First of all, we would like to appreciate the reviewer1's comments and suggestions. In response to the reviewer comments, we have made relevant revisions in the manuscript. Listed below are our answers and the changes made to the manuscript according to the questions and suggestions given by the reviewer. Each comment of the reviewer (colored black) is listed and followed by our responses (colored blue).

Interactive comment on "Dependence of aerosol-precipitation interactions on humidity in a multiplecloud system" by S. S. Lee

Anonymous Referee #1

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This paper presents the aerosol-precipitation interaction in a mesoscale cloud ensemble (MCE). The author concludes that aerosol-precipitation interaction is determined by the competing effects of entrainment and low-level convergence. Since both entrainment and low-level convergence are sensitive to ambient humidity, aerosol effect on precipitation also depends on relative humidity. Model simulations indicate precipitation enhancement under high RH (in CONTROL run) and medium RH (CONTROL-15%) conditions; whereas precipitation suppression occurs under low RH (CONTROL -35%) condition. Subsequent sensitivity tests demonstrate the robustness of these conclusions to ice physics, downdraft, and higher model resolution (=50m). However, in the 'Conclusion and summary' section, author discussed that there is a possibility that precipitation suppression could be changed to precipitation enhancement if even higher model resolution was used for the RH-35% case. What is the optimal model resolution that can resolve entrainment sufficiently?

It is notable that the optimal model resolution for the entrainment has been a hot topic for debate even for warm shallow clouds in cloud modeling community and, unfortunately, there has been no established consensus about the optimal resolution. Some people say it is ~ 10 m and other people say it should be finer than ~ 1m for warm shallow clouds. For deep convective clouds, research on the optimal resolution has been sparser than that for warm shallow clouds. Hence, it is very hard to suggest a general optimal resolution for deep convective clouds based on our current understanding of entrainment and its modeling.

However, as shown in this study, the effect of aerosol on entrainment decreases with increasing resolution as simulated in other studies (e.g., Jiang et al. (2009)). Hence, this decreasing effect with increasing resolution can be considered a robust feature with a good confidence. In this study, we focus on this robust feature but not on the uncertain optimal resolution.

The paper needs substantial editing before it can be published. I found the current version is hard to read. Additionally, the paper needs to be reorganized, for example, there are two sections named 'Idealized cases' (4, 5.2). Those 'idealized cases' are simply the mid- and low-humidity cases. Using titles (such as 'Reduced humidity cases') that

are more informative to the readers would improve the readability of the paper. The title of section 5.1 should be capitalized (CONTROL) to be consistent.

The title of section 4 is now “Reduced humidity cases”
The title of section 5.2 is now “RH-15% and RH-35%”
The title of section 5.1 is now capitalized.

Specific comments:
Author used ‘increase in aerosol’ throughout the paper, which should be ‘increase in aerosol concentration’.

Done

In the abstract the author state that “Hence, there is not only a competition between the effect of evaporation on vorticity and that on low-level convergence but also the variation of the competition with humidity’. This sentence needs clarification. To my understanding, humidity controls the strength of entrainment and low-level convergence.
Therefore, it is the competition between entrainment and convergence that determines the changes in precipitation.

Here, I wanted to say that the competition between the effect of aerosol on vorticity and that on low-level convergence varies with humidity. For each of humidity levels, there is a competition between the effect of aerosol on vorticity and that on low-level convergence, which is different from competitions at the other humidity levels. At high- and mid-humidity, the aerosol effect on low-level convergence wins over that on vorticity and, at low-humidity, the effect on vorticity wins over that on low-level convergence in the competition.

The following is added in Abstract (LL43-46 in p2).

Hence, there is not only a competition between the effect of evaporation on vorticity and that on low-level convergence at a given humidity level but also the variation of the competition with the varying humidity.

Abstract ‘It is found’ should be ‘The author found’.

Done

Page 1, line 20, ‘between a single cloud’, it is really a single cloud or a single-layer cloud or a single-cloud system?

It can be either a single cloud or a single-cloud system. If we focus only on cloud itself when there is an isolated cloud, we can call it a single cloud. If we focus on cloud and its environment together for the identical isolated cloud, we can call it a single-cloud system. Here, since I talk about humidity, an environmental condition, together with cloud, it will be better that a single cloud in the text pointed out here indicates a single-cloud system. Hence, I replaced “a single cloud” with “a single-cloud system”

Page 6, line 10, ‘provide initial and large-scale forcings of humidity’ to ‘provide initial

large-scale forcings of humidity'.

Here, large-scale forcings are applied after the first time step when the initial conditions are applied. Hence, large-scale forcings and initial conditions are different from each other. To remove confusion, "provide initial and large-scale forcings of humidity" is replaced with "provide initial humidity and temperature and large-scale forcings of humidity and temperature"

Author indicates that 'Up to the top of the planetary boundary layer (PBL) around 2km, potential temperature and humidity do not change significantly : : :'. But judging from Fig. 1, both potential temperature and water vapor mixing ratio change quite a bit from surface to 2km. Author also mentioned balloon soundings of winds, temperature and dew-point temperature, was profiles shown in Fig. 1 based upon the balloon soundings?

1. "Up to the top of the planetary boundary layer (PBL) around 2 km, potential temperature and humidity do not change significantly, whereas above the PBL top, potential temperature (humidity) starts to increase (decrease) significantly. "

is replaced with

(LL171-174 in p6)

"Up to the top of the planetary boundary layer (PBL) at 1.6 km, potential temperature and humidity increase and decrease, respectively, but generally less significantly as compared to their variations above the PBL top"

2. Yes, profiles in Figure 1 are based on the balloon soundings. To indicate this,

"The TWP-ICE observations provide initial and large-scale forcings of humidity and temperature."

is replaced with

(LL168-169 in p6)

"The TWP-ICE balloon soundings provide initial humidity and temperature and large-scale forcings of humidity and temperature."

Fig. 4, author states that 'The comparison of precipitation between observation and the high-aerosol run in Fig. 4 demonstrates that precipitation is simulated reasonably well'. It seems to the reviewer that low-aerosol run is the observed aerosol condition that is measured by ACTIVE (see Section 3). Therefore, low-aerosol run should simulated the observed precipitation better than the high-aerosol run, since low-aerosol is the (near-) real aerosol condition. Does this imply the deficiency of the model?

The high-aerosol run in the text pointed out here is typo. It is replaced with "the low-aerosol run"

Furthermore, the author listed the averaged cumulative precipitation for high- and low-aerosol runs, but not the observed cumulative precipitation. Adding the observed cumulative precipitation will help the reader to decide which run simulated the precipitation better.

The observed cumulative precipitation is added and Section 5.1.1 is revised following suggestions here.

Page 16, line 18, ‘This factor is applied from when the average : : :’, remove ‘from’.

Done