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Characterisation of hail storms using a multi-data approach

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Severe weather associated with deep convection poses a significant threat to life, property and economy. Knowledge of the life-cycle of such event is needed to fully understand and hence predict convective weather events. The nowcasting of severe convective events, especially hail storms, remains a challenging endeavour that suffers from relatively low skill and high false alarm rates.

A comprehensive set of several hundred events that occurred in various parts of Germany is used to characterise hail storms. The analysed observations include measurements from a lightning detection network, precipitation radar, as well as information from automated cell detection algorithms based on radar reflectivity and radial winds which are combined with severe weather reports. A special focus is on mesocyclones as detected in radar data as well as on the lightning characteristics of the convective cells. The analysis reveals that about half of all hail storms in Germany are associated with a mesocyclone detected in radar data within 10 km and 10 min of the hail report. Some mesocyclone attributes, e.g. depth and maximum shear, are shown to have predictive skill for indicating the occurrence of hail. However, the reflectivity related parameters vertically integrated liquid-water content (VIL), VIL density (VILD) and echotop, have a stronger predictive skill. A feature which is shown to occur in many of the analysed severe hail cases is the so called lightning jump, i.e. a rapid increase in the total lightning density. It occurs well before the occurrence of observed hail and has thus a great potential to increase the lead time of warning of severe hail events.