SESSION: (B2) Modelling issues in S2D prediction

(B2-01)

Demands on the MPI Earth System Model to perform seasonal-to-decadal climate predictions

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The Max-Planck-Institute Earth System Model (MPI-ESM) is the baseline for the German Climate Forecast System (GCFS) and contributes to the upcoming CMIP6 experiments. An overview is presented on the latest developments of MPI-ESM as a seasonal-to-decadal climate prediction system. Results are shown with a focus on two topics: (i) the increased spatial resolution, and (ii) the initialization, each with respect to the (expected) subsequent prediction skill.

Compared to its precursors provided for CMIP5, a higher-resolved version of MPI-ESM (MPI-ESM-HR) has been developed, which represents in its atmospheric component a doubling in horizontal resolution (T127, ~100km). The model-tuning is straight-forward to targets of global mean temperatures, Arctic sea-ice, a well-balanced radiation budget and a stable ocean circulation. Two examples are presented by which a simple increase in resolution and a straight-forward tuning has and has not led to the desired improvement in prediction skill. First, the winter North Atlantic Oscillation (NAO) is considered, for which high prediction skill for the first winter has been found in a lower-resolved model version (T63, ~ 200km). Surprisingly, in MPI-ESM-HR the prediction skill is reduced. An examination of the predictants of the winter NAO reveal, that in particular the troposphere-stratosphere linkage is only weakly represented in MPI-ESM-HR. A mechanism that was not given much attention during the tuning process. Second, the storm track bias is substantially reduced over the North Atlantic and Europe in the MPI-ESM-HR compared to its lower-resolved version. Initialized experiments reveal substantially higher prediction skill for storm-track density in MPI-ESM-HR, and positive skill is found for years 1-5.

In addition, progress has been made in the initialization of decadal climate predictions. Approaches based on a nudging procedure of atmosphere and ocean reanalyses in to MPI-ESM induced imbalances in North Atlantic heat transport and budget. The induced transport modifications continue to be present in the freely running predictions and are seen to reduce forecast skill. The imbalances vary with different reanalysis products and with application of full fields or anomalies. The assimilation of anomaly fields largely keeps the heat transport and budget in balance and the according prediction skill is significantly higher compared to initializations from full fields. This result reflects the need for a “model-consistent” assimilation. In this respect an Ensemble Kalman Filter (EnKF) has been implemented in the oceanic component of the lower-resolved version of MPI-ESM. Initialized experiments with the EnKF assimilating EN4 and HadISST outperform experiments based on nudging techniques in terms of prediction skill in particular in the Pacific and the North Atlantic. The implementation of EnKF in MPI-ESM-HR is currently investigated.