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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.

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The authors link similar nonlinear model equations as an attempt to improve the prediction of the ensemble of models, instead of simply averaging multiple independent models. A problem with this approach is that combining nonlinear systems does not create a sort of average system; the coupling between systems can cause major changes in the dynamics. Examples of how coupling can change dynamics may be found in Pecora et al, Chaos vol. 7, p. 520-543 (1997).

While it is possible to adjust the coupled models to produce reasonable agreement with the true model, a constant problem with modeling nonlinear systems is that beyond the known training data, there may be some bifurcation that does not fit the model. It is always possible to have regions of phase space that are rarely visited, so they may not be seen during training, but they can affect later results. I haven't been able to

find a reference, but there was a contest in the 1990's to see how accurately different models could predict the future of a chaotic signal. Some models gave good short term predictions, but none could give long term predictions.

In eq. 5, the authors couple their combined model to the true Lorenz signal and use the coupling constant necessary to synchronize the models as a measure of the model accuracy. The coupling constant value may be related to the model error, but it is also possible that the coupling constant value is simple a measure of the stability of the combined system; it may be that the system that is closer to the truth is also less stable in this coupling configuration, so that it requires a larger coupling constant.

To summarize, combining models with coupling, as the authors propose, may actually produce a worse model than the individual models. Much knowledge of the actual processes of climate goes into the individual models; coupling these nonlinear models can alter them in unpredictable ways.

There are model estimation methods that are similar in spirit to the authors ideas. See, for example, J. C. Quinn et al, Parameter and state estimation of experimental chaotic systems using synchronization, Physical Review E vol. 80, 016201 (2009) .

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