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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "On the relationship between open cellular convective cloud patterns and the spatial distribution of precipitation" *by* T. Yamaguchi and G. Feingold

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We thank Referee 1 for his/her valuable comments.

1. The abstract and introduction should be more consistent in the reference to the closed to open cellular transition. In the abstract, it is clearly pointed out that the paper is focusing on the transformation of stratocumulus topped cellular convection into open cellular cumuliform convection. In the introduction, the authors refer more generally to low cloud transitions. This is a bit vague and can be misleading, as the reader could think at the stratocumulus to cumulus transition which takes place in the subtropics

when air masses are advected by the trades over warmer water, and on which a vast amount of studies had focused in the past (starting with Bretherton, 1992, Albrecht, 1995, Pincus et , 1997, Sandu et al. 2010, to cite just a few). The question addressed in the paper is really why open cell sometimes form within the persistent closed cell stratocumulus decks.

We added a paragraph clearly stating that our interest is transformation from closed to open cells in the introduction through aerosol-cloud-precipitation interactions. Additional references are now included.

2. In the abstract the phrase : " Finally it is shown that phase..." is not clear

The part is revised to "Finally it is shown that this transition occurs along a consistent path in the phase space of the mean vs. coefficient of variation of the liquid water path, droplet number, and optical depth."

3. page 25654, l3 - 'most often used method to achieve ..transition' should be rephrased

Revised for clarity.

4. page 25654, l15-18: isn't this in agreement with Wood 2011a study which shows that the cloud remains in a closed cell state if precipitation evaporates before reaching the ground?

In fig. 1 significant precipitation is implied by the W-band reflectivity near the surface. From the data we have, it is hard to judge how much rain reaches the surface and how much rain evaporates before reaching the surface. Thus it is not clear whether this supports Wood et al. (2011a) or not. This is the reason why we referred to Wood et al. (2011a) in this discussion, but did not state the agreement between Wood et al. (2011a) and fig. 1. We have revised the paragraph.

5. page 25655, l3-12. The authors should make clearer here what does their study bring compared to previous studies (for e.g. by Wang 2009, 2010, etc)

This part is revised to emphasize our focus.

6. Sect 2.2 - the discussion of the aerosol/droplet concentration in terms of both na and nt is confusing. Why na is fixed in S1 and nt is fixed in S2? How is the activation done? to what an na of 70 for e.g. corresponds in terms of droplet concentration? This is what matters in the end for rain formation...

As stated in the text, both na (aerosol number) and nc (cloud droplet number) are prognostic variables. Only the initial na is specified for S1. Because all simulations of S2 branch off from N130 of S1, at the restart nt (=na+nd) is specified because of the existence of cloudy grids. Activation is based on supersaturation, and a lognormal aerosol distribution is assumed. Revisions now clarify these points.

7. Sect 2.2, the authors say that S3 diverges from S1 at hour 3, but because it is on a bigger domain, it must be re-run from the beginning, right?

Yes; a sentence has been added to clarify.

8. In fig 2, it would be useful to show as well N250.

Showing N250 would not add any new information that has not already been shown with these plots since initial na > 130 results in closed cells as one can see from fig. 3. We also stated “As shown in the next section, N130 is the case with the smallest initial na among S1 that maintains closed cells for 12 h” in Section 2.2.

9. page 25660, the description of how the mode and the mode index are defined and computed is not very clear. Also, why is Nd in mm-2 and not in cm-3?

Revisions have been made for how bin size was chosen for the mode and mode index. We clarify that nc is cloud droplet number concentration, and Nd is the vertically integrated droplet number for cloud and rain (hence units of L-2). The unit is added when Nd is first introduced in 2.1, and “(vertically integrated droplet number concentration)” is added right after Nd is used in the fifth paragraph of Section 3.

10. It really never happens that because of the delay in Nd and tau with respect to LWP I>1.1 for 1 and I<1.1 for the other two?

We find this comment hard to understand. Since the time series of mode index has a peak, the combination of I>1.1 for LWP and I<1.1 for Nd and tau does occur, for instance at the time when the mode index of LWP reaches the peak for N090 (see Fig. 4c).

11. page 25665 - it would be interesting to discuss more in detail what is happening, rather than state the differences between the simulations, for e.g. why when there is convergence of RWP there is more surface precipitation?

As stated in the text, RWP is rain water path. A large RWP means more surface precipitation all else being equal. Thus there is a direct relationship between RWP and divergence. We make it clear that the convergence zone due to precipitation from adjacent divergence regions promotes updrafts, builds up condensate, and eventually results in rain there. Appropriate studies that have explored this in great depth have been referred to in the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 25651, 2014.