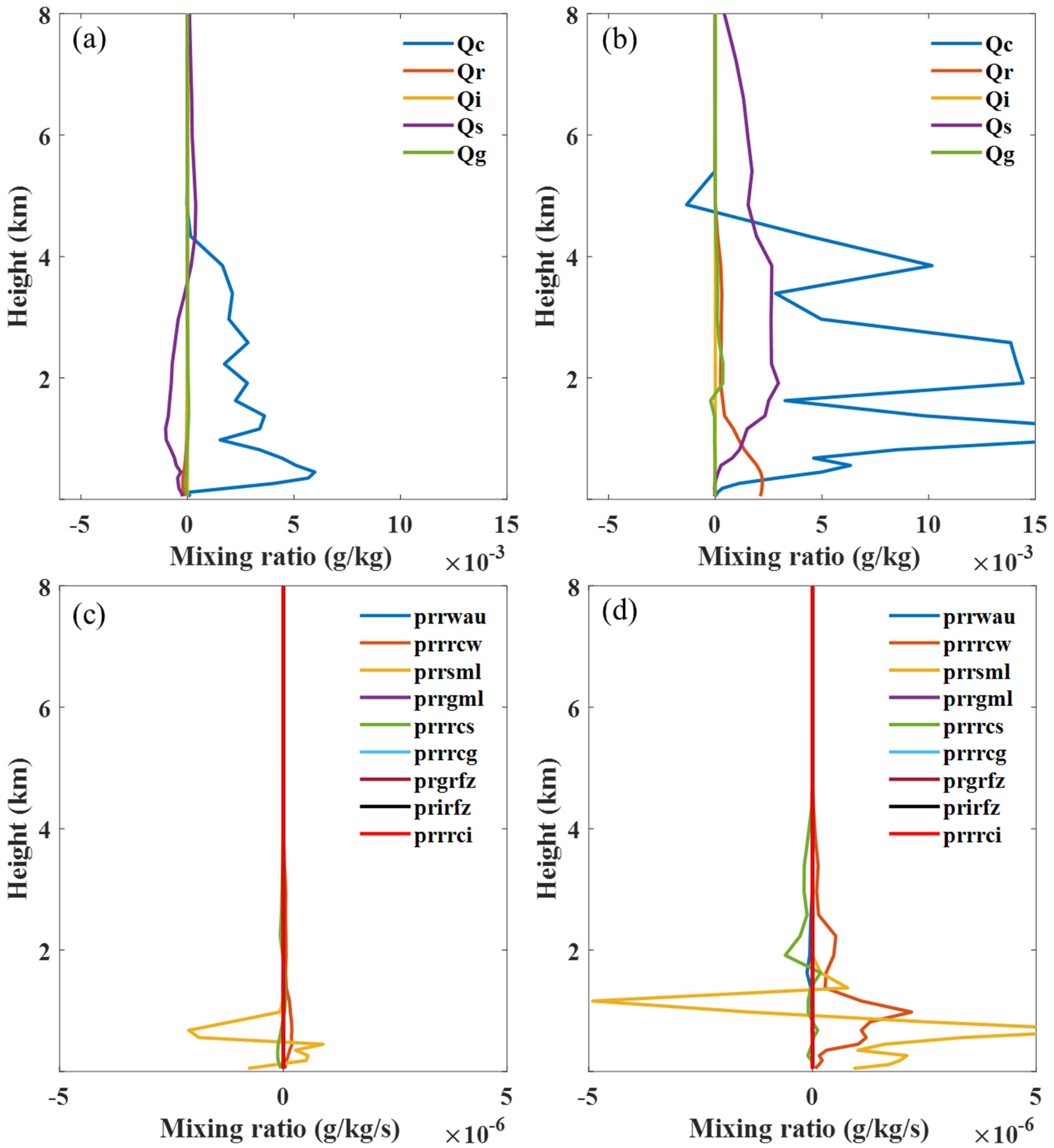

Figure S7: The difference of mean hydrometeors mixing ratio (top) and rain tendency processes (bottom)

between the E2 and E1 experiment on 7 January 2017 in the DA (a and c) and DB (b and d).

Minor Comments:

1. The weather stations in Figure 1 are not marked clearly.

Response: Revised. We have redrawn the Figure 1 to make the representation of the weather stations clearer. The new Figure 1 is added to the manuscript.

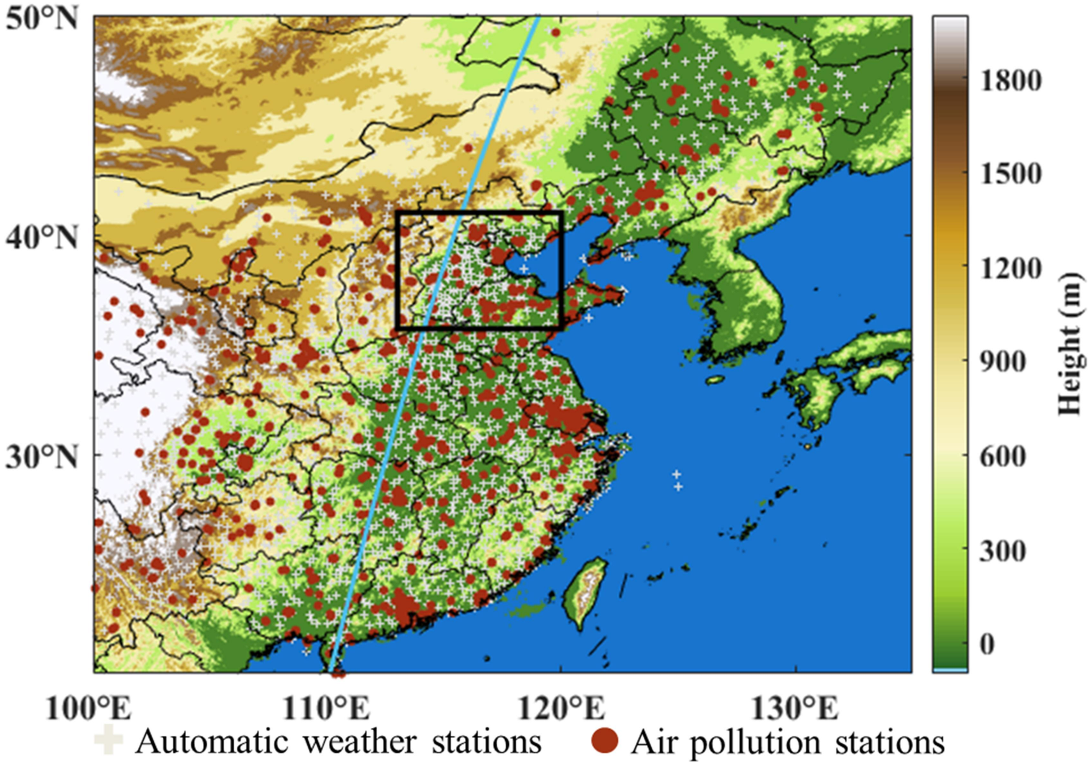

Figure 1: The map and topographic height of the simulated domain. The turquoise line represents a part of the CALIPSO satellite orbit tracks at 18:12 on 7 January 2017, the black rectangle represents the location of Jing-Jin-Ji, the gray cross signs are the automatic weather stations, and the dark red dots are the air pollution stations.

2. The fonts of some units need to be unified, such as the unit in line 289.

Response: Accept. The font of unit (°C) in line 292 is corrected as Times New Roman. Besides, we keep the fonts of the units throughout the manuscript unified.

3. In line 104, 'Number' >> 'number'.

Response: Accept. The "Number" is corrected as "number" in line 104.

4. Some abbreviations and symbols should be checked throughout this manuscript.

Response: Accept. We have rechecked the abbreviations and symbols throughout the manuscript, and made corresponding corrections.

5. The sentence in lines 124-127 need to be reorganized.

Response: Accept. The sentence "The updated operational atmospheric chemistry model GRAPES_Meso5.1/CUACE model mainly includes four modules: Pre-processing and Quality control, Standard initialization, assimilating forecasting, and Post-processing, is developed by CMA." has been rewritten as "The updated operational atmospheric chemistry model GRAPES_Meso5.1/CUACE developed by CMA mainly includes four modules: Pre-processing and Quality control, Standard initialization, assimilating forecasting, and Post-processing." in lines 125-127.

6. I think 'in NWP model' in line 55 is duplicated.

Response: Revised. We delete "in NWP model" in the original manuscript.

7. In line 241, 'additional new cloud' is not accurate and leads to a misunderstanding. Maybe change this to 'additional cloud field' or 'additional cloud'.

Response: Revised. As you mentioned, the "additional new cloud" may lead to a misunderstanding. We have corrected "additional new cloud" to "additional cloud fields" in line 245 in the manuscript.