

Interactive comment on “Vertical Dependence of Horizontal Variation of Cloud Microphysics: Observations from the ACE-ENA field campaign and implications for warm rain simulation in climate models” by Zhibo Zhang et al.

Anonymous Referee #2

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General Comments

This paper uses observational data from the ACE-ENA campaign to assess the horizontal variability and coverability of cloud water content and number concentration. The motivation for this study is the implication of these covariances on the parameterization of autoconversion in coarse resolution models. The study is unique in 2 regards: 1) it focuses on q-N covariability which is often ignored, and 2) it's evaluation of the covariabilities as a function of cloud height. The study finds that the so-called enhancement factor for autoconversion decreases robustly from cloud base to cloud top

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due to increasing correlation between q and N at cloud top. These results have important implications for the representation of unresolved cloud microphysical processes in climate and weather models.

I only have one critique of this paper. The authors should add non-precipitating clouds to the study. Once the clouds are drizzling the accretion process effectively dominates autoconversion in precipitation production, so in a sense we care more about the autoconversion process (and all of these covariabilities in non-precipitating clouds than we do in the precipitating clouds shown here. Also, there may be important differences between the covariability in non-precipitating and precipitating clouds and it would be informative to understand those differences if they exist.

The paper is very well written, adds to the field, and the methods are sound. I have some editorial comments below and a suggestion for future study.

In future studies (not in this paper) I would encourage the authors to look at height dependent correlations between q_c and q_r as they relate to accretion. Also understand in the height dependence of the precipitation fraction is critical in representing these unresolved processes.

Specific Comments:

None

Technical corrections:

Line 58: process -> processes

Line 370: explain -> explained

Figure 6: Can you put descriptive titles on each subplot or refer to the physical assumptions that correspond to each subplot in addition to referencing the equations to make it easier to figure out what everything means.

Line 485 abroad -> broad

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Lines 537: Eq is used twice to mean two different things.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-788>, 2020.