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Analyzing the derecho system over Poland on 11 August 2017.

Preface to the topical issue

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On the evening of 11 August 2017, a well organized mesoscale convective system (MCS: Houze 2018) moved through western and northern parts of Poland and produced a widespread wind damage. With peak wind gusts exceeding 150 km/h this storm had a remarkable intensity and resulted in 6 fatalities, 58 injuries and 79700 ha of forest being destroyed. In terms of both induced damage and social impacts, it was one of the most impactful convective storms observed in the modern era of radar measurements in Poland (Surowiecki, Taszarek 2020).

This storm rapidly intensified in the late afternoon hours over southwestern Poland when discreet convective cells organized into a squall line consisting of an embedded mesocyclone. In the later stages, the latter evolved into a mesoscale convective vortex (MCV; Bartels, Maddox 1991), which had a major contribution in the production of the most significant surface winds. In the mature stage, a strong cold pool lead to the formation of a large bow-echo (Klimowski et al. 2004). Nearly 1200 severe wind reports on the distance exceeding 450 km associated with this storm allowed to classify it as a derecho (a long-lived convective windstorm producing a widespread straight-line wind damage), consistent with definition provided by Johns and Hirt (1987).

Squall lines with bow-echo occur in Poland on average 10 times per year while those reaching a derecho criteria are much rarer with an average frequency of 1 per year (Celiński-Mysław, Matuszko 2014; Celiński-Mysław, Palarz 2017). However, the extreme intensity of derecho on 11 August 2017 appears to be very unique not only for Poland, but also in comparison with other derecho events across Europe and the United States (Guastini, Bosart 2016; Gatzen et al. 2020, Chernokulsky et al. 2022).

Due to immensely large social impact produced by this storm, it has become increasingly important to better understand how it developed, why it reached such intensity, how it was registered by observational systems, and finally, whether numerical weather models were able to predict such intensity? Providing answers to these questions may allow operational forecasters to better predict similar storms in the future while lessons learned from the outcome of 11 August 2017 may also provide future guidance to emergency managers.

Addressing aforementioned questions was the main motivation for this topical issue in Meteorology Hydrology and Water Management. The collection of articles elaborated by employees of the Polish Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) extends the findings of the initial work by Taszarek et al. (2019) by analyzing in greater detail the derecho event of 11 August 2017. The collection responds mainly to the vital need to further develop and improve the capabilities to effectively forecast and warn against such devastating convective storms. That includes an improvement in their understanding on the level of operational forecasters but also research scientists. The way toward that goal is to extensively document such cases using information from available observing systems. It is essential to consider the atmospheric environment supporting the existence of the systems, and study their development, evolution, and internal dynamics. On the other side, it is also essential to analyze and document the capabilities of the state-of-the-art operational numerical weather prediction tools and their ability to represent the basic dynamical processes associated with such convective systems. The observational and numerical studies, published in this collection, use the tools and products currently available at the time of writing (some even developed in the aftermath of the 2017 derecho), but many of them were not available at the time the event took place.

The opening article by Wrona et al. (2022) analyzes the synoptic and mesoscale conditions characterizing the atmospheric environment of the derecho system. The study confirms the presence of essential synoptic-scale ingredients for severe weather outbreak, including strong upper winds and large thermodynamic instability. It also shows a large-scale ascent known to dynamically force the development of the mesoscale convective systems. On the mesoscale, it indicates that the linear convective system, forming the derecho later, developed and propagated along the eastern edge of the vast cold pool resulting from the earlier deep convective development over southwest Poland.

The following two studies analyze the remote sensing observations of the derecho. Łuszczewski and Tuszyńska (2022) use reflectivity and Doppler radar data to study the evolution of the derecho's main convective features, especially the mesocyclone and rear inflow jet. The analysis revealed the details of the evolving structure of these interacting flows which decisively affected the intensity of the storm. Łapeta et al. (2021) present a collection of satellite products characterizing the environmental susceptibility for convection and its development, followed by the variety of products visualizing the convection, itself, and allowing to analyze its evolution, organization and strength.

The final set of studies analyzes the results of various numerical weather prediction tools. Figurski et al. (2021) use the WRF model to analyze the dependence of the forecasts on the source of the initial and boundary conditions, forecast initiation time, and model resolution. Kolonko et al. (2023) compare the results of the ALARO and AROME models for varying initiation times. They also present the models' representations of the mesoscale structure of low tropospheric flow and its vorticity. A work from Mazur and Duniec (2023) use the COSMO model to investigate to what extent increasing model resolution affected quality of the forecast for 11 August 2017. They found that the reduction of horizontal grid size from 7 km to 2.8 km increased the forecasts' value much more than the further grid size reduction from 2.8 km to 0.7 km.

We hope that articles available in this topical issue contribute to better understanding of derecho storms, will be of interest for scientists working in the area, and can serve as a future guidance for operational forecasters and emergency managers. The question is not whether storm of similar intensity to that of 11 August 2017 will occur again, but rather when and where.

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