Extreme values analysis in daily air temperature and precipitation series in the area of the Czech Republic since 1961

Petr ŠTEPÁNEK, Pavel ZAHRADNÍČEK, Petr SKALÁK Czech Hydrometeorological Institute, *e-mail: petr.stepanek@chmi.cz*

Abstract

The long-term series of air temperature and precipitation were investigated in the area of the Czech Republic in the period 1961-2007. These series were prepared, quality checked and homogenized by means of AnClim and ProClimDB software (www.climahom.eu). For extreme values analysis, 130 precipitation and temperature indices defined within CECILIA FP6 EU project were calculated and analyzed. The indices were calculated for various periods (e.g., 1961-1990, 1961-1970, 1966-1975, 1971-1980, etc., as well as yearly for 40 core indices) and time frames (monthly, seasonal and annual). Using the calculated indices, spatial and temporal changes of air temperature and precipitation extremes were described.

1. Introduction

The EU-project CECILIA (Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment) aims at delivering a climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe. This region appears particularly vulnerable with regard to future changes in extremes (Christensen and Christensen 2003, Schär et al. 2004), likely due to regional specificities such as highly varying topography and continentality, and to changes in soil moisture content (Seneviratne et al. 2006).
The project includes the analysis of extreme weather events in present day climate in the target region. For this purpose, a list of 130 precipitation and temperature indices was defined. The indices were calculated for various periods (e.g., 1961-1990, 1961-1970, 1966-1975, 1971-1980, etc., as well as yearly for 40 core indices) and time frames (i.e., monthly, seasonal and annual) using the software ProClimDB (Stepanek, 2007).
Datasets used for the indices calculation within the projects include regional datasets (e.g. European Climate Assessment & Dataset, ECA&D), local datasets available to the individual partners (covering the Czech republic, the Carpathian basin, Romania, and Bulgaria) as well as model data - 10km CECILIA RCMs driven by the RegCM3 and Arpège European simulations and also a selection of pre-existing RCM/GCM datasets (PRUDENCE, ENSEMBLES).
Here, we present results from the analysis of the selected temperature and precipitation extreme indices from stations observations for the area of the Czech Republic in the period 1961-2005.

2. Used dataset

For extreme value analysis in the area of the Czech Republic, data records of 111 stations were selected from CHMI (Czech Hydrometeorological Institute) climatological database. Before processing, input station data were **quality controlled and homogenized** in daily scale, using whole database (all available stations). After homogenization, possible gaps in the series were filled applying geostatistical methods.
Data pre-processing and indices calculation was performed by ProClimDB database software (http://www.climahom.eu) developed by one of the author.

3. Selected indices

Only selected indices out of all 131 indices could be presented here. Those selected are:
Number of index: name (Definition)

Temperature indices

18: Tmax 95th percentile (95th percentile of daily values of maximum temperature within given time frame)

34: Tmin 5th percentile (5th percentile of daily values of minimum temperature within given time frame)

52a: Mean heat wave length (day-weighted average of spell lengths of at least 6 consecutive days: $Tx_{ij}>Tx_{inorm}+5$, where Tx_{ij} is the daily maximum temperature at day i of period j and Tx_{inorm} is the calendar day mean calculated for a 5 day window centred on each calendar day during a specified period. Lengths limited to the relevant time frame)

61: Percentage of days with Tmax > 90th percentile (%age of days with maximum temperature > 90th percentile, where 90th percentile is taken from all values for 5-day window around calendar day within base period 1961-1990)

Precipitation indices

99: Fraction of total precipitation above annual 95th percentile (fraction of total precipitation above annual 95th percentile - sum and percentile based on wet-day amounts)

104f : Max. nb of consecutive wet days (maximum number of consecutive wet days. Full spell lengths considered)

107f: Mean wet spell length (mean wet spell length (days). Full spell length considered. Day-weighted)

115: Greatest 5-day total rainfall

4. Air Temperature

Fig. 1 shows differences for max. temperature 95th percentile and min. temperature 5th percentile between periods 1996-2005 and 1961-1970 for the area of the Czech Republic. Max. temperature 95th percentile raised about 1.0°C within the whole area of the Czech Republic (mainly in northern parts), while min. temperature (5th percentile) increased about 1.9°C (mainly in western parts). Average daily temperature amplitude increased only by 0.1°C but large spatial differences exist – generally DTA increased in northern parts while decreased in southern parts.
Fluctuations of annual values in the period 1961-2007 were analyzed for four selected stations – two from the east and two from the west of the country, and one of the two with lower and one with higher altitudes (Aš, Žatec, Bílá, Mošnov). For these stations, min. temperature increased significantly mainly in summer, max. temperature in year, winter, spring and summer.

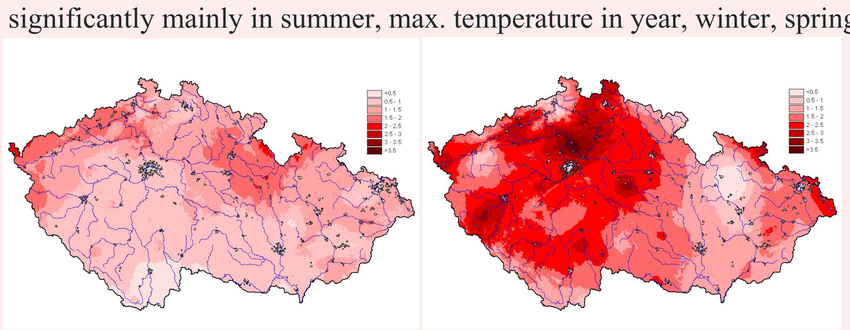


*Fig.1. i18 - Tmax 95th percentile (left) and i34 - Tmin 5th percentile (right). Decadal mean 1996-2005 **compared** to decadal mean 1961-1970.*

Mean heat wave length (i52a) does not change with time in eastern part of the Czech Republic (Moravia) while it increased in western part (Bohemia) – here the values in 1960s were lower compared to Moravia but in the last decade they overcome them. The mean heat wave length prolonged by 0.9 days (within the whole area). Linear trends are statistically significant for winter, summer and year (Fig. 2).

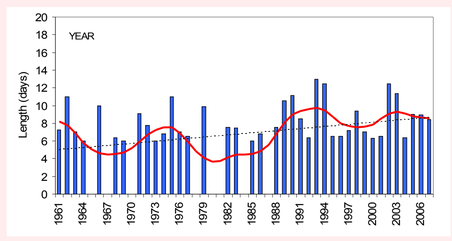


Fig.2. i52a - fluctuations of mean heat wave length. Station Mošnov, 1961-2007.

Linear trends for percentage of days with maximum temperature above 90th percentile (i61) are statistically significant for year, winter, spring and summer (Fig. 4). For the whole area the percentage increased from 9.0% in the 1960s to 14.8% in the last decade (Fig. 3).

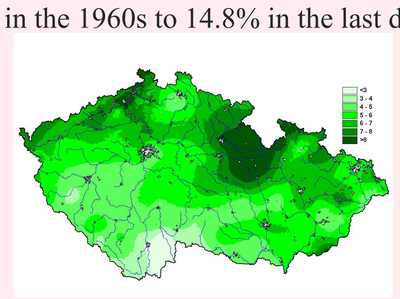


*Fig. 3. i61 - Percentage of days with Tmax > 90th percentile. Period 1996-2005 **compared** to 1961-1970.*

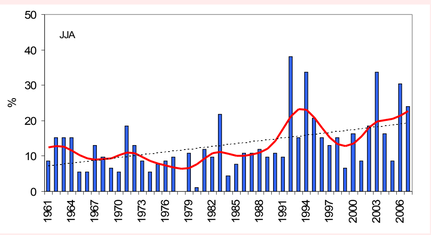


Fig.4. i61 - percentage of days with Tmax > 90th percentile. Summer. Station Mošnov, 1961-2007.

5. Precipitation

To study fluctuations of annual values, the same set of four stations as for air temperature was selected. Fraction of total precipitation above annual 95th percentile (i99) shows no significant trends (0.05) in the studied period (Fig. 5). Eastern parts of the Czech Republic have higher values than western parts (Bohemia) (Fig. 6).

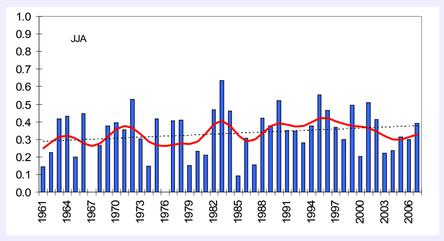


Fig.5. i99 – fluctuations of fraction of total precipitation above annual 95th percentile. Summer. Station Aš, 1961-2007.

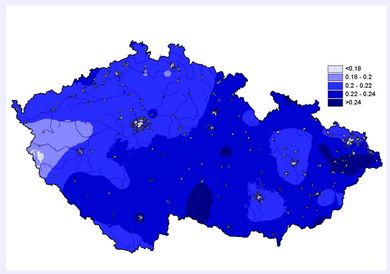


Fig.6. i99 – fraction of total precipitation above annual 95th percentile. Decadal mean 1996-2005.

Mean wet spell length (i107f) reflects well change with altitude (Fig. 8), the same is valid for the max. number of consecutive wet days (i104f). Again, there is no change compared to previous periods (Fig. 7).

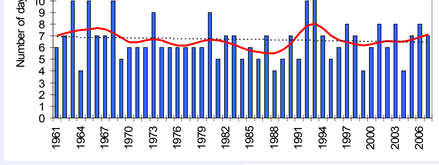
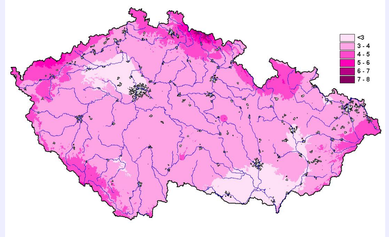


Fig.8. i107f – mean wet spell length. Decadal mean for 1996-2005.

Fig.7. i104f - fluctuations of max. number of consecutive wet days. Station Mošnov, 1961-2007.



The highest values of maximum 5-day total rainfall (i115) are found in mountainous areas with exception of western border, the highest values are reached in north and east parts of the Czech Republic. Increase in totals within the studied period is found in north and east as well (Fig. 10). Linear trends are insignificant in all seasons and year (Fig. 9).

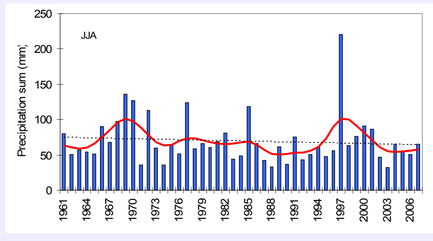


Fig.9. i115 - Fluctuations of greatest 5-day total rainfall. Summer. Station Mošnov, 1961-2007.

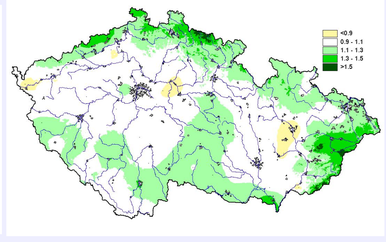


*Fig.10. i115 - greatest 5-day total rainfall. Decadal mean 1996-2005 **compared** to decadal mean 1961-1970.*

6. Conclusions

A few results of extreme value analysis in the area of the Czech Republic for the period 1961-2007 within the CECILIA project has been shown. These results will be later compared to analysis of extremes from corrected model outputs – experiments of RCM ALADIN-Climate/CZ simulations for A1B scenario and time slice 2020-2050.
As for precipitation, trends in the selected extreme indices (fraction of total precipitation above annual 95th percentile, maximum number of consecutive wet days, mean wet spell length, greatest 5-day total rainfall) are not statistically significant (for p=0.05).
Air temperature indices, on the other hand, show positive linear trends which are statistically significant mainly for year, winter and summer.
Spatial differences exist between western (more maritime) and eastern (more continental) parts of the Czech Republic both for air temperature and precipitation indices. Such pattern was also found in changes of the indices with time (1960s compared to the last decade).
All data processing including analysis were done by ProClimDB database software developed for processing climatological datasets. The software can be download for free from: http://www.climahom.eu

Acknowledgement:This work has been done in the frame of the EC FP 6 project CECILIA that is supported by the European Commission.