EMS Annual Meeting Abstracts
Vol. 14, EMS2017-218, 2017

Ensemble generation method based on Bred Vectors (BV) for inter-annual to decadal climate prediction.

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We implemented a modified version of the classical Bred Vector (BV) method by Kalnay and Toth (1993) on longer timescales, and such specifying the "errors of the month/year". The method differs from the classical breeding to generate growing uncertainty modes by selecting specific time scales and related spatial scales by application on an almost stationary background field. It produces modification of the oceanic velocity, temperature and salinity initial variables with the the error growth measured by the weighted total energy norm. To obtain adequately scaled disturbance amplitudes by a physically/statistically proven method we created an additional algorithm for constraining the BV to the observations/re-analysis as a spatial regression, which we present, here, in this study. The development of the method, the construction design and all following tests are done in the frameworks of the ongoing decadal prediction MiKlip project (www.fona-miklip.de). The breeding routines are externally created and are able to be implemented in different coupled climate model systems. A hindcast starting from the year 1961 and finishing in year 2008 was performed using the Hamburg MPI-ESM LR (T63L19/GR15) pre-operational forecast system. For each starting year, nine BV were calculated on twelve months looping period over five iterative steps and the forecast operated for ten years forward. The investigated variable are the change of global mean ocean temperature in the top layers and the energy growth after each iterative step. The study showed that the most sensitive regions in the ocean responsible for inter-annual to decadal variability are localized by higher uncertainty growth rates. Although, the costs for the ensemble generation based on BV are higher than the ones dealing with e.g. lagged conditions, we consider breeding as more sophisticated way to produce climate predictions.