Project: **873**

Project title: **SPECS/EUROSIP**

Project lead: **Johanna Baehr (IfM) and Wolfgang Mueller (MPI-M)**

Project participants: Felix Bunzel (MPI-M), Mikhail Dobrynin (IfM), Daniela Domeisen (IfM, now: GEOMAR), Matthias Fischer (IfM), Kristina Froehlich (DWD), Holger Pohlmann (MPI-M).

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Overview: The central aim of the project is the continuation of the development of a seasonal prediction system based on the initialized coupled climate model MPI-ESM. The simulation contribute to the SPECS project (IfM and MPI-M contributions) project, the RACE project (TP 2.3), and the continuing development of the German Climate Forecast System (GCFS).

Summary: In comparison to the proposal, we conducted all simulations required for the collaborative efforts in SPECS, and all simulations needed for our contribution to the RACE project. We also performed and analysed the simulations to enable our partner DWD to start the near-operational version of the seasonal forecast system (GCFS1.0), now providing forecasts every month. The performed simulations were the basis for several joint publications (Baehr and Piontek, 2014; Baehr et al., 2015, Domeisen et al., 2015), a contribution to the CHFP forecasts archive (including a currently submitted joint publication with may other partners: Butler et al., 2015), a joint proposal to the Copernicus Climate Change framework, and in addition publications which are currently in preparation (e.g., Bunzel et al.; Dobrynin et al.)

Example results:

1. Seasonal hindcasts ensembles with MPI-ESM-LR, MPI-ESM-MR and MPI-ESM-HR

For the SPECS project, we completed a set of seasonal hindcasts using MPI-ESM-LR, MPI-ESM-MR and MPI-ESM-HR. Both MR and HR setups are similar to the default version MPI-ESM-LR (Baehr et al. 2015). An assimilation experiment was performed nudging ERAinterim for the atmosphere (vorticity, divergence, temperature and surface pressure) and ORA-S4 for the ocean (temperature and salinity). Further sea ice data from the National Snow & Ice Data Center (NSIDC) was used for nudging sea ice concentrations. The breeding method (Baehr and Piontek 2014), which was also applied for the perturbation strategy in MPI-ESM-LR, is used to create the hindcast ensemble of 10 members and at least 7 months length, starting on 1st of May and November between 1981 and (at least) 2011. These seasonal hindcasts at different resolutions of MPI-ESM (with reference to SPECS tasks: LR - task 3.1.3, MR - task 4.1.2, HR - task 4.1.3) are all completed.

Improved hindcast skill of NINO3.4 temperatures could be achieved especially with the MR configuration for the hindcast set starting 1st May between 1981 and 2011. The skill of the HR configuration lies only in the range of the LR configuration, probably suffering from a lack of model tuning, which we plan to address in the next allocation period.

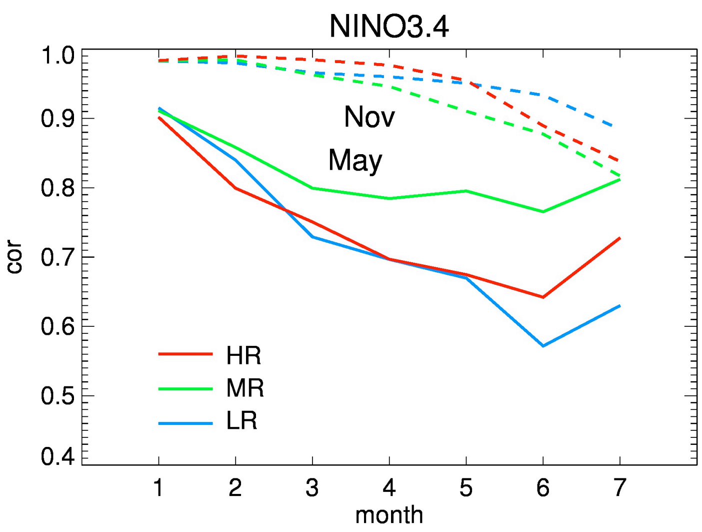

Figure 1: Correlation skill of ensemble mean NINO3.4 sea surface temperatures for different lead months starting on 1st May and Nov between 1981 and 2011 in the seasonal MPI-ESM systems using the LR, MR and HR configurations.

2. Impact of soil moisture initialization in MPI-ESM-LR

The impact of soil-moisture initial conditions on the seasonal prediction skill of 2-meter air temperatures in Central/Southern Europe was investigated with the Max Planck Institute Earth System Model (MPI-ESM). An assimilation run was performed with MPI-ESM version 1.1 in low-resolution (LR) configuration with a 5-layer soil scheme. In this experiment Newtonian relaxation (or "nudging") was used to assimilate vorticity, divergence, temperature (except for the boundary layer), and surface pressure in the atmosphere, as well as temperature, salinity, and sea-ice concentration in the ocean component of the model. With this setup the April-mean soil moisture in Central/Southern Europe was indirectly assimilated into the new MPI-ESM version 1.1 with an anomaly correlation coefficient (ACC) of almost 0.9 over the period 1981-2011 in the upper two layers (reference: ERA-Interim). With the old MPI-ESM version 1.0.02, where a bucket-type soil-scheme is implemented, an ACC of merely 0.6 is obtained (see Fig. 2). When the 5-layer soil-scheme is switched off in MPI-ESM v1.1, the ACC in April does also not exceed 0.6 in the new model version. Thus, the improvement in indirect soil-moisture assimilation must originate from the 5-layer soil-scheme.

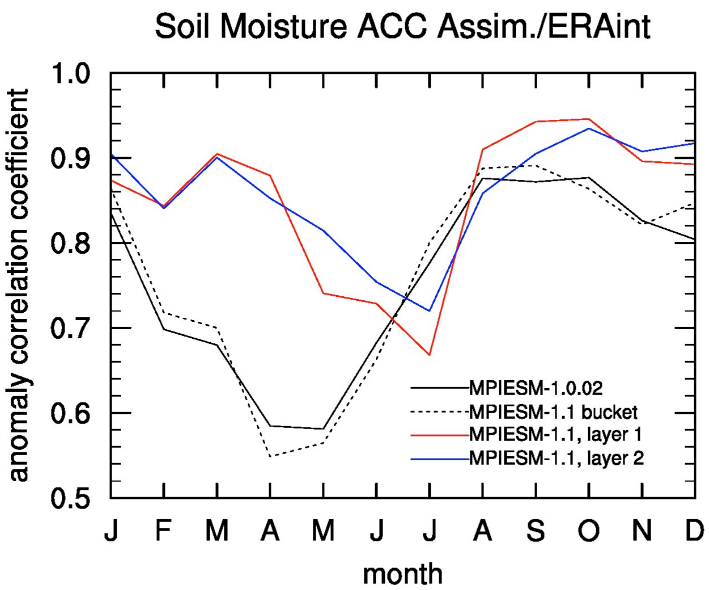

Figure 2: Soil moisture ACC obtained from assimilation runs performed with the old MPI-ESM v.1.0.02 (black solid line), the new MPI-ESM v.1.1 using the old bucket-type soil scheme (black dotted line), and the new MPI-ESM v1.1 using the new 5-layer soil scheme (layer 1 in red, layer 2 in blue), are shown.

Further results

As proposed, the impact of different sea-ice initializations, different ensemble generation techniques, and number of ensemble members was analysed within SPECS. Also, the hindcasts for the MR setup were increased to an ensemble size of 30 in total. For RACE, both the reference set of hindcasts started from present day conditions (20 start years with 10 ensemble members each) was compared to a hindcast ensemble set started from future climate change conditions (20 start years with 10 ensemble members each).

References

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