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Interactive comment on “Diagnosing the average spatio-temporal impact of convective systems – Part 2: A model inter-comparison using satellite data” by M. S. Johnston et al.

Anonymous Referee #1

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General comments

In Johnston et al. (2013; ‘Part A’), the authors outlined a methodology for producing composites of deep convective systems. In the current paper (‘Part B’), the authors apply this methodology in order to compare results from three climate models with satellite-retrieved data. The scientific significance, scientific quality and presentation quality are all good. However, I would question parts of the written interpretation of the composites. I hope the comments below can help to improve the manuscript. After re-drafting, the paper should be suitable for publication in ACP.

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Specific comments

1. **‘Observations’ or ‘Satellite-retrieved data’?** Throughout the manuscript, satellite-retrieved data are referred to using words like ‘observations’ and ‘observed’. Although satellite-retrieved data do constitute a type of indirect observation, it would be preferable to use ‘satellite-retrieved data’, ‘satellite data’ or equivalent. These satellite data may contain errors, and hence they may not represent the reality that ‘observations’ might imply to some readers.

2. **Errors in the TRMM 3B42 data.** In section 4.1.1 (and sect. 5 p9178.13-16), the authors point out that light precipitation is more common in the models compared to TRMM 3B42. Although the primary reason for this disagreement may indeed be model error, the possibility of errors in TRMM 3B42 should also be mentioned. Huffman et al. (2007; doi:10.1175/JHM560.1) acknowledge that the TRMM 3B42 data ‘have precipitation rate–dependent low bias due to lack of sensitivity to low precipitation rates over ocean in one of the input products’. A lack of sensitivity to light precipitation may explain part of the disagreement between TRMM 3B42 and the models. Furthermore, Huffman et al.’s Table 2 suggests low biases of 0.2–1mm/day (0.01–0.05mm/hr) in TRMM 3B42, comparable to the disagreements between TRMM 3B42 and the models reported in Table 3 of Part B.

3. **Model configuration information.** Although Table 2 provides a helpful summary of the convective and stratiform cloud schemes used for the simulations and helpful information about the models is provided the sect. 2.2, the description of the model configurations in sect. 2.2 appears quite minimal. Based on the information in sect. 2.2, would a user of any of the three models be able to configure a simulation in exactly the same way as the simulations in Part B? If the answer is ‘No’, then more information about the specific configurations should be provided. For example, are there clear default configurations, or have choices been made about what schemes to use (apart from the convective and stratiform cloud schemes mentioned in Table 2)? What MAM3 aerosol emissions have been used in CAM5? (I understand that the standard AMIP

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configuration MAM3 emissions files do not cover 2007/2008, instead ending in 2006.) How many years/months/weeks of atmospheric spin-up have been simulated prior to the start of the analysis period (2007)?

4. **Results: rain rate.** The following points could be mentioned in sect 4.2.1: (a) In Fig. 4, the TRMM ocean RR composites appear to me to be quite symmetrical with respect to time. The dominance of westward propagation is not obvious. Rather, the peaks at the east and west of the domain at both -ve and +ve lags are consistent with the composite containing a mixture of both eastward and westward propagating systems, although westward propagating systems may be slightly more common. (b) The central ‘doughnut hole’ in the TRMM land RR composites at -ve and +ve lags is constant with averaging across systems moving in random directions. In contrast to the ocean composites, which appear to be largely constrained to propagating zonally, the land composites suggest that a meridional component of propagation is as likely as a zonal component. Having said this, the movement of the peak superimposed on the ‘doughnut hole’ suggests a slight weighting towards westward propagating systems. (c) The fact the EC-Earth (and, to some extent, ECHAM6) land RR composites reproduce the hole suggests that they correctly reproduce the possibility of a meridional component of propagation.

5. **Results: upper-tropospheric humidity.** (a) ‘Afterwards, there is a notable reduction in moisture at the domain centre that continues beyond 18h.’ In Fig 5a, there actually appears to be an increase between 15h and 18h, in disagreement with this statement. Is this due to aliasing (mentioned in Part A)? (b) ‘In contrast, in ECHAM6 and CAM5, UTH remains high throughout the composite and does not exhibit any distinct temporal asymmetry.’ Is this comment about a lack of distinct temporal asymmetry accurate? Figs. 5c,d appear to me to exhibit temporal asymmetry, peaking at 6h, although ECHAM6 and CAM5 do indeed exhibit a high bias compared to the satellite-retrieved data.

6. **Results: cloud fraction.** ‘Thus, as was the case with UTH, only EC-Earth is able

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to capture the observed temporal asymmetry with respect to hour 0.' As above, I would question whether this is an accurate interpretation of the figure.

7. **Results: CF time-altitude anomaly.** 'Because the observations tend to be noisy, the spatio-temporal pattern of the anomaly in the figure emerges only after applying a 12h running average. Such smoothing is not applied to the models as they are not significantly affected.' For consistency, would it not be preferable to apply the same smoothing to the models?

8. **Results: outgoing longwave radiation.** 'The models show zonal bands of high OLR both north and south of the domain, but the observations show only a narrow band of higher OLR to the south.' This apparent feature is probably amplified by the specific colorbar used in Fig. 10, combined with the fact that the models have higher OLR than the satellite-retrieved data across the whole domain. Looking carefully at the figure, I think that the difference in zonal symmetry between the satellite-retrieved data and the models is not pronounced.

9. **Captions.** The captions could be expanded so that the figures can be better understood without reference to the text (or earlier captions). For example, it would be good for acronyms to be defined again in each caption. In Figs 4, 5, 6, 8 and 10, the domain size should be stated. In Fig. 7, the smoothing details should be mentioned. In Fig. 12, it would be preferable to replace 'discussed in the text' with a brief explanation, e.g. 'eastward, westward and stationary'.

10. **Figures.** The colour bars in Figs 4, 5, 6, 8 and 10 would be more readable if they were made thicker.

Technical corrections/suggestions

p9157.8: 'over-produce' to 'over-predict', for consistency with 'under-predict' later in the sentence. It would also be good to add 'compared to satellite-retrieved data' to the end of this sentence.

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p9157.20: define 'CF'.

p9157.26: 'This study suggests' may be more accurate than 'This study shows'. Improving the models and demonstrating improved agreement appears to be beyond the scope of this paper.

p9159.8: 'in GCM' to 'in a GCM'.

p9160.22: 'high spatial resolution model' to 'relatively high resolution climate model data'. The resolutions used are only 'relatively' high for current climate models (and they are very low resolution compared to many other sorts of model, eg large eddy simulations or regional NWP models).

p9162.7: '2), and' to '2) and'.

p9162.16: 'the top 9 percentile'. Should this be 'data exceeding the 90th percentile'?

p9162.18: '9 percentile' or '90th percentile'?

p9162.22: Is a sample size matching step applied, as in sect 3.3 of Part A?

p9163.9-10: 'The results are analysed within each region' to 'The results have been analysed within each region (not shown)'.

p9164.8: 'more common than over land' to 'more common over ocean than over land'.

p9164.8: 'Silmulated' to 'Simulated'.

p9164.15: 'late evening' to 'midnight'.

p9164.26: 'a slight drop' to 'a drop'.

p9168.17: Consider started new paragraph before 'The observed land-based...'

p9168.26-27: All three models are mentioned, but only two numbers are provided. Is there a missing number? Or should 'ECHAM6' be removed, given that it is mentioned in the next sentence?

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p9173.9-11: Use of 'lower pressure levels' (ie higher) and 'higher pressure levels' (ie lower) is potentially misleading. It would be preferable to use 'higher' and 'lower' instead, talking with respect to height.

p9177.6: 'Hovmöllers, but averaged' to 'Hovmöller diagrams averaged'

p9182.1: should the second reference also occur within the parentheses?

p9182.1: the 'and' at the end of the line could be replaced with a full stop.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 9155, 2014.

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