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Geoscientific Model Development Discussions

Interactive comment on "ASoP (v1.0): A set of methods for analyzing scales of precipitation in general circulation models" *by* Nicholas P. Klingaman et al.

Anonymous Referee #2

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General comments: This paper proposes a diagnosis method for precipitation of general circulation models (GCMs) by using a native temporal and spatial grids and discusses dependency of temporal and spatial averages of precipitation. Precipitation behaviors of GCMs have been usually evaluated by climatological mean states. However, this study clearly shows that even if the climatological mean (or 3-hr average) precipitation is almost the same, its temporal and spatial behaviors are very different if analyzed by the native grids and original time step. This aspect of precipitation might affect large scale behaviors and hence must be more focused for the analysis, evaluations, or improvements of GCMs. The methodology is clear, and it implication is sound. Thus, I suggest publication of this study after minor revisions described below. Although the

proposed diagnosis will be useful, the authors can go further more. In the text, the authors mention "persistency" or "intermittency" of precipitation. We need to compare many figures (e.g. Fig. 4 vs Fig. 7) to evaluate "persistency" or "intermittency". The authors should consider some quantifications of "persistency" and "intermittency", and show summary of these quantities of the models with difference samplings.

Specific comments

p. 3, L18, "Such diagnostics": It is not clear which "diagnostics" is referred to in this paragraph. Please clarify.

p. 4, L5-6, "Both products are derived from a combination of infrared and microwave sounders and calibrated against gauge data.": The authors should add more information on the difference between TRMM and CMORPH for readers who are not familiar to the details of the products of precipitation. In addition, since TRMM 3B42 is not solely based on the TRMM data, it is not appropriate to call it "TRMM". The authors should make a remark on it if the abbreviation of "TRMM" is to be used.

p. 5, L23, "We find the central point in each region and extract the timeseries of precipitation.": I suggest that "find" should be replaced by "define" or an appropriate word.

p. 5, L26, "in Figs. 2b and 2c for CMORPH": These should be "Figs. 2c and 2d".

p. 6, L10, "these computations result in a matrix of correlations with distance and time, as shown in Fig. 2c.": I guess that this is for Figs. 2e and 2f.

p. 6, L14, "Fig. 2b": This should be replaced by "Figs. 2c and 2d".

p. 6, L16, "For the ranges shown here, the CMORPH 0.25_ correlations decline more quickly with time than with space.": It is ambiguous to say which is "more quick" between time and space. Add more explanations.

p. 8, L20, "The 1D histogram suggests that MetUM-GA3 oscillates between lighter (< 9 mm day−1) and heavier (> 30 mm day−1) rain rates, with almost no instances

of moderate rates (9–30 mm day−1).": This is an interesting behavior of precipitation of the MetUM-GA3. Please consider adding sample figures of time sequence and snapshot distribution of precipitation of MetUM-GA3.

p. 8, L25, "The bi-modal 1D histogram suggests that most deep convection in MetUM-GA3 is strong.": It is not clear how "strong" or stronger than what? Please add more explanations.

p. 9, L10: "Despite having the finest horizontal resolution" should be replaced by "Because having the finest horizontal resolution"?

p. 9, L13: After "The lag-1 correlation at the central gridpoint is slightly negative", add "for MetUM-GA3" for readability.

p. 9, L19: Delta is superscript. Please correct such that "0.5–1.5Δx".

p. 10, L33, "While there were no observation-based constraints on timestep rainfall": This statement is incorrect. We can use the ground radar data for very high-spatial and temporal resolution of precipitation, such as 1 km and 10 min. We can also use satellite radar data for high-spatial distribution of precipitation, such as PR of TRMM or DPR of GPM. The authors should add discussions on using and analyzing such high-resolution radar data for evaluations of precipitation in future directions.

p. 10, L34, "Both TRMM and CMORPH produce histograms that are broader than the models' histograms and which peak at heavier precipitation rates.": These observation also have biases especially for lighter rainfalls. The authors should add remark on the biases of the observations in the earlier sections such as in the methodology.

p. 11, L8, "(dashed line on Fig.s 4a)": "Fig.s 4a should be "Fig. 4a".

p. 11, L15, "Conversely, models with more persistent timestep precipitation (e.g., GEOS5, MRI-AGCM, CAM5 and MIROC5) display greater intermittency for 3-hr means.": To clarify the sentence, please add "when Fig. 9 is compared with Fig. 4". It is not clear how great the intermittency is. The authors should quantify the intermittency.

p. 11, L28-29, "SPCAM3, ECEarth3 and CanCM4 are perhaps closest to TRMM and CMORPH, but are still more persistent.": Again, it is not clear how these models are close to the observations. Please consider quantification of the persistency.

p. 11, L34, "We note that there are also differences between TRMM and CMORPH over this short period: CMORPH displays more frequent light precipitation than TRMM, which has been shown to under-detect light rainfall (Huffman et al., 2007, e.g.,). TRMM is more intermittent than CMORPH.": The authors should note why these differences come from between the two observations. "(Huffman et al., 2007, e.g.,)" should be "(e.g., Huffman et al., 2007)".

p. 12, L3, "All models display higher correlations": Add "at 3h interval (Fig. 10b)" at the end of this sentence.

p. 12, L11, "Spatial averaging reduces timestep intermittency in all models (Fig. 11).": The observations of TRMM and CMORPH should also be added to Fig. 11.

p. 12, L18-20, "This suggests that using a common horizontal grid or a common timescale does not necessarily create a fair comparison between models, due to differences in the number of points or timesteps, respectively, that are combined to create the average.": It is not appropriate to say "a fair comparison", because it is not clear in what sense the fair comparison means. Use of a common horizontal grid or a common timescale has its importance for some purposes. Please rephrase this sentence.

p. 12, L24, "the comparison of Fig. 4a and Fig. 11a suggests that MetUM-GA3 likely has only a few precipitating gridpoints . . .": This sentence is not clear. Please explain what the authors want to mean.

p. 12, L28, "By contrast, the comparison of Fig. 4f and Fig. 11f": Add "(GEOS5)" for clarification.

p. 12, L39, "in Figs. 7a and 12a) implies": Delete ")".

p. 14, L9, "Although there are no verifying observations for our timestep data": As

mentioned before (p. 4, L5-6), the ground radar data can be used for verification of the timestep data.

p. 14, L33-34: “Fig. 4a” and “Fig. 4b” should be “Fig. 7a” and “Fig. 7b”, respectively.

p. 14, Section 4 Discussion: For understanding of properties of cumulus convection schemes, single column models (SCM) have been widely used. Especially, SCM under a radiative-convective equilibrium (RCE) condition is a useful framework for understanding the timestep behaviors. For example, Satoh and Hayashi (1992, J. Atmos. Sci.), Takata and Noda (1997, J. Meteor. Soc. Japan) for SCM in RCE. Please add discussions on the above aspects of using a SCM for understanding of intermittency.

-Satoh, M., and Hayashi, Y. Y. (1992). Simple cumulus models in one-dimensional radiative convective equilibrium problems. Journal of the Atmospheric Sciences, 49, 1202-1220. -Takata, K., and Noda, A. (1997). The effect of cumulus convection on CO2-induced climate change in the tropics. Journal of the Meteorological Society of Japan, 75, 677-686.

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