FLASH FLOODS IN THE CZECH REPUBLIC IN JUNE 2009

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I. INTRODUCTION

The weather in June and July 2009 in the Central Europe was accompanied by remarkably frequent convective storms producing series of flash floods that caused 12 fatalities and damage over 200 mil EUR. The worst flooding occurred on June, the 24th in north-east part of the Czech Republic, near the town called Nový Jičín. This case study aims to describe the event and to briefly summarize the performance of operational warning system.

II. ATMOSPHERIC ENVIRONMENT AND DEVELOPMENT OF THE CONVECTIVE STORMS

On 20th June 2009 a significant trough was passing across Central Europe with an attendant frontal system. Later on, it decomposed into a cut off low that began to stagnate over Southeastern Europe. On 22nd June 2009 warm front over Central Europe started its slow progress to the west with very moist airmass being advected behind it. The cut off low started weakening thereafter while stalling over the same area. As of 23rd June 2009, with warm and very moist airmass at lower levels, in the weak easterly flow across whole troposphere, a peculiar period of weather commenced over Central Europe with thunderstorms being reported nearly every single day till the mid July. Strong diurnal heating destabilized the atmosphere on daily basis and due to the slow thunderstorm movement and high values of humidity, numerous flash floods was occurring throughout the area.

The most prominent event of the flash floodings occurred on 24th of June 2009 when a cut off low was centered over Balkan (Fig. 1) A trough has formed on its northern edge with slight movement to the west. Quite early in the day a convergence line has formed approximately on the borders of Slovakia and Czech Republic, with southward extension into Austria and northward into Poland. The pressure gradient increased over Western Bohemia with northwesterly surface wind, while a southeasterly winds or calm conditions were present to the east of convergence line. Diurnal heating in combination with the advection of moist air from northeast have led to further destabilization. Numerous showers and thunderstorms initiated along with the convergence line during the afternoon, having the peak activity in the evening (Fig 2, 3 and 4). With slow movement of the whole system a training effect was observed, especially across Silesia and northeast Moravia. In this region, the wind measurements of automatic stations showed a local zone of convergence that has persisted for most of the event duration (between 17 and 20 UTC). Numerous cells have originated in proximity to the region where the flash flood occurred. The initiation and/or development of the storms in the area might have been enhanced also by the orography that is favourable for uplifting the air that is flowing from northeast.

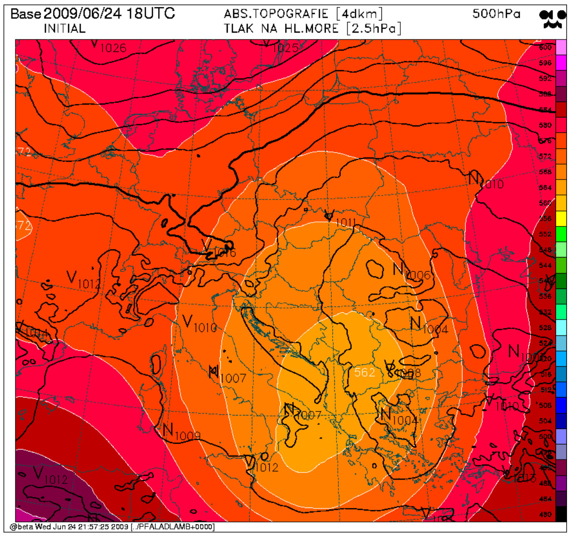

FIG. 1. The 500 hPa geopotential (color) nad MSLP (isolines) on June 24, 2009, 18 UTC. Operational analysis of NWP model ALADIN.

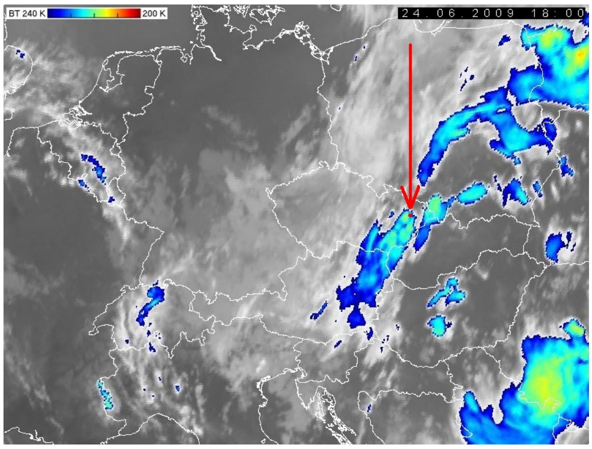

FIG. 2. Channel 10,8 µm of the radiometr SEVIRI (METEOSAT 9) along with the brightness temperature below 240 K on 24th of June 2009, 18 UTC. The arrow points to the area of the flash flood occurrence marked by the red dot.

More than 120 mm has fallen in the 3 hours of the precipitation event with rain gauge measurements at station Bělotín showing clearly passage of numerous heavy rain producing cells with 5 peak rainfall intensities of several mm/min. Original (uncorrected) radar-based quantitative precipitation algorithm underestimated the totals severely (twice), probably due to attenuation. We also hypothetize that the drop size distribution of the rainfall might have been influenced by warm-rain collision coalescence processes, contributing to the underestimation of the rainfall totals.

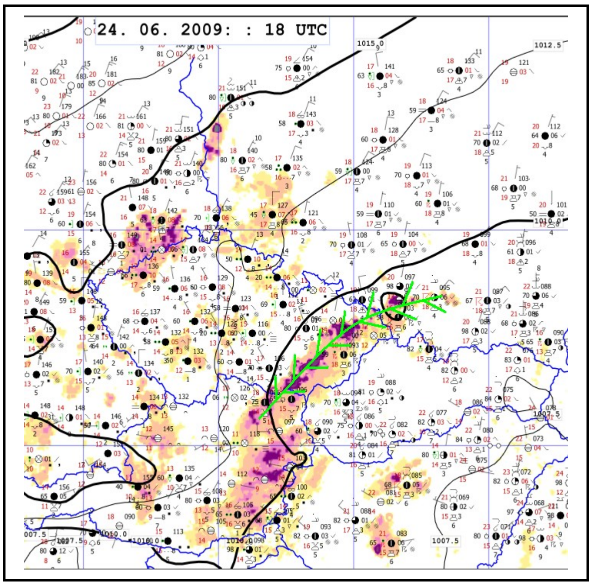

FIG. 3. Surface analysis on June, 24, 18 UTC with synchronized radar reflectivity field.

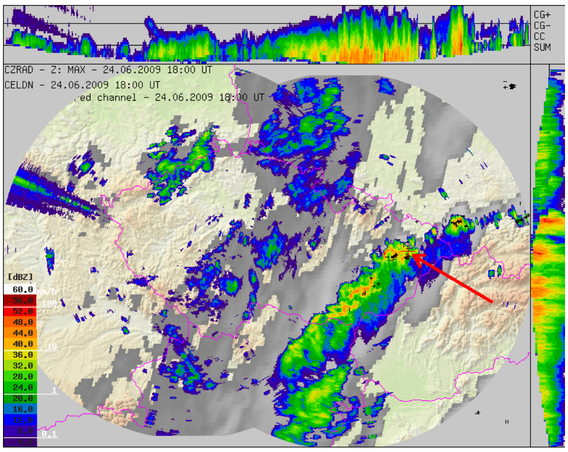

FIG. 4. Radar reflectivity measured by two C-band radars along with 10,8 μm (truncated) channel of SEVIRI instrument and data from lightning detection system. The affected area can be located by small red cross, at which the arrow is pointing.

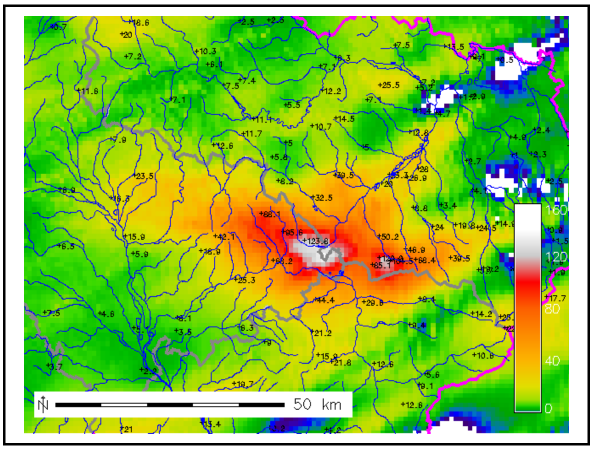

FIG. 5. Daily radar precipitation estimate from radar Skalky merged with raingauge measurements by the method KED from 24 June 2009, 06 UTC to 25 June 2009, 06 UTC. The grey and violet lines indicate the borders of the administrative regions and the border of the Czech Republic, respectively.

Two algorithms of quantitative precipitation estimate (QPE) that utilizes radar-based QPE and raingauges are currently running at the Czech Hydrometeorological Institute. One of the algorithm is the kriging with external drift (KED), see, e.g. Hengl et al, 2003. The final estimate is at the Fig. 5.

The result of the heavy rainfall was one of the worst flash floods in last decade, comparable the extent of similar disaster that occurred in 1998. Four fatalities were reported and many people were injured along with numbers of houses that were completely swept out by the streams. The river stage has risen by more than 5 meters during the flood, leaving very little reaction time to residents.

From the hydrological point of view, river Jičínka was the hardest hit, culminating at 605 cm and having peak discharge with estimated repetition time of more than 300 years.

III. WARNING SYSTEM

The Czech Hydrometeorological Institute (CHMI) repeatedly issued the flood alert (advisory) the previous day (23rd of June) and the 24th of June, emphasising the possibility of flash floods over the area of the Czech Republic. The alerts were being issued until 11-12 UTC. After the convergence line (squall line) had been formed, another warning message was issued (at 18.10 UTC), better specifying the area of the development of the storms. Although the message informed about the heavy rainfall, it did not include any explicit mention of the flash floods.

According to the detailed study of the precipitation, it became obvious that the severity of the flash flood was enhanced by the hydrological conditions, especially by the fact that most of the heaviest precipitation fell onto one small catchment.

III. CONCLUSIONS

The flash flood that occurred the 24th of June 2009 was one of the most catastrophic events in last decade. It showed that despite the new technology and improvement of the nowcasting techniques the warning system is still far from being satisfactory. The planned improvement include more frequent QPE using radar (15 minutes data with adjustments available every 5 minutes) and better monitoring of the precipitation in relationship with hydrological conditions, especially catchment size, shape etc. However, as Šálek et al showed, the inclusion of the hydrological part into the forecasting (nowcasting) system, although generally beneficial, will result in lead time of the theoretically possible warning comparable to the time of hydrological response. Crucial part of the new planned systems is also better education of the public and the authorities resulting in adequate reaction the warnings.

V. REFERENCES

Hengl, T., G. Geuvelink, A. Stein, 2003: Comparison of kriging with external drift and regression kriging. Technical report, ITC.

Šálek, M., L. Březková, P. Novák, 2006: The use of radar in hydrological modelling in the Czech Republic - case studies of flash floods. *Natural Hazards and Earth System Sciences*, **6**, 229–236.