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## High-resolution hail detection: probability of occurrence and size of hailstones based on weather radar data

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The HAIL application was developed and implemented in the Institute of Meteorology and Water Management – National Research Institute (IMGW) as a component of the MeteoWarn system of detection and forecasting of dangerous weather phenomena. The application contains two algorithms: (i) hail detection and probability estimation; (ii) estimation of the maximum hail size that occurs in the event.

The probability of hail is determined using own hail detection algorithm based on fuzzy logic using the following weather radar products: the differential reflectivity (ZDR) and the exceedance of 0°C isotherm for echo top 40, 45, 50 dBZ (EHT40, EHT45, EHT50). Threshold have been introduced for the parameters to prevent false hail detection, above which hail is possible to occur. Additionally some other radar parameters: maximum reflectivity (C<sub>MAX</sub>), vertically integrated liquid water (VIL), constant altitude plan position indicator (CAPPI) on 4 km, and EHT are checked. The maximum hail size is calculated from the parameters: VIL, EHT50, and isotherm 0°C.

The developed algorithms were verified by observations in meteorological stations staffed by trained observers. The stations are limited to specific locations, but they are the most reliable and precise source of data about weather phenomena. Verification data for calibration are observations from synoptic stations and for hail size additionally observations from the European Severe Weather Database (ESWD). The results of the verification show good enough reliabilities of the two HAIL products. Validation based on the contingency table provided the following results: the probability of detection (POD) is 0.99, the false alarm ratio (FAR) is 0.02, and the critical success index (CSI) is 0.98. POD of no hail is 0.39, FAR is 0.38, and CSI is 0.31.