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Ensemble generation for decadal scale forecasts using breeding in the ocean

Robert Piontek and Johanna Baehr
University of Hamburg, KlimaCampus, Hamburg, Germany (rpiontek@gmail.com)

We employ breeding to improve the spread in ensembles for decadal scale forecasts. Breeding (Toth and Kalnay, 1993) was originally developed in the context of weather forecasting. Essentially, breeding works by computing the difference between a control simulation and a perturbed simulation, which is then normalized and used as a perturbation for the next initialization. After a few cycles, the perturbations begin to resemble the fastest growing error modes of the model, with the desired result that the ensemble spread can be increased, especially at short lead times.

Here, we apply breeding to the oceanic component of a global coupled climate model (ECHAM5/MPIOM). We breed temperature and salinity (but not velocities), and use a vertically dependent normalization factor, based on the natural variability of the free model.

The results of the breeding are compared to ensembles generated with lagged initial conditions. As a basis for the comparison, we compute the ensemble spread skill score of our perfect model experiments, which is the ratio of forecast error to the ensemble spread, averaged over different start dates. Our analysis focuses on the upper ocean heat content and the MOC, particularly in the North Atlantic. Initial results indicate that the breeding technique has the potential to improve both the spread and the forecast error of decadal scale forecasts.