Abstract

Floods associated with extreme precipitation are one of the most serious natural hazards, which produce substantial human and socio-economic losses in central Europe. One way to reduce the impact of flooding is by increasing preparedness with better flood forecasts and warnings, which is not possible without a proper understanding of physical processes leading to a flood hazard. However, frequent research on floods in relation to causal precipitation and synoptic conditions is usually carried out regionally, although some events often affect areas of a size of entire countries or even larger.

The thesis was focused exactly on these large-scale precipitation and flood events that occurred in the second half of the 20th century and then until 2013, for which the size of the affected area is as crucial in the extremity assessment as the magnitude of flood discharges or precipitation totals. The extremity indices used for the assessment of extreme precipitation and flood events connected both aspects. The larger area of interest defined within central Europe allowed examining the spatial structure of events, the differences between them, and their relation to conditions in the atmosphere. To connect the extremes of precipitation with extremes in atmospheric conditions, the causal circulation was evaluated quantitatively, based on the characteristics of the moisture flux at 850 hPa isobaric level in the area of extra high upward vertical velocity, which are both important ingredients for the occurrence of extreme precipitation in central Europe.

As a result, the different types of moisture flux conditions corresponded perfectly with specific seasonal and spatial patterns of extreme precipitation. There were only two main types of extreme precipitation events in central Europe, the difference between them can be explained by the seasonal distribution of anomalies of moisture flux from the respective sectors: (i) warm half-year events with prevailing northern moisture flux and affecting mainly eastern central Europe, and (ii) events with prevailing western moisture flux occurring in the west and exclusively from September to March.

Only in case of events with northern moisture flux, a close connection existed between moisture flux anomalies and precipitation extremeness. This fact allowed to consider the application of moisture flux anomalies from the northern sector in forecasting and extreme weather warnings. However, the question remained whether the predictability of moisture flux anomalies is good enough to support the correct prediction of extreme precipitation events. The results showed that the general use is probably not possible due to worse vertical velocity forecast; the approach based on moisture flux anomalies could be applied only to the largest summer precipitation events, for which the forecast was good and stable. Therefore, predicting moisture flux anomalies potentially could help to increase preparedness for the same type of precipitation events that produced the most damaging central European summer floods, such as in July 1981 and 1997, August 2002 or June 2013.

Keywords: floods, extreme precipitation, extremity index, moisture flux, predictability, central Europe