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Towards a Seasonal Prediction System using MPI-ESM

J. Baehr (1), M. Botzet (2), K. Froehlich (3), L. Kornblueh (2), S. Tietsche (2), and W. Mueller (2)

(1) University of Hamburg, KlimaCampus, Hamburg, Germany (johanna.baehr@zmaw.de), (2) Max Planck Institute for Meteorology, Hamburg, Germany, (3) Deutscher Wetterdienst, Offenbach, Germany

We compare the predictive skill of the last two generations of the MPIM coupled climate model systems on seasonal time scales. Parallel experiments are carried out with two fully coupled climate models: (i) MPI-ESM: ECHAM6/MPI-OM as used for the CMIP5/IPCC-AR5, (ii) COSMOS: ECHAM5/MPI-OM as used for the IPCC-AR4. Both models use the same ocean resolution (about 1.5 degrees horizontal resolution with 40 vertical levels), and the same horizontal resolution in the atmosphere (T63; $\sim$200 km grid point distance). The vertical resolution in the atmosphere is 31 levels in ECHAM5, and 47 levels in ECHAM6, including the lower stratosphere. Assimilation runs are performed from 1979 to 2001 (at present), nudged to the ECMWF re-analyses in the atmosphere (vorticity, divergence, temperature, surface pressure) and ocean (temperature, salinity). Atmospheric temperatures are only nudged above the boundary layer. MPI-ESM additionally includes sea ice nudging (NSIDC data). Ensemble hindcast simulations are initialized from the assimilation runs between 1989 and 1998, starting each May and November, and run for 9 months. For each start date, 6 ensemble members are created with slightly modified initial conditions (1 day lagged initialization).

The nudged experiments show a reduced warm bias and a more realistic warming trend in global mean temperature for MPI-ESM compared to COSMOS. Model drift is similar in MPI-ESM and COSMOS, but is highly variable on horizontal scales and is crucially dependent on the initial month. Tropical SSTs show small RMS errors in both systems. The individual forecasts for each starting date seem to predict the observed temperature anomalies. Observed El Niño (e.g. 1997/98) and La Niña (e.g. 1988/89) events are well predicted, except for the 1994 prediction. For Nino3.4, however, the RMS error appears larger for MPI-ESM than for COSMOS. Predictive skill of the western Pacific upper ocean heat content is also investigated. Presently, additional ensemble simulations with additional start dates are performed to improve the statistical significance and robustness of the results of the MPI-ESM prediction system.