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Connecting atmosphere models to improve model states by partial synchronization

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Internal variability of atmospheric general circulation models (AGCMs) is a challenging issue in interactive-ensemble methods. At high latitudes internal variability is so high that the ensemble mean varies too smoothly as compared to the individual members. This leads to unrealistic underestimation of the ocean-atmosphere coupling effect in the high latitude area. To overcome this problem, we take advantage of nonlinear synchronization to bring different nonlinear systems toward a single state. Multiple AGCM (CAM4, CAM5 and ECHAM6), components in the ESM families (NorESM1, CESM1 and MPI-ESM1), are connected in this study. The atmosphere model states are connected by using six-hourly snapshot atmospheric nudging on a few leading spherical harmonic components. Optimal weights for achieving synchronization of the AGCMs are determined using a machine learning algorithm to minimize global synchronization errors. Additional physical criteria are applied in order to reduce model systematic error because complete synchronization doesn't guarantee the removal of model systematic error. The potential of the approach for building a super model with multiple atmospheric models is discussed.