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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of aerosols on precipitation over the Maritime Continent simulated by a convection-permitting model" *by* M. E. E. Hassim et al.

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Responses to Referee 2 – Authors' response in bold

The authors would like to thank the Referee for reviewing our paper and for the comments provided.

General comment: This study examines aerosol effects on tropical convection and the associated rainfall over the region centered at New Guinea using numerical simulations with the WRF model. The results show a small impact of differing cloud droplet number concentration on convection, and the impact is found to be of opposite sign to what is referred to as "convective invigoration". This study is of interest to the community in

which the notion of convective invigoration is controversial. I would recommend this paper to be published in Atmos. Chem. Phys. after the authors address my concerns described below.

Major comments:

My major concern is that the authors' microphysical analysis is not enough to identify the mechanism responsible for the suppression of rainfall from convective clouds in polluted conditions. The authors invoke the classical notion of the aerosol indirect effect on warm clouds, which accounts for reduced particle size and less efficient collision-coalescence process, but it is not clear how such a microphysical modification in warm clouds influences the subsequent ice processes (including riming) that lead to the graupel formation. The authors should add comparisons of particle size and the process rate of conversion among water species (e.g. auto-conversion and riming) between pristine and polluted conditions for stratiform and convective clouds. Such an analysis would clearly demonstrate that (i) the polluted condition suppresses the warm rain process through the classical second indirect effect mechanism, (ii) the ice crystals (cloud ice in this simulation) produced from the smaller-sized cloud droplets tend to have smaller particle sizes, and (iii) such smaller ice particles have less efficiency of riming that produces graupel. If the authors add these analyses, then their findings would be substantially strengthened.

Unfortunately, it is not possible to repeat the simulations and retrieve the conversion process rates for the water species. Instead, we present in Figure 1 below the time evolution of the column-integrated water paths for cloud water, rain, cloud ice, snow, and graupel, averaged over the analysis domain, to get a sense of where the precipitation in the two cases is coming from. These diagrams and their discussion have also been added to the manuscript to supplement the averaged mixing ratio profiles already shown in the manuscript. The diagrams show that the most significant differences between PRIS and POLL come from warm-rain processes. Differences in the ice species are less signif-

icant percentage-wise (note different vertical scale in all panels) and the PRIS minus POLL occasionally changes sign for snow. However, the difference between the 16-day mean snow paths for PRIS and POLL are similar in magnitude to the differences in cloud water and rain (0.01-0.02 g m^{-2}). We also expanded the discussion of other recent modeling studies.

Minor points:

1. Summary of model configuration is necessary (Section 2.1). The authors state that the physics packages were selected as in Hassim et al. (2016) (page 5, line 5-7). The authors should describe the model configuration in this paper as well in a concise manner. Would it be possible to include a table that summarizes the physics schemes/packages that are employed in this study?

A table summarising physics scheme/packages used in the model study has been included.

2. More clarified description of microphysics scheme is necessary (Section 2.2). The authors mention that cloud ice and rain are double moment – how about other species? Are they all treated as single moment (i.e. predicting only mixing ratios)?

The Thompson scheme is double-moment only for cloud ice and rain. All other species are single-moment, with the cloud droplet concentration prescribed to 100 per cc in PRIS and 1,000 per cc in POLL. These points are now made clearer in the text (Sec. 2.2)

3. There are some editorial errors. Page 5, line 28: power law the links → power law that links Page 13, line 29: than → then

Errors corrected.

4. The figures should be better labeled. Figure 2: Please put “PRIS” and “POLL” to the left of the figures. Figure 7: Please put “Convective” and “Stratiform” to the left of the figures and “Land” and “Ocean” above the figures. Figures 13 and 14: Please put

“Convective” and “Stratiform” to the left of the figures and “Qcloud”, “Qrain”, “QNrain”, “Qice”, “Qsnow” and “Qgraup” above the figures.

Done as suggested.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-402, 2016.

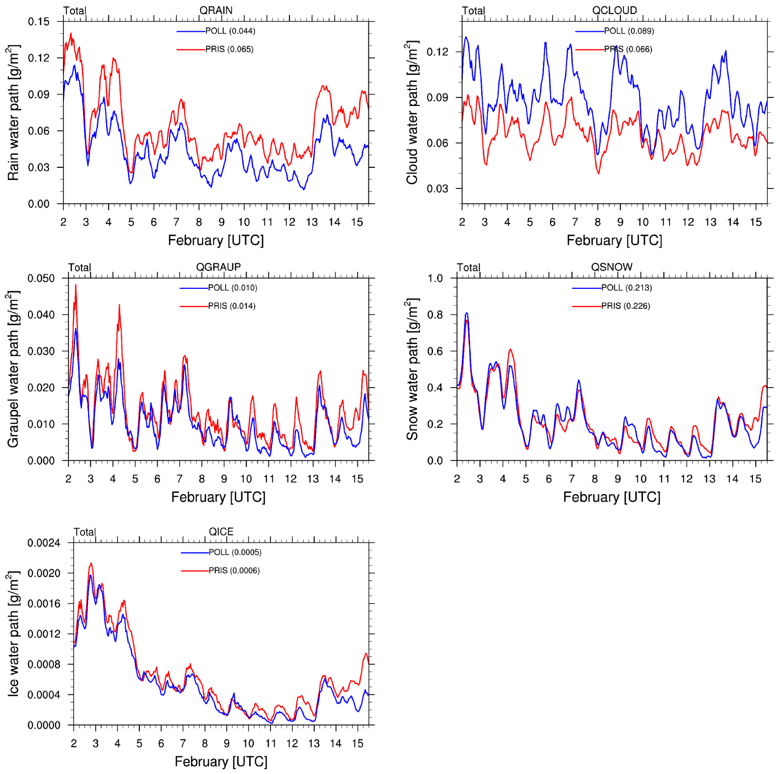

Fig. 1. Domain-averaged paths of various microphysical species from POLL (blue lines) and PRIS (red lines) as a function of time.