PalMod WG4.4: Algorithmic and Implementation Performance Optimization

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The ultimate goal of the BMBF funded project PalMod is the transient simulation of the entire last glacial cycle with a comprehensive earth system model coupled to an ice sheet model. The last glacial-interglacial cycle, especially the termination of the last glacial period, is one of the best constrained global-scale climate change signal in Earth history documented by climate archives. Nevertheless, the understanding of the underlying dynamics is still limited, especially for epochs preceding the Last Glacial Maximum (LGM, 21,000 years before present (BP)) and with respect to abrupt climate shifts and associated changes in the sea level and Atlantic meridional overturning circulation (AMOC) during glacial and interglacial periods.

During the first project phase a simulation of the last glacial termination starting at the last Glacial Maximum (21,000 years ago) with prescribed atmospheric greenhouse gas concentration and insolation shall be performed with the earth-system model MPI-ESM coupled to the ice sheet model PISM. The major objective of this work package is to provide continuous performance optimization of the global fully coupled comprehensive Earth System Model for long-term transient paleoclimate simulations. The paleo-version of the MPI-ESM will be built upon the existing coarse resolution configuration MPI-ESM-CR and include all features required for performance and proxy-based validation of the transient multi-millennia simulations like interactive coupling with ice sheet and solid earth models, time-varying land-sea-mask and ocean topography, embedded dust cycle and carbon isotopes models etc.

It is obvious that, besides the physical adequateness of the model, high computational efficiency of the code enabling throughput rates of the order of several simulated centuries per day is essential for the success of the project. The emphasis of this work package will therefore be on the incremental update of different modules, algorithms and numerical schemes to more efficient computational solutions. We are strongly focussed to encourage the interplay between model improvement, numerical needs and computer science allowing for measurable improvements in the 1st project phase.