Giant hail in Poland produced by a supercell merger in extreme instability

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This work focused on an exceptionally severe supercell thunderstorm that produced giant hail in the densely populated area of Gorzów Wielkopolski in Poland on 11 June 2019. The main purpose of our research was to investigate the uniqueness of this storm, as well as examine the reasons for the occurrence of a giant hail. Severe thunderstorms that occurred over eastern Germany and western Poland caused severe material losses primarily due to large hail. For the first time such an accurate inventory of 79 large hail reports on such a small area has been carried out, including the largest with a diameter of 12 cm and heaviest with a weight of 380 g. Information on large hail incidents was derived from voluntary observers and reports available in social media. Evaluation of environmental and Doppler radar data indicate that three unique aspects characterize this event. Firstly, the storm benefited from a favorable convective environment including a record-high CAPE exceeding 4000 J kg$^{-1}$ that was the highest ever measured value at a proximity rawinsonde station of Lindenberg, and the highest for this region according to ERA5 since 1950. Synoptic scale patterns indicate that a low pressure system over western France with an easterly oriented trough lead to the advection of warm and unstable air mass towards central Europe. Convective initiation in the discreet mode took place along the convergence line ahead of the approaching cold front. Large atmospheric instability and strong vertical wind shear driven by the upper tropospheric jet stream allowed convection to quickly evolve into supercells. Secondly, moisture pooling along the convergence zone led to convective initiation of 3 isolated cells that merged together. Two of them with already embedded rotation. This merger subsequently evolved into a single powerful mesocyclone that was a main cause of giant hail. Third, a supercell had the biggest intensity over a densely populated area, which led to considerable material losses, but also allowed collection of a large number of hail reports. Distribution of these reports indicates that peak hail size varied significantly on very small distances. Storm has been producing giant hail for around 20-minutes over a distance of around 10 km and was preceded by a well-developed velocity couplet, bounded weak echo region and hook-echo signatures on the Doppler radar scans.