EXTREME WEATHER PHENOMENA IN EVERYDAY LIFE. EXPERIENCE FROM A WORKLIFE OF CHMI'S EMPLOYEE PROVIDING CLIMATOLOGICAL INFORMATION AND CLIMATE SERVICES

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As a main organization that ensures atmospheric monitoring and climatological data collection in the Czech Republic, Czech Hydrometeorological Institute (CHMI) plays essential role in providing climatological data and climate services to the public. Each of the 7 CHMI's regional offices has a team of employees specialized in such activities. Research done in various parts of the world shows increasing frequency of extreme weather events in the last decades.This tendency doesn't omit even the Czech Republic (e.g. Kyselý, 2002; Doleželová, 2014). Considering extreme weather phenomena, people ask the most often about heavy rains or droughts, extremely high or low temperatures, strong winds or dangerous phenomena like thunderstorms or hailstorms. „Nice" examples of all of these aforesaid were years 2013 and 2014. In 2013, we experienced very hot and dry summer with extremely high temperature, heat waves and exceptionally long periods without precipitation as well as intense rains causing floods in the transition spring/summer. In 2014, dry winter and spring were ensuited by stormy and haily summer and unexceptionally wet autumn. The paper is focused on the description of CHMI's activities oriented towards climate services and its putting into practice at Brno regional office of CHMI. These activities are described in relation to extreme weather phenomena whose increasing occurrence is considered to be clear manifestation of climate change. Examples from years 2013 and 2014 are mentioned. Attention is paid also to its causes, effects and impacts on society, ecosystems and everyday life.

Keywords: climate services, Czech Hydrometeorological Institute, extreme weather phenomena

INTRODUCTION

Czech Hydrometeorological Institute (CHMI) plays essential role in monitoring of the atmosphere and hydrosphere in the Czech Republic. As main Czech organization ensuring the activities oriented towards measuments of quantitative characterics and observations of numerous qualitative parameters, it has many important tasks in meteorogical, climatological and hydrological field. CHMI has 7 regional offices and it is divided into several departments. Department of meteorology and climatology (DMC) can be found at each of the regional offices. Every DMC has several employees specialized in activities oriented towards providing climatological information and climate services to the public. Such services include commercial activities (expert opinions) as well as informative and educational activities towards the public.

The group of CHMI's climate services recipients is quite diverse ranging from individual persons who were injured or damaged on their property because of extraordinary weather phenomena through police and justice to companies planning to start a business in the branch of wind or solar power planting. The phenomena about which all these „customers" ask the most often are without doubt extreme weather phenomena comprising heavy rainfall, thunderstorms or windstorms as well as periods of extremely high/low temperatures or exceptional snow cover conditions. Such conditions can lead to huge either material or even human life damage! Trees falling on the vehicles, houses, buildings and other real estate seriously damaged by heavy rainfall…These are the cases when insurance companies really do need expert opinions to be able to reimburse to their clients. Another important topic are phenomena that are highly concentrated in both space and time like hailstorms or small eddies leading to unprecedented damage on crops, houses etc. In winter time, we have to face special phenomena comprising rime, glaze ice or black ice. All of these can cause serious accidents and injuries and thus the information is important for insurance companies, police or justice.

Preceding two years (2013 and 2014) were by chance literally full of such extreme phenomena of various types, providing us with good examples of frequently required climate services. The main feature of the year of 2013 was exceptionally hot and dry summer coming after the period of intense rains resulting in floods in May and June. During the heat waves in July and August, records of maximum temperature were reached at several meteorological stations. The period from the end of June to the first decade of August was characterized by numerous dry spells when total precipitation amounts of the whole period were counted in tenths of millimeters. This long dry spell was only occassionally interrupted by particular squalls that were spatially isolated and thus precipitation were recorded only at some places. This kind of summer was very hard especially for small farmers and poultry breeders who experienced substantional damages on crop and animals resulting from insufficient irrigation and extremely high temperatures. Farmers and poultry breeders were therefore the most frequent among the customers requiring expert opinion from CHMI.

In 2014, we experienced winter and spring that were below normal in terms of precipitation. This dry period was followed by very stormy summer when numerous cases of severe thunderstorms accompanied by various related phenomena like high wind speed events, hailstorms or torrential rains were detected. August and September were exceptionally wet and below normal in terms of sunshine duration. The most common applicants for CHMI expert opinion were thus the farmers (crop damaged by wet conditions) and insurance companies (various types of damage caused by thunderstoms and related events).

The aim of this paper is to introduce climate services provided by CHMI via the examples of extreme weather phenomena recorded during the years of 2013 and 2014.

MATERIALS AND METHODS

In this paper, data from climatological and precipitation measuring sites belonging to the CHMI's monitoring network were used. As an example well-know to the author of the paper, data from CHMI's Brno regional office were used. It comprised 26 climatological stations and 102 precipitation stations as well (see Fig. 1 and 2). In terms of meteorological phenomena, the processing included maximum daily temperatures, daily precipitation sums, maxima of wind speed and recorded/observed convective phenomena. Data were measured by: humidity and temperature probe (electronic sensor) (temperature), Hellman raingauge and automatic tipping-bucket raingauges (precipitation) and automatic cup anemometer based on opto-chopper principle (wind speed). Analysed period included years 2013 and 2014. Heat waves were defined as periods with at least 3 consecutive days with daily maximum temperature above 30 °C that is the limit value for "tropical day". Dry periods were understood as periods with at least 3 consecutive days with daily precipitation amounts lower than 1 mm (commonly used limit values for "dry day" – see e.g Karl et al., 1999, Wang et al., 2013) and wet periods were defined in the same way but with lower limit value of 5 mm of precipitation amount per day. Windstorms are limited by daily maximum wind speed of 75 km.h^{-1} and convective events and related phenomena are assessed according to observational and radar data as well. Data were processed with the help of ProclimDB software (Štěpánek, 2015).

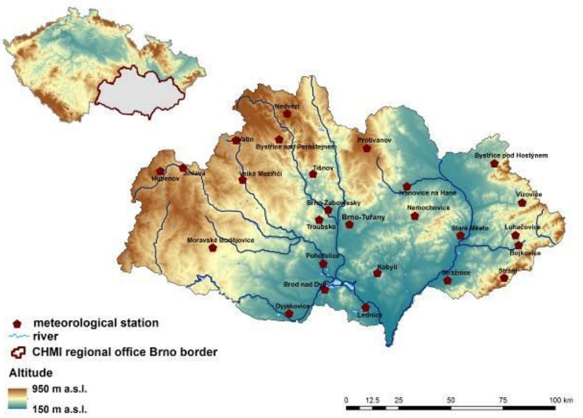

Fig. 1 Location of climatological stations used in this study

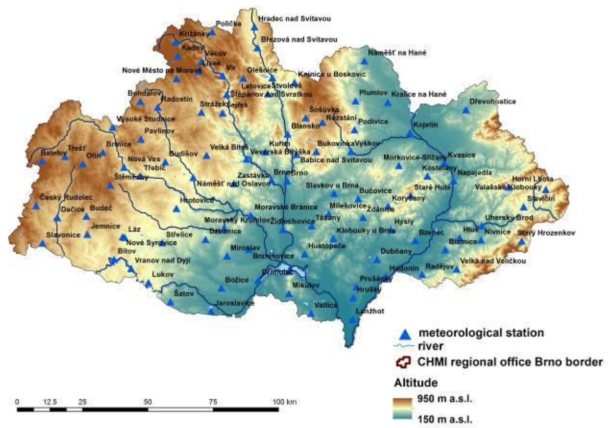

Fig. 2 Location of precipitation stations used in this study

RESULTS

Heat waves

Periods of high temperatures represent remarkable danger for persons suffering from various chronic diseases as well as for sensitive or elderly persons. In the context of climate services provided by CHMI, poultry breeders form group that is interested the most often in high temperatures. In case of temperatures above 30 °C, poultry is death-prone and its breeders can experience considerable financial damage. For this reason, they need official CHMI data about temperatures to be recompensed by the insurance companies. As a consequence of extremely hot summer 2013, 26 CHMI's expert opinions focusing on daily maximum temperatures were required, while in less warm 2014 it was only 6 expert opinions. In 2013, records of daily maximum temperatures were reached at 11 sites. The hottest days were 3 August or 8 August 2013. On 3 August 2013 record of daily maximum temperature for this day was exceeded at all analysed sites. On 8 August 2013 daily record of maximum temperature was reached and exceeded at all sites except Hubenov site. According to the longterm data (1961−2014), the average value of maximum length of heat wave per year ranges from 0.7 days (sites located in elevation above 700 m a.s.l.) to about 5.4 days. Total maximum of 17 or 18 days was at the majority of stations reached in 1994. In a very hot year of 2013, number of heat waves at particular stations varied between 3 and 5 with its average length ranging from 3.0 to 5.7. The longest warm spell lasted for 9 days and it was observed at 8 sites in the southern part of the studied area (see Fig. 3). Its time span was from 1 August to 9 August at all these sites. In 2014, overall frequency of heat waves reached values between 0 and 4 with its average length ranging from 3.0 to 5.5. The longest warm spell lasted for 8 days (from 14 July 2013 to 21 July 2013), but it was recorded only at one site (Strážnice).

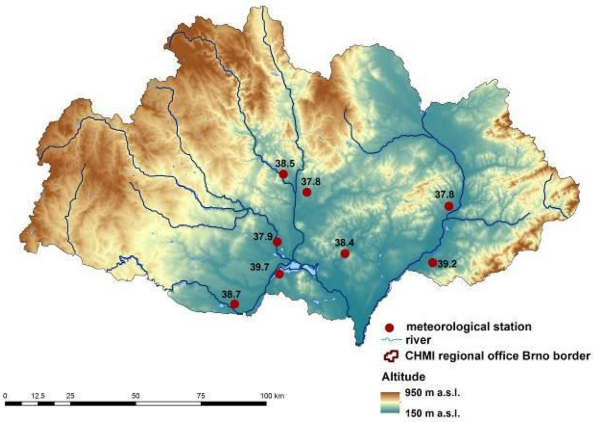

Fig. 3 Location of sites with the longest warm spell in 2013 (numbers represent maximam daily temperature reached during this heat wave)

Dry periods

The summer of 2013 was exceptional by combination of long periods of high temperatures and very low precipitation (or completely without precipitation). CHMI's expert opinion about drought was the most often requested by particular farmers (because of insurance or state subventions) and by insurance companies. Overall number of dry periods in 2013 varied between 25 and 37 with average length between 6.1 and 9.3 days. The longest dry period lasted for 40 days and it was recorded at urban measurement site Brno-Židenice. The period with daily precipitation sums lower than 1 mm lasted from the end of the wet period in June (25 June) up to the day with serious thunderstorm on 4 August 2013. Dry spell longer than 35 days occurred at 3 more stations at similar time (end June – end July/beginning August). In 2014, between 21 and 42 dry periods were detected with average length from 5.3 to 9.5 days, while the longest dry spell lasted 33 days and occurred in winter/spring period (10 February 2014 – 14 March 2014). The average value of maximum annual length of dry spell in the period 1961−2014 ranged from 20.9 days to 27.4 days. Longest dry spell was at particular stations recorded in different years. The absolute maximum was measured at Kostelní Myslová in 2006 (4 September 2006 − 26 October 2006).

Convective phenomena (thunderstoms, hailstorms)

Convective phenomena are typically concentrated into summer months, but they can occur also in late spring and early autumn months. The season of 2014 was quite rich in the number of thunderstorms and hailstroms. Their occurrence started in April and ended in October. The season is extraordinary by the occurrence of first peak of thunderstorm and hailstorm activity that came quite early – just in the second and third decade of April. First thunderstorm appeared on 8 April and others followed on 14 April, 15 April, 20 April and 28 April. These are all the dates when thunderstom activity was observed at more than 20 of all stations (climatological or precipitation) used in this study. All events except the one on 8 April were accompanied by hailstorm activity that reached the maximum on 14 April and 15 April (highest number of affected stations). As far as atmospheric circulation is concerned, April events were linked to the pressure trough or pressure trough travelling acros central Europe, eastern and northwestern cyclonic situation.

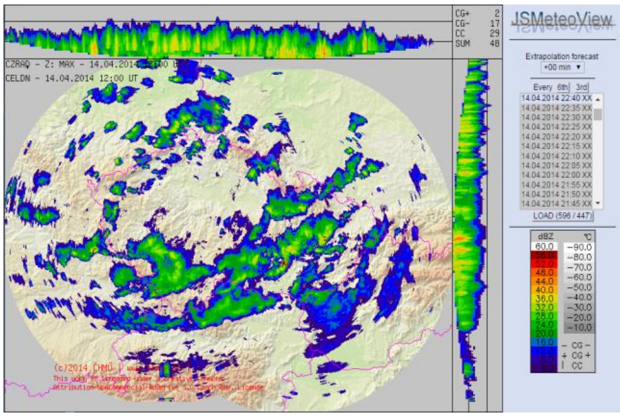

Fig. 4 Maximum radar reflectivity on 14 April 2014 12:00 UTC (13:00 CET) (cross marks the position of Brno city)

Another days with developed thunderstom and hailstorm activity in the season 2014 were especially 21 July (thunderstom recorded at more than 50 stations!) and 3 August (thunderstorm recorded at more than 30 stations). Both events were accompanied also by hailstoms. These events were linked to travelling pressure trough (21 July) and northwestern cyclonic situation (3 August). Both events were concentrated into afternoon/evening hours and especially the August event has led to serious impacts. As the hailstorm activity was very strong on that date, it produced extensive damage on buildings and traffic infrastructure. As it was connected also with strong wind gusts, it has made some local roads and railways impassable because of fallen trees. So far, CHMI regional office Brno has coped with 9 requests for expert opinion about this event. The requests were set by various insurance companies, experts, farmers, forestry company and building company as well. As we know that the damage caused by hails can emerge with a 1-2 years lag, we can expect further requests for 3 August 2014 event coming during this or even the following year.

It is noteworthy that convective events are very complex and thus can have multiple hazardous impacts including electric activity, strong showers, wind gusts (gust fronts) and hails. This is reflected also by the request for expert opinions on 3 August 2014 event when particular clients asked for different pieces of information – including lightning occurrence, wind speed, rainfall analysis and information about hail.

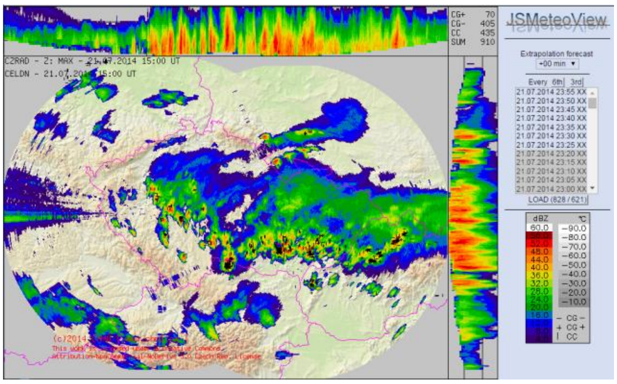

Fig. 5 Same as in Fig. 4 but for 21 July 2014 15:00 UTC (16:00 CET)

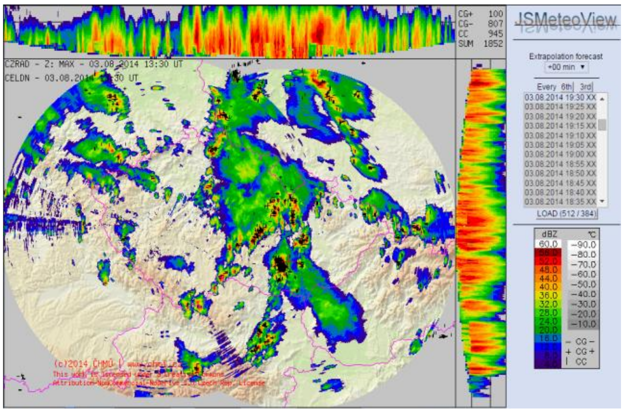

Fig. 6 Same as in Fig. 4 but for 3 August 2014 13:30 UTC (14:30 CET)

In 2013, occurrence of convective events started in April, but their frequency was substantially lower compared to April 2014. More thunderstorms were detected in May, especially on 19 May and 21 May, related to pressure trough over central Europe. June 2013 was very wet but the precipitation had (with the exception of period from 9 June to 11 June when severe thunderstorms were detected) rather long-lasting character. This was followed by long hot and dry period from the end June to end July/ beginning August during which hardly any precipitatin were detected at many locations. The most "dramatic" period of 2013 in terms of thunderstorms was the August when several serious events occurred, especially on 4 August 2013 and 9 August 2013 with more than 50 stations affected! With 3 August 2013 or 8 August 2013 being at several sites the hottest days ever recorded, thunderstorms of 4 August and 9 August terminated long period of extremely warm tropical air inflow. In terms of atmospheric circulation, both events were linked to pressure trough.

Windstorms

Windstroms are defined as periods with average wind speed higher than 75 km.h^{-1} (according to the Beaufort's scale). For the purpose of insurance companies the limit value of 75 km.h^{-1} is set for maximum wind speed (wind gust) in a 10-minute interval. However, as the density of sites monitoring wind speed is not as high (approx. 1 site per 550 km^2), some events with high wind speed are not recorded. Such events can be connected with local convective phenomena (development of convective cells) and are detectable by means of radar data. Considering measured values, 83 cases of windstorms as defined above were detected in 2013 and 61 cases in 2014 (at all stations). Distribution of days with windstorms according to the months can be seen in Fig. 7.

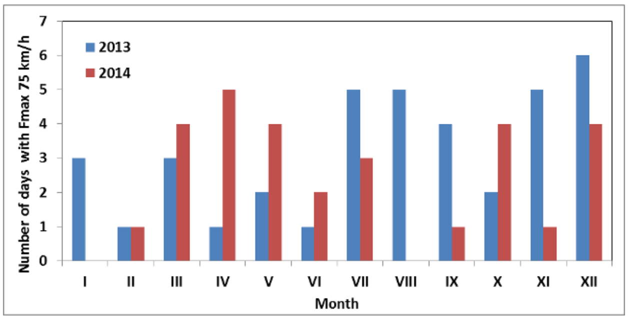

Fig. 7 Number of days with windstorm in 2013 and 2014

In 2013, the highest number of such days appeared in summer months and in autumn/winter period, while in 2014 it was rather during the spring. This spring occurrence was connected to frequent convective phenomena in April as mentioned above. The most significant dates in 2013 are 4 August, 6 December and 7 December when windstorms were recorded at 11, 11 and 10 sites respectively. The events on 4 August 2013 were connected to strong convective activity on a cold front whose passage has terminated the period preceding extreme heat wave. December events resulted from convective activity on a cold front as well. In those days, atmospheric front was passing over the Czech Republic in the NW–SE direction. It was one of the rare but not impossible situations with winter convective activity when even some lightnings were recorded. In 2014, total number of events with maximum wind gusts higher than 75 km.h^{-1} was lower and they have rather local character (it si proven by the fact that the number of affected stations in one day was in majority of cases not higher than 3). The most significant date in 2014 is thus the 16 March when windstorms were recorded at 7 sites. Affected area included especially the SW part of the studied area and it was subjected to the influenceof a warm front passage.

It should be noted that expert opinions on wind speed and windstorm occurrence are among the most frequent customers' requests. So far, we have received 87 requests concerning windstorms during 2013 (number of requests in particular years were 72, 15 and 0 in 2013, 2014 and 2015) and 103 requests concerning windstorms during 2014 (96 and 7 requests in 2014 and 2015 respectively).

Wet periods

It appears that reasonable limit of daily precipitation amount for setting wet period in the geographic environment of the Czech Republic is 5 mm as periods with consecutive days with e.g. 10 mm of daily precipitation amount are rather exceptional. Total number of such wet periods in 2013 varied between 0 and 5 with the average length ranging from 3 to 5 days. The longest wet period lasted for 6 days and was recorded at Batelov station in the period from 29 May to 3 June 2013. This period coincided with the first phase of May/June flooding in the Czech Republic (second phase occurred between 8 June and 11 June and third phase between 23 June and 26 June). Synoptic causes of particular phases differed slightly. The first phase was connected to extensive pressure low that got „stucked“ over the Czech Republic (http://voda.chmi.cz/pov13). This phase was the longest when not necessarilly the most abundant in terms of total precipitation amount (see Tab. 1).

So far, CHMI received about 10 requests for expert opinion concerning precipitation amounts, rainfall intensities or description of overall meteorological situation of this events (including all 3 phases). It might seem to be not so much but we should realize that the floods of 2013 had their „epicentre“ rather in Bohemia (western part of the Czech Republic) while the studied area was affected in less serious way. In 2014, 0 to 4 wet periods were detected with average length between 3 to 5 days.

Tab. 1 Statistical characteristics of total precipitation amounts per various phases of flooding in 2013

Characteristic / phase	**Phase 1 (29.5.–3.6.)**	**Phase 2 (8.6.– 11.6.)**	**Phase 3 (23.6.-26.6.)**
Average total precipitation amount (mm)	47,3	14,5	58,8
Minimum total precipitation amount (mm)	20,8	0,0	17,8
Maximum total precipitation amount	87,7	51,1	114,3
Maximum daily precipitation amount (mm)	49,2	39,2	104,0

The longest wet period lasted for 5 days and it occurred at 5 stations in between 11 September and 15 September 2014. September 2014 was exceptionally wet with monthly rainfall ranging values from 150 % to 320 % of the longterm average (1961−1990). At some locations August and October were also above normal (but not so much as September). In fact, October 2014 was not so wet but it was typical by low sunshine duration and thus especially farmers got very strong feeling of some extraordinary conditions. Total number of requests for expert opinion on precipitation and sunshine for the period August 2014 to October 2014 has risen to about 40.

CONCLUSION

The paper presented CHMI's activities focused on providing of expert opinions that is an important part of climate services ensured by CHMI. These acitivies were presented with the help of examples from years 2013 and 2014 that were particularly rich in extreme weather phenomena occurrence. As stated in many works, such phenomena and their increasing frequency are considered to be significant manifestation of ongoing climate change. Increasing extremity of the climate was documented even in the studied area (e.g. Doleželová, in print). Moreover, extreme weather events are not only important indicators of environmental changes, but they are also in centre of the interest of the public as illustrated by frequent demands for expert opinions on extreme weather situations.

The spectrum of CHMI's clients demanding for expert opinion is quite wide, including individual citizens as well as legal persons. Among the most frequently requested expert opinions are those dealing with extremely high/low temperatures, torrential rains, strong winds or convective events accompanied by various dangerous phenomena like lightning, hails and others. The examples from years 2013 and 2014 show that one serious event can result in tens of expert opinions requests (e.g. the occurrence of windstroms in boths years, severe thunderstorm on 3 August 2014 or torrential rain on 31 July 2014). For this reason, studies of extreme weather phenomena should continue and further methods for their evaluation should be developed and enhanced to be able to cope with special requests and to answer them in more and more sophisticated way.

LITERATURE

Doleželová, M., 2014: Changing amounts or spatio-temporal distribution? The study of precipitation trends and the occurrence of extreme precipitation events in the region of southern Moravia (SE part of the Czech Republic) in the period 1961─2013. In 14th EMS Annual Meeting & 10th European Conference on Applied Climatology (ECAC) Proceedings. (Prague 6.10. – 10.10.2014).

Doleželová, M., in print: Teplotní a srážkové poměry teplého půlroku na jižní Moravě v období 1961−2014. Spějeme k větší extremitě klimatu? In Herber, V. (ed.): Fyzickogeografický sborník 13, Nejen fyzická geografie ve studiu kulturní krajiny.

Karl, T.R., Nicholls, N., Ghazi, A., 1999: CLIVAR/GCOS/WMO workshop on indices and indicators for climate extremes: Workshop summary. Climatic Change, 42, p. 3–7.

Kyselý, J., 2002: Temporal fluctuations in heat waves at Prague-Klementinum, the Czech Republic, from 1901−97, and their relationships to atmospheric circulation. International Journal of Climatology, 22, p. 33−50.

Štěpánek, P., 2015: ProClimDB – software for processing climatological datasets, CHMI, regional office Brno, http://www.climahom.eu/ProcData.html

Wang, H., Chen, Y., Xun, S., Lai, D., Fan, Y., Li, Z., 2013: Changes in daily climate extremes in the arid area of northwestern China. Theoretical and Applied Climatology, 112 1-2, p. 15−28.

Internet sources:

Vyhodnocení Povodní V Červnu 2013 (The evaluation of floods in June 2013). Available online on: http://voda.chmi.cz/pov13/pov2013.pdf.