Appendix 1. Interpretation of the users' needs based on a self-made questionnaire.

In order to survey the needs of the climate data end-users a short questionnaire was compiled and sent to climate change related research groups and institutes working within the FORESEE database target area. Fig. S1 shows the results of the questionnaire answers. A total of 42 results were processed.

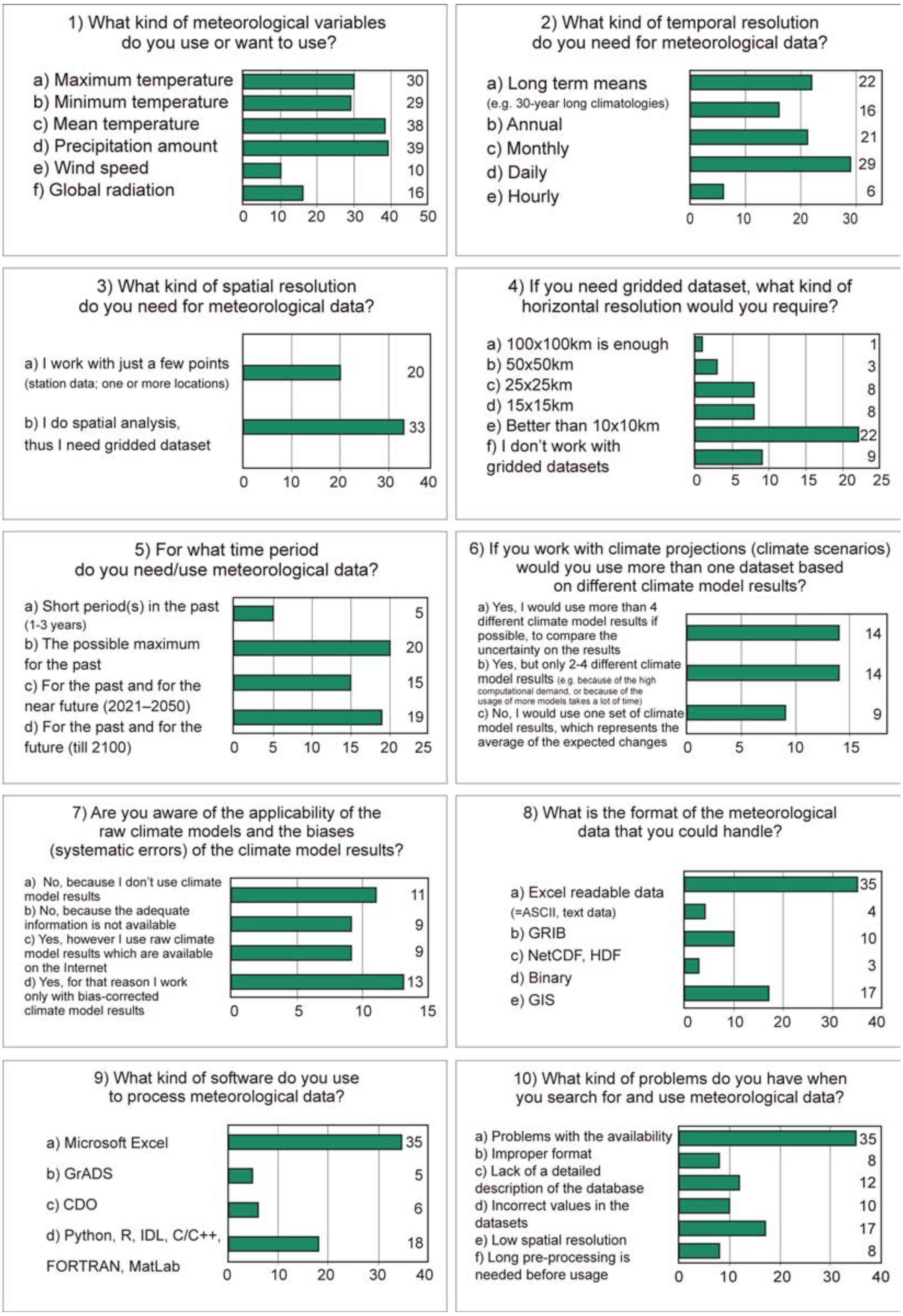

Figure S1. Summary of the questionnaires returned by the potential end-users of the database

Appendix 2. Comparison of the E-OBS and the CRU TS 1.2 databases with the CarpatClim reference database.

The CarpatClim was constructed with state-of-the-art data homogenization and interpolation methods (Szalai et al. 2013) based on a dense observation network (e.g. number of rain gauge stations used for the construction of CarpatClim in Hungary was 109 (M. Lakatos, personal communication), while the E-OBS uses 18 stations only (Klein Tank et al. 2002)).

Daily minimum/maximum temperature and precipitation from the CarpatClim was interpolated to the 1/6×1/6 degree resolution grid of the FORESEE, and compared to the E-OBS and CRU TS 1.2 datasets for the periods 1961-1990, 1971-2000, 1961-1970, 1971-1980, 1981-1990, and 1991-2000. Difference maps, spatially averaged biases, standard deviation of grid cell based differences, and squared linear correlation coefficients were evaluated.

Fig. S2 shows the results of the comparison for 30 years mean differences for the period 1961-1990 (the other long term means revealed similar pattern; not shown here). Table S1 shows quantitative and country-specific comparison results for 1961-1990 (the results were similar for the other time periods).

The CRU provides better estimates for Hungary, Croatia, Slovakia, Slovenia and Romania (but not in Ukraine; Fig. S2) as compared with the E-OBS database. The overall performance of CRU TS 1.2 was better than that of E-OBS for the entire CarpatClim domain.

Klein Tank AMG, Wijngaard JB, Können GP, et al. 2002 Daily dataset of 20th-century surface air temperature and precipitation series for the european climate assessment. *Int J Climatol* **22**:1441-1453, doi: 10.1002/joc.773

Szalai S, Auer I, Hiebl J et al. 2013 Climate of the Greater Carpathian Region. Final Technical Report. www.carpatclim-eu.org.

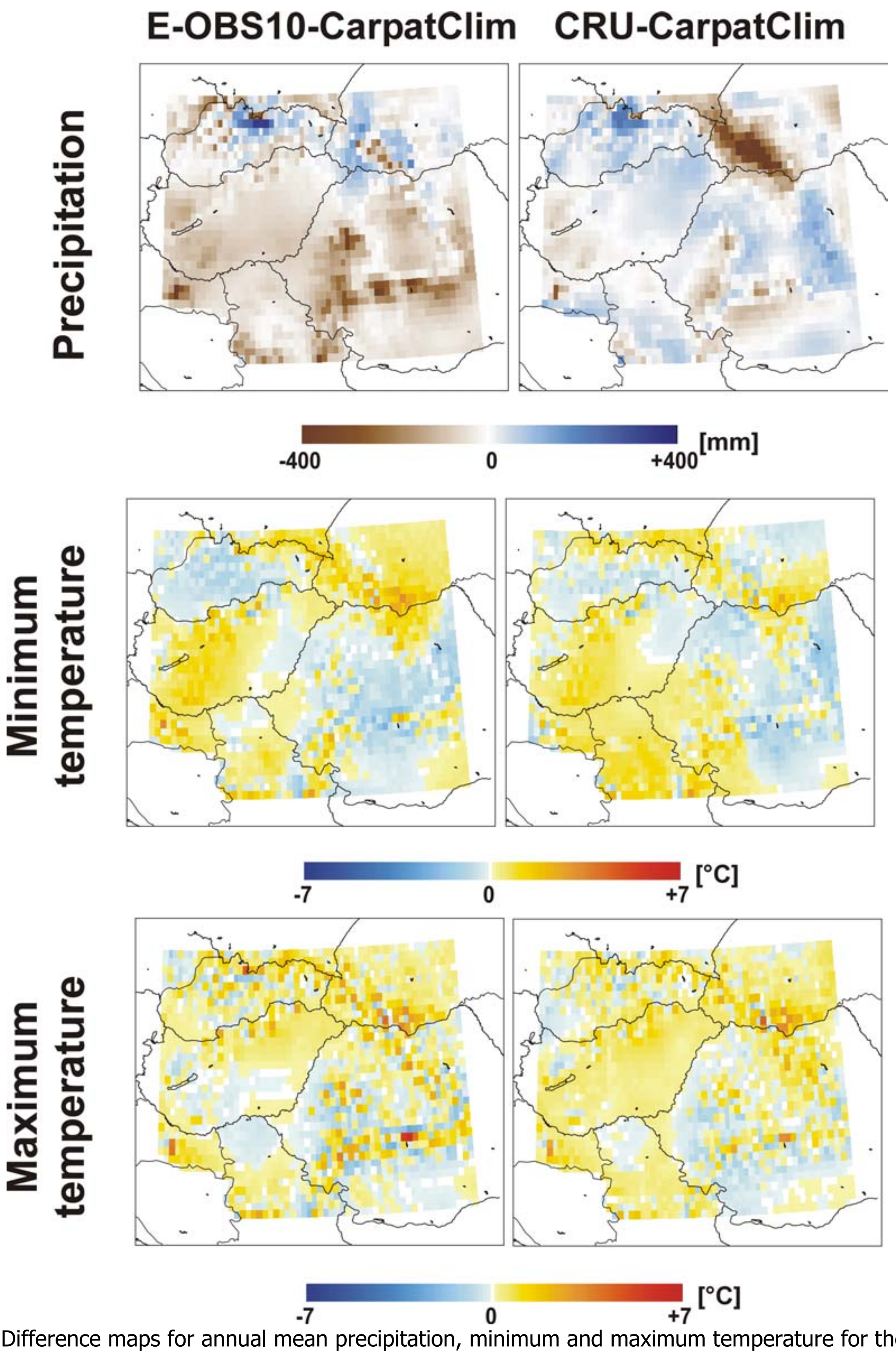

Fig S2. Difference maps for annual mean precipitation, minimum and maximum temperature for the period 1961–1990 between E-OBS (left) and CRU (right) datasets, and the CarpatClim reference database

Table S1 Comparison of E-OBS and CRU dataset with CarpatClim reference database. Differences, standard deviations and squared correlation coefficients were calculated for the target area of CarpatClim dataset, and were divided by countries based on 1961–1990 climatologies

Based on 1961–1990 climatologies	number of grid cells on FORESEE grid	Annual precipitation differences relative to CarpatClim database		Standard deviation of annual precipitation differences relative to CarpatClim database		Squared correlations coefficient relative to the CarpatClim database	
Regions		E-OBS	CRU	E-OBS	CRU	E-OBS	CRU
Croatia	63	-97.33	1.42	84.09	68.18	0.65	0.75
Hungary	367	-65.04	3.03	32.98	34.58	0.73	0.71
Romania	721	-75.51	-2.18	68.85	54.39	0.68	0.81
Serbia	181	-65.52	0.19	50.88	37.67	0.81	0.88
Slovakia	215	-8.93	30.39	84.28	62.87	0.73	0.84
Ukraine	251	-0.86	-96.15	64.74	139.70	0.91	0.76
Whole CarpatClim area	1798	-55.59	-11.20	70.72	78.81	0.79	0.74

Based on 1961–1990 climatologies	number of grid cells on FORESEE grid	Annual mean minimum temperature differences relative to CarpatClim database		Standard deviation of annual minimum temperature differences relative to CarpatClim database		Squared correlations coefficient relative to the CarpatClim database	
Regions		E-OBS	CRU	E-OBS	CRU	E-OBS	CRU
Croatia	63	0.54	0.26	0.60	0.66	0.24	0.21
Hungary	367	0.31	0.19	0.53	0.46	0.38	0.49
Romania	721	-0.24	-0.24	0.61	0.59	0.91	0.93
Serbia	181	0.11	0.57	0.57	0.50	0.56	0.65
Slovakia	215	-0.36	-0.11	0.54	0.43	0.90	0.93
Ukraine	251	0.55	0.04	0.62	0.60	0.82	0.81
Whole CarpatClim area	1798	0.05	0.01	0.68	0.60	0.87	0.91

Based on 1961–1990 climatologies	number of grid cells on FORESEE grid	Annual mean maximum temperature differences relative to CarpatClim database		Standard deviation of annual maximum temperature differences relative to CarpatClim database		Squared correlations coefficient relative to the CarpatClim database	
Regions		E-OBS	CRU	E-OBS	CRU	E-OBS	CRU
Croatia	63	0.41	0.39	0.73	0.57	0.55	0.74
Hungary	367	0.11	0.26	0.42	0.35	0.67	0.77
Romania	721	-0.05	-0.05	0.85	0.56	0.89	0.96
Serbia	181	-0.03	0.12	0.55	0.39	0.71	0.86
Slovakia	215	0.12	0.09	0.75	0.53	0.84	0.92
Ukraine	251	0.39	0.42	0.78	0.74	0.78	0.80
Whole CarpatClim area	1798	0.09	0.12	0.74	0.56	0.91	0.95

Appendix 3. Differences between the non-corrected/corrected climate model results and the observation based dataset.

Figures S3-S5 show the mean annual precipitation amount, maximum and minimum air temperature based on the observations for 1951-2013, and the biases of the 10 non-corrected climate models. Fig. S3 shows that all models overestimate the annual mean precipitation amount in areas with higher elevation; in some cases the overestimation reaches 2000 mm. The temperature biases are between -10 and +10 °C with high inter-model variability (Fig. S4-S5).

Bias corrected RCM outputs reproduced the observations considerably well. Annual precipitation biases became close to zero (bias was less than 2 mm in each RCM). In case of mean minimum and maximum temperature, the biases were always less than 0.05 and 0.1 °C, respectively. The difference maps for the corrected model results are not shown here because of quite random pattern of differences and generally low-informative content.

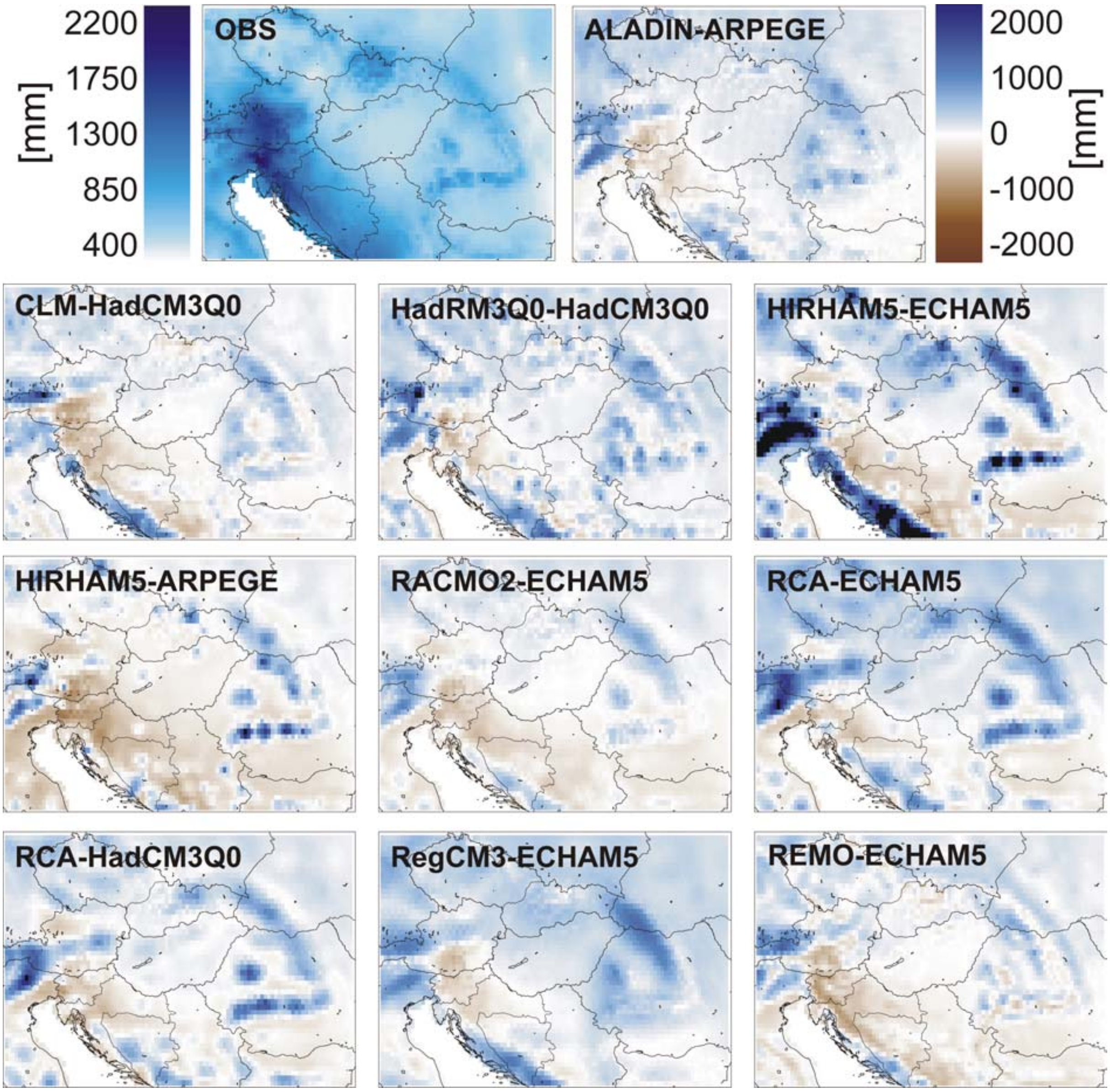

Fig S3. Annual precipitation [mm] for the 1951-2013 period based on the observations (OBS, top left) and the biases of the 10 non-corrected RCM-GCM simulations (blue colors indicate overestimation, brown colors show underestimation)

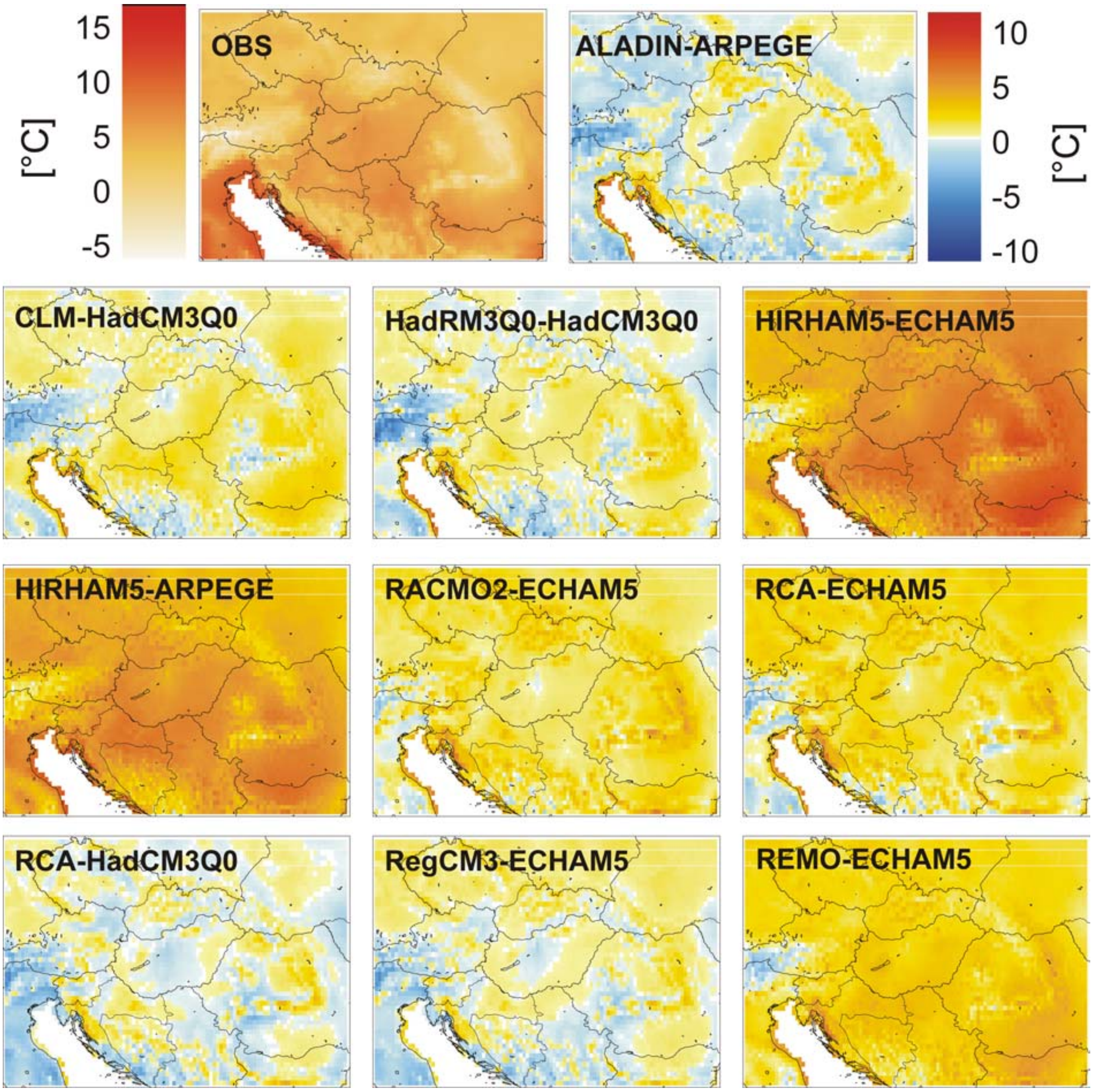

Fig S4. Annual mean minimum temperature [°C] for the 1951-2013 period based on the observations (OBS, top left) and the bias of the 10 non-corrected RCM-GCM simulations (red colors indicate overestimation, blue colors show underestimation)

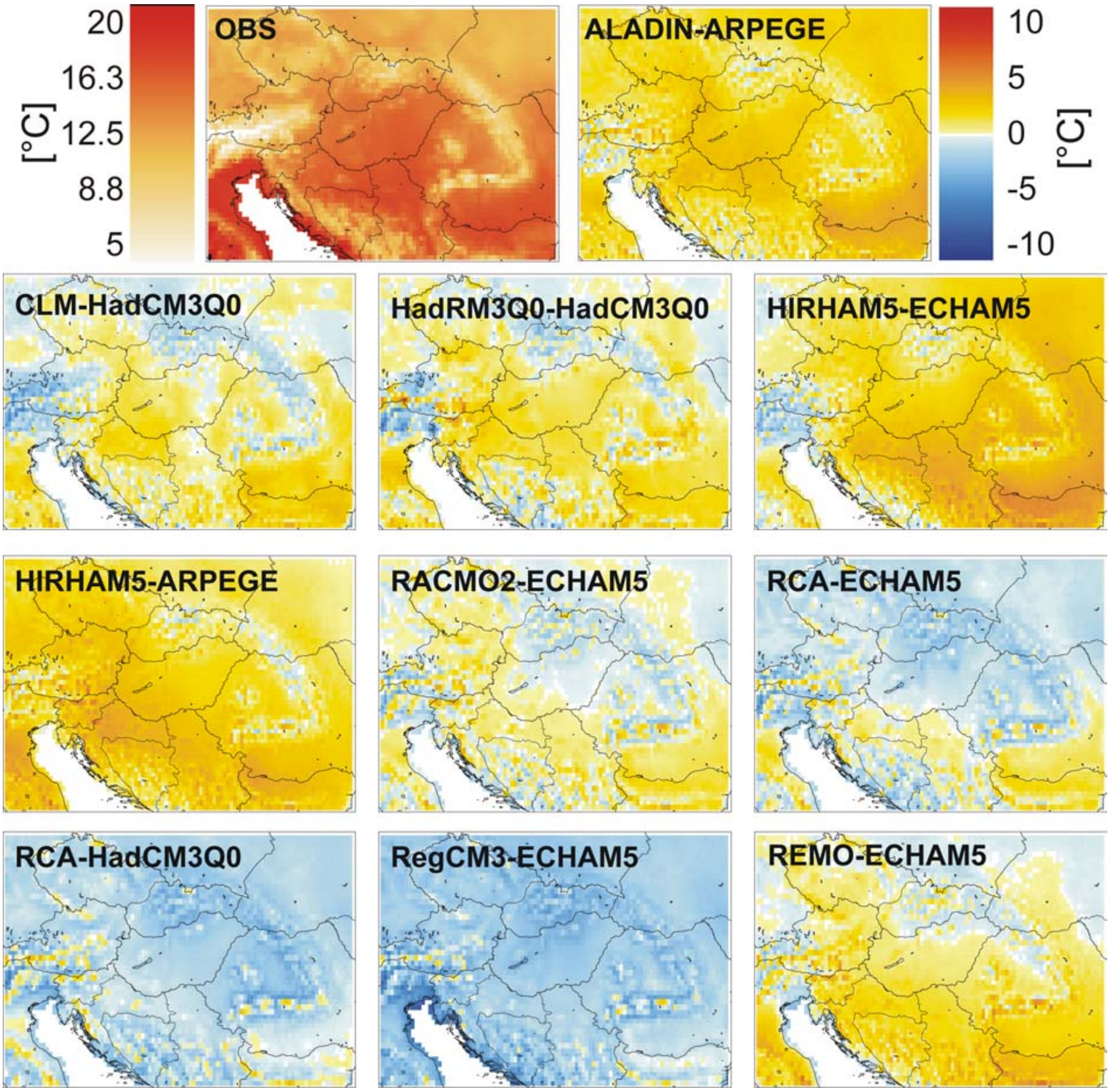

Fig S5. Annual mean maximum temperature [°C] for the 1951-2013 period based on the observations (OBS, top left) and the bias of the 10 non-corrected RCM-GCM simulations (red colors reveal overestimation, blue colors indicate underestimation)

Appendix 4. Relationship between simulated and observed standard deviation of precipitation time series based on the non-corrected and the corrected climate model results.

As the applied bias correction alters the statistical properties of the precipitation time series, we evaluated the effect of the correction and explored whether the adjustment improves the match between the observed and simulated precipitation time series or not. We evaluated this match using the ratio of standard deviation of uncorrected and corrected RCM results, and the observations.

The 1961-1990 period was selected to visualize the effect of bias correction on the model results. Fig. S6 shows the ratio of the standard deviations of precipitation time series based on model results and observations. In case the ratios are close to one the standard deviation of the given dataset approximates well the observations.

In Fig. S6 it can be seen that the raw model results show standard deviation ratios largely different from one in many regions (in some cases the ratio can be as high as 4.6 (not visible due to selected scale)). After the bias correction, the standard deviation ratios get much closer to one in all GCM-RCM combinations, which indicates that the applied two-step precipitation bias correction scheme improved the temporal variance of precipitation.

Note that the FORESEE database contains exclusively observation-based data for the past, not the bias corrected model results. Simulated data for the past are used to construct the transfer functions to correct the future simulations.

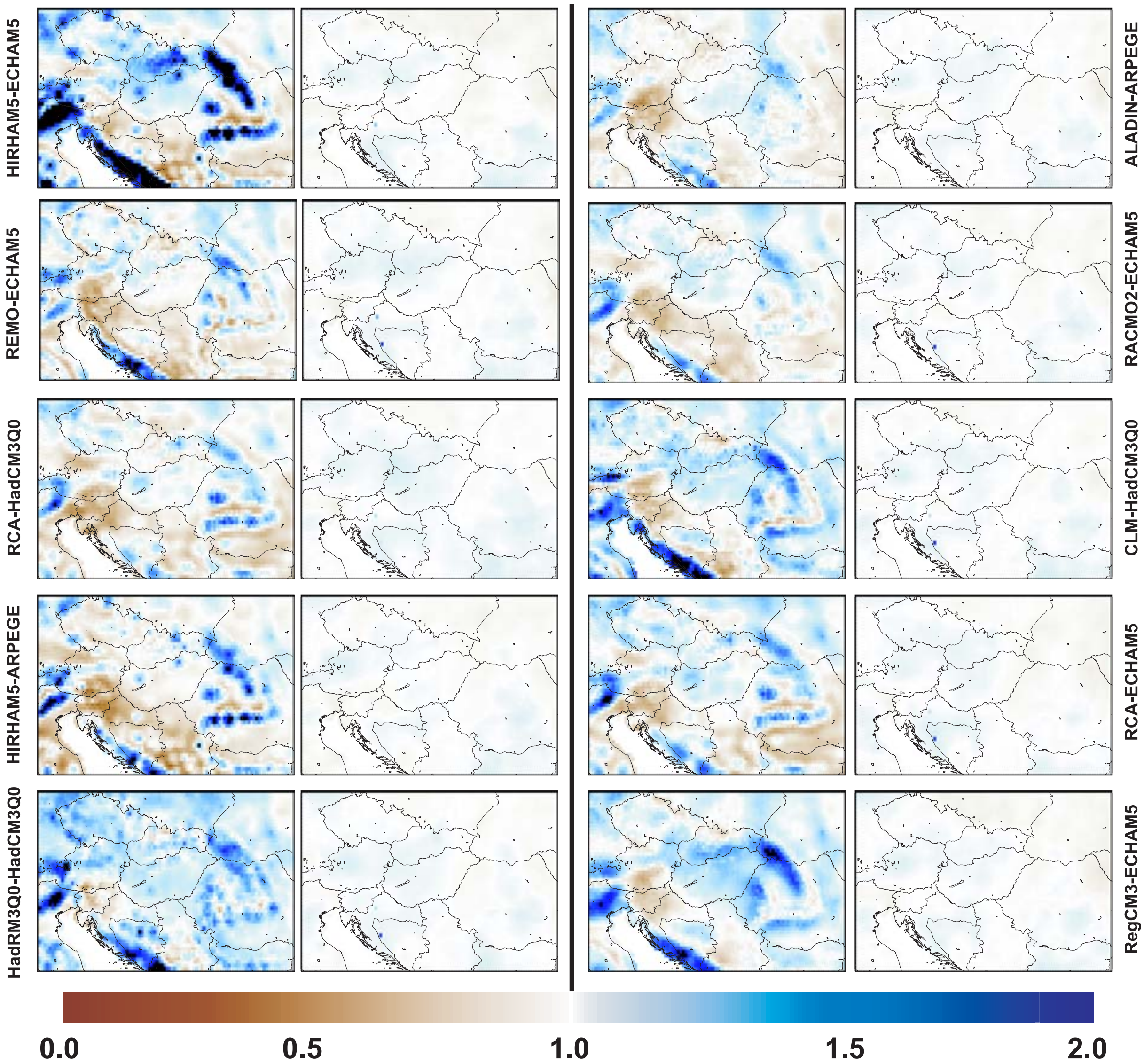

Fig S6. Standard deviation ratios of the raw climate model results and observations (first and third column) and bias corrected climate model results and observation (second and fourth column) for the 10 GCM-RCM combinations based on the 1961-1990 period. In case of a good match the ratios are close to one.

Appendix 5. Comparison of simulated (uncorrected and corrected) and observed annual number of wet days.

Bias correction is expected to alter the statistical properties of the precipitation time series due to the applied correction method. Here we study the effect of bias correction in terms of precipitation frequency. Fig. S7 shows the spatially averaged annual number of wet days for the FORESEE domain for the 1951-2100 period. The figure shows that the simulated annual number of wet days is overestimated by a factor of 2-3 in the period 1951-2013. The bias correction forced the frequency of wet days approaching the observed values.

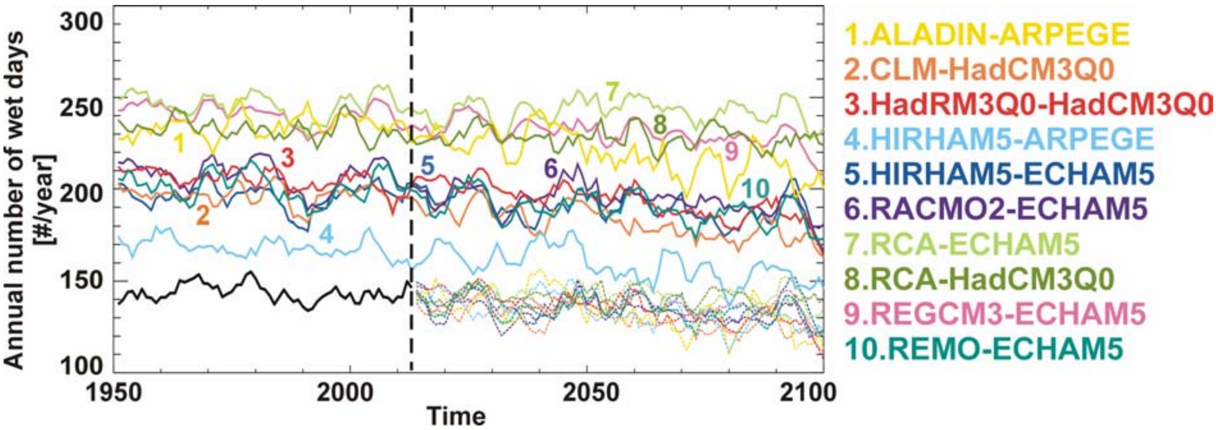

Fig S7. Spatially averaged annual number of wet days for the Central European target area for the 1951-2100 period smoothed with 5 years moving average. The black thick solid line is based on the observation, the dashed and dotted grayscale thick lines represent the non-corrected climate model results. The dashed and dotted grayscale thin lines show the bias corrected climate model results for the period 2010-2100. The line styles and the numbers refer to the RCM-GCM list on the right side.