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# *Interactive comment on* "Implications of model error for numerical climate prediction" *by* O. Martínez-Alvarado

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Dear author

As suggested by your response, I have contacted Referee #2 for further clarification on some issues. I would encourage you to fully revise your manuscript, taking into the issues raised by the referees. In particular, Referee #2 is concerned whether there is adequate statistics and whether there is enough new finding to justify a paper.

In his recent reply to me, Referee #2 felt that most of his concerns still hold. Below are his clarifications on questions raised by the author concerning the review:

p.C104: I am genuinely interested in knowing how he/she knows that; would his/her statement be applicable to the actual climate system and to our current means of ob-



serving it?

Answer: A system such as Lorenz '63 has a certain climatological behaviour which is typically described by the PDF. A perfect model of Lorenz '63 would have exactly the same PDF and the same climatological behaviour, otherwise it would not be perfect. Therefore, a perfect model of Lorenz '63 would show no biases. In principle the same is true for a perfect climate model. However, it is obviously non-trivial to define the terms "climate" or "climatological behaviour" for the earth system and arguments on these definitions fill plenty of publications. Still, the sentence that a perfect climate model will show no bias in climate runs is valid, whatever definition of climate is applied.

p. C106: It is not clear what PDF Anonymous Referee #2 would like to see and I don't see any strong reason why my figure should be a PDF.

Answer: The PDF characterises the climatological behaviour of the system. Figure 1 tries to represent exactly this but it fails since it does not comprise a sufficiently long model integration. If enough statistics is used, it is easy to calculate a two or three dimensional plot of the PDF (e.g. x against z as done in Figure 1) that does not change when the model is integrated for a longer time (otherwise it needs to be integrated for a longer time). It is also easy to compare different PDFs by simply plotting the difference, or by using quantities such as the Hellinger distance. If the author would integrate the trajectory in Figure 1 for a longer time, he would recognise that Figure 2b would change. I do not think this is acceptable. It would be much better to give the values of the probability density at the specific points of the imperfect model instead in Figure 2b. If the probability density is zero, it might be useful to evaluate the minimum distance to the next point of the PD being non-zero.

p.C109: To better understand Anonymous Referee 2's point I would need clarification on what is meant by 'fails to reproduce the model error'.

Answer: If the truth is not included in the "envelope" of forecast ensemble members and if all ensemble members are clustering around the deterministic model simulation as

seen in Figure 6b, the ensemble spread is obviously under-dispersive. The ensemble spread is underestimating model uncertainty and is not able to represent the forecast error of the forecast model correctly. This is what was meant by: The ensemble fails to reproduce the model error.

p.C111: My mistake: I referred to Figure 3a.

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