

Project: bb1203

Project Title: NUKLEUS – Actionable local climate information for Germany

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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). 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, 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. The ensemble is currently analysed and the data is 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). It is intended to extend the access to external users.

In the second project phase we add several more simulations to assess the uncertainty of the phase 1 ensemble, including simulations for other scenarios, transient aerosols and land use change (see below). 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.

Effect of emission scenario on regional warming levels

During the reporting period, six additional SSP scenario simulations (SSP245 and SSP585: 12km, 3km GWL2K and GWL3K) for one model combination (ICON-CLM driven by EC-Earth) were added to the NUKLEUS simulation ensemble. The temperature difference between the future and the historical period increases with the additional anthropogenic radiative forcing according to the CMIP6 scenarios (see Figure 1), with the strongest warming in the north-east and east of Germany in SSP585.

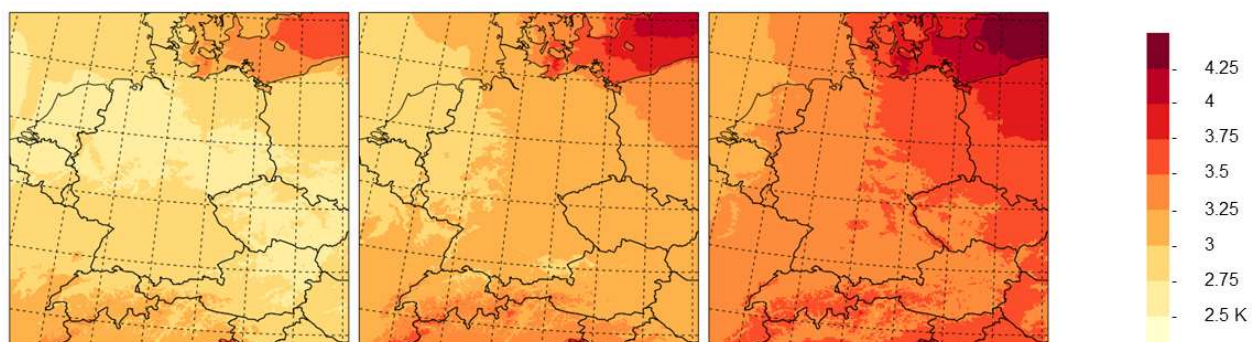


Figure 1: Change signal of the annual mean 2m temperature for 3 scenarios and GWL+3K time period (left SSP245: 2062-2091, center: SSP370: 2047-2076, right: SSP585: 2040-2069 with respect to the historical period (1961-1990), from the ICON-CLM driven by EC-Earth simulation.

Additional simulations have been performed to estimate the effect of transient aerosol concentrations on the regional climate trends. Furthermore, the final setup for optimized versions of CCLM and ICON-CLM for the CORDEX CMIP6 simulations has been achieved. An ERA5 driven evaluation simulation has been performed. The historical simulations on the EUR-12 grid have been started in October.

The climate indices according to ETCCDI (CCI/WCRP/JCOMM Expert Team on Climate Change Detection) and ETSCI (WMO and WCRP extension) are calculated using the Freva plugin ClimDexCalc2. They describe climate characteristics with a focus on climate extremes. The analysis for Germany shows a significant increase in heat events, such as the number of summer days or tropical nights (see figure 2), and a decrease in cold events, such as the number of frost days or icing days.

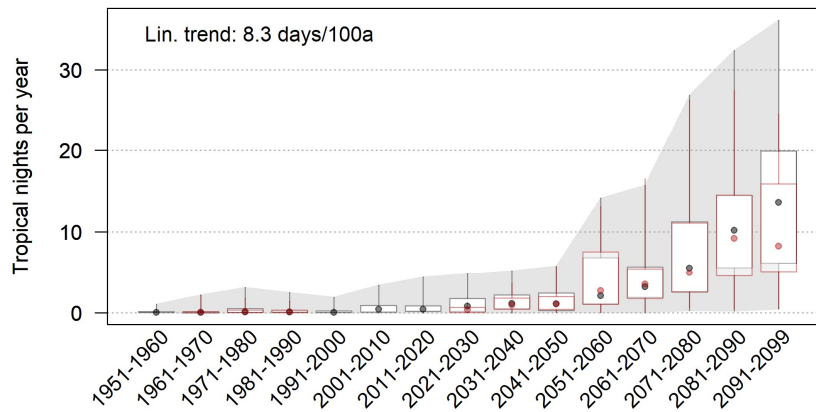


Figure 2: Climate index of annual number of tropical nights (daily minimum temperature > 20 °C), boxplots contain area means over Germany from 5 simulations (red=3km/CPM simulations, gray=12km, shaded area: range from ensemble maximum to minimum)

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 or WDCC. Currently, DOKU space is requested for the KIT-KLIWA essential data from the ISAP project.

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.