Project: **1373**

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

Principal investigator: **Claas Teichmann**

Report period: **2024-05-01 to 2025-04-30**

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 are performed over two selected regions in Europe which cover the four demonstrator cities of Impetus4Change. Project partners are also performing 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 demonstrator cities, on the other hand, they will feed into the projects machine learning activity, i.e., convection-permitting regional climate model (CPRCM) emulators, where the ensemble of climate simulations will be used as training data.

Planned work and performed simulations

The first step of the project was 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, 2000-2009) can be well represented. The regional climate model simulations are performed using the non-hydrostatic version of the regional climate model REMO over two sub-domains of the EURO-CORDEX domain covering central northern Europe and central southern Europe at 0.0275° (Fig. 1). 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 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.

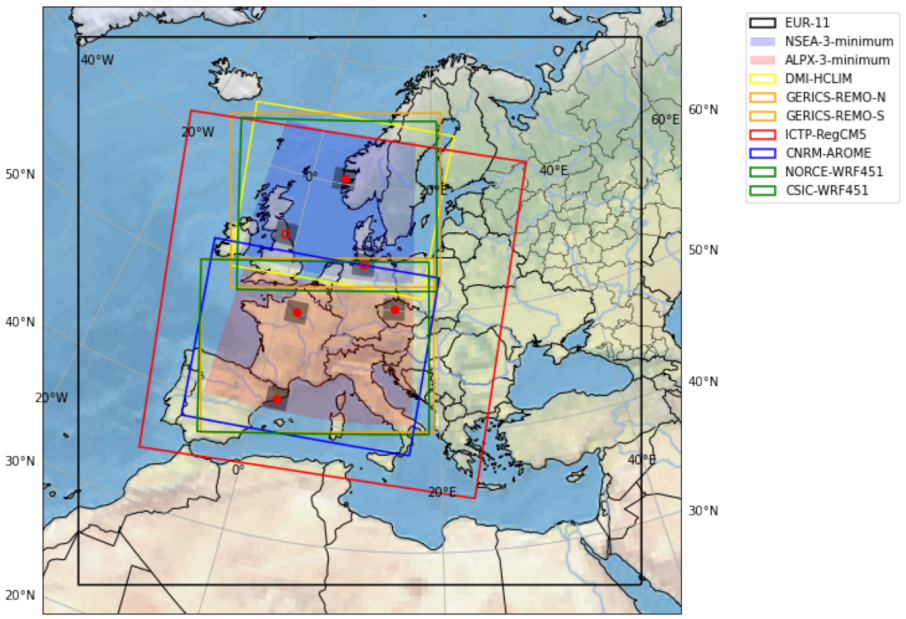

Figure 1: Simulation domains as of October 2023 excluding the boundary. It is decided within I4C that the domains should at least cover the minimal areas over northern (NSEA-3-minimum, blue shade) and southern (ALPX-3-minimum, red shade) areas. GERICS REMO-TEB domains are shown in orange. (Source code for the Plot: https://github.com/jesusff/domains/tree/i4c)

Progress, delays and new allocation of resources

The urban scheme (Town Energy Balance model, TEB; Masson, 2000) was newly implemented into the regional climate model REMO in order to have a more realistic representation of cities and improve present biases in urban-rural climates. For the upcoming allocation period, we plan to (re-)run the listed simulations, because we have an updated version of REMO-TEB that fixes critical issues of the urban-rural climate. Previously, REMO-TEB simulations featured, e.g., a surface temperature warm bias in urban areas during the day, resulting in an inverse urban heat island pattern (Fig. 2). Data of the updated REMO-TEB simulations are essential within the project for the development of climate services and training of the CPRCM emulators. Furthermore, they contribute to the FPS-URB-RCC initiative to assess climate change in urban areas.

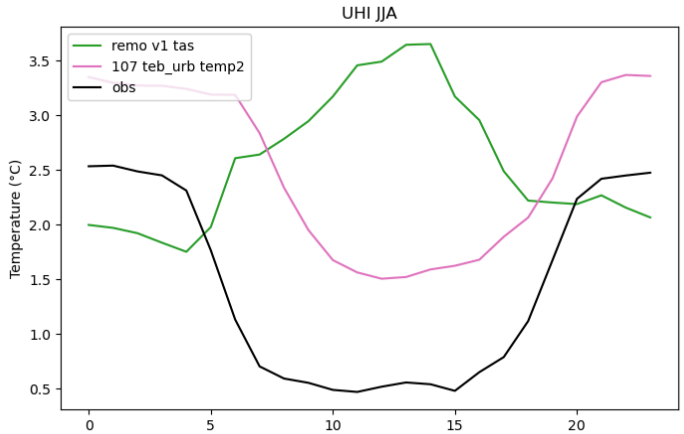

Figure 2: Diurnal cycle of the mean urban heat island (UHI) intensity in °C for summer 2020 (June-August, JJA) comparing Paris urban to rural stations for REMO-TEB version 1 (green), REMO-TEB updated version (pink) and observations (black, source FPS URB RCC).

Masson, V. (2000). A physically-based scheme for the urban energy budget in atmospheric models. Boundary-layer meteorology, 94, 357-397.