Hail hazard in Germany related to atmospheric and orographic characteristics

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In several regions of Central Europe, such as southern Germany, Austria, Switzerland, and Northern Italy, severe hailstorms cause considerable damage to buildings, automobiles or crops. Single extreme events with hailstone sizes of 8 cm or more exhibit a damage potential of several hundred to more than one billion €. Due to their local-scale extent and a lack of direct monitoring systems, hailstorms and their impacts are not observed accurately and comprehensively by a single monitoring system. Therefore, until now, information about the probability and spatial distribution of damaging hail events are not available for Germany. The challenge is to assess hail intensity and probability by combining data from appropriate observations systems such as radar or lightning detection stations.

Based on the vertical extent of high reflectivity obtained from three-dimensional (3D) radar data of the German Weather Service (DWD) radars, signals from large hail cells were reconstructed for a period of 7 years (2006-2012). Individual hail cells including their footprints were identified by applying of a cell tracking algorithm to the 3D radar data. The applied methods were calibrated and validated with additional loss data provided by a building and crop insurance company. The results of the radar analyses reveal a high spatial variability in the probability of hail, which is due to the superposition of large-scale climatology (e.g., a north-to-south gradient in static stability) and local-scale flow dynamics. It is found that most of the hail hot spots are located downstream of the low-mountain ranges, e.g., at the lee side of Black Forest, Harz, or Bergisches Land. The spatial distribution of hail events is related to several atmospheric characteristics such as general flow direction, static stability, or Froude number. Additional semi-idealized model simulations with COSMO show that horizontal flow convergence at low levels resulting from flow around the mountains and gravitiy waves may be decisive for the spatial distribution of the detected hail events.

The reconstructed event set of past hailstreaks will also be used to estimate the damage potential of large hail and to model total losses depending on the probability (return period).