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A comparison of the flood precipitation episode in August 2002 with historic extreme precipitation events on the Czech territory

Daniela Řezáčová, Marek Kašpar*, Miloslav Müller, Zbyněk Sokol, Vilibald Kakos, David Hanslian, Petr Pešice

Institute of Atmospheric Physics ASCR, Boční II/1401, Prague 4, Czech Republic

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Abstract

The hydro-meteorological characteristics of the flood from August 2002, which affected a great part of the Czech territory, particularly the Vltava and Labe river basin, were compared with corresponding conditions during similar flood events in the summer seasons of 1997, 1890, 1897 and 1903. The comparison shows analogies in synoptic conditions and causal precipitation heights. The heaviest precipitation fell in the area of a considerable horizontal pressure gradient on the rearward side of the cyclone which advanced very slowly to the north-east across Central Europe and created conditions for the transport of moist air as well as for an organized long-term updraft enhanced in orographically exposed regions. The varying features of the individual events were based on the spatial–temporal distribution of causal precipitation and also on the very different saturation of the catchments. It was chiefly the extraordinary time concentration of precipitation together with the highest catchment saturation that made the flood in 2002 the most extreme.

The extremeness of meteorological fields during two episodes in July 1997 was compared with two episodes in August 2002 with the aid of the reanalysis data from ECMWF. The first episode in 1997 and the second episode in 2002 were the most similar and more extreme in terms of the large-scale fields of basic meteorological quantities. The similar features of these episodes are specifically an intensive influx of moisture into Central Europe and intensive upward motions in

* Corresponding author. Tel.: +42 2 72016024; fax: +42 2 72763745.
E-mail address: kaspar@ufa.cas.cz (M. Kašpar).

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the precipitation area. The extremeness of upper- and low-level potential vorticity fields was evaluated to diagnose the behavior of the cyclone and frontal precipitation bands accompanying it. The suitable spatial configuration of positive upper- and low-level potential vorticity anomalies induced an additional amplification of upward motions in the precipitation area that apparently contributed to triggering the heavy precipitation over Central Europe. On the whole, quantities reached more extreme values during the second episode in 2002.

Keywords: Precipitation; Summer floods; Czech territory; Hydro-meteorological conditions; Extremeness of meteorological quantities; Distribution function

1. Introduction

Heavy, widespread precipitation caused extensive flooding in the Labe and Danube river basins in August 2002, which devastated many parts of Central Europe (Grazzini and van der Grijn, 2003). While the Czech Republic (CR) and Germany were the most severely affected, the floods also struck areas in Austria, Slovakia and Romania. For the Czech Republic, the Czech Hydrometeorological Institute (CHMI) published a national meteorological report (Strachota, 2003) and a national hydrological report (Šercl, 2003). For both the territory of Central Europe and the CR, the floods are discussed from the forecaster's perspective, for instance in Šopko (2003).

In order to assess the hydro-meteorological conditions which brought about the causal precipitation, we compared the meteorological characteristics of the event in 2002 with similar historical events that occurred in the Czech territory (Řezáčová et al., 2003). Causal precipitation fell on the rearward side of a cyclone that was located over or in the vicinity of the CR. Such circulation types with the cyclone's centre over Central Europe occur from time to time and are typical for this region. During these events, the probability of high daily totals observed is usually the highest (Ustrnul and Czekierda, 2001). A synoptic pattern, precipitation amount and area, as well as the influence of the antecedent precipitation in 2002 were compared with corresponding conditions which caused flood events in Bohemia in 1890 and 1897, and in Moravia in 1997 and 1903. The synoptic patterns and precipitation characteristics could only be deduced from the meteorological ground data for the 1890, 1897 and 1903 events. To compare the precipitation episodes in 2002 and 1997, we used the ECMWF reanalyses from the ERA-40 database (ERA-40, 2002). This comparison was focused on the determination of the extremeness of meteorological quantities. This paper summarizes the main results and draws attention to apparently similar and different features.

Apart from Introduction, the paper contains three main chapters. Section 2 is focused on the basic comparison of the event in 2002 with historical floods. The characteristics of the events and data sources are described in Section 2.1. Section 2.2 discusses both the analogous and different attributes of synoptic conditions and precipitation characteristics. Section 2.3 concentrates on the impact of a preceding saturation of catchments on the discharge level of the Vltava in Prague. In Section 3, the synoptic conditions for the events in 2002 and 1997 are compared on the basis of the extremeness of meteorological fields.