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

D1.1: Assessment of climate change information for CEE from previous projects

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Lead contractor for this deliverable: ICTP

Revision [final]

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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)	

Data used for model assessment

Two sets of data were assessed as part of the Deliverable D8.

1) Data from climate simulations produced with coupled Atmosphere-Ocean General Circulation Models (AOGCMs) participating in the CMIP3 intercomparison project completed in support of the Fourth IPCC Assessment Report (AR4). This dataset includes experiments with 21 models from laboratories worldwide. Simulations for 20^{th} century climate with observed greenhouse gas (GHG) forcing and for 21^{st} century climate under forcing from three IPCC SRES emission scenarios were available. The three scenarios include the A2, which lies close to the upper end of the SRES scenario range, A1B, which lies close to the middle of the range, and B1, which lies close to the lower end of the range. The horizontal resolution of the models varies from about 1.2 degrees to 4.5 degrees. The data are stored at the web site **www-pcmdi.llnl.gov** and are of public access and a list of the CMIP3 models can be found in this web site.

2) Data from Regional Climate Model (RCM) simulations completed as part of the previous European project PRUDENCE. In this case simulations with 10 RCMs were available for two time slices, 1961-1990 for present day conditions and 2071-2100 for future climate conditions under forcing from two IPCC SRES scenarios, the A2 and B2 (which also lies towards the lower end of the IPCC scenario range). The PRUDENCE regional model simulations were driven at the lateral boundaries by corresponding global simulations with three global climate models. The data are available at the web site **http://www.dmi.dk/f+u/klima/prudence/,** which also reports a description of the participating models.

In order to assess these simulations against observed climate, observations were used from the dataset developed at the Climatic Research Unit of the University of East Anglia (referred to as the CRU dataset). This includes monthly temperature and precipitation data onto a global land 0.5 x 0.5 degree grid for the period 1901-2002.

Measures used for model assessment

The assessment included two types of analysis. In the first the performance of the CMIP3 and PRUDENCE ensembles of models was evaluated against the CRU observations. In the second the climate change signal produced by these two ensembles was intercompared to assess the robustness of the projected changes. The variables assessed include seasonal mean and interannual variability for temperature and precipitation, where the interannual variability is measured by the interannual standard deviation for temperature and the coefficient of variation (standard deviation divided by the mean) for precipitation.

Results of the assessment

Figures 1-8 present maps of the biases (1961-1990) and changes (2071-2100 minus 1961-1990) for the A2, A1B and B2 scenarios in the CMIP3 AOGCMs and PRUDENCE RCM ensembles over the European region for mean precipitation, precipitation interannual variability, mean temperature and temperature interannual variability, respectively, and for two seasons (December-January-February, or DJF; and June-July-August, or JJA). Also reported in the figures are the corresponding values averaged for six selected CECILIA sub-regions.

Analysis of mean temperature (Figures 1-2) reveals that the CMIP3 ensemble does not exhibit strong systematic biases, both in DJF and JJA, with areas of positive and negative bias generally less than 2 C. The CMIP3 biases are mostly positive over mountainous regions, as a result of the smooth topography of the models, and over the Mediterranean in DJF. Conversely, the PRUDENCE RCMs exhibit a predominant warm bias over Europe in both seasons, although this is relatively small, especially over the western European regions. Focusing on the CECILIA sub-regions, the temperature biases are less than 2 C except over Romania in JJA for the PRUDENCE models. Biases of the order of 2 C or less are consistent with the performance that can be expected by state-of-the-art models over this region. Analysis of the scenario simulation reveals warming of up to 5.2 degrees C by the end of the 2100 century, maximum in the southern CECILIA regions in JJA and in the northern regions in DJF. As expected the warming is greatest for the high GHG emission scenario (A2).

The CMIP3 ensemble tends to underestimate temperature interannual variability over the European and CECILIA regions in DJF, except for the Alpine region, and shows mixed performance in JJA, with a prevalence of an overestimation over the eastern CECILIA regions (Figures 3-4). By comparison, the PRUDENCE RCMs show an dominant underestimate of temperature variability over central Euorpe in DJF ans an overestimate in JJA (Figure 1-2). The temperature variability change signal is consistent in the CMIP3 and PRUDENCE simulations, with a decrease in the winter and an increase in the summer. This implies that the change signal does not depend on the biases in the present day simulations. The decreased temperature variability in winter can be at least partially attributed to the melting of snow and related decreased efficiency of the snow-albedo feedback mechanism, while the increased in summer variability can be attributed to the drying of the continental interiors and stronger land-atmospherre feedbacks.

Concerning mean precipitation (Figures 5-6) the models tend to overestimate precipitation in over the CECILIA regions in DJF and underestimate it in JJA, with consistent biases in the CMIP3 and PRUDENCE ensembles. The JJA biases are mostly less than 30% over the CECILIA regions, while they exceed 60% over the northernmost region. The precipitation change signal is consistent with previous simulations, with a general decrease in summer (maximum in the southernmost CECILIA regions) and a dipolar pattern in winter (increased precipitation in the northern regions and decreased in the southern ones). The precipitation change patterns are generally consistent across different scenarios, being of largest magnitude in the A2 one.

The model performance in reproducing precipitation interannual variability varies across seasons, regions and differs between the CMIP3 and PRUDENCE ensembles. In DJF the CMIP3 models underestimate variability throughout Europe, while the PRUDENCE models overestimate it the Mediterranean and underestimate it over central Europe. In JJA the PRUDENCE models show a general underestimate over the CECILIA area while the CMIP3 show a more varied signal. Analysis of the change scenarios reveals a projected dominant increase in the summer and a smaller and more mixed signal in the winter.

Figures 9-14 show for three CECILIA regions (the Alpine region, a central European region and a southeastern European region) the trends in temperature and precipitation seasonal anomalies (with respect to 1961-1990) for the 20th and 21st century simulations in both the CMIP3 AOGCM and PRUDENCE RCM ensembles. Also reported are the observed anomalies for the 20th century period (from the CRU dataset). For the 21st century projected anomalies for different IPCC SRES scenarios are reported (A1B, B1 and A2 in the CMIP3 dataset, A2 and B2 in the PRUDEENCE dataset).

In the case of the Alpine region, the CMIP ensemble captures the observed 20th century warming (Figure 9) and simulates warming in the range of 1 to 6 C by 2100, maximum (minimum) in summer (winter) and in the A2 (B1) scenario. The warming values simulated by the PRUDENCE ensemble are in line with those of the CMIP3 ensemble. Concerning precipitation (Figure 10), observations show negligible trends during the 20th century in all seasons except for summer, when a slightly negative trend is found. This is captured by the models. The projections indicate a positive precipitation trend in winter and negative trends in the other seasons, with these trends being consistent across scenarios.

For the central European region the model ensembles again capture the warming observed in particular during the second half of the 20th century and produce a pronounced warming of up to several degrees C throughout the 21st century (Figure 11). For this region the warming is maximum in the winter season. Precipitation shows rather negligible trends in the 20th century, with decreasing precipitation trend in the summer and fall and small increasing trends in winter and spring (Figure 12).

Finally, the Southeastern European region shows the largest 21st century warming in the summer season, up to about 6 C by 2100 (Figure 13) and decreasing projected 21st century precipitation in all seasons, especially in summer (Figure 14). The model ensembles also capture a small observed decreasing precipitation trend found during the last decades of the 20th century.

FIGURES:

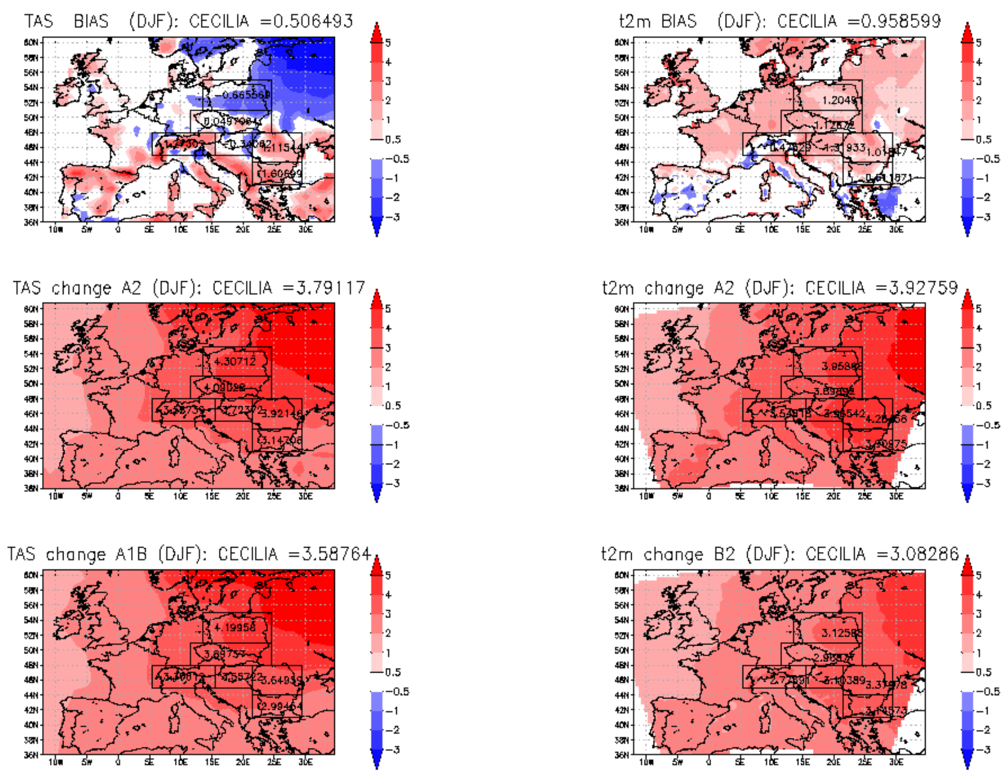

Figure 1: Mean surface air temperature bias (1961-1990) and change (2071-2100 minus 1961-1990) for the CMIP3 (left column) and PRUDENCE (right column) ensembles and the winter (DJF) season. Numbers in the boxes, which encompass the CECILIA region, indicate averages over the corresponding region.

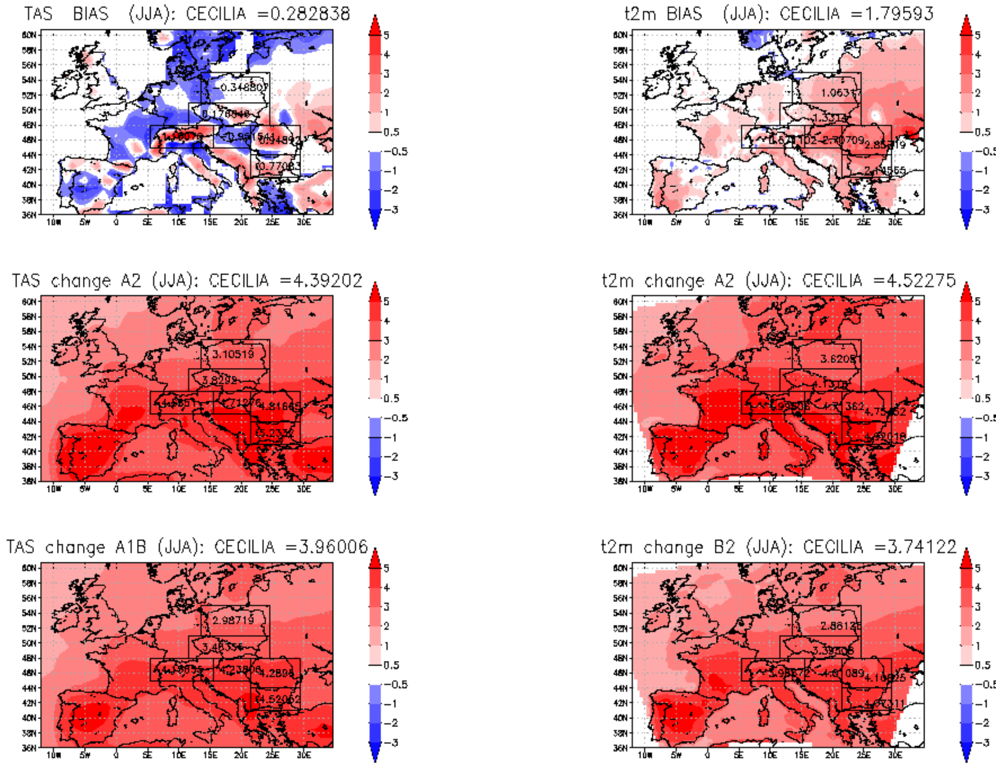

Figure 2: As figure 1 but for JJA mean surface air temperature.

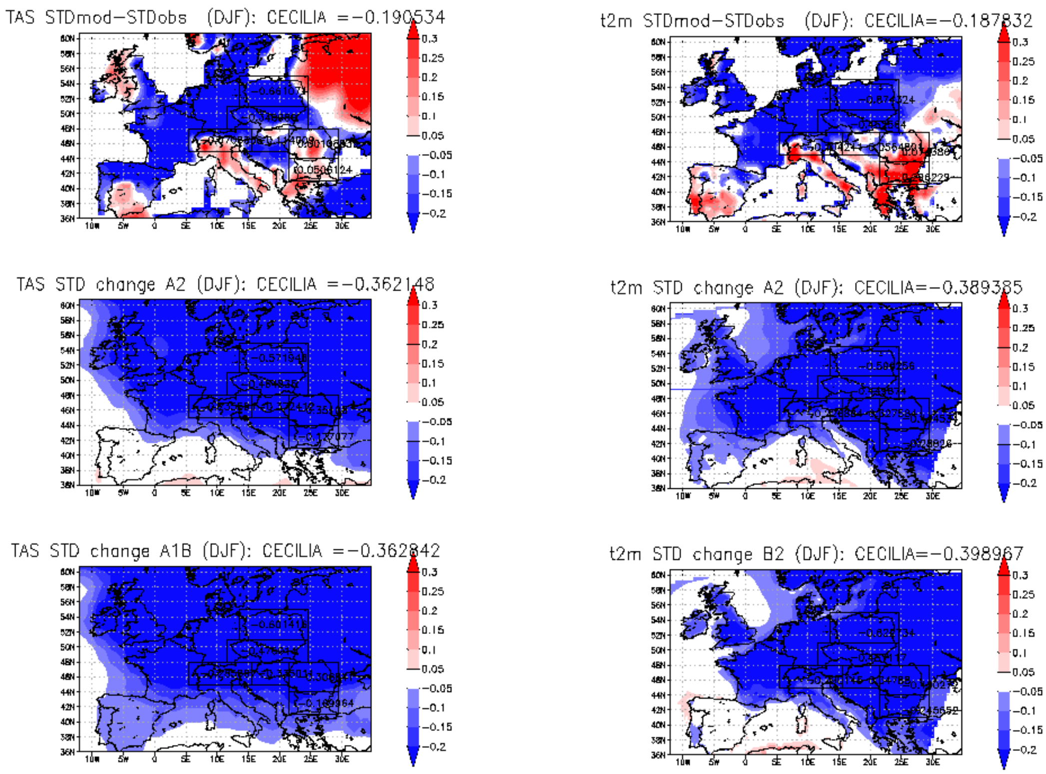

Figure 3: As figure 1 but for DJF surface air temperature interannual variability (as measured by the interannual standard deviation.

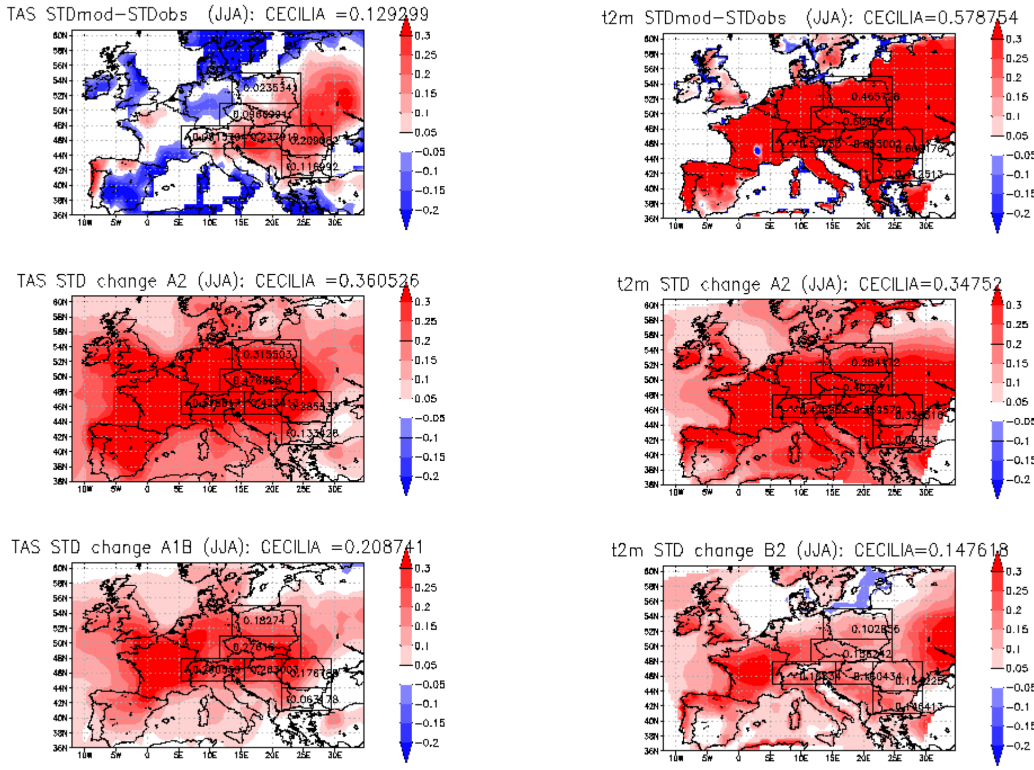

Figure 4: As figure 1 but for JJA surface air temperature interannual variability (as measured by the interannual standard deviation) .

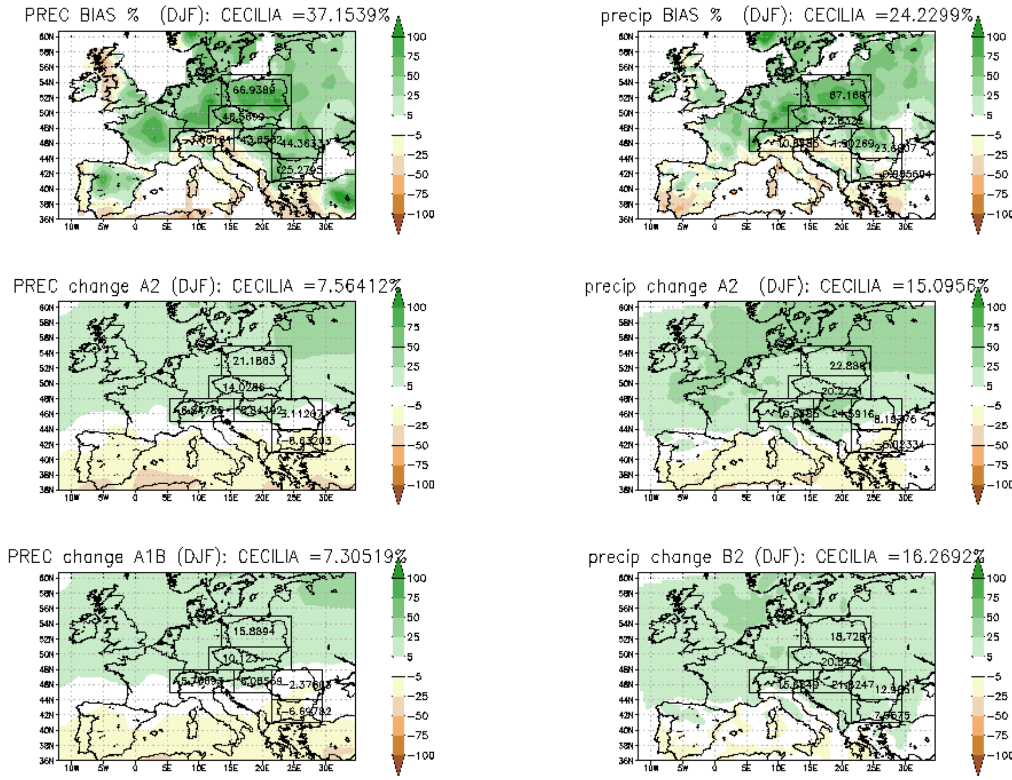

Figure 5: As figure 1 but for DJF mean precipitation.

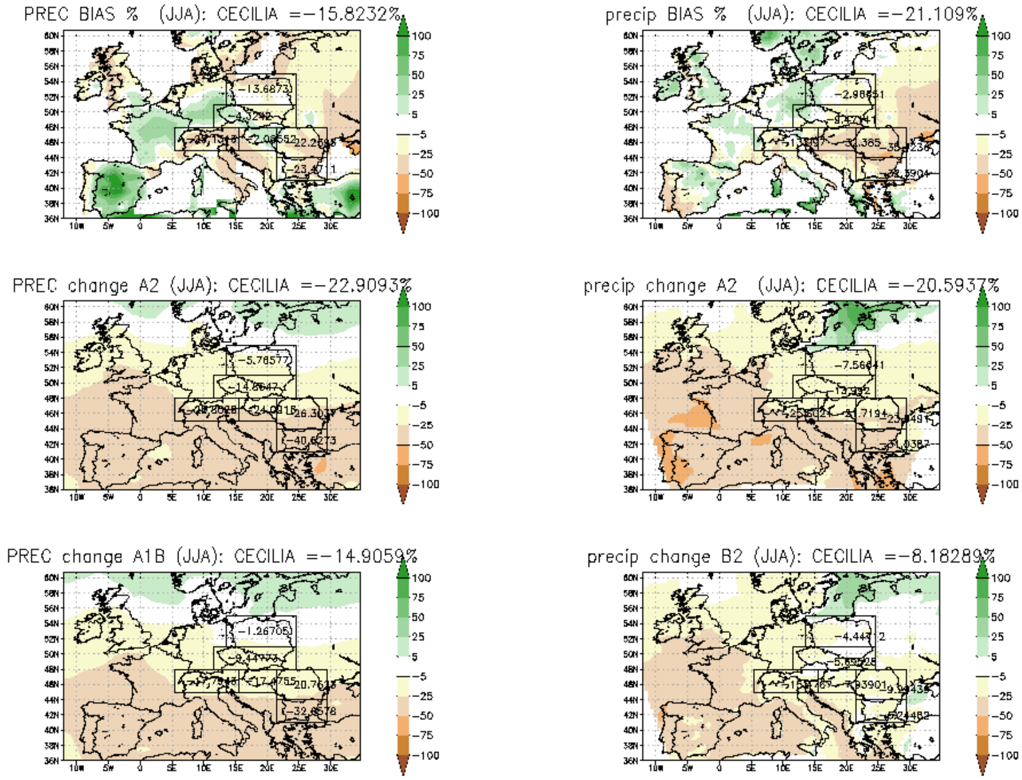

Figure 6: As figure 1 but for JJA mean precipitation.

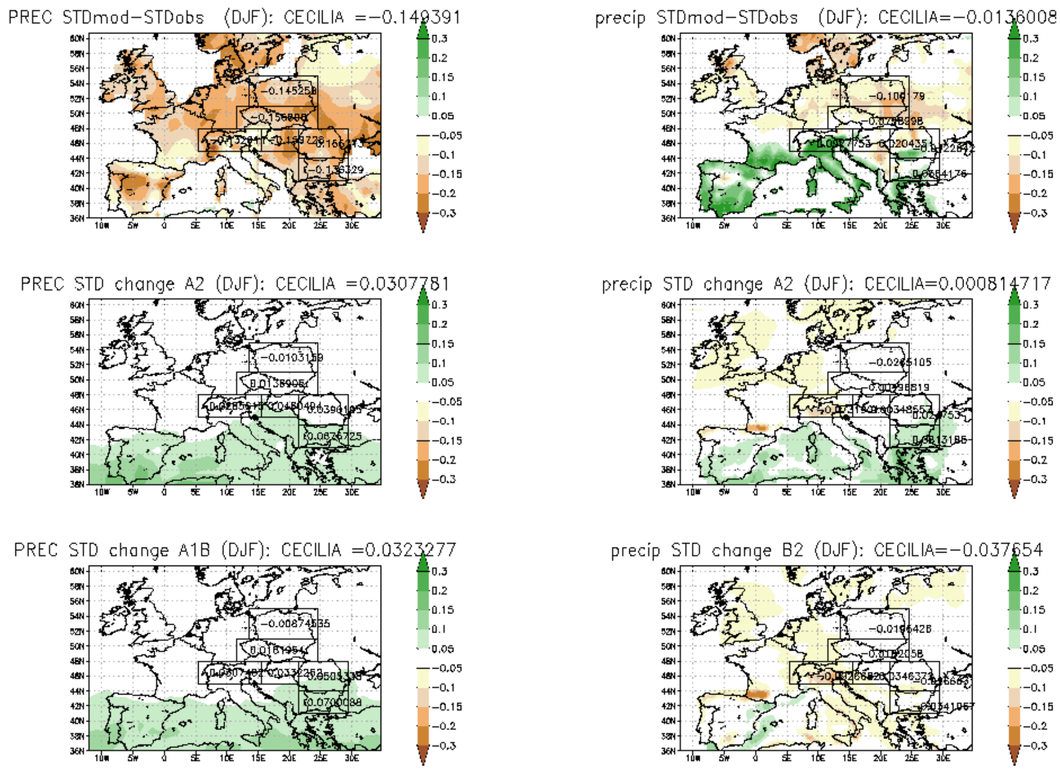

Figure 7: As figure 1 but for DJF precipitation interannual variability (as measured by the interannual coefficient of variation).

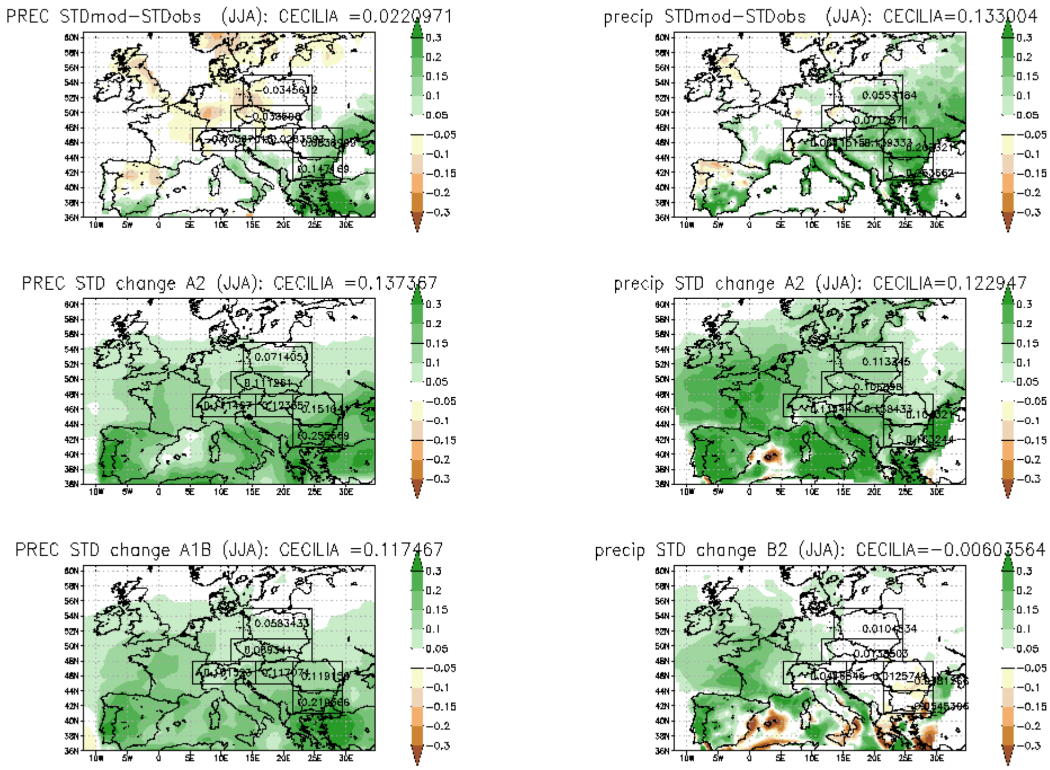

Figure 8: As figure 1 but for JJA precipitation interannual variability (as measured by the interannual coefficient of variation).

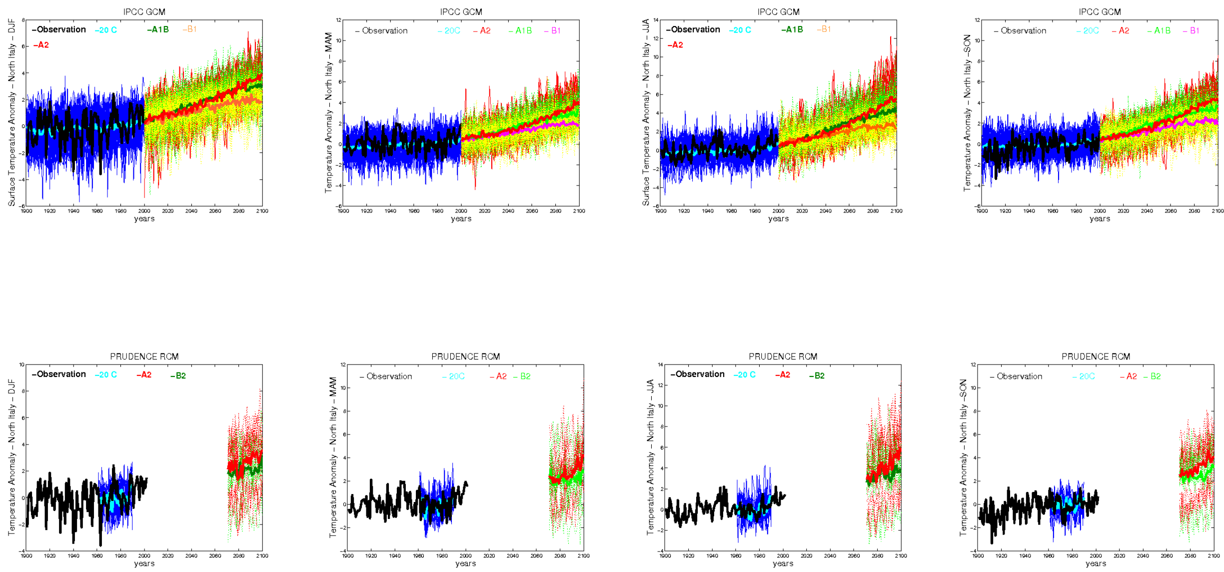

Figure 9: Temporal trend of seasonal surface air temperature anomalies (compared to 1961-1990) for the 20th and 21st century over the Alpine CECILIA region in the CMIP3 (upper panels) and PRUDENCE (lower panels) ensembles.

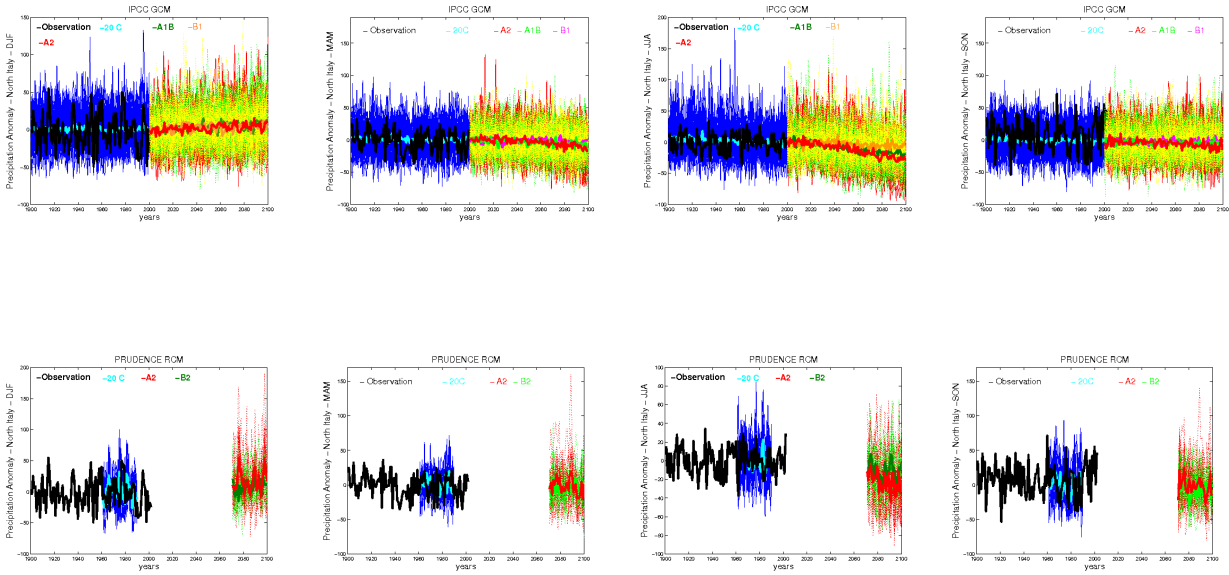

Figure 10: Same as figure 9 but for precipitation in the Alpine CECILIA region.

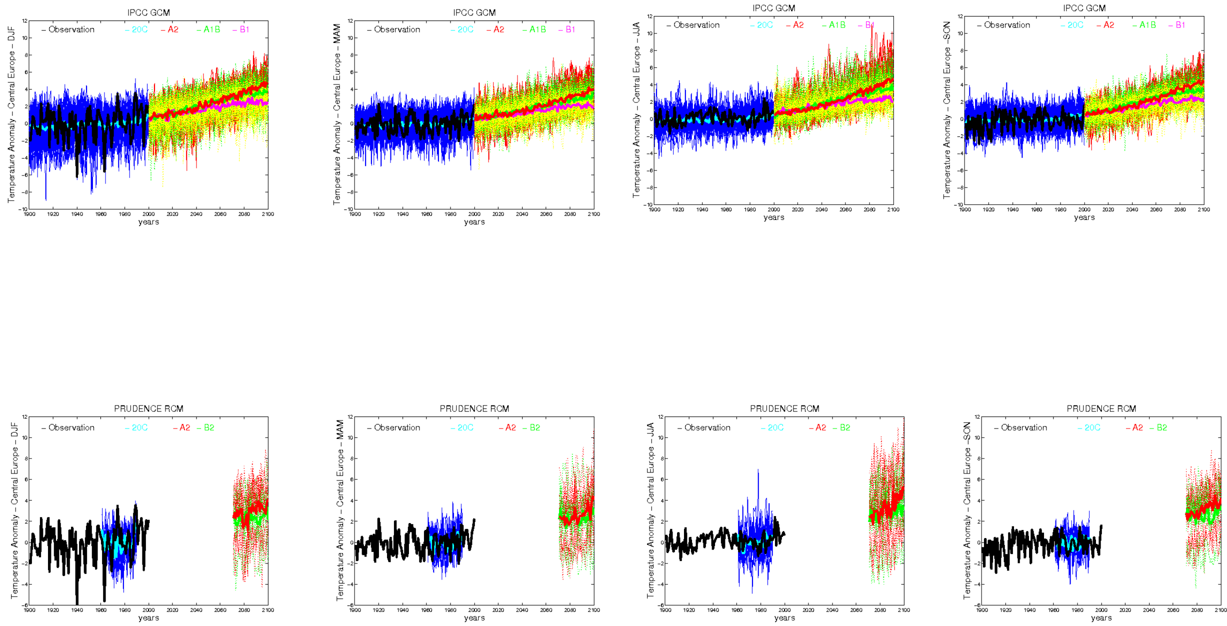

Figure 11: Same as figure 9 but for surface air temperature over the Central Europe CECILIA region.

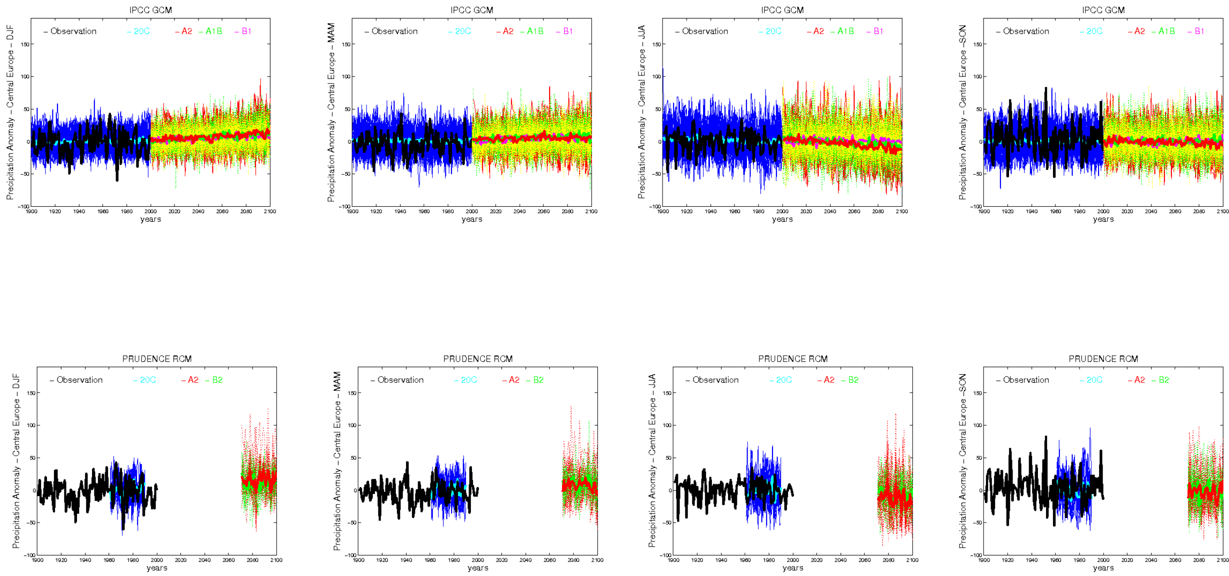

Figure 12: Same as figure 9 but for precipitation over the Central Europe CECILIA region.

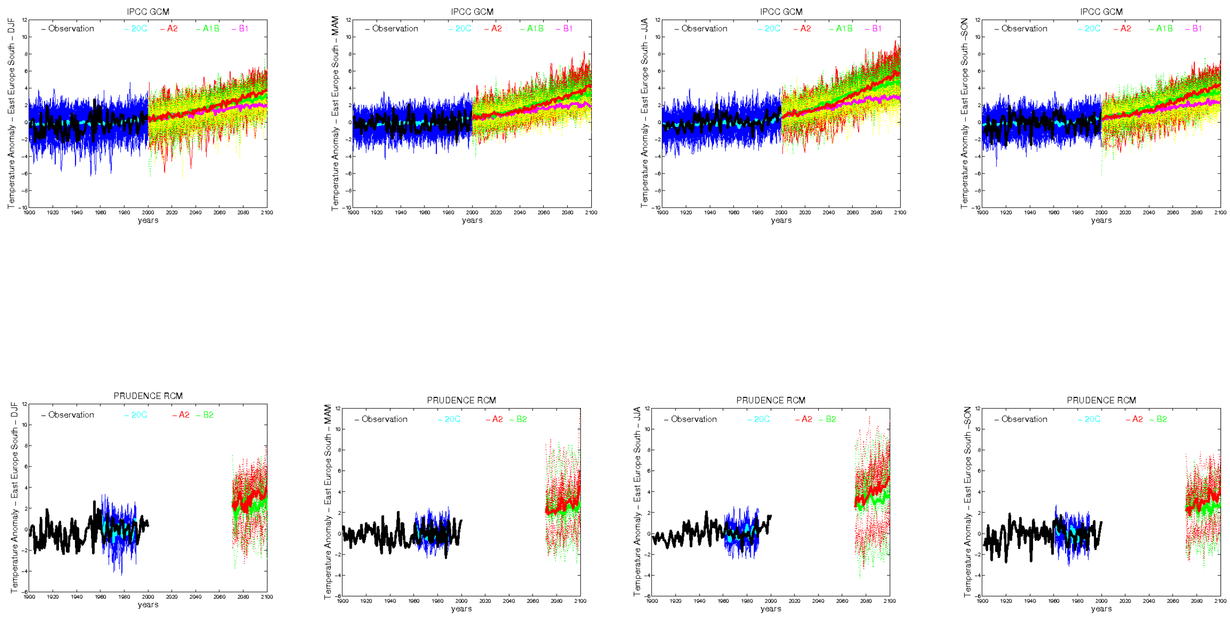

Figure 13: Same as figure 9 but for surface air temperature over the Southeastern Europe CECILIA region.

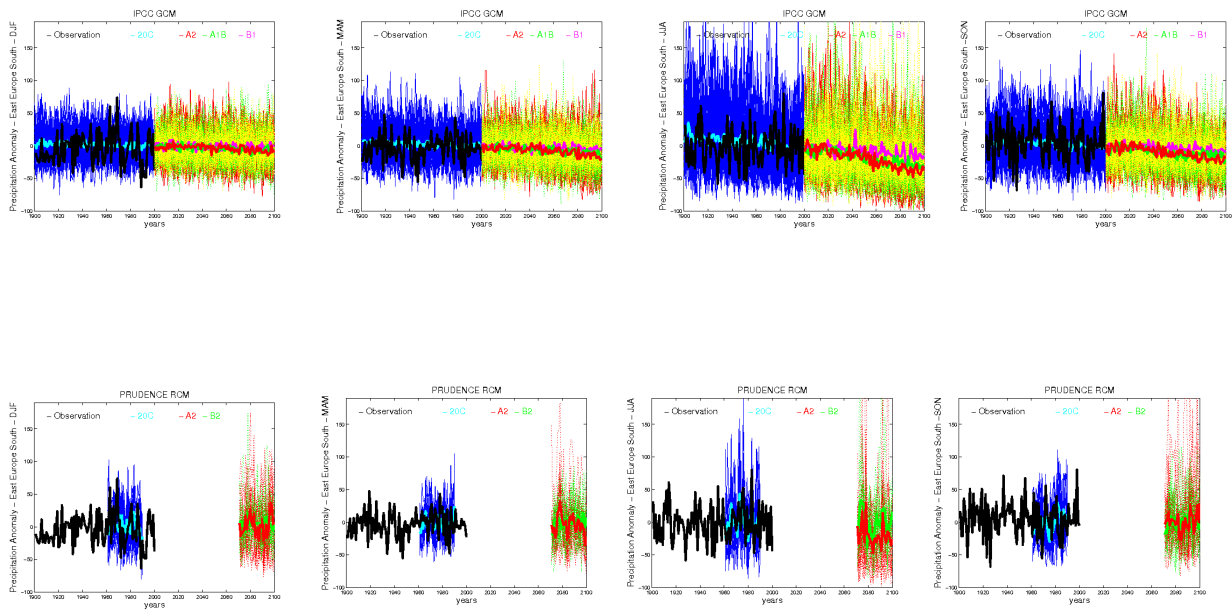

Figure 14: Same as figure 9 but for precipitation over the Southeastern Europe CECILIA region.