Project: **1066**

Project title: **Simulations of the Last Interglacial and of the Mid-Holocene with MPI-ESM and AWI-CM in the framework of the Paleoclimate Model Intercomparison Project, phase 4 (PMIP4)**

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Report period: **2018-01-01 to 2018-12-31**

We report on our modelling efforts with MPI-ESM-LR and AWI-ESM[1] in the framework of simulations for the Paleoclimate Model Intercomparison Project, Phase 4 (PMIP4) during the first 10 months of allocation period 2018. First of all, we would like to thank the WLA for the positive evaluation of our last proposal. We replied to the WLA's comments via the online form and would like to elaborate some further aspects below.

We acknowledge that resources at HLRE-3 are already under strain during the allocation period of 2018 because of the ongoing CMIP6 modelling efforts. Consequently, we have tried to limit utilization of resources at HLRE-3 in the framework of DKRZ-Project ba1066 during 2018 as much as possible. First of all, we decided to completely drop simulations with MPI-ESM-HR from our PMIP4 modelling plan. Although we would have been very interested in studying HR-simulations in the framework of PMIP4, and although we still believe that this would have been a valuable contribution to the scientific community, we will defer the respective simulations to a later time. Our current aim is to conduct as many simulations with T63-resolution in the atmosphere as possible. This decision is justified as our overriding scientific interest is the study of model output derived from simulations at T63-resolution – the resolution employed by us for the majority of our modelling tasks with both MPI-ESM and AWI-ESM.

The announcement of another update of the CMIP6-version of MPI-ESM-LR, that became available on the 7th of September, and the fact that the CMIP6/PMIP4 data request has not yet been finalized, caused significant problems with our proposed time schedule for the allocation period of 2018 in project ba1066. As we aim at generating climate simulations that are suitable for the provision to CMIP6/PMIP4 data portals, we are forced to a) use official CMIP6-versions of climate models, to b) generate the simulations at HLRE-3, and to c) fulfill the official CMIP6/PMIP4 data request. Hence, our modelling plan, as proposed for the current year, has been delayed.

In the beginning of 2018 we have employed the previous CMIP6-version of MPI-ESM-LR (mpiesm-1.2.01) for generating a spinup of simulation lig127k_MPI-ESM-LR. Yet, it soon became clear that there was the plan for another update of MPI-ESM-LR towards the final CMIP6-version (mpiesm-1.2.01p1). In order to not cause unnecessary computational load on HLRE-3, we refrained from employing the HLRE-3 for generating further spinups with mpiesm-1.2.01, as this version was already known to be outdated. While we have employed the AWI-ESM to generate a number of model spinups, including lig127k_AWI-ESM and hol9.5k_AWI-ESM, we were not able to finalize any of the simulations due to the lack of the finalized CMIP6/PMIP4 data request. Hence, we are forced to apply again for computational resources for various tasks that already have been proposed for the allocation period of 2018.

Despite these setbacks, we have been able to make scientific progress with our work in 2018. Based on the equilibrated climate state of simulation lig127k_MPI-ESM-LR, that has been recently generated with the updated CMIP6 model-version of MPI-ESM-LR (mpiesm-1.2.01p1), we are currently preparing daily-mean time series of simulated near surface air temperature and total precipitation. These will be employed towards the analysis of climate variability for a hydrometeorological study that is led by Paolo Scussolini of the Vrije Universiteit Amsterdam. The study aims to explore how large changes of the hydrological cycle might be in future warmer-than-present climates, and to discuss potential impacts of extreme events, like storm surges and coastal flooding, on society. These scientific questions are tackled based on modelled climate differences between Last Interglacial (LIG) and Pre-Industrial (PI) (Scussolini et al., 2018).

Based on our work in DKRZ-project ba1066, we find that simulating the climate of the LIG at 117 ka before present by means of the MPI-ESM-LR reproduces expected temperature anomaly patterns with respect to a PI reference state. This in particular includes widespread cooling during boreal winter (DJF), and widespread warming during boreal summer (JJA). The annual mean temperature anomaly simulated with MPI-ESM-LR is in agreement with results from earlier studies (Fig. 1), e.g. the publication by Pfeiffer and Lohmann (2016), who employed the predecessor-model of MPI-ESM, the Community Earth System Models (COSMOS). Yet, we also find that MPI-ESM-LR provides more details of regional climate (Fig. 1) due to increased spatial resolution.

[1] Note, that the AWI-CM has been renamed to AWI-ESM in the framework of contributions to CMIP6/PMIP4. This is in order to distinguish the version with dynamic vegetation (now called AWI-ESM) from the version without dynamic vegetation (for the latter version, the model name "AWI-CM" remains). Besides the renaming, the model did not change with respect to last year's proposal, where we still referred to the employed version, that already then considered dynamic vegetation, as "AWI-CM".

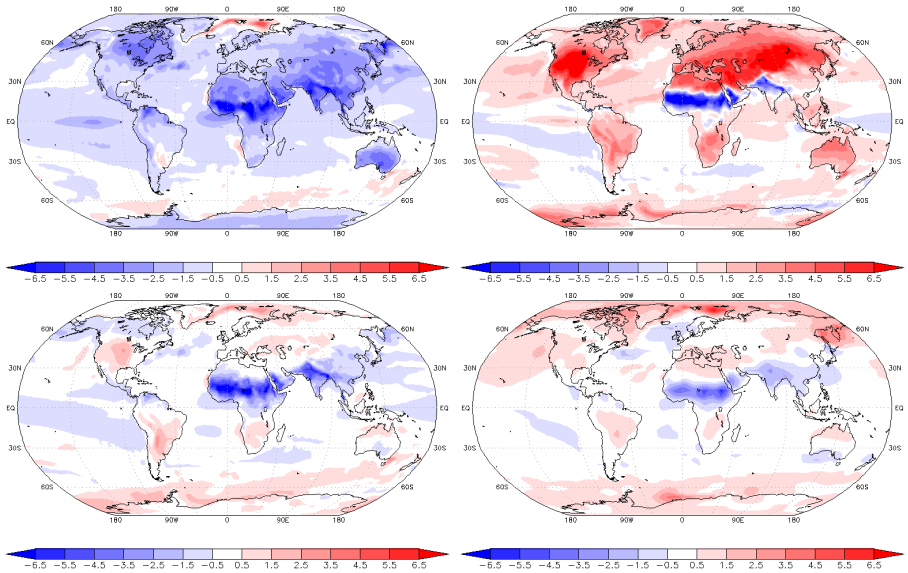

Fig. 1: Modelled surface air temperature anomaly (°C), Last Interglacial – Pre-Industrial. Top: DJF (left) and JJA (right), derived from simulation lig127k_MPI-ESM-LR. Bottom: annual mean in lig127k_MPI-ESM-LR (left) and simulation with a predecessor model (right; Pfeiffer and Lohmann, 2016). Orbital parameters and greenhouse gases are similar in both simulations, albeit not identical. The MPI-ESM-LR has double the horizontal resolution.

When comparing simulation lig127k_MPI-ESM-LR, based on MPI-ESM-LR, (Fig.1, top and bottom left) to simulation lig127k_AWI-ESM (Fig. 2), we find that MPI-ESM-LR and AWI-ESM agree well with respect to major patterns of LIG-temperature-anomaly. Yet, there are obvious differences – examples include boreal winter and annual mean in the region from the North Atlantic Ocean to the Arctic Ocean. While the first assumption is that these differences are related to different model formulations and spatial resolution in the ocean, a more detailed analysis will be performed in the coming year based on the CMIP6/PMIP4-conformant model output.

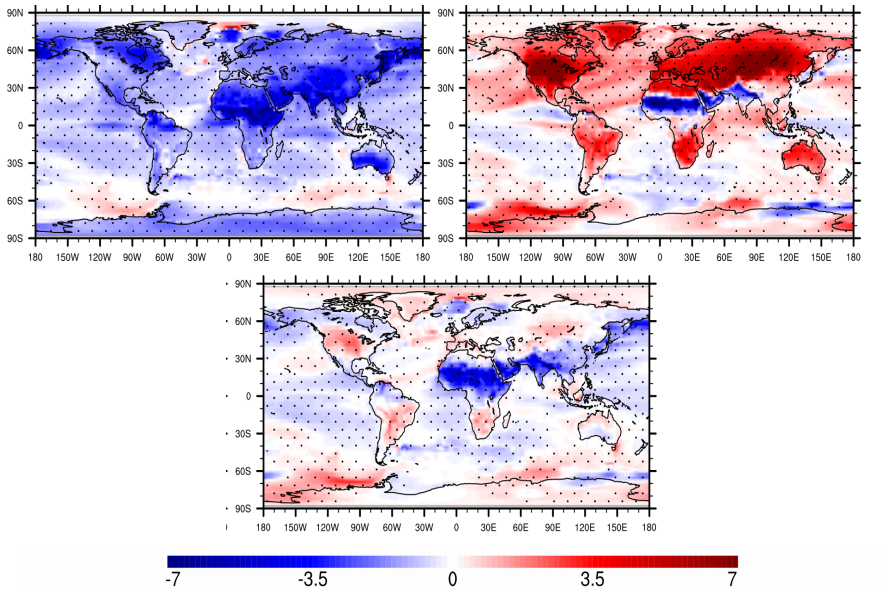

Fig. 2: Overview on modelled surface skin temperature anomaly in units of °C, Last Interglacial – Pre-Industrial, as modelled with the AWI-ESM. Top: DJF (left) and JJA (right). Bottom: annual mean.

References:

Pfeiffer, M. and Lohmann, G.: Greenland Ice Sheet influence on Last Interglacial climate: global sensitivity studies performed with an atmosphere–ocean general circulation model, Clim. Past, 12, 1313-1338, https://doi.org/10.5194/cp-12-1313-2016, 2016.

Scussolini, P., Ward, P., Bakker, P., Aerts, J., Renssen, H., Veldkamp, Ted, and Coumou, D.: Floods of a warmer world: learning from the last interglacial, 20th EGU General Assembly, EGU2018, Proceedings from the conference held 4-13 April, 2018 in Vienna, Austria, p.18730, 2018.