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Hail probability in Central Europe related to orographic characteristics

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Hailstorms are among the most expensive natural disasters in Central Europe due to the very high damage potential caused by the large kinetic energy of the solid hailstones. For example, two supercells in Germany on 27 and 28 July 2013 bearing hailstones with a diameter of 10 cm were responsible for 3.1 billion EUR in insured and 4.0 billion EUR in economic losses, respectively. Considering the event definition over a 72-hr period usually applied in the insurance industry, this was the costliest natural catastrophe worldwide in 2013 (insured losses) and one of the most expensive loss events in Germany. Therefore, detailed knowledge about the probability and severity of hail events is required for mitigation purposes as well as necessary for quantifying the hail risk.

For this purpose, we quantified hail signals for Germany, France, Belgium and Luxembourg from radar reflectivity by considering both a lower threshold of 55 dBZ of the maximum Constant Altitude Plan Position Indicator (max-CAPPI) and an adjusted version of the Waldvogel criterion (distance between melting layer and echotop height). Additional filtering with lightnings and tracking of the signals improves the reliability of the detected hail streaks. The spatial variability of the frequency of hail signals is supposed to be caused by the superposition of large-scale climatology and local-scale flow dynamics that is somewhat related to the orography. A surprising finding is that most of the hot spots in hail frequency are located downstream of low-mountain ranges. Additional simulations with the numerical weather prediction model COSMO confirm that flow convergence at lower levels emerging downstream of the mountains play a major role for the specific distribution of the hail events. These convergence zones tend to occur especially for low Froude number flows, where the flow is expected to go partly around the mountains. A historical catalogue of the most severe past hail events detected by radar is further used to estimate the hail risk and the probable maximum loss for a specific insurance portfolio.