## 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) Project lead: Gerrit Lohmann Report period: 2024-01-01 to 2024-10-31

We report on project progress during the first 10 months of allocation period 2024 in the framework of simulations for the Paleoclimate Model Intercomparison Project, that is related to the Climate Model Intercomparison Project.

During the years 2023/2024 the model AWI-CM3, for which we have requested computational resources, has been subject to continued and intense model development and improvements. In particular, the ocean model has seen an extensive overhaul. Since this process took much longer than expected, and since the upgrades of the ocean component are only just now being included into the coupled model, we therefore have not yet been able to progress with the simulations that we had planned for 2024. We had already proposed to run the official CMIP6-DECK simulations, as outlined by Eyring et al. (2016) and references therein. While these planned simulations are not yet suitable as a genuine CMIP7 contribution, they had their value to help us to characterize the model metrics towards evaluating the model's current state and to inform us on the necessity of further model improvements and model tuning towards making the model ready for the next round of intercomparison in CMIP and PMIP.

The delay in the ocean model component was so extensive that now the official CMIP7 forcings, created by the input4MIPs project, are already emerging at the horizon. CMIP-IPO and the forcing task team have announced that the piControl forcings will likely become available in early spring 2025. Therefore, we decided to refrain from running the soon outdated CMIP6 type simulations, but to rather directly invest computational resources from HLRE4 towards generating a first version of genuine CMIP7 simulations that, depending on results, can either directly contribute to CMIP7, or that can inform on potential further model development in the framework of CMIP7 and PMIP5. Simulations with a preliminary version of the improved model, that have been conducted in another DKRZ project, have shown that indeed the warm bias in the Southern Ocean has been reduced in the model, improving the realism of simulations in this region that is crucial for the overal climate system via its relation to large-scale circulation system like the Antarctic Circumpolar Current and meridional overturning in the Atlantic and Pacific Ocean basins. This gives us some hope that the generation of PMIP simulations, and the related CMIP simulations that are necessary to enable the model-model comparison of AWI-CM3 at the spatial resolution employed for paleoclimatology, will proceed more smoothly during 2025 then it did during 2024.

Finally, we would like to comment on the comment by the WLA regarding GPU readiness of models, that was conveyed to us in the context of resource allocation for 2024. Indeed, the ocean model FESOM2 is already being made ready for use on GPU-based hardware. This work is done at Climate Dynamics at AWI who also develop the FESOM2 model and the coupled system AWI-CM3. To my knowledge several parts of the model are already GPU ready, while other parts still are optimized for CPU and necessitate further work. For the openIFS, that is the atmosphere component of AWI-CM3, we hope that we will be able to draw on work done at ECMWF and within the EC-Earth community to keep their IFS model up-to-date with developments in high performance computing architecture.

## **Reference:**

Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E.: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., 9, 1937-1958, https://doi.org/10.5194/gmd-9-1937-2016, 2016.