Project: bb1203Project Title: NUKLEUS – Actionable local climate information for GermanyPls: H. Feldmann, K. Sieck, J.G. Pinto, K. Keuler, C. KadowProject funding: BMBFFunding period:01.04.2020 – 31.05.2023 (Phase I), 01.06.2023 – 31.05.2026 (Phase II)Reporting Period:01.11.2022 – 31.10.2023

This is a follow-up DKRZ computing time proposal for the projects NUKLEUS and ISAP, which are contributions to the BMBF funded research program RegIKlim (German: Regionale Informationen zum Klimahandeln). The first phase of NUKLEUS ended in May 2023. The second phase started in June. The first phase of ISAP ends end of October 2023 and the start of phase 2 is planned for November.

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). The consortium stays the same in phase 2.

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.

Three dynamical regional climate models (RCM) 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. The ensemble is currently analysed (see below) and the data is mostly already available in CMOR format within the FREVA system. Users from RegIKlim now have access to the data for analysis, bias correction or subsequent impact modelling (e.g. hydrological modelling, PALM4U or EnviMet, etc.). It is intended to extend the access to external users.

In the second phase we add several more simulations to assess the uncertainty of the phase 1 ensemble, including simulations for other scenarios, transient aerosols and landuse change. These simulations were recently started. However, the main focus will be on development of a so called "Klimakataster" to make the information available for the development of a wide range of municipal adaptation strategies.

Assessment of the simulation quality

Currently, the quality of the NUKLEUS simulations is evaluated intensively. A publication, which will focus on the concept, setup and the evaluation simulations is in preparation.

The following figures compare the results for the three RCMs on the German CEU-3 domain for the ERA5 driven evaluation simulations for the period 2005 - 2014. The evaluation of the 2m-temperature data from the three ERA5 driven simulations against gridded (HYRAS) or station-based observations revealed a low bias relative to older simulations like e.g., from CORDEX-CMIP5. The bias is mostly in the range of +/-1 °C. ICON-CLM and CCLM tend to be too cold especially in northern Germany (Figure 1), whereas REMO tends to be too warm in southern Germany. Overall, ICON-CLM provides the lowest RMSE.

All three models show a tendency towards a wet bias (Fig. 2). For ICON-CLM and CCLM this bias gets stronger towards the east and the south. Compared to older simulation the mean bias is relatively low, especially for ICON-CLM. REMO displays a wet bias in the northern part of Germany and especially over mountain ridges.



Figure 2: 2m-temperature bias [°C] of the NUKLEUS CEU-3 evaluation simulations from ICON-CLM, CCLM and REMO against HYRAS for the period 2005 - 2014



-50 -40 -30 -20 -10 10 20 30 40 50 %

Figure 2: Precipitation bias [%] of the NUKLEUS CEU-3 evaluation simulations from ICON-CLM, CCLM and REMO against HYRAS for the period 2005 - 2014

Data Management

The ensemble of simulations is currently made available to the project partners using the RegIKlim Freva instance (https://www-regiklim.dkrz.de). All simulation data had to be transferred to the CMOR respective CORDEX (meta-)data standards. This work took more effort than expected since many format and metadata errors occurred during the first month of LEVANTE, which had to be repaired during the post-processing.

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 to ESGF.

For the second funding phase 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 htmlbased plots enabling an interactive inspection of the results. Further Plug-ins will be incorporated in phase 2.

Enabled by the FREVA implementation, partners from RegIKlim focus regions now start to work with the data more intensive than previously. 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.

Resources used at DRRZ III 2023 (until October)			
Period	Node-hours	Work	Archive
01.01 - 27.10.2023	120496	1138 TB	3096 TB

Resources used at DKRZ in 2023 (until October)