Geophysical Research Abstracts
Vol. 16, EGU2014-12939, 2014
EGU General Assembly 2014

Interactive Ensembles Without Loss of Spread Information

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If the members of an ensemble of different models are allowed to interact with one another in run time, predictive skill can be improved as compared to that of any individual model or any average of indvidual model outputs. Inter-model connections in such an interactive ensemble can be trained, using historical data, so that the resulting "supermodel" synchronizes with reality when used in weather-prediction mode, where the individual models perform data assimilation from each other (with trainable inter-model "observation error") as well as from real observations. In climate-projection mode, parameters of the individual models are changed, as might occur from an increase in GHG levels, and one obtains relevant statistical properties of the new supermodel attractor. In simple cases, it has been shown that training of the inter-model connections with the old parameter values gives a supermodel that is still predictive when the parameter values are changed.

It might seem that by allowing ensemble members to interact and synchronize, we lose the advantage of using the ensemble to estimate uncertainty in prediction/projection from ensemble spread. Here we investigate the possibility of extending the machine learning scheme to estimate uncertainty in the trained connections, so as to effectively form an ensemble of supermodels. A larger training set is generally required to learn the uncertainty in the values found, but the task can be reduced by restricting the possible connection values to a discrete set. An alternative strategy is simply to import the spread information from an ordinary, non-interactive ensemble. We examine and compare the two strategies, using a variety of models, and reason about their applicability to the case of climate models that differ in their parameterizations of a sub-gridscale process.