Project No. 037005

CECILIA

Central and Eastern Europe Climate Change Impact and Vulnerability Assessment

Specific targeted research project

1.1.6.3.I.3.2: Climate change impacts in central-eastern Europe

D3.6 Comparison with results of ENSEMBLES

Due date of deliverable: 31st December 2009
Actual submission date: 31st December 2009

Start date of project: 1st June 2006 Duration: 43 months

Lead contractor for this deliverable: CUNI

Final version

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Introduction

Although the CECILIA regional climate models (RCMs) were run in a comparatively high spatial resolution, their rather limited number as well as differences in the positioning of the respective integration domains make it difficult to create a rich-enough ensemble, usable for estimates of uncertainties of the simulations. In order to better capture the spread of the systematic errors or the state-of-the-art regional climate simulations, as well as of the projected changes, intercomparison of the results with selected 14 ENSEMBLES models was done by the CUNI team for the region of Central Europe, along with validation targeted at the area of the Czech Republic. Unlike in the CECILIA deliverable D2.6, the focus here was especially on the spatial patterns of temperature and precipitation, rather than mean values for relatively large target regions. The results for two seasons are presented: climatic winter (DJF) and summer (JJA).

RCM data

The CECILIA simulations in 10 km horizontal grid were represented by two versions of the RegCM3 regional climate model, run at CUNI and ELU, which cover the Czech Republic as the CUNI's primary region of interest. The analyzed ENSEMBLES models are listed in Table 1, along with their driving simulations. Note that some of the RCMs (HadRM3, RCA) appear several times in the ensemble, paired with different global models. Due to partial data corruption, the PROMES model was only used for the validation part of the analysis.

Table 1: List of employed CECILIA and ENSEMBLES models

Acronym	Institution	RCM	GCM
CUNI-RegCM3	CUNI	RegCM3 (alpha)	ECHAM5
ELU-RegCM3	ELU	RegCM3 (beta)	ECHAM5
C4IRCA3	C4I	RCA3	ECHAM5
DMI-HIRHAM5	DMI	HIRHAM	ARPEGE
CNRM-RM4.5	CNRM	Aladin	ARPEGE
ETHZ-CLM	ETHZ	CLM	HadCM3Q0
KNMI-RACMO2	KNMI	RACMO	ECHAM5-r3
METNO-HIRHAM	METNO	HIRHAM	BCM
METO-HC HadRM3Q0	HC	HadRM3Q0	HadCM3Q0
METO-HC HadRM3Q3	HC	HadRM3Q3	HadCM3Q3
METO-HC HadRM3Q16	HC	HadRM3Q16	HadCM3Q16
MPI-M-REMO	MPI	REMO	ECHAM5-r3
SMHIRCA BCM	SMHI	RCA	BCM
SMHIRCA ECHAM5-r3	SMHI	RCA	ECHAM5-r3
SMHIRCA HadCM3Q3	SMHI	RCA	HadCM3Q3
PROMES	UCLM	PROMES	HadCM3Q0

Validation

Validation of the RCMs was done for the area of the Czech Republic, against a set of observations from 65 weather stations (Fig. 1), for the period 1961-1990. The presented examples illustrate the behavior of the models with regard to the basic validation characteristics: mean seasonal values of temperature (Figs. 2 and 3) and precipitation (Figs. 4 and 5).

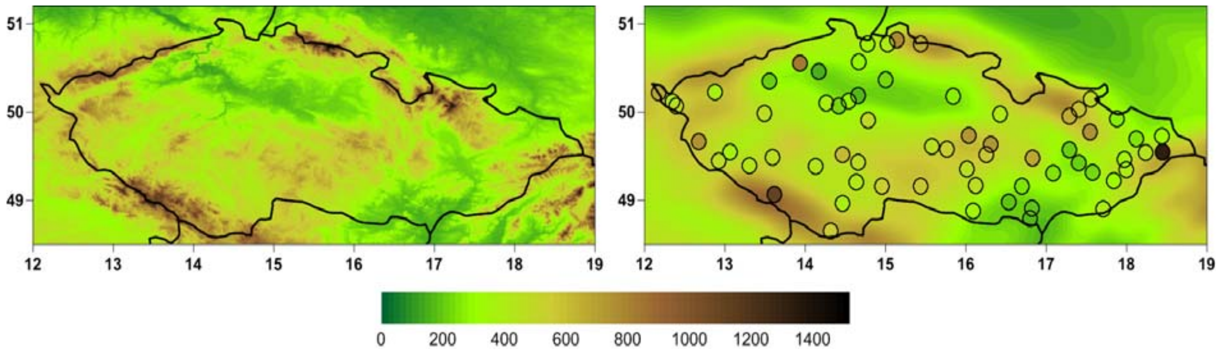

Figure 1: Orography (m) of real terrain (**left**) and its representation in the 10 km version of the RegCM model (**right**). Circles represent elevations of weather stations used for validation of the model outputs

In case of winter temperature (Fig. 2), both analyzed runs of the 10-km version of the RegCM3 model behaved in a very similar fashion: The values were overestimated at most stations, except the ones located at the highest altitudes (which suffered from the most significant mismatch between altitude of the station and orography of the model). The ENSEMBLES models exhibited a profound spread of results, sometimes even within a group of simulations using the same RCM driven by different GCMs (SMHIRCA), but the bias was generally smaller than for CECILIA simulations.

In summer, the CECILIA simulations exhibited a distinct cold bias (Fig. 3); the spread of the results from the ENSEMBLES models was again substantial.

The level of details in the temperature fields was mildly higher in the CECILIA simulations, due to their higher spatial resolution; some of the ENSEMBLES simulations struggled to realistically capture the orographic effects associated with the presence of higher mountain ranges (e.g., SMHIRCA model in winter, which underestimated the effect of the mountains in the western part of Bohemia on winter temperature, regardless of the driving GCM).

In case of precipitation, there was a distinct difference between the RegCM-based simulation run at CUNI (extreme wet bias in both DJF and JJA) and at ELU (more realistic precipitation means, though still with a clear tendency to wetter-than-real climate), due to different parameterization of the convective precipitation in alpha and beta versions of the RegCM3 model. The spread of results from the ENSEMBLES models was distinct, especially in summer. Despite their lower resolution, many of the ENSEMBES models were able to simulate a rather realistic spatial pattern of precipitation (e.g., the occurrence of drier area in the NW part of Bohemia). In contrast, the structures produced by the ELU 10 km simulation were more distorted (especially in winter), possibly because of the proximity of the edge of the integration domain.

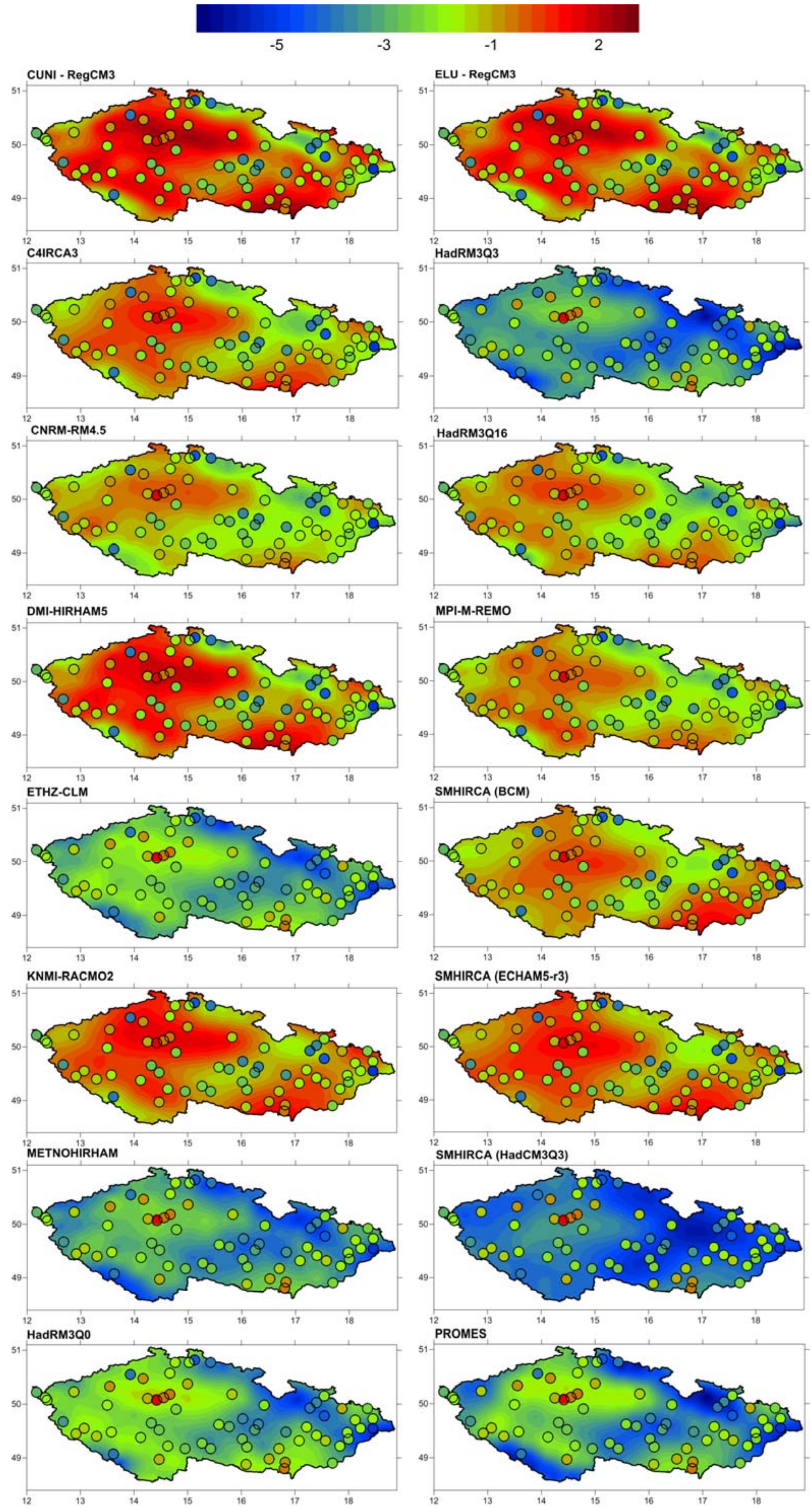

Figure 2: Mean DJF temperature (°C), simulated (**background maps**) and observed at weather stations (**circles**) for the period 1961-1990.

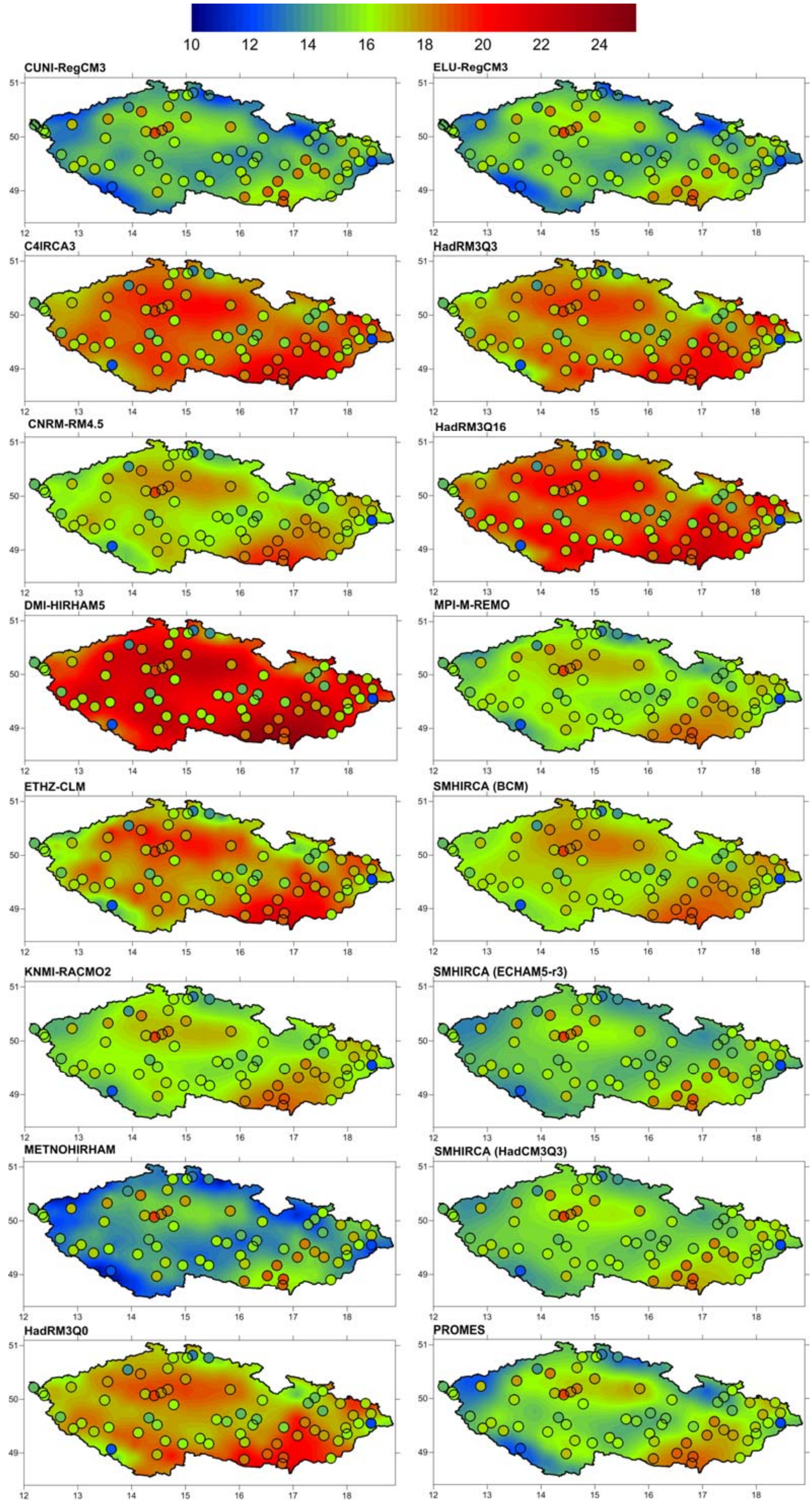

Figure 3: Mean JJA temperature (°C), simulated (**background maps**) and observed at weather stations (**circles**) for the period 1961-1990.

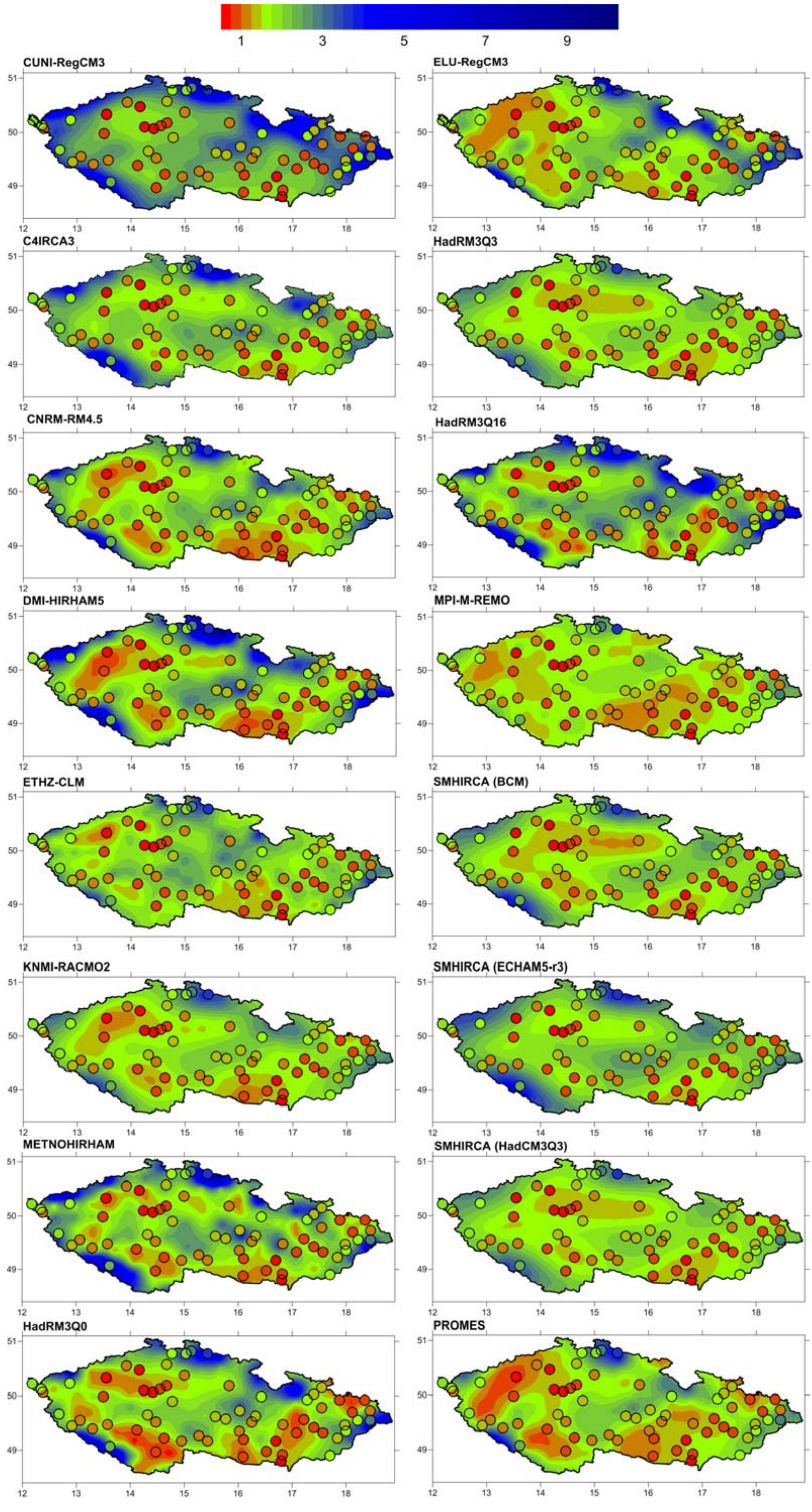

Figure 4: Mean DJF precipitation (mm/day), simulated (**background maps**) and observed at weather stations (**circles**) for the period 1961-1990.

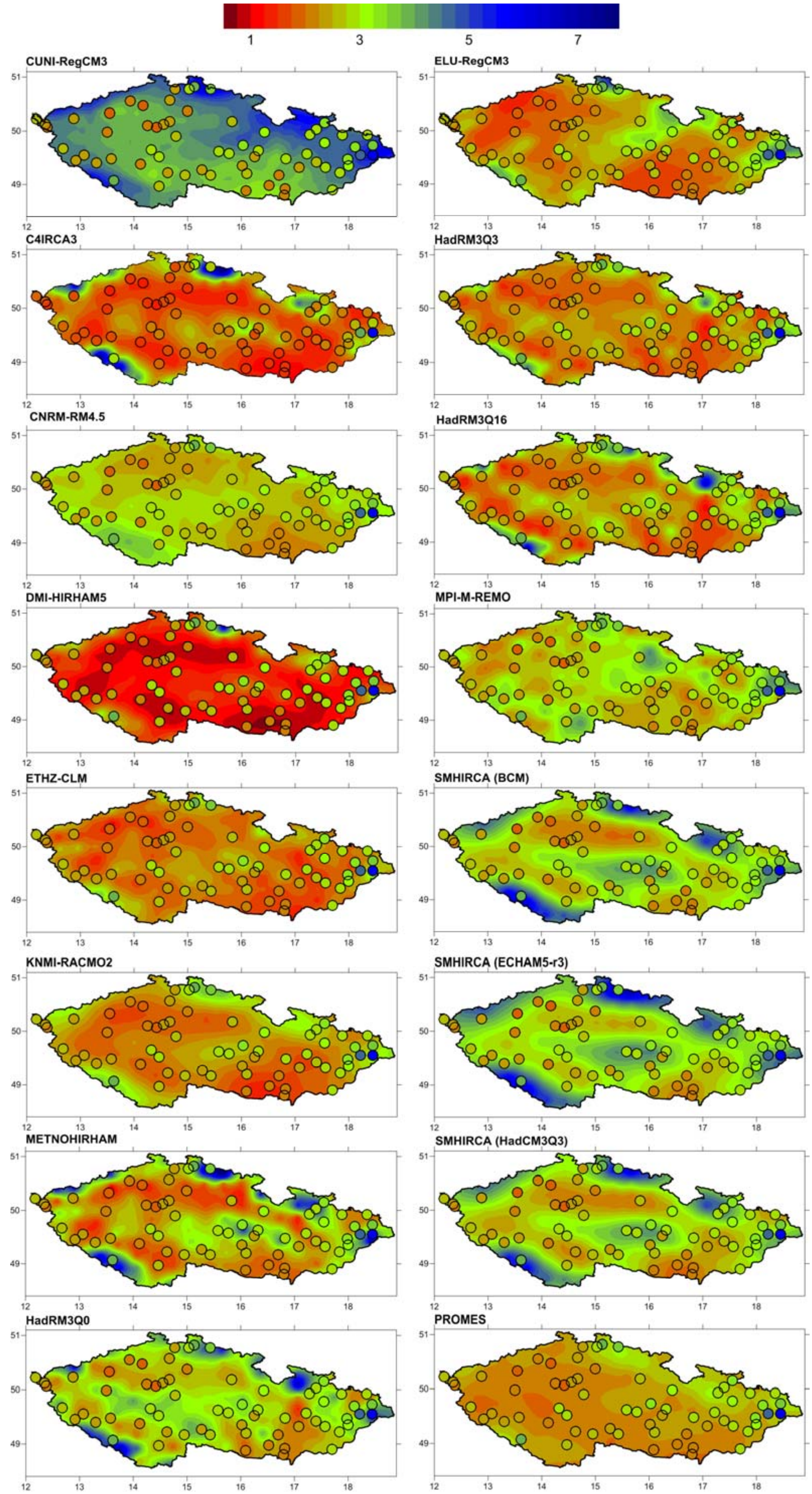

Figure 5: Mean DJF precipitation (mm/day), simulated (**background maps**) and observed at weather stations (**circles**) for the period 1961-1990.

Future changes

The simulated future changes of mean temperature and precipitation were studied for the period 2021-2050. A larger region (Figs. 6-9) was targeted than in case of validation, as no limitations were imposed by the (un)availability of observed data.

The simulated temperature rise varied significantly among the models as well as among geographic locations; the typical values of the increase ranged between approximately 0.5 and 3°C (Figs. 6 and 7). Both CECILIA simulations gave projections near the lower range of changes indicated by the ENSEMBLES simulations. There was a general tendency for higher increase of the summer temperature in the S or SE part of the targeted region; other than that, the spatial patterns of temperature change from different models exhibited little common features. Some models (esp. DIM-HIRHAM5) produced a pattern correlated with model orography in winter, but such a structure did not seem to be typical for the entire ensemble, nor was it visible in the high-resolution CECILIA simulations.

Although most of the models indicated an increase of precipitation in winter, a few showed an opposite tendency (Fig. 8). In summer, the ambiguity was even stronger (Fig. 9). Some models showed a distinct spatial variation of the change throughout the analyzed region, but no clear common geographical pattern was identified in any of the seasons.

Summary and conclusions

One of the primary goals of the CECILIA project was the investigation of the properties of high-resolution regional climate models and identification of the eventual gain associated with the resolution increase. Our comparison of CECILIA and ENSEMBLES models brought rather mixed results: While the increased resolution does not seem to generally reduce the mean biases over large areas (as is demonstrated in deliverable D2.4 for various regions and all CECILIA models), some finer details of the simulated fields are more clearly expressed in the 10 km resolution. But it should also be noted that the differences between the outputs of various ENSEMBLES simulations themselves are substantial, and some of them perform on par with the analyzed CECILIA simulations. The resolution itself may therefore play an important role in obtaining realistic simulations for orographically complex regions, but not necessarily the dominant one. The statistical techniques of bias-correction and localization may also be used to bring additional details to the simulated fields (see deliverable D3.2), while addressing not just the problem of insufficient resolution, but also reducing systematic errors of the RCMs.

Regarding the simulated future changes of temperature and precipitation, the increase of resolution in the CECILIA models seems inconsequential. Even in the coarser grid used by the ENSEMBLES models, the level of spatial variability is sometimes profound, higher than in the two CECILIA simulations, especially in the case of temperature. Considering the low mutual agreement of the studied models, the real value of such fine details is questionable, and they should probably be treated as just stochastic fluctuations.

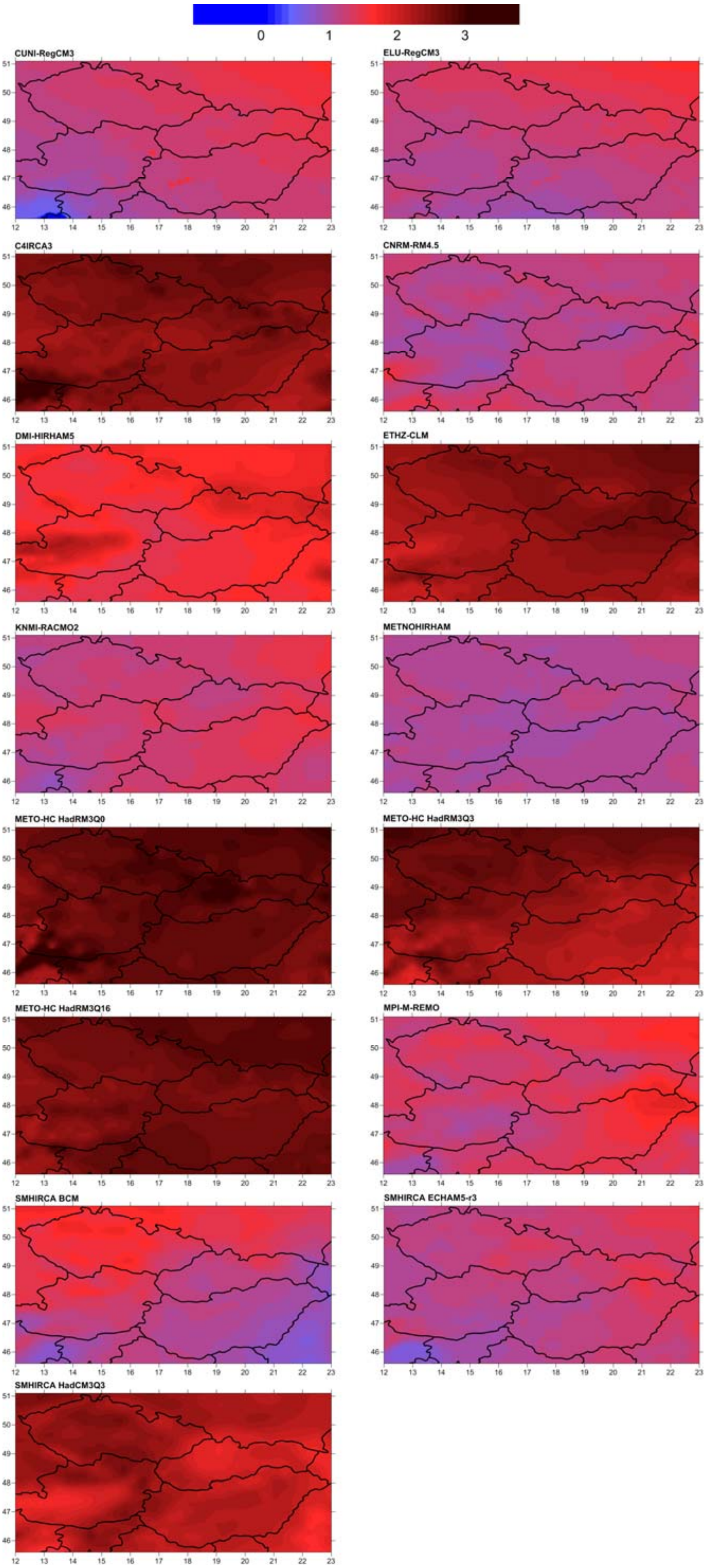

Figure 6: Simulated change of mean **DJF** temperature (°C) between periods 1961-1990 and 2021-2050.

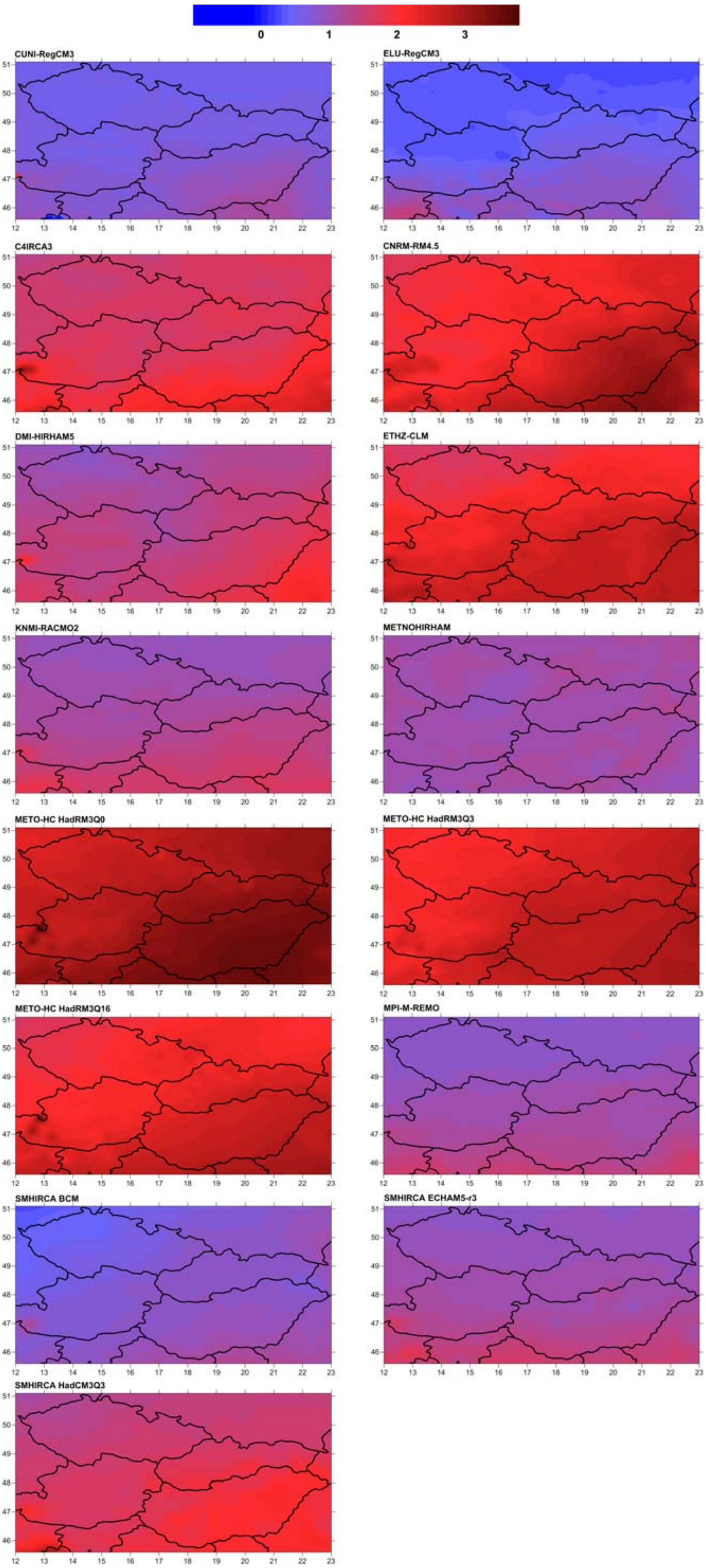

Figure 7: Simulated change of mean **JJA** temperature (°C) between periods 1961-1990 and 2021-2050.

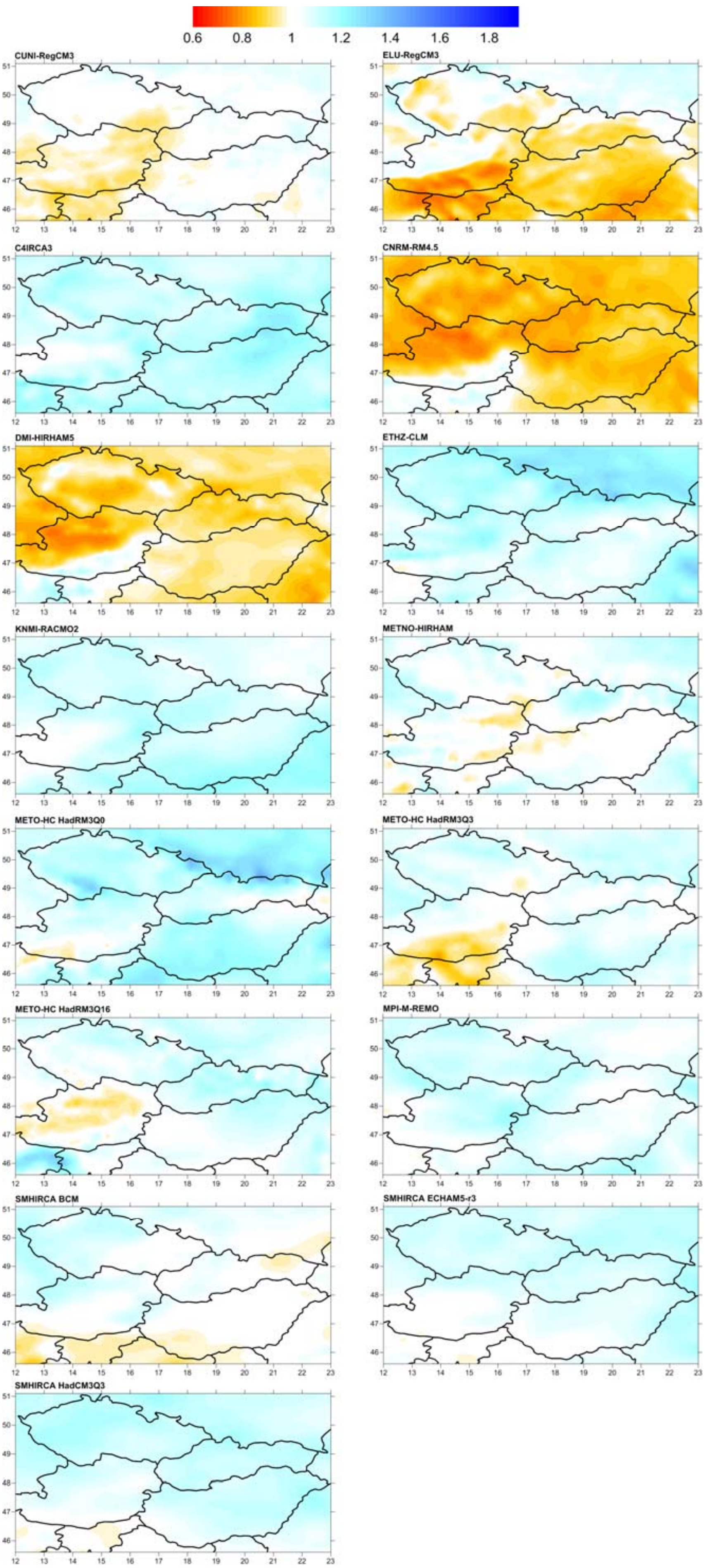

Figure 8: Simulated relative change of mean **DJF** precipitation between periods 1961-1990 and 2021-2050.

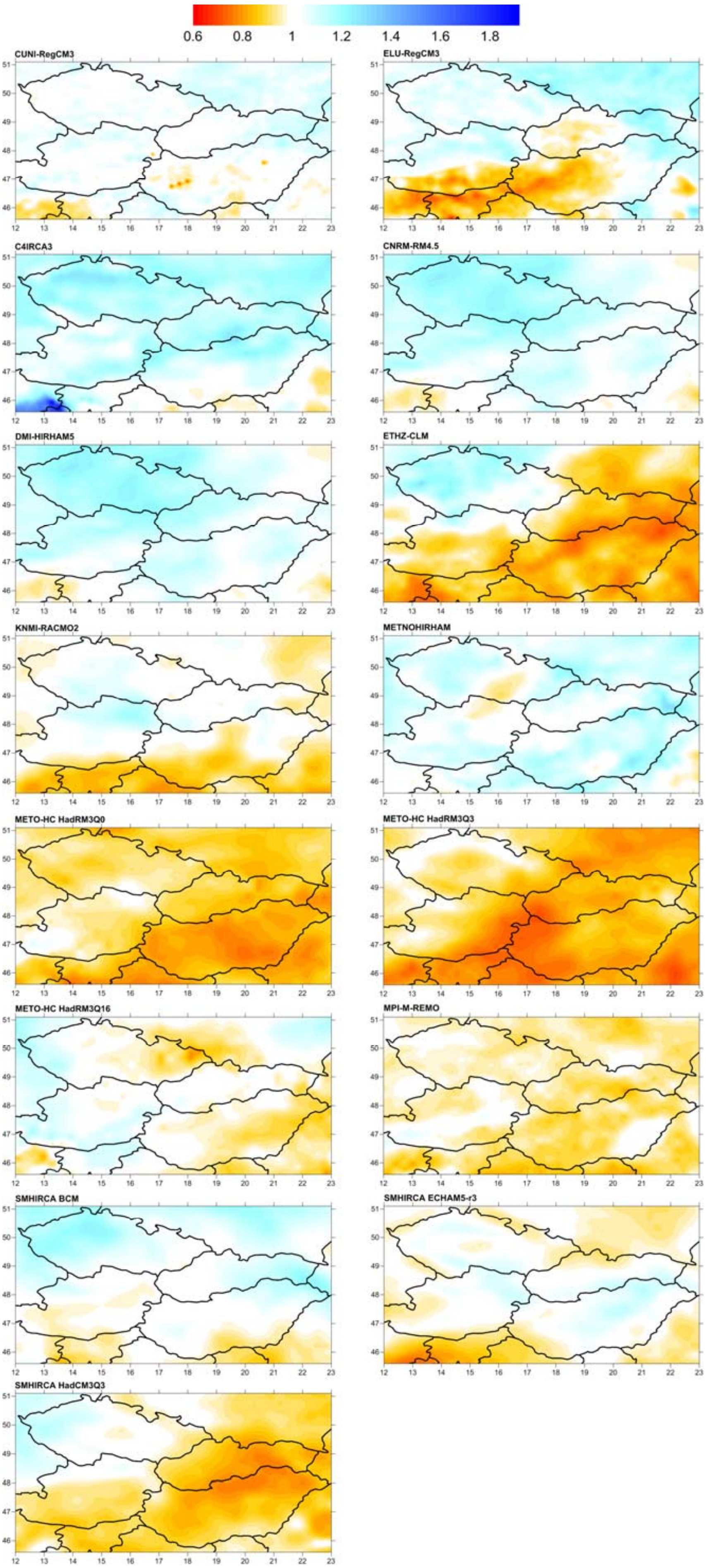

Figure 9: Simulated relative change of mean **JJA** precipitation between periods 1961-1990 and 2021-2050.