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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Statistical properties of cloud lifecycles in cloud-resolving models" *by* R. S. Plant

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1. General comments

The manuscript presents an analysis of cloud-resolving model simulations with a Large Eddy Model for an idealized case of radiative-convective equilibrium. Convective cores, defined as moist buoyant updrafts, are tracked and the evolution of various parameters over the convective-core lifecycles are investigated. Relationships between current clouds and clouds of the previous timestep are defined, distinguishing simple, straightforward relationships (birth, death and straightforward contenuation) and events (merging, splitting and more complicated relationships), the latter of which occur for about half of the cores. The average lifetime of the lifecycles was found to be nearly 30 min - the occurrence of events lengthens the lifetime.

Analyses of convective clouds based on a tracking of individual clouds have been performed earlier by means of observations like satellite and radar data. An investigation based on model simulations offers new possibilities. Not only can the results serve as an evaluation for those obtained by means of observational data, but also can sensitivity studies be performed. The author knows about those advantages but unfortunately misses a comparison with previous studies, for example. Although the definition of convective core may be different for other investigations, such a comparison is recommended. The fact that other definitions of convective core can easily be implemented in the presented methodology, allows for such a comparison. In conclusion, the methodology gives the possibility to learn more about convective development by means of sensitivity studies and to better understand results based on other data. The study makes use of model data with a high temporal and spatial resolution. The results are presented on a 5 min time interval base, which is well chosen for comparisons with previous studies based on satellite and radar data.

The manuscript presents an interesting, novel approach to quantify and express the lifecycle of convective cores, including simple and complicated relationships within the same framework. This is done by determining the fraction of clouds involved in a relationship and storing them in a library. However, it remains unclear how the final timeseries of a dying core is determined. This may become clearer by providing an example. The concept of separated events gives a good idea about the impact of interactions between convective cores. It would be interesting to consider the different events (splits, merger and complicated relationships) as well as different lifetimes separately.

Altogether, the presentation of this manuscript is well structured and comprehensible. Only some specific aspects remain unclear, which are addressed in the specific comments section below.

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8, S10174–S10179, 2009

2. Specific comments

p 20540ff: In the methodology, the cloud identification is described, however, the thresholds of the convective core identification criterions are missing, which would be interesting to know.

p. 20543: Can you give the range of the model timestep variation? Is the halo region always defined by the same single gridlength, which is stated to be the maximal motion in a timestep?

p. 20542: You speak of data errors that can produce tracking errors and refer thereby to radar data. There, clutter is a big problem. Which sort of data errors are present in your model data?

p. 20544: The timeseries of clouds are stored in a library. How does this library look like in practice and how are the timeseries identified that belong together? An example may be helpful to understand the timeseries.

p. 20544: Can you please give a definition of multi-generational clouds and clarify the related fractional association. Is the fractional association related to the whole life-cycle? What exactly is meant by "all possible sequences" that need to be summed up? Regarding the lifecycle from cloud n to cloud c as a flow diagram, do "all possible sequences" relate to all different arms of such a diagram? Could you give an example for the case of more than one sequence from n to c being apparent? Do those sequences partly overlap? I assume that a lifecycle without any event occuring has just one possible sequence, while the number of possible sequences increases with increasing number of events...?

p. 20546: Definition of lifetime - does this mean you get one timeseries for each dying cloud?

p. 20546: One of the restrictions says that clouds are not allowed to extend backwards for more than 10 generations. Thus, a cloud cannot grow older than 10 generations?

ACPD

8, S10174–S10179, 2009

Interactive Comment

How is a "generation" defined here?

p. 20547: The artificial dynamical system of cellular automata used for test purposes should be introduced in more detail. What are the "game-of-life rules"? Can you give the basic results of the test?

p. 20548: You speak of 4617 completed convective cores - does that mean you have identifid 4617 lifecycles? I understand that a convective core is a cloud identified at a specific time step- thus, a "completed" convective core is the lifecycle of such a core? Distinguish convective cores and the lifecycle of convective cores...

p. 20548ff: You determined average lifecycle for different properties. Previous studies deal with such lifecycles based on e.g. radar data investigations (e.g. Lopez 1983, Weusthoff and Hauf, 2008). Despite the problem regarding the cloud definitions, a qualitative comparison may be drawn... Maybe a variation of the threshold would make the results even better comparable?

References:

López, R. E., D. O. Blanchard, D. Rosenfeld, W. L. Hiscox and M. J. Casey, 1983: Population characteristics, development processes and structure of radar echoes in South Florida., Mon. Weather Rev., 112, 56-75

Weusthoff, T. and T. Hauf, 2008: Basic characteristics of post-frontal shower precipitation rates, Meteorol.Z. 17(6), p. 793

ACPD

8, S10174–S10179, 2009

Interactive Comment

3. Technical corrections

p. 20538, line 4: change to "from timestep to timestep"

p. 20539, line 22: What is Q2?

p. 20541, line 2: change to "...it is possible to define thresholds for model variables ..."

p. 20542, line 9: change to "Relationships with clouds at the previous timestep"

p. 20542, line 28ff: "in order for there to be ...", rephrase sentence...

p. 20543, line 8: Unfinished sentence ("Construct ..."), please rephrase...

p. 20543, line 21: Change to "... signifies ..."

p. 20544, line 25ff: Can you please include the equation for the fractional association?

p. 20548, line 17: Change to "54.2

p. 20548, line 23-24: I do not understand the meaning of the sentence: "... the pattern is specific to the core in question ...". What do you like to express with that statement. To what extent is the evolution core-specific?

p. 20550, line 10: Change to something like "The role of events within the lifecycle"

Table 1 gives some statistics of the convective cores. The proportions of the relationships are given with respect to the number of straightforward continuations - how many of those straightforward continuations were identified?

Figure 2 displays the distribution of the lifetime of convective cores. The vertical axis is denoted with "number of cores". As stated above it would be good to distinguish convective cores and the lifecycle of convective cores which is rather meant here. A convective core itself is a feature at a specific timestep, while the evolution of the convective core contains several convective cores, which together constitute the lifecycle?

Figure 4: the colors red and magenta can hardly be distinguished.

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8, S10174–S10179, 2009

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 20537, 2008.

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8, S10174–S10179, 2009

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