

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

R. S. Plant

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Response to Anonymous Referees #1 and #2

General comments

I thank both referees for what were clearly very detailed readings of the article. A revised article has been submitted to ACP that has benefited from addressing their comments.

Both referees were very positive about the article, recognizing the novelty and usefulness of the methods presented. They were both critical, however, of two aspects: first, that the methodology might have been presented more clearly in places; and, second, that comparisons with observational studies would be desirable.

On the first point, the suggestion to provide an example lifecycle was a very good

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one. I have added a schematic figure to present the example, and now refer to this at every stage through the methodology section, in order to clarify how the algorithm is applied in practice. Referee #2 also requested that the terminology should be more clearly defined. This is a fair point, as the word “cloud” for example was used in subtly-different ways at different stages of the article. I have revisited the terminology used throughout, adding some explicit definitions where appropriate.

On the second point, I had argued that a direct and quantitative comparison to observational studies would not be appropriate in this article. Although the referees accepted the argument, they were nonetheless strongly in favour of some qualitative comparisons being made. On reflection, this seems entirely sensible. It is important, for example, to establish that the statistics obtained from the model are realistic. Various comparisons of this nature have now been made, and are scattered through the revised article, with around 10 additional references to observational studies included.

Specific Comments from Referee #1

The numbering of comments made, both here and elsewhere in this reply, is my own.

1. p20540ff: The precise definition for cloudy grid boxes is now given in the revised text. All three variables must exceed a very small, positive threshold together, but this could be on any vertical level within the column.
2. p20543: The model timestep ranges from 0.30 to 0.65 s, as stated in the revised text. The halo region is indeed a single gridlength throughout.
3. p20542: In observational data, errors such as radar clutter can cause a pixel to be flagged as cloudy when there is no cloud present in reality. Model data does not suffer from any such, false-positive, errors.
4. p20544: Such an example has indeed been included in the revised article.

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5. p20544: I trust that the example provided will have clarified these queries. But let me also state specifically that:
- The association relates a cloud object at a current timestep to an object held in the library.
 - Possible sequences would indeed refer to different arms of a flow diagram (like that shown in Fig. 1 of the revised article). That is a nice way of thinking about it.
6. p20546: Yes, this is a correct interpretation. I have clarified the point in the revised article.
7. p20546: Consider the flow diagram for an n th-generation lifecycle. To go from the final cloud object back through to the first cloud objects means that we have to follow a sequence of n objects. The example lifecycle in the revised article includes a third-generation object.
8. p20547: The artificial system was used to provide tests on the coding. Some simple rules of my own devising were used purely for testing purposes. I wanted to make sure that the algorithm would cope with simple systems in which (a) events almost never happened, or (b) events were extremely common. Lots of timestep-to-timestep checks were easy to do in these simple systems and told me that the algorithm is robust and that the code does what it should do. I suspect though that giving details of all these tests is not particularly helpful to the reader. Some timestep-to-timestep tests were done to check the final implementation into the CRM and provide the same result. In the revised article, I have therefore decided to drop the mention of the artificial systems rather than make a lengthy diversion on details of my preliminary testing processes.
9. p20548: In the revised article, I have tried to take pains to define the terminology more clearly. In particular, there is now an explicit definition of exactly what is

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meant by a lifecycle.

10. p20548: As noted in my response to the General Comments above, various qualitative comparisons have now been made, including comparisons with the specific references that the referee suggests.

Technical corrections from Referee #1

1. p20538, line 4: Hyphenation removed, as requested.
2. p20539, line 22: Q_2 is the apparent moisture sink. This has been noted explicitly in the revised text, and a citation which defines Q_1 and Q_2 has been added.
3. p20541, line 2: Grammar corrected, as requested.
4. p20542, line 9: Grammar corrected, as requested.
5. p20542, line 28ff: This phrase has been reworded, as requested.
6. p20543, line 8: The sentence has been rephrased, as requested.
7. p20543, line 21: Grammar corrected, as requested.
8. p20544, line 25ff: The fractional association was defined in the main text, but this has been replaced by an explicit equation, as requested.
9. p20548, line 17: Unfortunately the referee's comment appears to have been garbled, with some text missing after 54.2
10. p20548, line 23-24: The sentence was intended simply to say that individual life-cycles have their own individual patterns of development: i.e., that every lifecycle is different. The sentence has been rewritten to make this clear.

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11. p20550, line 10: The heading has been changed as suggested.
12. Table 1: There were 3.1×10^7 straightforward continuations. This is noted in the caption to Table 1 in the revised article.
13. Fig. 2: The label on the vertical axis has been corrected, as requested.
14. Fig. 4: The colours used on the original figure appeared clear on-screen but were less clear on paper. That has been corrected.

Specific Comments from Referee #2

1. p20539, line 22: See response to the Specific Comment 2 from Referee #1.
2. p20541, line 19: See response to the Specific Comment 1 from Referee #2.
3. p20542, line 26: This sentence has been reworded to make clear that the condition requires $<$ rather than \leq .
4. p20542, line 29ff: This text has been partially rewritten, and has been supplemented by a detailed discussion of the example lifecycle that has been included in the revised article. Based on that lifecycle, explicit illustrations are now provided to show the meaning of the subsets, their properties and how this reveals the character of relationships.
5. p20543, line 2: This sentence has been reworded, as requested.
6. p20543, line 9: This correction has been made.
7. p20544, line 28: There is no reference area required. The sentence has been rewritten in order to make that clear.

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8. p20545: I am not sure that I really understand the referee's comment here. His first sentence is simply not correct. I believe that the source of the problem may be my own lack of clarity in explaining how the fractions are obtained. Therefore, I have tried to resolve the matter by describing explicitly an example of how the formulae work in practice for an event in the example lifecycle.
9. p20547, line 3: I agree that the meaning of "duration" may have been unclear. The sentence has been reworded.
10. p20547, line 9: The mention of cellular automata has been removed from the revised article: my reply to specific comment 8 from referee #1 explains why.
11. p20548, line 5: By "completed convective cores", I simply meant "lifecycles". This has been corrected in the revised article, which also gives an explicit definition of a lifecycle.
12. p20548, line 7: There are 52.4 cloudy grid boxes in the domain on average. When these grid boxes are connected together into the cloud objects that are ultimately tracked, 45.4 of the grid boxes are connected-up and 7.0 remain unconnected. The unconnected boxes are not considered any further. But a large majority of all the cloudy grid boxes that occur are tracked. I agree that this may not have been obvious in the original article and the sentence has been reworded.
13. p20549, line 17ff: The figures are consistent in that: (i) the peak of the mass flux distributions in Fig. 4 increases and decreases through the lifecycle as one would expect from Fig. 3; and, (ii) the changes with time in the mass flux distributions in Fig. 4 are stronger at the beginning and end of the lifecycle than they are towards the middle of the lifecycle, again as one would expect from Fig. 3. These points are noted explicitly in the revised article, and are consistent with observations.
14. p20550, line 20: I believe that such behaviour is indeed realistic, although it would be very difficult to check this from observational data. The messiness is essen-

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tially behaviour at very high time-resolution that is missed at lower resolutions. This is nicely illustrated by the example lifecycle provided in the revised article. There would not seem to be anything inherently implausible about the lifecycle. And yet, radar data at 5min temporal resolution (say) would not pick out any messiness. It would probably detect no event at all: it might happen to pick out a split, but it could never pick out the complete, more messy story.

Technical corrections from Referee #2

1. Commas have been removed on three occasions, as requested.
2. p20549, Eq. (8): The terms in this equation have been fully defined, as requested.
3. p20549, line 6, and elsewhere: Probability has been changed to frequency on four occasions, as requested.
4. Fig. 3 and 4: The symbols in Fig. 3 carry no specific meaning, and so have been removed for clarity. There are no symbols on Fig. 4.

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

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