Geophysical Research Abstracts
Vol. 21, EGU2019-19044, 2019
EGU General Assembly 2019

Supermodeling with nonlinear interactions and state dependence

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Recently an interactive ensemble approach has been proposed in which the models interact during the simulation. This approach is called the super modeling approach. The common way to model interaction is by adding linear nudging terms in the dynamical model equations. These terms nudge the solutions of the models towards each other and in this way towards a consensus solution. With sufficient nudging, it can be shown that the tendencies of the consensus are weighted averages of the individual model tendencies. In other words, the supermodel tendencies are linear combinations of the individual model tendencies. Several methods including linear regression have been proposed to optimize the weights.

In this work, we explore two extensions of this paradigm. First, we consider the case where supermodel tendencies are non-linear combinations of the individual model tendencies. Such a non-linearity can be modeled by a neural network optimized with backpropagation. The second extension is the case where supermodel tendencies depend not only on the individual model tendencies, but also on the model state.

These extensions, intended for application to climate modeling, are here explored in numerical experiments with low-order chaotic dynamical systems.