

Project: **1373**

Project title: **Impetus4Change - Improving near-term climate predictions for social transformation**

Principal investigator: **Claas Teichmann**

Report period: **2023-05-01 to 2024-04-30**

*Maximum of 2 pages including figures. 9 pt minimum font size.*

## **Project overview**

The overarching objective of Impetus4Change is to improve near-term climate information and services at local to regional scales where impacts are most keenly felt, and on-the-ground adaptation is implemented. Further, Impetus4Change will strengthen and support the alignment of said services with end-user adaptation planning needs through improved accessibility and usability.

In the frame of Impetus4Change, the regional climate model REMO is further developed to consider specific land surface characteristics of urban areas to provide a more realistic representation of regional to local climate especially in the surroundings of cities. In the frame of this modeling activity, REMO has been extended by the Town Energy Balance Model (TEB model) to incorporate a sophisticated representation of urban surfaces.

Using the improved version of REMO, non-hydrostatic long-term climate simulations will be performed over two selected regions in Europe which cover the four demonstrator cities. Project partners will perform non-hydrostatic model simulations over similar model domains to obtain an ensemble of climate simulations over the demonstrator cities which enables us to assess the bandwidth in climate change information due to different modelling approaches. These simulations will on the one hand be directly used in the co-development of climate services in the four demonstrator cities, on the other hand, they will feed into the projects machine learning (CPRCM emulators) activity, where the ensemble of climate simulations at convection permitting scale will be used as training data.

## **Planned work and performed simulations**

The first step of the project is to evaluate the newly created regional climate model including the TEB scheme and to assess whether the long-term climate (over the ERA5.1 time period, 1981-2020) can be well represented. The regional climate model simulations will be performed using the regional climate model REMO, over the EURO-CORDEX domain at 0.11° horizontal resolution and the non-hydrostatic version of REMO over two smaller domains covering central northern Europe and central southern Europe at 0.0275°. For the remainder of this reporting period, we plan to complete the first run of REMO with the new urban scheme, TEB, over the EURO-CORDEX domain at 0.11° over a 40-year period. This will be followed by the downscaled simulations at 0.0275 for the two domains described below under the new computing allocations.

For the second step of the project, 20-year-timeslices of different global warming levels (GWLs) are downscaled for the two focus regions covering all demonstrator cities at 3km resolution. The MPI-ESM1.2-HR was selected for downscaling by REMO in the frame of the project together with the project partners. We will use the SSP3-7.0 scenario to align with CORDEX and EURO-CORDEX protocols. Following the priority list of GWLs, we aim to cover the top 3 priorities of the project: GWL +3°C (providing an extreme climate training sample for the emulators developed elsewhere for the project), a reference period (as used in WP4 and IPCC AR6), and GWL +1.5°C (likely covered by decadal prediction simulations). Not yet included here are priority 4-6: GWL +2°, +1° and +4°C.

## **Delays and progress**

The progress of the planned simulations for the reporting period was unfortunately largely impacted by several issues. One, after a full-time position allocated to the project was vacated in early 2023, it took until 03/2024 to fill the position due to delays in the hiring process. As GERICS' has various responsibilities within the project apart from the outlined work here, other tasks were prioritised because of, e.g., deliverable deadlines and not all planned simulations could be realised in this period.

The urban scheme (TEB) was newly implemented into the regional climate model REMO, which also took longer than expected, mainly due to the lack of programmers time. Nevertheless, first test simulations were conducted within the frame of the project. The results look reasonable and REMO (including TEB) is now ready for the first longer evaluation simulation (ERA-5.1 downscaling). These simulations were initially planned for the first computing time allocation period of this project, but can only be started now.

Due to the above mentioned reasons, we could not use most of the computing time and storage allocated to us in the current application period. Nevertheless, we are confident to use the remaining and the new computing time for the evaluation and the climate projection experiments. Our new colleague has already started to work on the project in March 2023 and the TEB scheme is implemented in REMO, thus we don't see any major obstacles.

In addition, the Impetus4Change project deliverable “D3.2 - Experimental protocol for the new CPRCM I4C simulations and lists of the planned runs” was submitted and accepted in October/November 2023. It describes the domains and the simulations agreed upon in the frame of the project. The domains are depicted below and the simulations are described in the computing time request.

The remaining computing time (until 06/2024) will further be used for the evaluation simulation at the 0.11° resolution (EVAL\_EUR011).

While preparing for the test simulations, we decided to adjust the two main domains (ALPX-3 and NSEA-3) that were outlined in our previous request to include Hamburg in both domains (which makes the simulations much more useful in other projects and activities located in Hamburg, also, we can investigate the dependency of the climate change signal on the location of the model domain for Hamburg). Increasing the sizes from 721x541 grid points (ALPX-3) and 649x541 grid points (NSEA-3) to 721x577 grid points and 649x541 grid points, respectively. The test simulations of the two domains (ALPX-3 and NSEA-3) show much longer wallclock time than estimated for the previous request, which was based on information from NUKLEUS simulations. In response to the increased wallclock time and slightly larger domains, we cut the planned simulation time period back from 50 years (40+10 spin-up) to 30 years (20+10) for the remaining two evaluation simulations. The historical and climate projection simulations are also reduced to the minimum required time periods of 20 years each in order to save computing time and storage space. Depending on the experiences in the upcoming simulations and the additional requirements within the project (depending on the outcome of our analysis and the progress of the emulators), we envisage to apply for additional computing time at a later stage of the project.

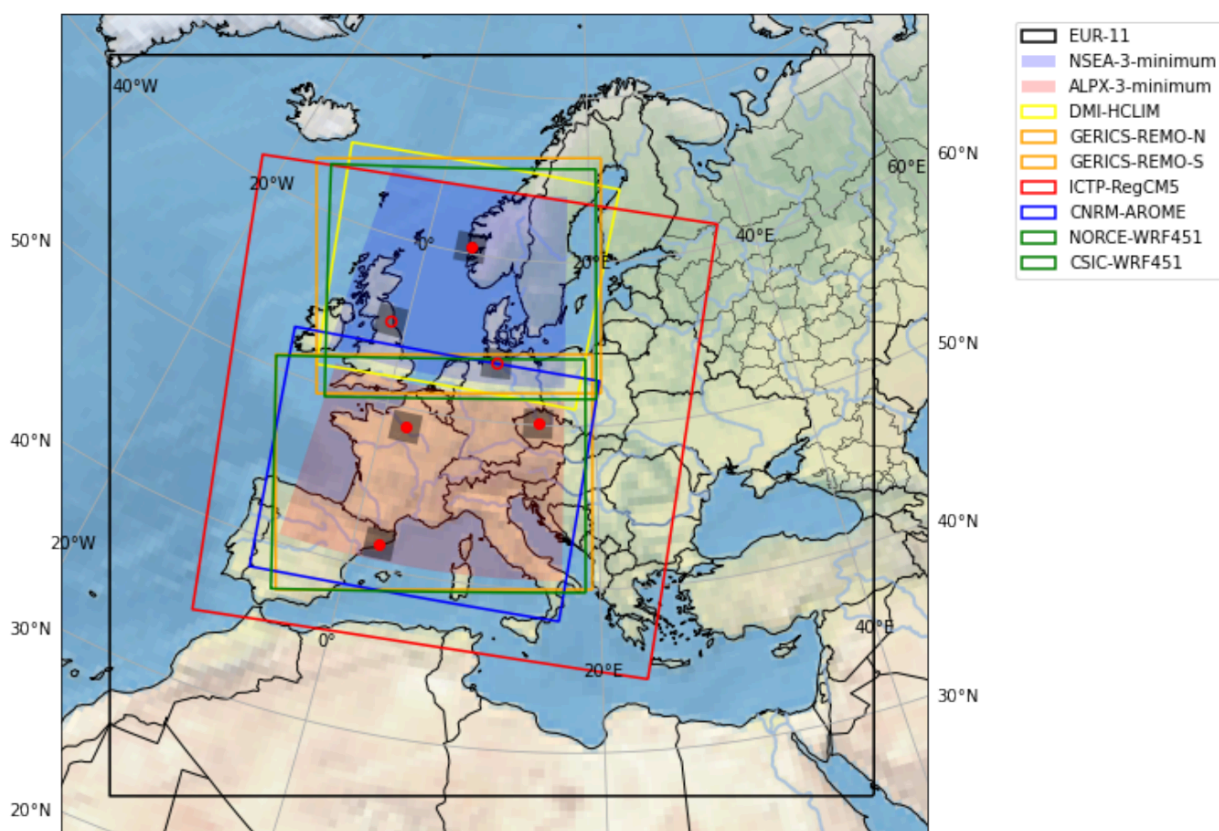


Figure 1: Simulation domains as of October 2023 excluding the boundary. It is decided that the domains should at least cover the minimal areas over northern (NSEA-3-minimum, blue shade) and southern (ALPX-3-minimum, red shade) areas. (Source code for the Plot: <https://github.com/jesusff/domains/tree/i4c>)