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The life-cycle of hail storms: lightning, radar reflectivity and rotation characteristics

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An 8-year analysis of Central European hail storms is presented. A comprehensive set of six hundred hail storms that occurred on 169 different days in various parts of Germany is used to characterise these events. 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. Additionally to the storms' parameters during the time of the observed hail, the temporal evolution of the storms' characteristics is analysed in order to study the convective life-cycle and identify parameters with predictive skill.
A special focus is on the lightning characteristics of the convective cells. A feature that is shown to occur in many of the analysed severe hail cases is the lightning jump, i.e. a rapid increase in the total lightning density. It occurs well before the observed hail and has thus a great potential to increase the lead time of warnings of severe hail events. Instead of fixed thresholds for the definition of a lightning jump, a lightning jump intensity parameter is introduced and tested. The analysis also reveals that several storms show a pulsating lightning activity. Furthermore, nearly three quarters of the hail events are associated with a mesocyclone that was automatically detected in radar data. As expected, high reflectivity values were measured during the time of the observed hail.