Abstract

Every year severe storms cause material damage and fatalities. For this reason, it is crucial to develop the detection and forecast methods of every threat associated with storms. To prevent severe weather fatalities, research on the death circumstances is desirable as well. Studies on severe storms are more important due to observed climate change which will change the occurrence and the intensity of storms in the many regions across the world. This doctoral thesis is an analysis of several aspects of severe storms: radar-based severe storm detection, severe storm forecasting and the detailed analysis of the severe storm fatalities. The detection aspect was made by proposing new indicators of hail detection. This indicators are based on Vertically Integrated Liquid hail detection method, but the integration was limited to the selected isotherms heights range, where the hail forms. This precise information on the isotherms heights was derived from the ERA5 reanalysis. The data on the severe phenomena occurrence are derived from the European Severe Weather Database. The results show that proposed new VIL-based method detects hail threat relatively well, but the operational warning generation basing on this method is impossible due to short lead times, compared to currently used methods. The cases of not detected threats as well as the false alarms were analysed and discussed. In the second part of the thesis, the usefulness of the ERA5 reanalysis in hail forecasting in the period of 1948-1955 was examined. This research was possible thanks to access to the hail books which gather data on hail occurrence in Poland between 1948 and 1955. While in the case of a general regularity indicating more favorable conditions for the development of larger hail than the smaller one, in the case of individual events the values of indicators calculated on the basis of reanalysis data did not always indicate possibility of development of any storms with hail in the period between 1948 and 1955. The analysed indicators for the modern period (2015-2022) reached the similar values as it was described in the literature. This part of the thesis presents the spatio-temporal analysis of the hail occurrence in Poland and the list of the most significant days with hail. The last issue which was discussed in the thesis was the occurrence of sudden meteorological events in Central Europe. A total of 801 people died in Central Europe in the period 2010-2020, of which 345 people were victims of avalanches, 209 people were victims of severe wind gusts, 151 people were killed by lightnings, 94 people were killed by excessive rainfall and 2 people were killed by tornadoes. Fatalities had different characteristics depending on the type of the phenomenon. Fatalities which were killed by the avalanches were mostly males who took intentional risk, while the flood victims were the oldest group of fatalities and the gender proportions were equal. Heavy rainfall fatalities was the group of people which

frequently involved disabled people, who were not able to move upstairs to prevent drowning. Severe wind and lightning fatalities were in the great majority people who stayed outdoors or sheltered in the light constructions when the storm approached. The occurrence of fatalities caused by some of the phenomena had its own spatial pattern. The number of lightning fatalities rises from west to east part of the study area, the flood fatalities occurred within the mountainous and urbanized areas and the wind fatalities occurred within the whole study area. Under the study period, victims were killed in many single-victim incidents; no single incidents with a high number of fatalities were recorded.