Stěpánek, P., Skalák, P., Farda, A., Zahradníček, P.: Climate change in the area of the Czech Republic according to ALADIN-Climate/CZ simulations. Šiška, B. – Hauptvogl, M. – Eliašová, M. (eds.). Bioclimate: Source and Limit of Social Development, International Scientific Conference, 6th – 9th September 2011, Topoľčianky, Slovakia

CLIMATE CHANGE IN THE AREA OF THE CZECH REPUBLIC ACCORDING TO ALADIN-CLIMATE/CZ SIMULATIONS

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Abstract. In the last years, simulations from the ALADIN-Climate/CZ regional climate model (RCM) became available for the area of the Czech Republic thanks to several national or international projects (e.g. the EC FP6 projects CECILIA or ENSEMBLES). The simulations were performed according to the IPCC A1B emission scenario with various spatial resolutions, from which simulations at 10 km are presented here. Since models suffer from biases, the model outputs were statistically corrected using quantile approach of M. Déqué. After the correction, RCM outputs were statistically processed and analyzed.

Introduction

Regional climate models (RCMs) are the state of the art tools employed for downscaling information from the coarse resolution global circulation models (GCMs) on a local scale. The regional climate model ALADIN-Climate/CZ is an adaptation of ALADIN numerical weather prediction model, version CY28T3. Within the EU FP6 project CECILIA it was coupled with GCM ARPEGE to provide a projection of future climate in two periods, 2021-2050 and 2071-2100, according to the IPCC A1B emission scenario. Its description can be found e.g. in Farda et al. (2007) or Farda (2008).

Within the CECILIA project, 131 extreme indices for air temperature and precipitation have been defined. The list of the indices comes from definitions of the previous STARDEX project and WMO indices, but also includes additional indices considered useful for the analyses of extremes within the project. In this work we present only selected indices and the overall results for the whole Czech Republic.

Data and methods

Before the analysis of the future climate, the model data were corrected according to validation results carried out for the period 1961-1990. For this purpose (comparison with truth), the so called technical series were recalculated from station data in the positions of grid points of the model (ALADIN-Climate/CZ grid at 10 km horizontal resolution, for the details about the method see e.g. Štěpánek et al., 2011). All input station observations were quality controlled, homogenized in daily scale and gaps in data were filled (for more information about the preprocessing of station dstat please refer to Štěpánek et al., 2009).

According to relationship between the RCM outputs and the recalculated station data (technical series for the grid points), outputs of A1B scenario integrations of the future climate were corrected applying an approach of Déqué (2007) that is based on a variable correction using individual percentiles. After the correction, the model outputs are fully compatible with the station (measured) data.

The corrected model outputs were then used for calculation of 131 extremes indices of temperature and precipitation, for all the 789 grid points within the area of the Czech Republic (see Fig. 1). The spatial and temperal variability was then studied for the the whole period 1961–2009 (recalculated station data into grid positions), near future 2021-2050 and far future 2071-2100 (corrected model outputs). Here we present only results for the average over all these points (for a given indice) from the whole area.

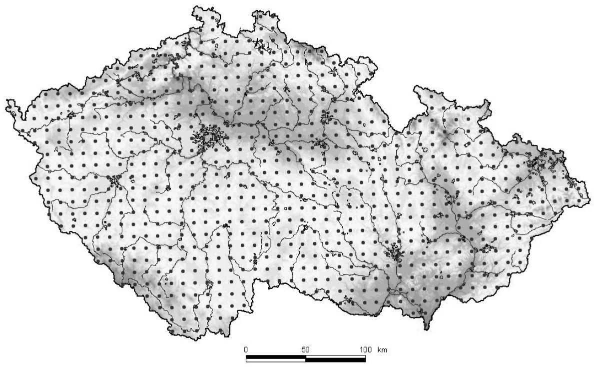

Figure 1. Technical series recalculated from station data for grid points of ALADIN-Climate/CZ

All data processing was performed by ProClimDB database software for processing of climatological datasets (free download is possible from http://www.climahom.eu/, Štěpánek, 2008). Interpolation, where needed, was carried out applying an approach adopted at CHMI utilizing local linear regression (dependence of given meteorological element on altitude) and universal kriging interpolation method (Šercl, 2002).

Results and disscussion

While number of hot days (days with maximum temperature equal or more than 30°C) occured 5.4 days per year in average for the period 1961–2000, for the period 2021–2050 it is expected that 9.6 of such days will occur and in the period 2071–2100 even 28 days per year. In the present the highest number of hot days occure in July, but for the future the model gives the highest number of days in August. In the whole period 1961–2100 the model indicates statistically significant trend ($p=0.05$) of two days per 10 years, the highest increase occurring mainly in the 2071–2100 period (Fig. 2). As it is shown on the Fig. 3, increase in the number of hot days is not evenly distributed in space, in the period 2021–2050 the highest increase is expected for the Polabí region. Within the whole area of the Czech Republic, maximum 2 days increase is expected on 32.4% of the area, while more than 8 days per year increase is expected for 12.1% of the area.

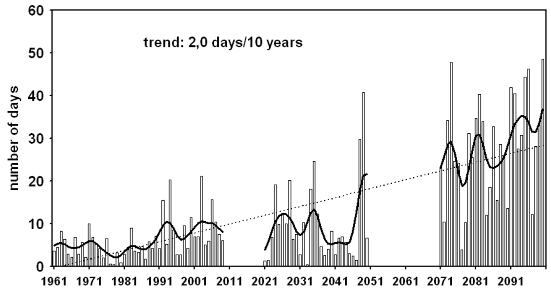

Figure 2. Number of hot days – averaged series for the Czech Republic (smoothed with Gaussian low-pass filter for 10 years)

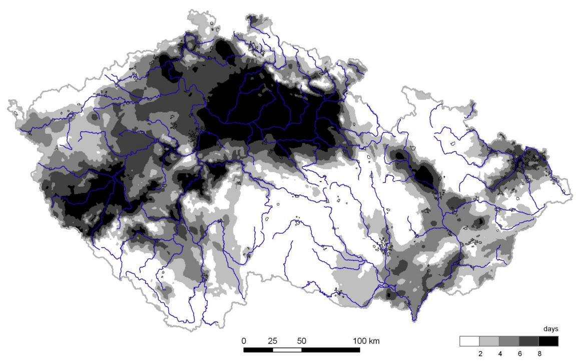

Figure 3. Number of hot days – difference between averages for periods 2021–2050 and 1961–2000

Average of annual maxima of air temperature in the period 1961–2000 is 31.9°C. For the near future this value will increase by 1°C, while in the period 2071–2100 the value reaches 37°C. For some of the grid points the values exeed 40°C. Statistically signifant trend for the whole period 1961–2100 is 0.46°C per 10 years (Fig. 4).

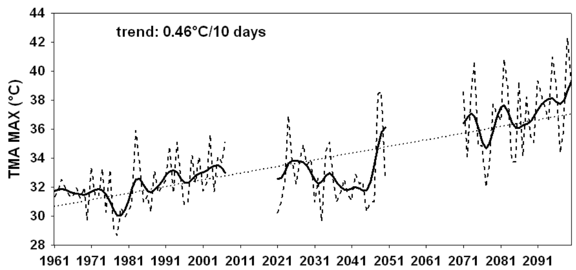

Figure 4. Number of hot days – averaged series for the Czech Republic (smoothed with Gaussian low-pass filter for 10 years)

On the contrary number of frost days (minimum temperature does not reach 0°C) is decreasing in the whole period 1961–2100 by 4.4 days per 10 years (in the period 1961–2000 the statistically significant trend is 4 days per 10 years with 121.8 days per year in average). Number of ice days (maximum temperature stays below 0°C) will continue decrasing in the future according to the model by 2 days per 10 years (statistically significant trend). In the period 1961–2000 the trend is 2.5 days per 10 years with 38.2 of frost days in average, compared to 26.6 days for the near future and 17.2 days for the far future.
As for precipitation, the average amount for the whole Czech Republic shows no statistically significant trend over the whole period (1961–2100, see Fig. 5), the same is valid also for annual maxima.

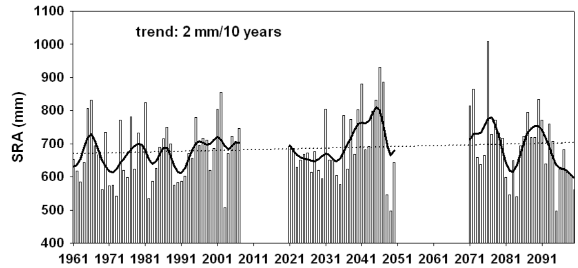

Figure 5. Annual precipitation – averaged series for the Czech Republic (smoothed with Gaussian low-pass filter for 10 years)

Average length of dry period (considered as no precipitation occurence for at least 10 consecutive days) is 41.7 days in the period 1961–2000, but again we found no statistically significant trend for the whole period (1961–2100). Percentage of wet days (wet day – a day with precipitation equal or more than 1 mm) again shows no statistically significant trend (with 30.3% of such days in the period 1961–2000).

Conclusions

Corrected simulations of ALADIN-Climate/CZ RCM were analyzed for air temperature and precipitation based on corrected model outputs using technical series recalculated from station data for the area of the Czech Republic. The final series consisted from the technical series (presence – 1961-2009) and from the corrected outputs - near (2051-2070) and far (2071-2100) future. While for air temperature we find statistically significant trends in all characteristics (increase in air temperature, number of hot days, while decrease for frost or ice days), for precipitation we find no statistically significant trends (p=0.05), neither in average characteristics, nor in maxima, number of dry or wet days.

Acknowledgements The present work was supported by the European Commission under the Contract No. 037005 and the Grant Agency of the Czech Republic under project no. P209/11/0956.

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