Project: 965
Title: Regional Palaeoclimate Modelling and Palaeoenvironmental reconstructions
Report for allocation period 01.01.2024-31.12.2024

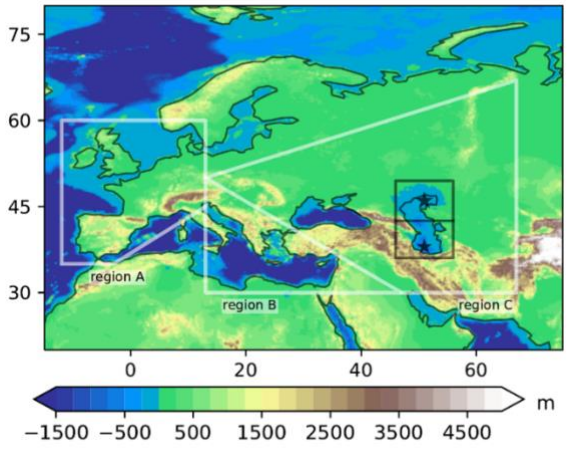
During the year 2024, granted resources where used to address different research questions. Several publications (submitted, envisaged) benefit from resources in project bb0965. Collaborations with people from AWI as well as external partners (University of Cologne, University Koblenz, University Budapest, RWTH Aachen) are ongoing concerning different aspects of regional paleoclimate simulations with high resolution.

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

The first part of this year's project was aiming at the characterization of the regional climate and large-scale atmospheric circulation in the Caspian Sea region during the Last Glacial Maximum (LGM), as represented in global climate models within the PMIP4 framework assessed via the database (/pool/data) of DKRZ and compared to proxy evidence. We found that global climate model data (AWI-ESM-1-1LR and MPI-ESM1.2-LR) are closer to proxy data in the Caspian Sea region than in the Mediterranean and Western Europe (see Figure 1 and Table). Furthermore, the atmospheric circulation of the region was assessed via jet stream and storm track characteristics and by applying the circulation weather type approach to classify the daily atmospheric flow into directional and rotational weather types.

This was preparatory work to analyse regional climate model simulations that will be described subsequently. The results have been submitted to JGR-A and are currently in review:

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



		T_{ann} [°C]	precip [mm/year]
Region A	Proxy	$\mathbf{-8.5 \pm 2.0}$	$\mathbf{-394.5 \pm 101.7}$
	# Data points	7	7
	AWI	-3.8	122.4
	MPI	-4.6	2.7
Region B	Proxy	$\mathbf{-5.8 \pm 2.0}$	$\mathbf{-231.9 \pm 100.5}$
	# Data points	9	10
	AWI	-3.8	7
	MPI	-3.9	59.1
Region C	Proxy	$\mathbf{-9.0 \pm 1.5}$	$\mathbf{-183.2 \pm 77.7}$
	# Data points	13	11
	AWI	-6.5	-47.8
	MPI	-7.5	-156.3

Figure 1, Table 1: Topography of Europe and the Pontocaspian region. White polygons indicate regions for which a model-proxy comparison is computed. Left: Model-Proxy comparison for LGM minus PI data of annual mean temperature and precipitation for the three marked regions in the figure. Green shadings indicate the level of agreement between the two data sources.

During the Late Pleistocene (around 120 to 10 thousand years before present), the water levels of the Caspian Sea varied by more than a hundred meters. At extreme transgression states, the Black Sea and the Caspian Sea were eventually connected via the Manych Strait. However, the temporal link between the Black Sea and the Caspian Sea water level variations and their precise dating is still under debate and especially the LGM is a period that is highly debated due to conflicting evidence.

We therefore performed sensitivity experiments with different water levels of the Caspian Sea under LGM conditions to represent today's water level (-27m above sea level (a.s.l.)), a regression state (-100m a.s.l.) and a moderate and extreme transgression state (0m a.s.l. and +50m a.s.l.). We used the WRF model adapted to paleo conditions and the simulations were driven by PMIP4 LGM simulations of the MPI-ESM1.2-LR model. The tow nested domains and respective lake areas are depicted in Fig. 2. First analyses of the regional simulations have begun and will be continued this and next year, a publication is envisaged for 2025.

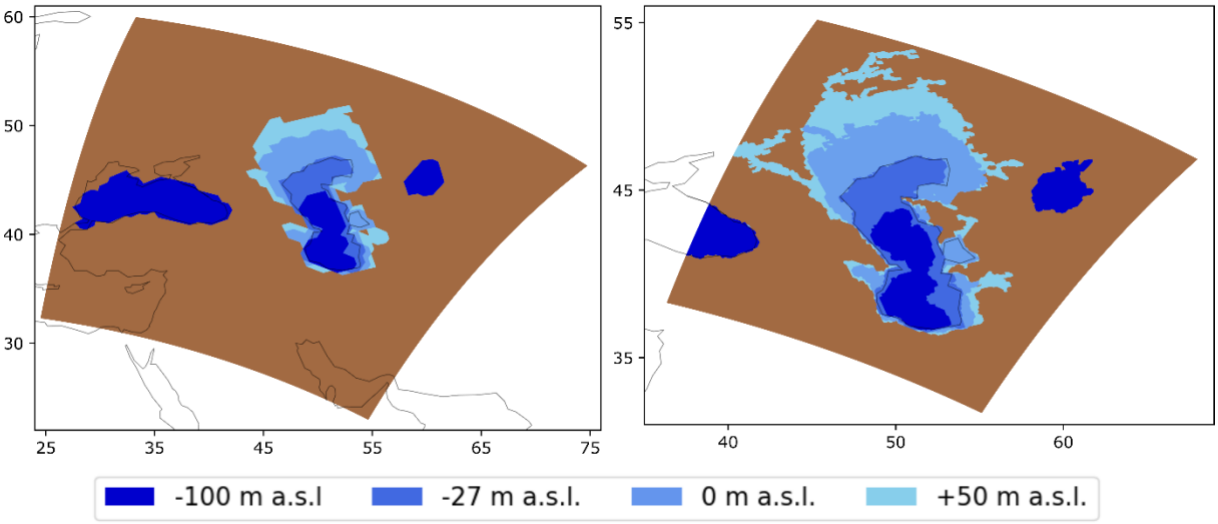


Figure 2: Domains and lake areas of the sensitivity experiments with the WRF model. Left: Domain 1 with 50km grid spacing, right: nested domain 2 with 12.5km grid spacing.

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

Due to personnel shortcomings, we could not advance as fast as desired in this sub-project in 2024. However, first calibration runs over the Altai with ICON-CLM have been performed successfully under paleoclimate conditions. The model code has been modified to consider different orbital configuration during the LGM. Likewise, the correct treatment of changed glacial GHG concentrations has been tested. We will continue working on this topic next year (see proposal for computing time for 2025).