

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: **2023-01-01 to 2023-10-31**

We report on project progress during the first 10 months of allocation period 2023 in the framework of simulations for the Paleoclimate Model Intercomparison Project, that is related to the Climate Model Intercomparison Project.

During the years 2022/2023 the model AWI-CM3, for which we have requested computational resources, has been subject to intense model development and improvements. Various model versions, that differ in details of the parameterization, versions of the model components, and component coupling, have been employed and tested. Aim was to reduce biases in high latitudes of the Northern and Southern Hemispheres and to solve a problem in the energy balance for simulations with a paleoclimate modelling framework (i.e. adaptations of the orbital forcing). We were able to mitigate unphysical long-term trends in global mean temperature that was related to significant energy imbalance in the model. Furthermore, the warm bias in the Southern Hemisphere and as well the cold bias in the Northern Hemisphere, have been reduced. Still, we see the need for further improvements of the model performance. To this end we request resources for CMIP/PMIP-style simulations that will be used to evaluate current model developments and the state of the simulated climate. Simulations produced in the upcoming allocation period will likely not be the finalized model output that will be used in the next model intercomparison. Rather, creating these simulations will be a part of the ongoing development of the model towards its final CMIP/PMIP version. We will test and evaluate the model in its current state, to which we have brought it during the period of 2022/2023. Doing so is necessary in order to further improve the model for various different climate states and to inform us on the need for further model tuning.

We acknowledge that we were too optimistic regarding the availability of dynamic vegetation in the model. Our modelling plan for allocation period 2023 was heavily focused on testing and optimizing the AWI-ESM3, i.e. AWI-CM3 but including the LPJ-GUESS dynamic vegetation model. This plan was based on discussions with the developers of LPJ-GUESS who couple the model to the openIFS atmosphere model in the framework of the EC-Earth project. Last year in October the schedule announced to us was that by early spring 2023 the LPJ-GUESS coupling would be at a level of maturity that enables first runs with AWI-ESM3. Yet, the availability of the coupled setup has been delayed several times since then. Consequently, we have not yet run the simulations that we proposed for 2023 and for which availability of the coupled openIFS/LPJ-GUESS setup is essential. Instead, we have focused on improving the AWI-CM3, a step essential towards bringing the model to a state where we can employ it for production runs for CMIP and PMIP. The simulation work done in this context have been covered by computational resources from other projects. Yet, we are now in a position where we would like to produce a larger set of standard CMIP/PMIP simulations to evaluate the current state of the model and to inform on the need and direction of further model development and improvement. Therefore, we request resources for the upcoming allocation period that will be employed towards evaluation of the current state of the model (see request document for details).

Another construction site is the update of CMORizing scripts and software to AWI-CM3. Fernanda Matos, who is currently working in this project on making the AWI-CM3 ready for paleoclimate research, is currently conducting a research stay at a research group in the EC-Earth Consortium that uses IFS/openIFS as the atmosphere component in their Earth System Model. Scientists at the host institution have experience in CMORizing IFS/openIFS and NEMO output. Fernanda Matos is adapting the procedures for CMORizing openIFS to use with AWI-CM3.

Another step to be done is extending the possibility of CMORizing to FESOM2. Finishing this will take some time, yet our goal is to have the procedures for CMORizing ready by the start of the modelling for CMIP7/PMIP5. Currently the lack of CMORizing methods for AWI-CM3 is not a major problem as we are still running simulations in the context of model development. Simulations produced in this context will naturally be relevant only to a small circle of scientists.