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Decadal climate predictions improved by an interactive and synchronized ensemble via ocean ensemble dispersion filtering

Christopher Kadow, Sebastian Illing, Igor Kröner, Uwe Ulbrich, and Ulrich Cubasch
Freie Universität Berlin, Berlin, Germany (christopher.kadow@met.fu-berlin.de)

Decadal predictions by Earth system models aim to capture the state and phase of the climate several years in advance. Atmosphere-ocean interaction plays an important role for such climate forecasts. While short-term weather forecasts represent an initial value problem and long-term climate projections represent a boundary condition problem, the decadal climate prediction falls in between these two time scales. The ocean memory due to its heat capacity holds big potential skill on the decadal scale. In recent years, more precise initialization techniques of coupled Earth system models (incl. atmosphere and ocean) have improved decadal predictions. Ensembles are another important aspect. Applying slightly perturbed predictions results in an ensemble. Instead of using and evaluating one prediction, but the whole ensemble or its ensemble average, improves a prediction system. However, climate models in general start losing the initialized signal and its predictive skill from one forecast year to the next. Here we show that the climate prediction skill of an Earth system model can be improved by a shift of the ocean state toward the ensemble mean of its individual members at seasonal intervals. We found that this procedure, called ensemble dispersion filter, results in more accurate results than the standard decadal prediction. Global mean and regional temperature, precipitation, and winter cyclone predictions show an increased skill up to 5 years ahead. Furthermore, the novel technique outperforms predictions with larger ensembles and higher resolution. Our results demonstrate how decadal climate predictions benefit from ocean ensemble dispersion filtering toward the ensemble mean.

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This study is part of MiKlip - a major project on decadal climate prediction in Germany: http://www.fona-miklip.de/decadal-forecast