Joint Report of PalMod Projects 989, 1030, and 1192

Project: 989
Project title: PalMod WG1, Physical System
Project lead: Gerrit Lohmann (AWI), Gregor Knorr (AWI), Volker Klemann (GFZ), Uwe Mikolajewicz (MPI)
Report period: 2024-01-01 to 2024-12-31

Overview

During the allocation period of 2024 several effects led to a less-than-anticipated use of computational resources. These can be summarized as follows: PISM-VILMA simulations planned at PIK were delayed due to ongoing work with the description paper of the PISM-VILMA coupling, which has recently been published (Albrecht et al., 2024). Changes in personnel at PIK contributed to this delay. Torsten Albrecht started a new position since 09/24 and will continue working only part-time in PalMod together with a new PostDoc as replacement, who hopefully will start at the end of the year 2024. At AWI updates to the ocean model (FESOM2.6+icebergs, including stable water isotope code) and the coupling of PISM delayed some parts of the simulations. While updates to the ocean component of AWI-ESM ensure reflection of recent improvements and developments in the final transient runs to be performed at AWI, further development of PISM coupling became necessary in order to improve ice sheet responses during the last interglacial. This work was supported by accelerated runs from 130 ka to 127 ka with varying thicknesses and domains for ice sheets (Northern Hemisphere vs. Greenland), that estimated the sensitivity of transient ice sheet development in the context of model resolution and of initial ice sheet height, and that supported analyzation of threshold behavior in the coupled system.

Work at AWI

A milestone of the work at AWI was the publication of a manuscript that highlights summer snowfall as a driver for rapid growth of the Laurentide Ice Sheet before the Last Glacial Maximum (Niu et al., 2024). This work exploited the substantial advancements in the climate modelling toolbox at AWI that are an outcome of the PalMod project. Climate modelling with the coupled climate – ice sheet system AWI-ESM2/PISM showed that prior to the Last Glacial Maximum the volume of continental ice increased by a sea level equivalent of around 50 m (Figure 1). Key driver for this significant ice sheet buildup was transport of humidity from the warmer and moister low-latitude Atlantic Ocean into the interior of the north American continent. The following increase in summer snow fall did not only provide the necessary water volume for ice sheet growth; it also acted as important radiative feedback, that fostered climate cooling and reduced melt rates of ice sheets. Another important step was publication of the model description paper for the fully coupled Lagrangian iceberg model implemented in AWI-ESM in GMD (Ackermann et al., 2024). The model allows for tracking iceberg trajectories and accounts for freshwater and heat flux feedback to the ocean component. In a pre-industrial simulation with model icebergs in the Southern Ocean, effects on sea ice and bottom-water formation are evident. Iceberg dynamics help to reduce temperature and salinity biases that are common to Earth system models.

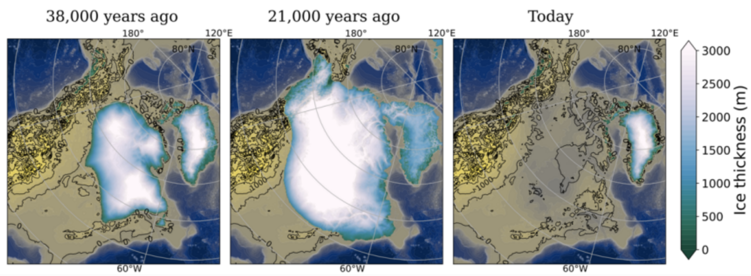

Figure 1: *Ice sheet extent and height over the north American continent and Greenland simulated with the coupled climate ice sheet system AWI-ESM2/PISM: pre-LGM climate (30 ka before today, left), LGM (21 ka before today, middle), and today (right).*

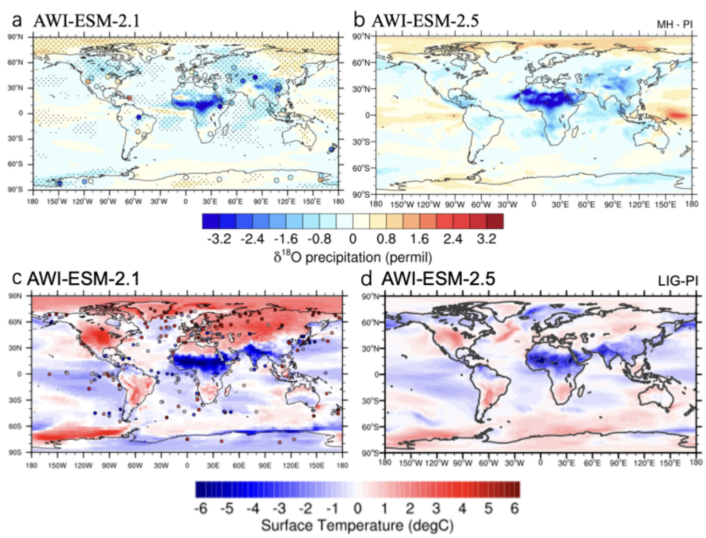

Figure 2: *Simulated anomalies in precipitation-weighted annual mean δ18O in precipitation between MH and PI in AWI-ESM2.1 (a) before the updates and (b) after the updates to the ocean model (resulting in AWI-ESM2.5). Simulated annual mean surface temperature anomalies (°C) between LIG and PI periods in AWIESM2.1 (c) before the updates and (d) after the updates to the ocean model (resulting in AWI-ESM2.5). Circles in panels (a) and (c) represent reconstructed paleoenvironmental characteristics.*

In the context of WP3.2 simulations "Isotope and climate variability since the last deglaciation" we tested model behavior under warm and cold climates. In the pre-industrial simulation, the global mean ocean temperature is only 0.36 K higher than suggested by observations, representing a significant reduction in the model bias. The magnitude of Northern Hemisphere warming during the Last Interglacial (Figure 2) has decreased compared to earlier results, but the previously missing Antarctic warming has been improved in the new model version (Shi et al., 2022). Stable water isotopes for the Pre-Industrial and Mid-Holocene periods are very similar to those from the previous version (Shi et al., 2023). However, vertical temperature and salinity structure could not be maintained in the LGM simulation, leading to an overly deep and strong upper branch of the AMOC that we could link to Antarctic Sea ice generation (Figure 3). In-depth analyses revealed that consideration of freshwater fluxes that are related to the ice-sheet retreat helps to improve the simulated climate. In order to take these new insights into account we have delayed the planned execution of the transient simulations somewhat and are currently preparing the updated model system for further work in the project (see allocation document for details).

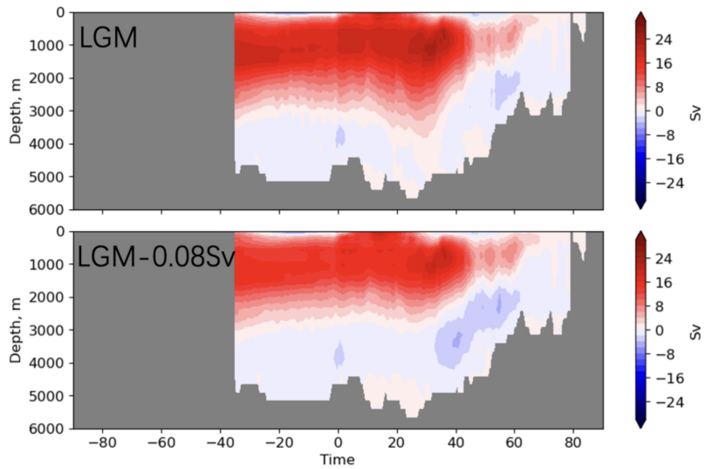

Figure 3: *Simulated stream function of zonally integrated meridional overturning circulation over the Atlantic basin for a default LGM setup (upper panel) and with an additional meltwater flux calculated from GLAC-1D at 20 ka before present (lower panel).*

Work at MPI

At MPI-Met, we performed and analyzed an ensemble of deglaciation simulations with the fully synchronously coupled MPI-ESM-CR-mPISM-VILMA model system. By performing an ensemble of eight simulations, we show that the simulated climate evolution from LGM to PI, and the simulated deglaciation, are sensitive to model parameters, particularly to the vertical background mixing in the ocean (Mikolajewicz et al. 2024).

On the one hand there are common features among members of the simulation ensemble: All simulations capture the main climate feature of the transition, including the massive retreat of the ice sheets and the weakening of the AMOC due to increased ice melt, and are in good agreement with observational data. All ensemble members show abrupt cooling events. For glacial periods and during the early deglaciation, these events are caused by surges from the Laurentide and Fennoscandian ice sheets, that result in the release of large amounts of icebergs into the North Atlantic, the Nordic Seas and the Arctic. The resulting meltwater input into the ocean leads to reduced surface salinity, suppressed formation of deep water, and weakens the AMOC. After the end of each surge event, the system recovers to its previous state (Figure 4). This Heinrich Event-like variability represents a glacial mode of internal climate variability of the coupled model system.

On the other hand, critical characteristics of simulated transient climate show model parameter dependency: The timing of the simulated Heinrich Event-like surge events shows a considerable scatter across the simulation ensemble. Additional sensitivity experiments confirm that timing and strength of these events depend on the initial conditions and on model tuning. This indicates that a direct comparison of abrupt climate events based on a small number of simulations with observational data will be difficult, and that new approaches for model-data comparison are needed — methods, that focus less on the exact timing of such events, and that put more emphasis on the understanding of underlying physical processes. We also find that abrupt events occur later throughout the transition. They are caused by a long-term shift in the sign of the Arctic freshwater budget, by changes in river routing and/or by the opening of ocean passages. Thereby, our results emphasize the importance of incorporating Earth system components, that are traditionally regarded as exhibiting a too-slow rate of change (e.g. solid Earth dynamics, ice sheets or geographical changes in land-sea mask or river routing) to be relevant for transient climate simulations. While we have focused our analysis on the overall deglacial climate response, our simulation ensemble also allows for a more detailed evaluation of a wide variety of processes in each of the individual modeled climate components.

To gain a more detailed understanding between Dansgaard-Oeschger cycles and Heinrich Events — i.e. the two prominent signals of glacial climate variability — we performed an ensemble of 24 simulations with the coupled ice sheet-solid earth model PISM-VILMA. The simulations are forced with a synthetic Dansgaard-Oeschger cycle. Using these simulations, we present a new Heinrich Event mechanism that overcomes previous shortcomings and reproduces all main characteristics of Heinrich Events from the paleo record under a wide range of forcing scenarios (Schannwell et al. 2024). In our mechanism, internal ice-sheet instabilities are the underlying cause for triggering Heinrich events. The timing of these events, however, can be locked into the cooling phase of the Dansgaard-Oeschger cycle through an atmospheric perturbation (e.g. snowfall and surface temperature) that is induced by the Dansgaard-Oeschger cycle itself. The atmospheric mechanism permits a pan-ice sheet response and allows for the occurrence of synchronous Heinrich events from two ice streams of the Laurentide ice sheet — a characteristic from the paleo record those previous theories, revolving around the ocean as the key driver, have so far failed to explain. A distinct advantage of the atmospherically driven mechanism is that it is applicable to ice streams terminating in the ocean as well as to ice streams terminating on land. Therefore, the mechanism could provide insights not only on episodic glacier accelerations in the past, such as Heinrich events, but also on modern-day episodic accelerations observed from mountain glaciers and ice streams draining the Greenland and Antarctic ice sheet.

To explore whether abrupt events, e.g. a slowdown of the AMOC or the disintegration of the Greenland or Antarctic ice sheets, may occur in the future, we have also started synchronously coupled simulations under different emission scenarios. Currently, projections mainly consider the contribution of ice-sheet melt on sea level (IPCC-AR6). Fully coupled simulations with interactive ice sheets will help us analyze processes and feedbacks in a physically consistent setup and assess uncertainties that arise from missing processes and feedbacks associated with ice-sheet changes in future projections. In addition, to facilitate ice sheet growth for glacial inception, we perform simulations that aim to test the sensitivity of our model system to vegetation and albedo evolution in areas close to ice sheets.

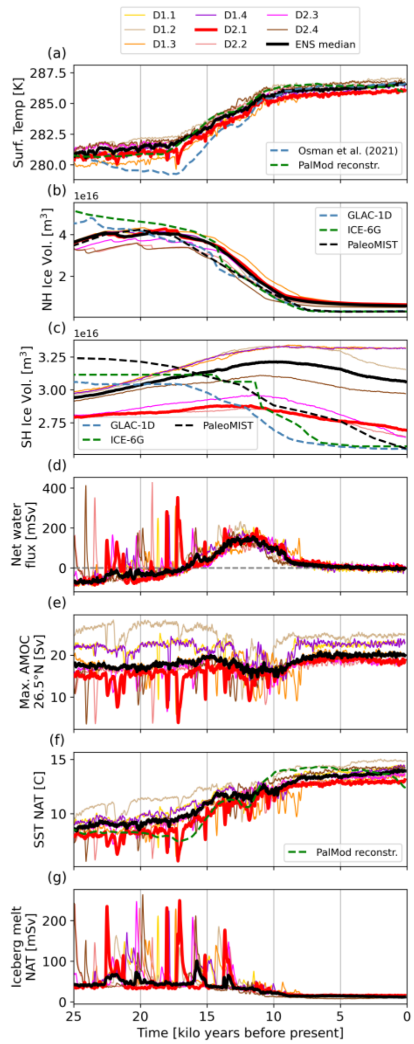

Figure 4: *Time series of global mean (a) near-surface air temperature, ice volume in the (b) northern hemisphere and (c) Antarctica, (d) net freshwater flux into the ocean, (e) strength of the AMOC at 26.5◦ N, (f) average SST of the North Atlantic (north of 30◦ N) and (g) iceberg meltwater flux into the North Atlantic for the model ensemble. The ensemble median is plotted with a thick black line. Model data shown are 100-year running means for climate model variables. Ice volume data are derived from snap shots 50 yr apart. Observational estimates are plotted in the time resolution given by the original data sets. The data from the PalMod reconstructions are anomalies.*

Work at GFZ

At GFZ, we further improved the global 3D viscosity structure in VILMA. This was achieved by adopting the previous viscosity structures based on a priori constraints. We applied the Haskell constraint with the sensitivity kernel given by Steinberger & Calderwood (2006) and updated our suite of 3D viscosity structures that were described in Bagge et al. (2020).

Using these new Earth structures we performed VILMA-3D test runs on Levante. In addition, we continued improving the rotational feedback implementation in VILMA-3D (Klemann et al., in prep) and performed ensemble model runs for VILMA-1D and for VILMA-3D with and without the new rotational feedback component in VILMA (Figure 5).

The new mechanism was used for the Earth structures generated for the coupled models in the PISM-VILMA description paper (Albrecht et al., 2024). For the revisions, we performed additional simulations to test for the forebulge feedback which can become relevant during glaciation phases in the Antarctic Ice Sheet particularly for weak Earth structures. The production runs also used a higher resolution (n512) in the sea-level part of VILMA.

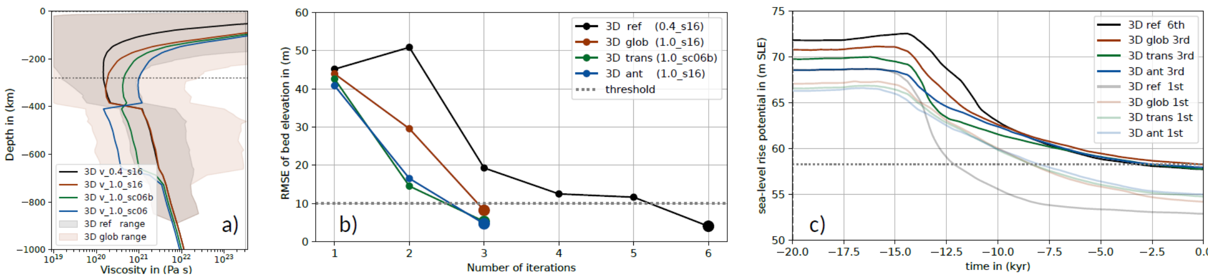

***Figure 5**: Global (logarithmic) lateral mean viscosity of 3D Earth structures a), RSL convergence at present b), and corresponding sea-level rise potential from Antarctica c) over the last 20 kyr for different 3D Earth model configurations. Black color indicates the reference 3D Earth structure '3D ref' (v_0.4_s16, Class-I), red-brown shows a similar 3D structure but with more lateral variability '3D glob' (v_1.0_s16, Class-I), green illustrates an intermediate 3D structure '3D trans' (v_1.0_sc06b, Class-III), and dark-blue refers to the 3D structure that has an opposite viscosity jump between the upper mantle and the transition zone '3D ant' (v_1.0_sc06, Class-II). In a) the range between global mininum and maximum viscosity for '3D ref' is shaded in grey, redish hue shows the '3D glob' Earth structure with larger lateral variability and thicker lithosphere. In c), for comparison, first iteration results are shown in transparent colors. This figure is taken from the supplement of Albrecht et al. (2024).*

Project: 1030
Project title: PalMod WG2
Project lead: Victor Brovkin
Report period: 2024-01-01 to 2024-12-31

Overview

WG2 of PalMod aims at understanding and quantifying feedbacks between biogeochemistry and climate during glacial cycles. In Palmod III, two work packages are focusing on the terrestrial and the marine carbon cycle.

WP2.1 "Terrestrial processes" investigates the feedbacks between climate and the terrestrial biosphere and carbon cycle for the entire last glacial cycle, with a major focus on the deglaciation and future climate. WP2.1 partner in this request is MPI-M.

WP2.2 "Marine processes" aims to improve the understanding of feedbacks between ocean biogeochemistry and climate for the last deglaciation and thereby improve the skills of ESMs in projecting the future ocean carbon sink and the changes in the marine environment.
WP2.2 partners in this request are AWI, CAU Kiel and UHH.

WP2.1 "Terrestrial Processes", MPI-M

WP2.1 performs work in three areas: 1) Transient modelling of the coupled global carbon cycle, 2) analysis of land cover changes in model and reconstructions, and 3) the role of remobilised permafrost carbon during the deglaciation.

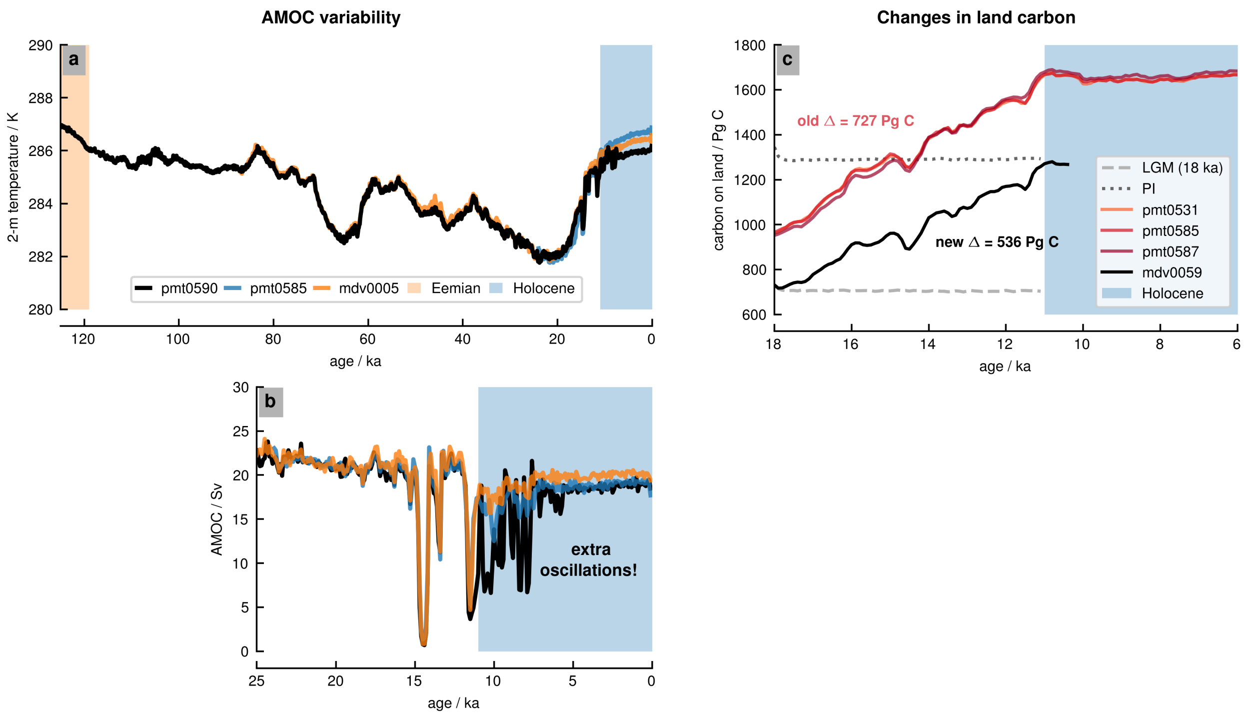

Fig. 2.1-1: a) 2m temperature in glacial cycle experiments, showing differing temperature trajectories for the early Holocene. b) Variability of the AMOC during the deglaciation in glacial cycle experiments. c) Total land carbon during the deglaciation, showing decrease in total C as well as carbon accumulation in adapted parameterisation.

For the transient modelling of the coupled carbon cycle, we had planned to conduct three full glacial-cycle experiments in 2024 to study processes over land contributing to long-term changes in the atmospheric composition of greenhouse gases. However, two issues have stalled progress so that simulations will start running only in the last quarter of 2024. First, the assessment of a previous glacial cycle experiment (Fig. 2.1-1a) showed a risk of substantial unexpected variability in the Atlantic Meridional Overturning Circulation (AMOC) because of the uncertainty in the initial condition for the ocean bathymetry (Fig. 2.1-1b). This problem was only detectable near the end of the simulation. Because a glacial cycle is a remarkably long experiment (over a yearlong) this sensitivity required a proper assessment.

Therefore in 2024 we performed short experiments to understand the source of this problem and how to prevent it. Part of this assessment was recently submitted for publication in a study of past and future climate change in North Africa (Duque-Villegas et al. submitted).

Secondly, the implementation of the land carbon cycle in the model had to be revised according to recent estimates of deglacial land carbon uptake (Fig. 2.1-1c). Tuning the terrestrial carbon component was also a necessary step before carrying out simulations with a fully interactive carbon cycle for the atmosphere, land and ocean. Hence in 2024 we did many equilibrium and transient experiments with coupled and uncoupled land-atmosphere setups of MPI-ESM to be able to bring the deglacial carbon uptake closer in agreement with current evidence. We focused mainly on changes to photosynthesis and soil carbon turnover parameters. The updated JSBACH (land model) setup is to be distributed to other working groups within the project.

For the analysis of land cover changes during the deglaciation, we had already found last year that the northern hemispheric forest biome expansion after the Last Glacial Maximum simulated by Earth system models leads pollen-based reconstructions by several millennia (Dallmeyer et al., 2022). The causes and consequences of this temporal mismatch are not yet clear. Therefore, we want to re-assess the past vegetation changes and do a systematic analysis of the impact of large-scale forest cover changes in the Northern Hemisphere on the atmospheric circulation and the climate. To this end, we conducted a first set of sensitivity experiments with prescribed, maximum continental-wide land-cover changes (i.e. 100% forest vs 100% grass cover) during different periods. Like expected, the continental forest cover changes not only affect the regions in which the land cover modifications are applied, but they also have a remote effect. This is particularly pronounced in the precipitation pattern (Fig.2.1-2, shown for 6.5ka BP). Continental forest cover mainly leads to a wetter climate over land, probably due to enhanced evaporation and water recycling. In addition to the regional changes, forests in North America and/or Europe primarily lead to more precipitation in the tropical monsoon regions, such as the West African monsoon region, and slightly less precipitation in Western Asia. In contrast, forest cover in Asia leads to less precipitation in parts of India and the Eastern part of the Tibetan Plateau and higher precipitation rates in Central and East North America. Forest cover in North America changes precipitation rates the most, because the land cover changes are located upstream of the hemispheric encompassing Westerly Jet system. The simulations will be further analysed in the upcoming month and in 2025.

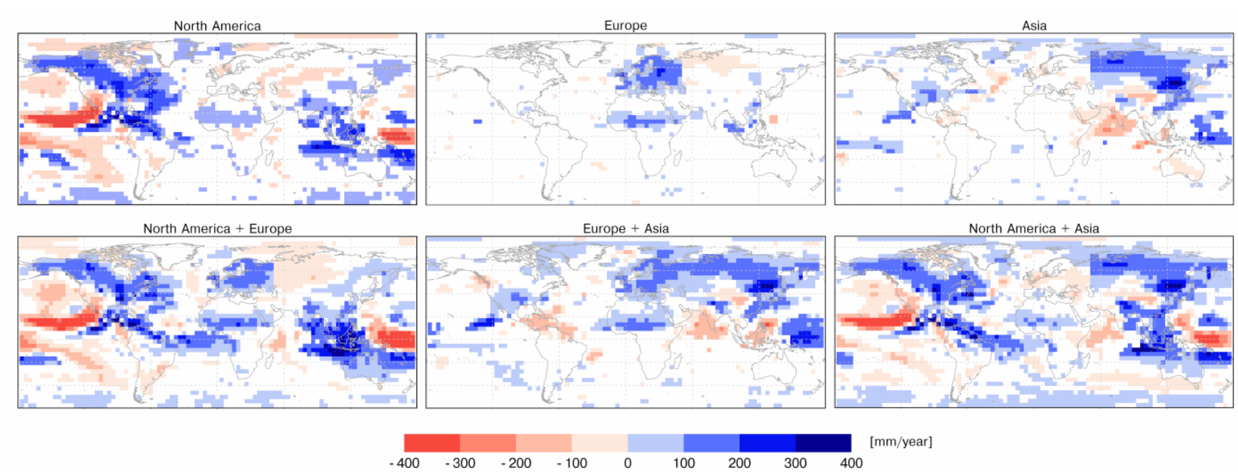

Fig. 2.1-2: The impact of continental forest cover changes at 6.5ka BP on annual mean precipitation, i.e. the difference in annual mean precipitation between simulations with 100% forest cover and 100% grass cover prescribed for the entire continent, respectively. Only significant changes are shown.

In another set of simulations, we planned to prescribe land cover for different time slices throughout the Bølling Allerød – Younger Dryas – Early Holocene period that are adapted to reconstructions. As the synthesis and calculation of the quantitative reconstructions has been delayed and this dataset has therefore not yet been finalised and published, it has not yet been possible to carry out these simulations. We plan to perform them by the end of this year.

Finally, we aim to investigate the role of remobilised permafrost carbon on atmospheric CO_2 during the deglaciation; particularly on abrupt rises in CO_2 concentrations like that observed at the start of the Bølling-Allerød. During the last year we performed a series of sensitivity tests on the version of the MPI-ESM we aim to use for this study in order to assess and tune the deglacial climate it produced. We are now closing in on a suitable set of parameters based on the result of these tests; however, we were unable to perform the longer sensitivity tests proposed last year as the impact of turning on the new permafrost scheme was greater than expected hence more work on tuning the model first will be required than originally estimated.

The role of glacial outburst floods from Lake Agassiz in triggering or extending the Younger-Dryas remains uncertain; during the last year we performed a set of studies of the effect of different Lake Agassiz drainage scenarios on the Younger-Dryas using MPI-ESM with an added dynamic lake component. The effect of the differing drainage scenarios on global climate proved minimal and there was no evidence of the Younger-Dryas being triggered by outburst flooding in our model. However, our study highlighted some issue with our experimental design and hence we aim to continue this study in the coming year using a more sophisticated experimental setup.

WP 2.2 "Marine processes", CAU Kiel

We are investigating how the acceleration or slow-down of the sinking of marine detritus, especially due to variations of particle ballasting, may have affected atmospheric pCO_2 during glacial-interglacial cycles.

For 2024, we were granted approximately 25100 node hours (we had originally requested 53400 node hours for deglaciation and inception simulation, and due to the ~53% cut in resources decided to focus on the deglaciation only). Unfortunately, in the first three quarters of 2024, we have not been able to effectively use the resources we were granted (we only used 1350 node hours, equivalent to just over 7% of the granted resources for the first three quarters). The reason is that, after we had started our first transient deglaciation simulations with MPI-ESM at the end of 2023, we soon ran into numerical difficulties with the transient setup leading to frequent model crashes. Despite several tries to circumvent these issues and an intensive error search, we have not yet been able to continue the planned/started transient MPI-ESM simulations. Because the numerical issues described above occurred only a few hundred model years after the initialization of our deglaciation simulations with the transient MPI-ESM setup, we unfortunately have no meaningful results to report yet from those runs.

To fulfil our PalMod project deliverables, we had to pause the error search and instead focus on CLIMBER-X developments and simulations, which we are not running at DKRZ, but at the CAU Linux cluster in Kiel. Nevertheless, we are planning to focus on MPI-ESM again starting in October 2024 and hope to at least make good use of the remaining computational time in the last quarter of 2024.

WP 2.2 "Marine processes", MPI-M

By the time of the report (September 2024), we had used 28852 node hours, less than that granted to our subproject (38317 for Jan-Sep, which is 14.9% of the computing time allocated to bm1030). This is because we have focused on analysing the existing model data and writing. Moreover, the planned second postdoc position in this subproject (responsible for conducting and analysing part of the planned simulations) is delayed to start in November 2024.

Our work in 2024 focused on constraining LGM and deglacial oceanic carbon and nutrient cycling and addressing global biogeochemistry's response to abrupt AMOC changes.

A) We conducted new sensitivity experiments within the PalMod ocean biogeochemical model intercomparison project (PalMod OBGC-MIP) to investigate the uncertainties concerning glacial marine nutrient content and terrestrial carbon storage. We have also conducted further model-data and inter-model comparisons among the PalMod models (MPI-ESM, AWI-ESM, and CLIMBER-X). The results were presented at the PMIP-carbon Workshop (Vienna, April 14, 2024) and EGU24 (Vienna, April 15-19, 2024). Currently, a manuscript on this topic is being prepared.

B) The analysis of previous LGM and transient deglacial simulations with MPI-ESM has inspired directions for adjusting the model to increase the glacial ocean carbon storage and deglacial oceanic CO2 outgassing. Specifically, we further tuned the ocean biogeochemistry model regarding temperature-dependent phytoplankton growth rate, DOC remineralisation rate and the fraction of dead cyanobacteria to DOC. The new tuning increases the deglacial CO2 outgassing by 18 ppm. We also found that different ecosystem model tuning leads to similar global mean nutrient and DIC distribution but with noticeable differences in the spatial distributions.

C) In collaboration with the proxy data scientist at UHH (Dr Sha Ni), we are conducting a model-data comparison for dissolved oxygen dynamics in the Arabian Sea. The recent reconstruction reveals an increased oxygen content in the bottom water from LGM to HS1, followed by a decrease from HS1 to Holocene. This feature is well presented in our latest transient deglacial simulation. We're conducting further analysis to explore the possible mechanisms.

D) We conducted a series of simulations with different freshwater hosing amplitude and duration to investigate atmospheric CO2 and global biogeochemistry's response to abrupt AMOC changes. The initial analysis of the model data has been presented to the PalMod partners to foster further collaboration. A joint protocol has been agreed upon to initiate a PalMod CO2-AMOC model intercomparison project.

WP2.2 “Marine processes“, AWI Bremerhaven

From January to September 2024, we completed 16 time slice simulations and 2 transient simulations with totally 132400 node hours, about 50% of the computing time requested. During the last three months of the year, we will start two deglaciation simulations and some tuning experiments with respect to the fully interactive CO2 and marine sediments (described in Ye et al., 2023) which will use up the remaining node hours.

Experiments conducted were:

1. PI and LGM reference simulations

Two time slice simulations under PI and LGM climate conditions were run according to the PMIP4 protocol for 1500 years each.

2. LGM experiments with alkalinity boosting

Eight LGM time slice simulations were conducted with alkalinity boosting by 40, 60, 80, 100, 160, 200, 240 and 280 mmol m-3 in the LGM alkalinity fields. All simulations were run for 250 years after the LGM-PMIP4 simulation of 1500 years. In the simulation with 240 mmol m-3 alkalinity boosting the atmospheric CO2 was lowered from 238 ppm to 190 ppm. This simulation was then continued for 250 years to ensure that the steady state concentration of CO2 stays around 190 ppm. This simulation is tagged as 'LGM-lowCO2' and used for the model intercomparison project within WP2 (Liu et al., 2024).

3. LGM experiments considering land carbon input and enhanced nutrient supply

Two time slice simulations under LGM climate were computed for 250 years each, starting from the LGM-PMIP4 simulation after 1500 years.

4. Dead-ocean simulations

Two time slice simulations were computed to quantify the contribution of marine biological carbon pump to the glacial CO2 draw-down. Both were run for 1000 years with biological activity switched off.

5. Experiments with preformed tracers

We implemented preformed tracers for DIC, DIN, DSi, Alk and O2 in AWIESM2 and conducted two time slice simulations for 1000 years each.

A part of the results were presented at the PalMod annual meeting 2024 (Ye et al., 2024). A manuscript based on these time slice simulations is being prepared.

6. Hosing experiments

Two hosing experiments were completed according to the protocol agreed within WP2. The total length of one experiment is 1000 years. The results will be used in the the model intercomparison project within WP2.

References:

Dallmeyer, A., Kleinen, T., Claussen, M. et al.: The deglacial forest conundrum, Nat. Comm. 13, 6035, https://doi.org/10.1038/s41467-022-33646-6,2022.

Ye, Y., Munhoven, G., Köhler, P., Butzin, M., Hauck, J., Gürses, Ö., and Völker, C. (2023). FESOM2.1-REcoM3-MEDUSA2: an ocean-sea ice-biogeochemistry model coupled to a sediment model, Geosci. Model Dev. Discuss. [preprint], https://doi.org/10.5194/gmd-2023-181, 2023.

Project 1192

Project title: PalMod Data Project

Project lead: Swati Gehlot (DKRZ)

Report period: 2024-01-01 to 2024-12-31

Overview

The project is led by PalMod phase-III cross cutting working group Data Hub (subproject CC1) which manages the model data produced. The project is used by WG1, WG2, WG3.

The project was created as a data project as an integral part of the PalMod Phase II Verbundprojekt CC.2 in 2021. Project bk1192 continues the work from Phase II and provides the “PalMod internal data pool” that stores and manages core results and data within the phase-II and phase-III scientific modelling WGs. This allows researchers from other work packages and working groups to use these data sets of common interest. Besides facilitating the intra-project collaboration, we assume that this will maximize data reuse while minimizing duplication of datasets on multiple accounts.
For this, all PalMod scientists, who need access to that data pool, which will be created during the runtime of the project PalMod and stored under account bk1192, will become members of the project. The project is expected to exist throughout the phase-III project runtime and possibly afterwards provide a space, where the scientific community will still be able to access and work with the (adhoc)data.

Summary of the work in 2024

Workflows detailing the import, access, share and distribute the data via the common data pool supplied by bk1192 are further developed (and distributed PalMod-wide) in close collaboration with the scientists with respect to their concrete requirements in the year 2023-2024. Along with being a core space for internal data sharing within the PalMod scientific WGs, the data pool bk1192 is also a dedicated space for DataHub-CC1 development and extension of model specific CMORization and publication workflows. Figure 1 shows the systematic usage plan of bk1192 for inflow and outflow of PalMod data.

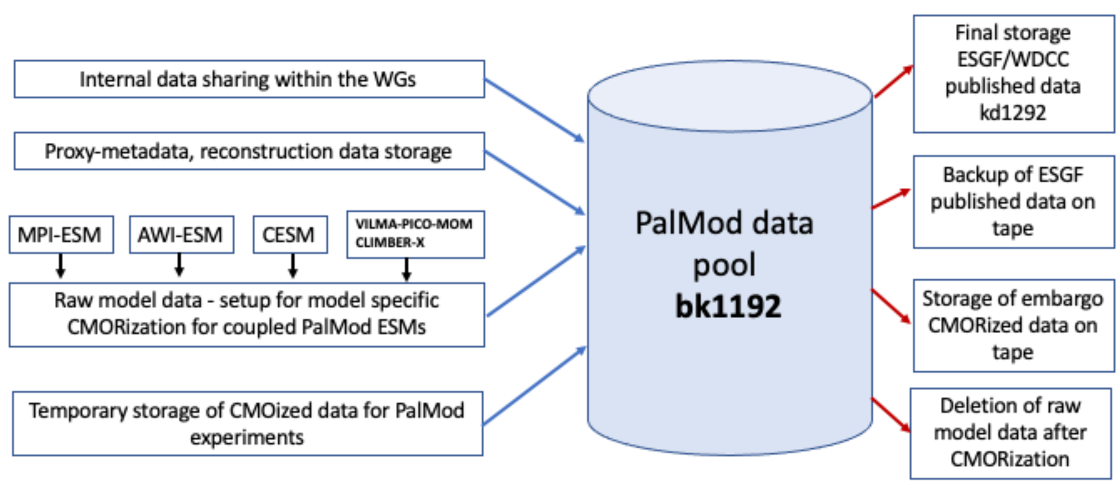

Figure 1: Storage workflow for PalMod data pool bk1192 resource. The multiple sources of data input are shown with black blue arrows. The red arrows show the subsequent movement of data after the CMORization is completed for coupled ESMs.

Resources in 2024

The resource request for 2024 has included mainly Lustre work space (250 TB). As the space is used not only for data provision but also for data standardization, the total amount of usage does not reflect the real needs. The demand is significantly higher during the process of standardization. Original data which was needed after the standardization is deleted from work as soon as possible.

Overview storage space for the data project bk1192

Project	Lustre work [TB]		CPU	
	Granted	Used (End of Sept)	Granted	Used
1192	250TB	131 TB	9.986	2

Since August 2021, the PalMod data pool is used as a primary resource for development of model specific CMORization, ESGF publication and WDCC archiving workflows within PalMod Phase II and PalMod Phase III.