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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An emulator approach to stratocumulus susceptibility" *by* F. Glassmeier et al.

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We thank the reviewer for the careful and very detailed reading of the manuscript and for the encouraging and helpful comments. We always refer to the original, unrevised manuscript in the following.

General comment

This paper presents an effective compromise between reductionist and emergent approaches, simplifying the former and adding more nuance and physical interpretation to the latter. The methodology is well described, and the sources of uncertainty are addressed. Overall, I find this to be a very interesting paper, and a nice contribution both scientifically and methodologically. The only issue I have is somewhat subtle and

involves the partitioning of the LWP and N space into quadrants. Specifically, I found the discussion of the four quadrants to be over-complicated - in particular, there does not appear to be much distinction between Q3 and Q4. The only plot that appears to show distinct behavior for Q3 vs Q4 is 5a, and the region of interest (the isolines of CF at lower left) is double-hatched, indicating much larger uncertainty in the emulator's ability to capture the behavior of the clouds in this region. Examination of Fig. 7 indicates there is perhaps only a single trajectory in this region of the state space, which makes me suspicious of the results. Instead of partitioning the drizzling portion of the state space into two distinct regions, I recommend first distinguishing between drizzling and non-drizzling (according to number) and then separating the non-drizzling cloud into those with large vs small LWP. This would result in three regions (Q1, Q2, and Q3+Q4), and I think the results based on the combined Q3+Q4 would be more robust. Certainly the key conclusion, that there is a strong dependence on N in the drizzling part of the state space, does not depend on dividing into Q3 vs Q4, right?

We agree with the referee's suggestion and have adapted text and figures accordingly.

Specific Comments

1. p3, lines 30-31: Do the combinations of initial conditions make physical sense? E.g., do they correspond to physically realizable atmospheric states? LHS, as a space filling algorithm, does not necessarily respect the physical constraints known to be true of real environments, and often one must apply these constraints a posteriori to the LHS ensemble of initial conditions.

   The referee is right that LHS sampling does not necessarily result in 'physically realizable' states. Specifically, not all combinations of initial conditions lead to cloud formation. As mentioned in p4, line 2f "Out of a 200-point Latin-hypercube sampling, 191 initial conditions are identified that are expected to form cloud based on applying saturation adjustment to the initial conditions." we indeed apply the cloud-forming constraint a posteriori. For clarification, we have replaced this *sentence by:*

"We create a Latin-hypercube sampling of 200 points. Not all of these correspond to conditions for which cloud formation is expected. Based on applying saturation adjustment as a posteriori condition, we identify 191 suitable initial conditions."

2. p12, line 4: Strictly speaking, the text here refers only to Fig. 4 not to Fig. 5, and I recommend removing the reference to Fig. 5 and instead making specific reference to it on line 7, which refers specifically to the cloud fraction results (shown in Fig. 5).

   This has been corrected accordingly.

3. p12, line 10: I'm nit-picking here, but shouldn't the sampling uncertainty be Fig. 6 (not Fig. 7) and the combined uncertainty plot be Fig. 7 (not Fig. 6) so that they are in the proper order? In the current version, Fig. 7 is discussed before Fig. 6, which is a little strange.

   This has been improved accordingly.

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