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Climatology of damage-causing hailstorms over Germany

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In several regions of Central Europe, such as southern Germany, Austria, Switzerland, and northern Italy, hailstorms often cause substantial damage to buildings, crops, or automobiles on the order of several million EUR. In the federal state of Baden-Württemberg, for example, most of the insured damage to buildings is caused by large hailstones. Due to both their local-scale extent and insufficient direct monitoring systems, hail swaths are not captured accurately and uniquely by a single observation system. Remote-sensing systems such as radars are able to detect convection signals in a basic way, but they lack the ability to discern a clear relation between measured intensity and hail on the ground. These shortcomings hamper statistical analysis on the hail probability and intensity. Hail modelling thus is a big challenge for the insurance industry.

Within the project HARIS-CC (Hail Risk and Climate Change), different meteorological observations are combined (3D / 2D radar, lightning, satellite and radiosounding data) to obtain a comprehensive picture of the hail climatology over Germany. The various approaches were tested and calibrated with loss data from different insurance companies between 2005 and 2011. Best results are obtained by considering the vertical distance between the 0°C level of the atmosphere and the echo top height estimated from 3D reflectivity data from the radar network of German Weather Service (DWD). Additionally, frequency, intensity, width, and length of hail swaths are determined by applying a cell tracking algorithm to the 3D radar data (TRACE3D; Handwerker, 2002). The hailstorm tracks identified are merged with loss data using a geographical information system (GIS) to verify damage-causing hail on the ground.

Evaluating the hailstorm climatology revealed that hail probability exhibits high spatial variability even over short distances. An important issue is the spatial pattern of hail occurrence that is considered to be due to orographic modifications of the flow. It is found that hail probability downstream of the low mountain ranges of Germany is strongly controlled by the Froude number. In the case of low Froude number flow, a convergence zone may develop downstream of the mountains, which may lead to the triggering or intensification of deep convection.

Based on the results obtained, a hail loss model will be created for the insurance marked to convert the observed hail parameter into monetary parameters, for example, mean loss or maximum loss. Such a model will allow to quantify the hail risk for a certain return period on the local-scale or to assess worst case scenarios.