Project: 965
Title: Regional Palaeoclimate Modelling and Palaeoenvironmental reconstructions
Report for allocation period 01.01.2025-31.12.2025

During the year 2025, granted resources were used to address different research questions. Several publications (submitted, envisaged) benefit from resources in project 965. Collaborations with people from AWI as well as external partners (University Koblenz, University Budapest, RWTH Aachen) are ongoing addressing different aspects of regional paleoclimate simulations with high resolution.

a) Regional climate of the Caspian Sea region during the Last Glacial Maximum:

The water level of the Caspian Sea varied extensively during the Pleistocene (~120 to 10 ka years before present). Different transgressions (higher lake level) and regressions (lower lake level) states of the Caspian Sea are well-defined and can be separated from each other. Nevertheless, absolute dating and to some extent also the order of different states of the Caspian Sea are still under debate due to conflicting proxy evidence. Therefore, also the water level during the Last Glacial Maximum (LGM) is unclear. Weakly developed paleosols at the southern coast of Caspian Sea near Gorgan may have developed during the LGM. Paleosols indicate more humid conditions and could therefore point towards a transgression state of the Caspian Sea. To analyse the influence of different assumed lake levels, we conducted regional climate model simulations with the WRF model, driven by data from the pool database at DKRZ as sensitivity experiment to investigate the impact of different Caspian Sea water levels on the regional climate.
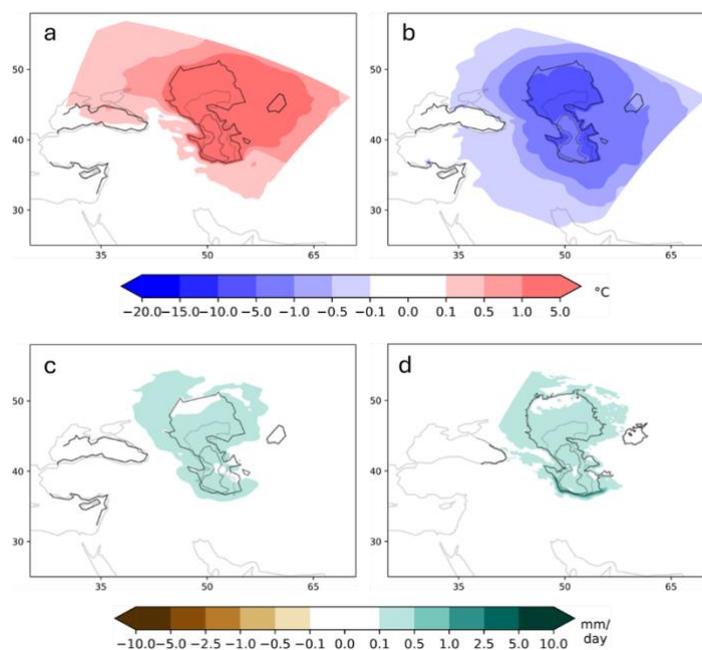

Figure 1: Long-term annual mean temperature (a,b) and precipitation (c,d) differences between simulations with Caspian Sea in transgression state (+50m a.s.l.) and regression state (-100m a.s.l.).

Preceding analyses of the atmospheric dynamics in the global forcing data were submitted in 2024 and published in 2025 (Stadelmaier et al. 2025). It led to the decision of using global MPI-

ESM simulations of the PMIP4 framework as it performed better than the AWI model of the same framework regarding LGM proxy data within the Caspian Sea region. The regional simulations have a horizontal resolution of 50km (domain 1) and 12.5km (domain 2). We find that the Caspian Sea in a transgression state leads to warmer winters and colder summers around the Caspian Sea, but with varying regions of influence (see Fig.1a+b; summer: north-east; winter: homogenously around Caspian Sea). A second important outcome is the increased precipitation at the southern coast of the Caspian Sea during the transgression state, in a region where paleosols were found. This pattern is only resolved in the higher resolution simulation (see Fig.1c+d). We plan to further analyse these findings in more detail and to prepare a publication in 2025/early 2026.

Stadelmaier, K.H., Ludwig, P., Kehl, M., and Pinto, J.G. (2025): Characterization of the Regional Climate and Large-Scale Atmospheric Circulation in the Caspian Sea Region During the Last Glacial Maximum. JGR: Atmospheres 130 (16), doi:10.1029/2024JD042262.

b) Regional climate in the Uvs Nuur basin (Altai, western Mongolia) during the LGM:

For the Uvs Nuur Basin in the Altai, paleoclimate simulations for the LGM and midHolocene have been performed successfully with ICON-CLM under a paleoclimate setup at 25 km grid spacing. The model code has been modified to consider different orbital configurations. Likewise, the correct treatment of changed glacial GHG concentrations has been tested. The simulations at 25 km grid spacing have been conducted in 2025 and first analysis have been performed this year (Figure 2). The analysis shows a clear cooling during the LGM compared to PI and MH conditions as expected. We will continue working on this topic next year, with a special focus on further horizontal refinement of the horizontal resolution (~7km grid spacing). (see also proposal for computing time for 2026).
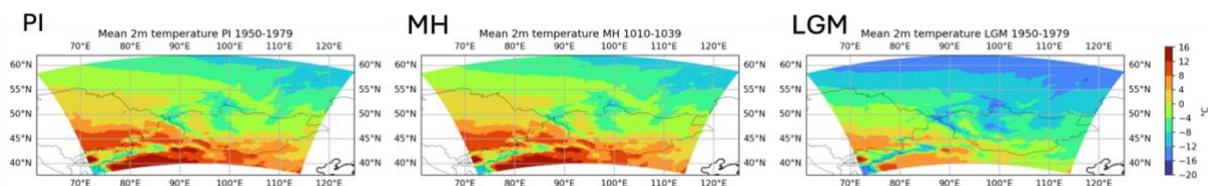

Figure 2: Mean 2-meter temperature (30-year mean) simulated by ICON-CLM for pre-Industrial (PI), midHolocene (MH) and Last Glacial Maximum (LGM) climate conditions in the Uvs Nuur Basin at 25 km grid spacing.