

Project: bb1203

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The NUKLEUS consortium consists of partners from the Helmholtz-Zentrum Hereon (HEREON), the Karlsruhe Institute of Technology (KIT), the Brandenburg University of Technology Cottbus-Senftenberg (BTU), the University Würzburg (UW), the Justus-Liebig University Gießen (JLU), the Technical University Dresden (TUD) and the German Climate Computing Center (DKRZ).

An important basis for action recommendations for adaptation measures are high resolution projections of the climatic changes created with regional climate models. This task is addressed by the RegIKlim cross-cutting activity NUKLEUS (Actionable local climate information for Germany; German: Nutzbare lokale Klimainformationen für Deutschland). Therefore, NUKLEUS developed and implemented a strategy to deliver an unprecedented ensemble of very high-resolution climate change simulations on a kilometre-scale for Germany. ISAP is part of RegIKlim as well and the ISAP computing time requests are included here as well.

Three dynamical regional climate models (RCM, namely CCLM, ICON-CLM and REMO) were applied within the project to cover the uncertainty range of the representation of regional scale processes. Three CMIP6 GCMs were downscaled under the ssp370 scenario (EC-Earth3-Veg, MPI-ESM-HR, MIROC6). In a first step a dynamical downscaling of the global climate simulation to the EURO CORDEX EUR-11 grid were performed, followed by a second step to convection permitting scales of 3 km resolution (CEU-3 domain). For ICON with its icosahedral grid, comparable model domains have been chosen.

Climate simulations

In 2025 simulations following the final CORDEX CMIP6 protocol have been performed. Specifically, with EC-Earth3-Veg and MIROC6 for different ssp-scenarios have been generated for the European CORDEX CMIP6 ensemble on the EUR-12 grid with CCLM and ICON-CLM.

In addition, Further downscaling of MIROC6 with ICON-CLM to 3km is currently performed on GPU nodes with ICON-CLM, which has been tested and adapted for GPUs on LEVANTE.

The resources granted were fully used in the first and second quarter and are expected to be fully consumed in the fourth quarter as well. However, in the third quarter setup problems were found and had to be eliminated, which together with the holiday season lead to a gap in the production runs, which are now continued.

“Klimakataster” and bias adjustment

A major focus for the RegIKlim-Consortium is the development of a so called “Klimakataster” which is intended to be an web portal for climate change adaptation and to make the information available for the development of a wide range of municipal adaptation strategies. This includes the development of FREVA plugins (<https://www-regiklim.dkrz.de/>) to provide stakeholders and subsequent impact modellers information and data on a municipal level. These plugins have been further developed, tested and applied in the reporting period. The Klimakataster will also offer the provision of bias adjusted versions of the NUKLEUS 3km ensemble data. The Quantile Delta Mapping (QDM; Cannon, 2015) was applied for the adjustment using HYRAS as observational reference. An example for the potentially non-linear effect of the correction on climate indicators and ensemble spread is given in Figure 1. The figure includes one of the climate indicators – specifically “tropical nights, which were calculated with the FREVA plugin ClimDexCalc2.

The bias adjustment and the storage of additional data caused a continued high degree of capacity utilization of the LEVANTE work.

Analysis and publications

In the reporting period the scientific analysis of the kilometre-scale convection permitting (CPM) simulations by NUKLEUS and ISAP was continued. Hundhausen et al. (2025) analysed the suitability of CPM ensembles to study sub-hourly precipitation extremes, an information crucial for considering climate change in flood risk maps. Laux et al. (2025) derived such flood risk maps under climate change using the NUKLEUS CPM ensemble. Pinto et al. (2025 under revision) used a large set of climate

indicators for various fields of applications under climate change. Beyer et al. (2025, submitted) assess the NUKLEUS CPM ensemble with respect to temperature and precipitation extremes.

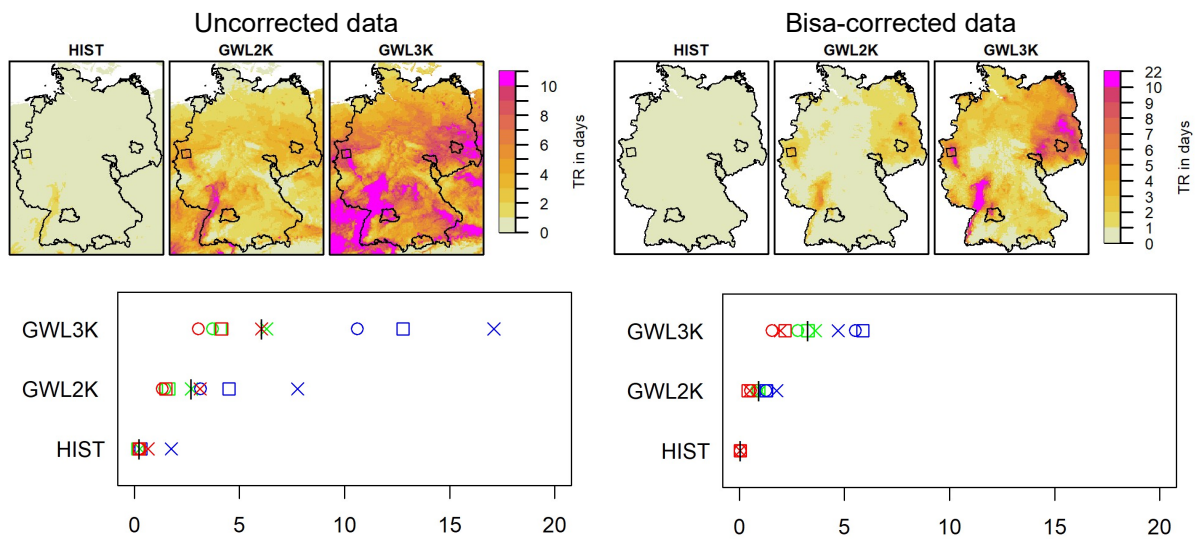


Figure 1: Comparison of the climate change signals for the climate indicator “tropical nights (TR, $T_{\min} > 20^{\circ}\text{C}$)” left before the correction and right after the correction.

Data Management

The ensemble of simulations is now ingested in different FREVA instances at DKRZ. They are available to the project partners within the RegIKlim. In addition, the data are also used within ClimXtreme or by the DWD. The data also as well used for the backend of the “Klimakataster”. All simulation data had to be transferred to the CMOR respective CORDEX (meta-)data standards.

Subsequently, we added reanalysis, observational and example model data to the data search engine. datasets provide the opportunity for project partners of the RegIKlim project to perform further impact modelling or analyses. It is intended to upload the CMORized simulations partly to ESGF (EUR-12 CORDEX-CMIP6) when possible or WDCC when no ESGF option exists (e.g. kilometre scale simulations, where a high demand exists).

During the project Freva will be extended as a backend for a climate change adaptation platform. Basic data analysis needs for most project participants were identified and plugins for application in Freva were developed accordingly. We also modified the Freva web part to display html-based plots enabling an interactive inspection of the results. Further Plug-ins will be incorporated.

Enabled by the FREVA implementation, partners from RegIKlim focus regions are working with the data. Therefore, we still need a large workspace to maintain the old data in addition to extra storage for the simulations promised during phase 2 of the project.

References

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