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Earth System Dynamics Discussions

Interactive comment on "A multi-model ensemble method that combines imperfect models through learning" *by* L. A. van den Berge et al.

Anonymous Referee #2

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Review of A multi-model ensemble method that combines imperfect models through learning by L.A. van den Berge, F. M. Selten, W. Wiegerinck, and G.S. Duane

The paper discusses a new multi-model approach to combine different models through coupling them during the integration into one super-model. The coupling coefficients are estimated from a learning, or training phase. The method is tested for simple chaotic dynamical systems. It is found that the super-model performs better than the individual models.

I have several concerns with the suggested approach:

1. The authors mention in the introduction as a motivation for their approach the study by Kirtman et al., (2003) where certain components of two different atmospheric mod-

els (momentum flux from one model, heat and fresh water flux from the other model) were coupled to an ocean model. By doing so one will almost certainly violate the physical balances of the systems (momentum and heat fluxes are not independent). The authors would need to address the issue of physical imbalances in a broader context.

2. Approaches that use a learning-from-the past methodology are inherently limited in their learning to a limited sample set of events that happen to have occurred in the past. However, what are the implications for the future? Are there any at all? Is the super-model, in principle, able to simulate a behaviour that is qualitatively distinctively different to the one that was used in the training period? What are the implications to the big question of climate change then, as noted in the introduction of the manuscript?

3. In their study the authors construct the super-model by averaging the individual models. By taking the ensemble mean a lot of very valuable information gets lots. In particular, it is not clear that the ensemble mean itself is an element of the attractor of the system. I would suggest to treat the super-model as an ensemble rather than as a deterministic model built from coupling individual models. This then opens the door to analysing model uncertainty in a much wider sense.

4. As the authors point out in the conclusion section, it is not clear a priori which state variables should be connected and which not. This problem is also linked to the question of how to couple systems with very different characteristic time scales. Perhaps the framework of a simplified dynamical system could be used to study these issues.

5. The authors use the paper by Rodwell and Jung (2008) to claim that fast atmospheric processes are the primary cause of systematic model errors. This statement is misleading as the paper relates to a specific example of aerosol and clearly is not representative for a wider range of typical systematic errors. A recent paper by Palmer & Weisheimer (2010) has some more theoretical discussion on the question of origins of systematic model errors.

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Reference Palmer, T.N. and A. Weisheimer (2010): Diagnosing the Causes of Bias in Climate Models - Why it is so Hard? Proceedings of the ECMWF Annual Seminar 2009 on Diagnosis of Forecasting and Data Assimilation Systems, Sep 2009, 1-13.

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