New climate model simulations for Hungary and their implementation in high resolution surface modelling – preliminary results of KlimAdat project

Beatrix Bán, Otília Anna Megyeri, Réka Suga, Gabriella Zsebeházi
Regional Climate Modelling Group, Modelling Unit, Hungarian Meteorological Service, Budapest

Introduction

The aim of the KlimAdat project is to create a complex database that is filled with detailed meteorological information to support climate change impact studies in different sectors, adaptation strategies and related decision making. The main objectives of the project are 1) performing new 10 km horizontal resolution climate model simulations with the ALADIN-Climate and REMO RCMs over Central and Eastern Europe with RCP4.5 and RCP8.5 scenarios; 2) performing urban climate simulations with the SURFEX land surface model on 1 km resolution for Hungarian cities; 3) extending the achieved climate projections with selected Euro-CORDEX simulations and building a web-based geo-information system including climate information tailored to users' needs. The poster is dedicated to present the preliminary results of 1st and 2nd goals.

Sensitivity study for integration domain size with REMO regional climate model

- At OMSZ regional climate projections were achieved earlier with REMO5.0 on 25 km horizontal resolution.
- In the KlimAdat project, model version is updated to REMO2015 and higher horizontal resolution (10 km) is aimed.
- Prior to the long term climate simulations, sensitivity study was performed to find the appropriate integration domain size. 11 year long simulations (1970-1980, 1 year spin-up) were performed on 3 different domains, each covering the Danube Catchment Area. The biggest domain (OLDDOM) is identical with the one, we used earlier (Fig. 1 and Table 1).

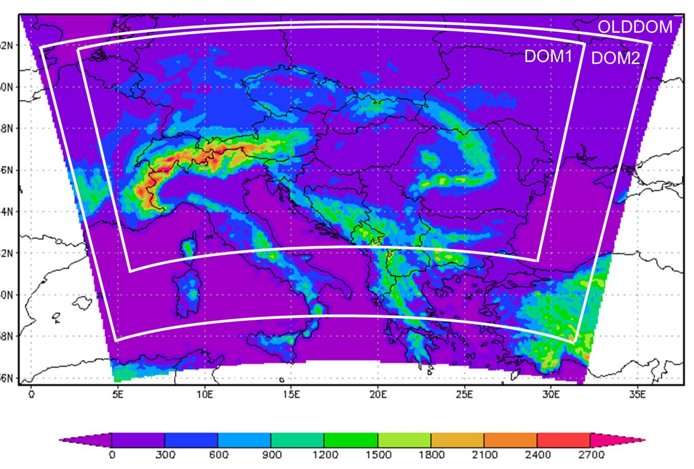

Fig. 1. The three domains (DOM1, DOM2 and OLDDOM) and their orography (m above sea level) used in the sensitivity study.

Table 1. Parameters of domains and simulation set up.

	DOM1	DOM2	OLDDOM
Number of gridpoints	203x123	243x163	253x203
Resolution	0.09°	0.09°	0.09°
Lowest left coordinate	-9.55°, -8.60°	-10.84°, -12.00°	-11.05°, -14.00°
LBC	MPI-M-ESM driven REMO on EUR44 domain		
Period of integration	1970–1980		

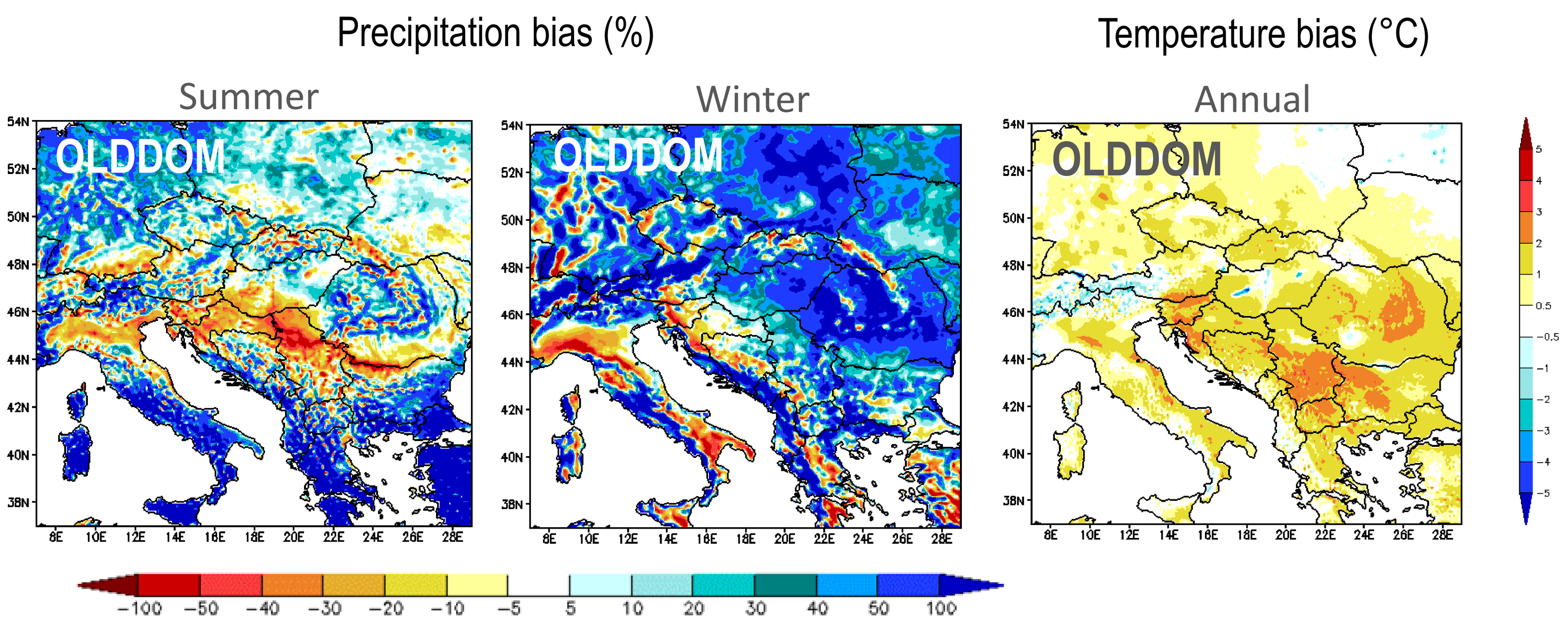

Fig. 2. Relative precipitation difference in summer and winter (%; first two panel) and annual temperature bias (°C; last panel) for OLDDOM, in 1971–1980. Reference: E-OBS.

RESULTS

- Precipitation: the model is too wet for Hungary in all seasons except summer. Bigger overestimation compared to its LBC.
- Temperature: overestimation for Hungary except winter. Lakes and Danube appear with 3-5 °C underestimation (Fig. 2)
- Small, sporadic differences between the precipitation simulations achieved on different domains (Fig. 3)
- Notable differences amongst the three simulations for the daily precipitation indices. Most reliable results obtained with the OLDDOM domain choice, except in summer, when with the smaller domain more heavy precipitation events occured (Fig. 4).

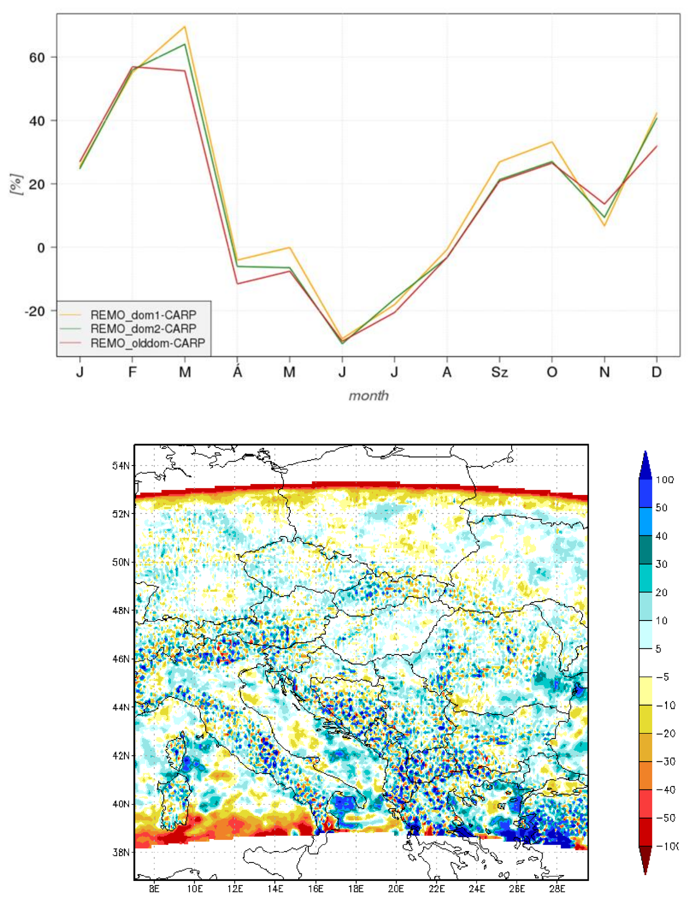

Fig. 3. Top: monthly relative precipitation bias (%) wrt. CARPATCLIM-HU in the three simulations. Bottom: summer relative precipitation difference (%) between DOM2 and OLDDOM.

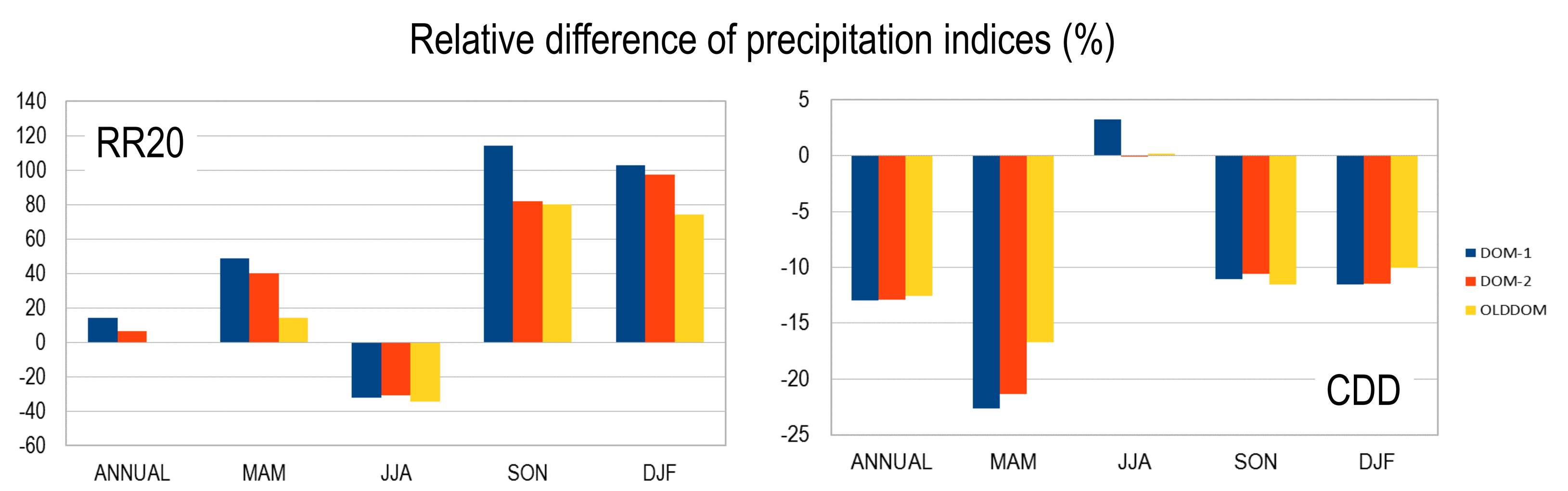

Fig.4. Relative difference of annual and seasonal mean RR20 (number of days, when precipitation sum is above 20 mm) and CDD (longest consecutive dry days) for Hungary in 1971–1980. Reference: CARPATCLIM-HU.

Climate projections of ALADIN-Climate driven by RCP4.5 and RCP8.5 scenarios

The twin simulation of the RCP8.5 driven ALADIN-Climate was achieved with the RCP4.5 scenario on 10 km horizontal resolution for a domain covering the Danube Catchment Area (similar to DOM2).

Table 2. Simulation set up

LBC	CNRM-CM5 driven ALADIN-Climate on EUR44 domain
Horizontal resolution	10 km
Period of integration	1951–2100
Integration domain	Central and South-Eastern Europe (DOM2)

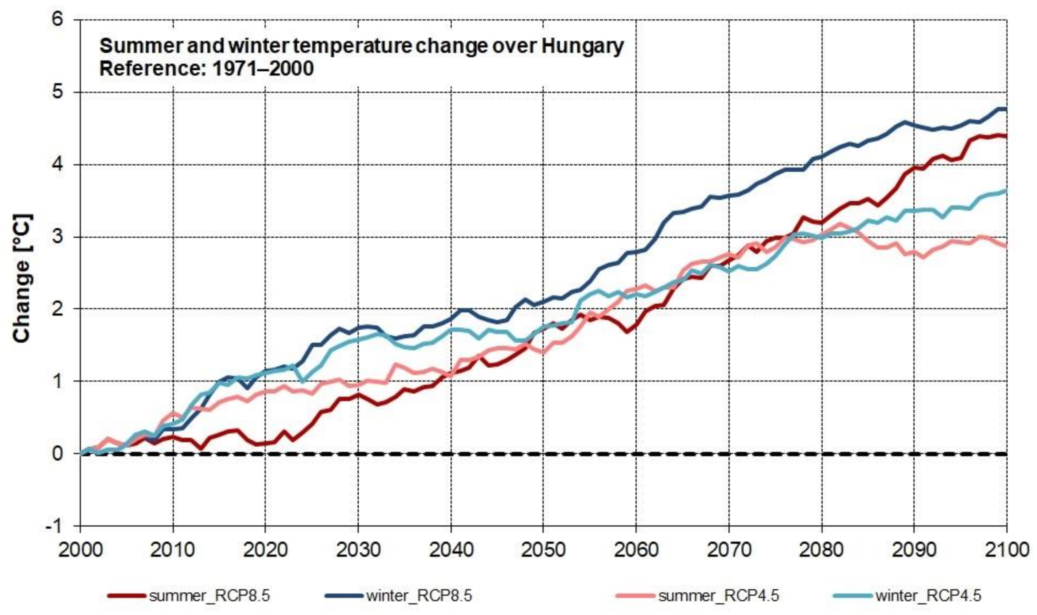

Fig. 6. Summer and winter temperature change (°C) for Hungary. Annual deviations from reference are smoothed with 30-year rolling average.

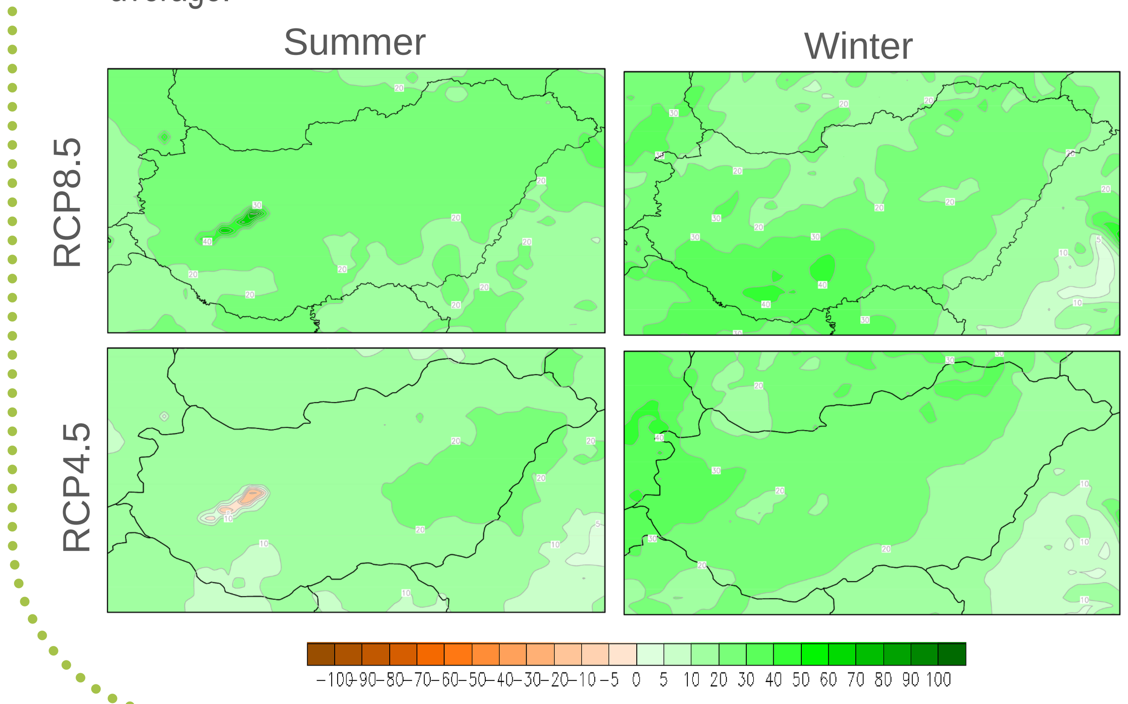

Fig. 5. Summer and winter relative precipitation change (%) in RCP8.5 (top) and RCP4.5 (bottom) forced ALADIN in 2071–2100 wrt. 1971–2000.

RESULTS

- Temperature: in the last decade of the 21st century, summer warming stops in RCP4.5 forced ALADIN. Strong temperature increase in winter, especially with RCP8.5 (Fig. 6)
- Precipitation: clear increase in summer and winter (and all season). In summer larger surplus is projected with RCP8.5. Over the area of Lake Balaton opposite sign of change is seen with different scenarios.

Validation of SURFEX/TEB for Budapest

- 10 km ALADIN-Climate regional climate model simulations are downscaled to 1 km horizontal resolution with the SURFEX/TEB land surface model over Hungarian cities (such as Budapest; Fig. 7). Two simulations are performed with different atmospheric forcings: ERA-Interim driven ALADIN (SFX_ei) and CNRM-CM5 driven ALADIN (SFX_gcm) (Table 1).

RESULTS

- Atmospheric forcings derived from CNRM-CM5 resulted higher summer temperatures (and larger positive bias) compared to ERA-Interim driven simulation (Fig. 8).
- Only small differences in gridpoint UHI in case of different atmospheric forcings (Fig 9).

Table 3. Simulation set up

Atmospheric forcings	ALADIN-Climate v5.2 (10 km resolution)
LBC for RCM	ERA-Interim, CNRM-CM5 driven ALADIN-Climate on EUR44 domain
Period of integration	SFX_ei: 1996–2005 SFX_gcm: 1961–2005
SURFEX domain	Budapest (61x61 gridpoint)

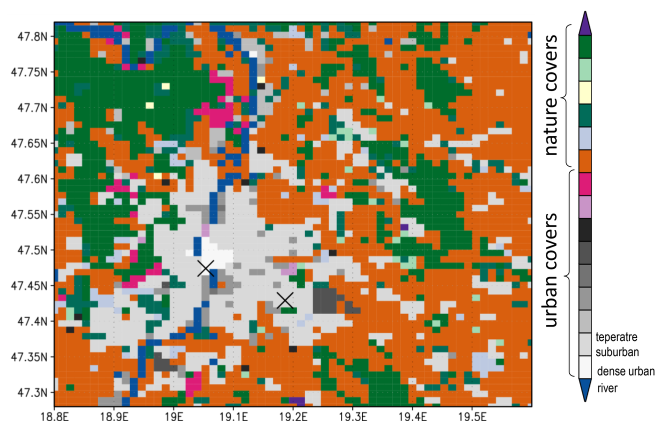

Fig.7. Domain and land surface cover type of SURFEX for Budapest. Gridpoints closest to urban and suburban stations are marked with X.

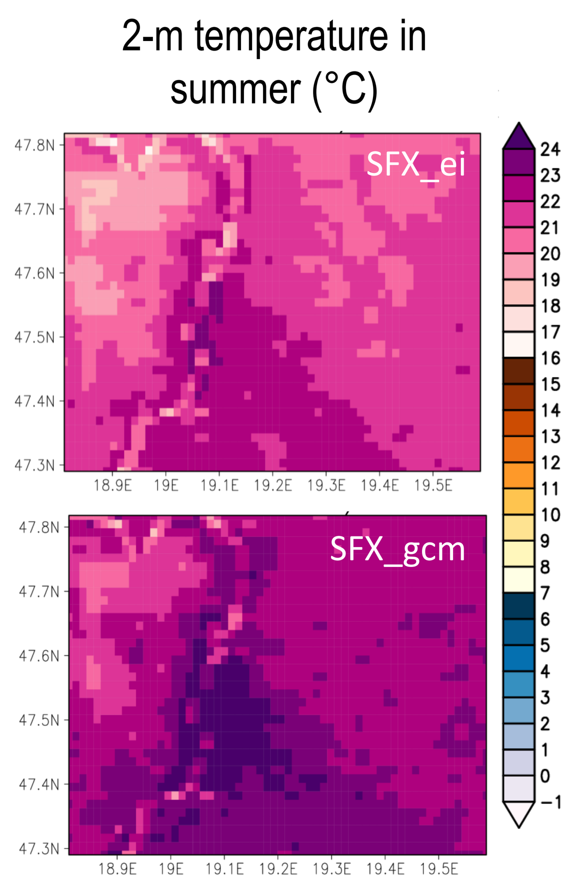

Fig. 8. 2-m temperature in summer in ERA.Interim and CNRM-CM5 driven SURFEX.

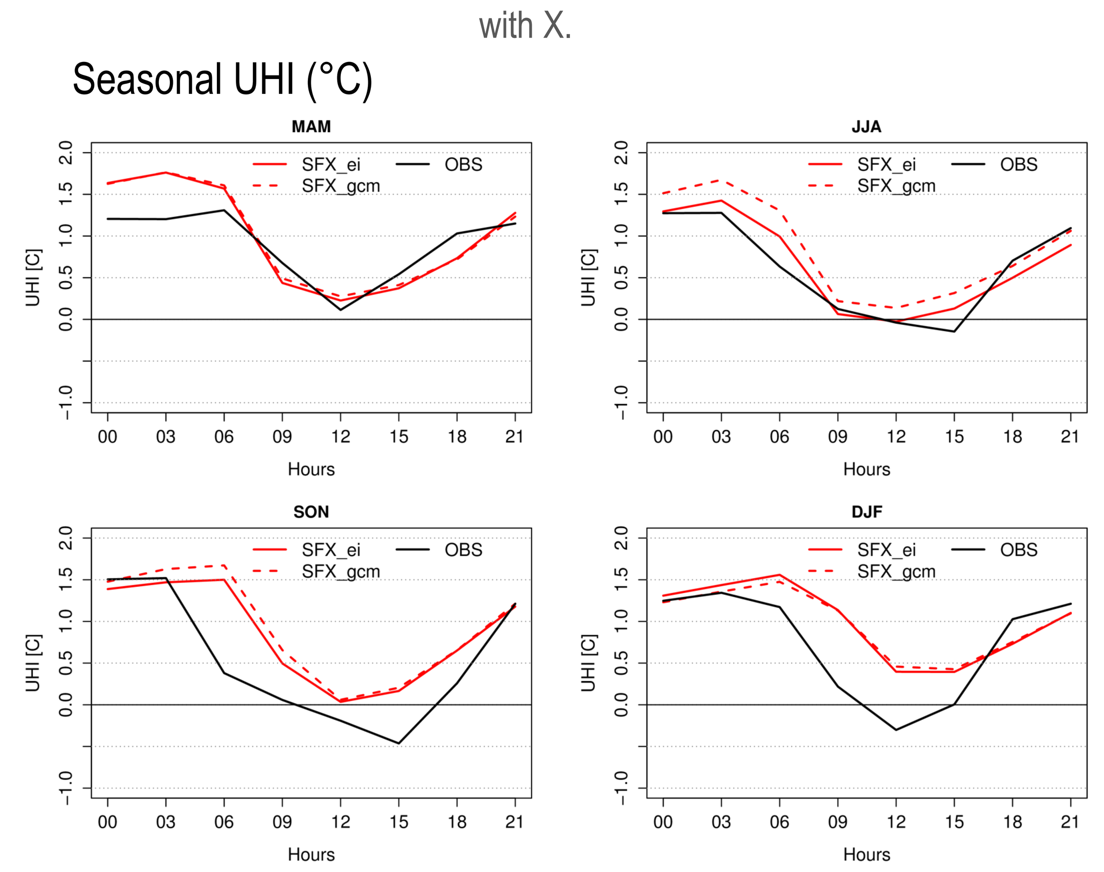

Fig. 9. Seasonal mean diurnal cycle of UHI in gridpoints of SURFEX (red) and in station measurements (black).

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