Project: 965
Title: Regional Palaeoclimate Modelling and Palaeoenvironmental reconstructions
Report for allocation period 01.01.2026-31.12.2026

During the year 2026, granted resources were used to address different research questions. Several publications (submitted, envisaged) benefit from resources in project 965. Collaborations with Helmholtz-colleagues at AWI and Hereon 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 (PhD-project):

During the recent years, the water level of the Caspian Sea varied by approximately 3m, with significant impact on the coastline. Looking at larger time scales, the water level variations have higher amplitudes: During the Late Pleistocene (~120 to 10 thousand years before present; ka BP), they varied by more than 100m. Regression and transgression phases were altering, in very high transgression states, the Caspian Sea was connected to the Black Sea, and eventually to the World Ocean. Many of the regression and transgression phases are well established and clearly distinguishable, however, their order of existence as well as the absolute dating is still under debate. As such, also the state of the Caspian Sea during the Last Glacial Maximum (LGM, 26-19 ka BP) is unclear due to conflicting evidence. The globally cold and dry climate with a ~130m lower sea level on global average could indicate a regression state of the Caspian Sea. On the other hand, weakly developed paleosols were found in the southern Caspian Sea region and dated within the range of the LGM. Paleosols usually form under warmer and wetter climate conditions. Therefore, their occurrence might point to a transgression state of the Caspian Sea.

To investigate the regional and local climate impact of the different states of the Caspian Sea during the LGM, we performed several high-resolution regional climate model simulations with WRF and driven by global MPI-P data using DKRZ resources of the project 965 as well as PMIP4 data provided in the pool database.

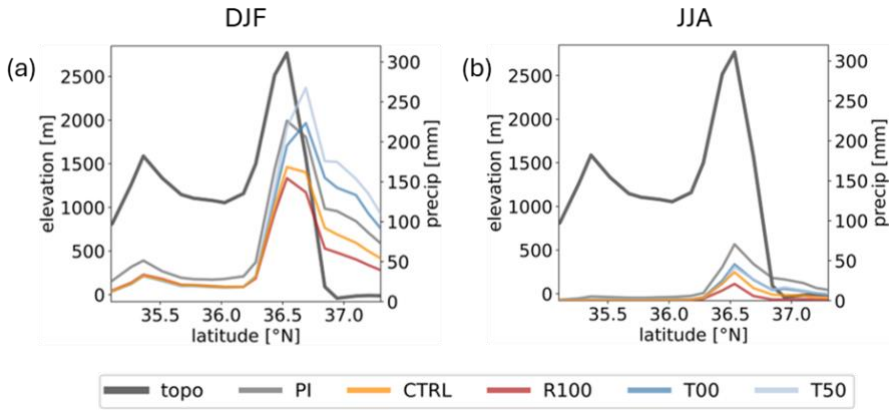


Figure 1: Cross sections at 54°E for PI topography and seasonal precipitation sums in winter (a) and summer (b) for the conducted WRF experiments. PI: under pre-industrial conditions with Caspian Sea at -27m above sea level (a.s.l.; water level of today); CTRL: LGM conditions with Caspian Sea at -27m a.s.l.; R100: LGM conditions with Caspian Sea at -100m a.s.l.; T00: LGM conditions with Caspian Sea at sea level; T50: LGM conditions with Caspian Sea at +50m a.s.l.

We find that the southern Caspian Sea region is most sensitive to the water level of the Caspian Sea, especially regarding precipitation. A high transgression state can partly overcompensate the LGM to pre-industrial (PI) precipitation reductions (see Fig. 1). This effect is limited to the southern/southeastern coast of the Caspian Sea, the same area where the potential LGM paleosols are found. A publication is currently in preparation, the submission is envisaged for this year:

Stadelmaier, K.H., Ludwig, P., Kehl, M., and Pinto, J.G. (2026): Impacts of Caspian Sea Water Level Variations on the Regional and Local Climate during the Last Glacial Maximum (in preparation).

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

A paleoclimate modelling approach is used to investigate the role of large-scale atmospheric circulation patterns on the moisture availability in the Basin of Great Lakes and the regional to local wind patterns relevant for aeolian transport. The model runs enable to evaluate changes in the interplay of Westerlies and East Asian Summer Monsoon (EASM) dynamics during selected climatic states (Pre-Industrial (PI), MidHolocene (MH) and Last Glacial Maximum (LGM)) and will contribute to an assessment of the hydrological cycle and shifts in local wind regimes in the Basin of the Great Lakes. Regional ICON-Simulations have been performed for PI, MH and LGM conditions by a 2-step-nesting approach to bring global MPI-ESM PMIP4 simulations (~200km grid spacing) to a final high-resolution data set covering 20 years of each climatic period at 10 km grid spacing (Fig. 2).

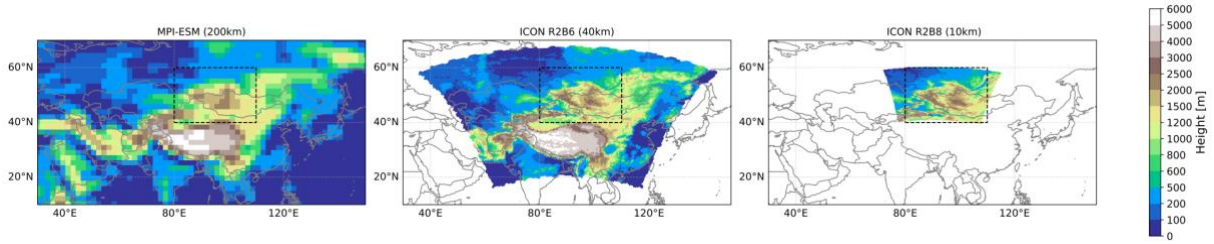


Figure 2: ICON-CLM model domains (40 km and 10 km grid spacing) and representation of topography by the MPI-ESM and ICON-CLM simulations

The model results are currently analysed in detail and a will contribute to upcoming publications. Our analysis focus on changes in the large-scale moisture supply / moisture sources during the different climate states. The model results, both global and regional, indicate general drier conditions during the LGM and MH, which is currently investigated in more detail. One hypothesis of the low MH precipitation is the missing regional moisture recycling due to not considering a potential transgression state of the Khyargas Nuur. Additional sensitivity tests with modified lake highstands are planned for 2027 (see proposal) to decipher the potential impact of an extended lake area. Furthermore, we will continue to investigate regional to local changes in simulated wind directions for individual dune locations in the Bor Khyar Els and in how far they agree with the proxy evidence.

c) Mid-Miocene in the Mediterranean

First runs to test different configurations scenarios with ICON-CLM for the Mid-Miocene have been performed in 2026. This work will be continued in 2027 (see proposal).