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Temporal and spatial distribution of total lightning densities in severe thunderstorms

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Lightning pose a significant threat to life, property and economy. Hence, the detailed knowledge of the occurrence of lightning and its characteristics is important. Furthermore, the knowledge of lightning characteristic of thunderstorms can support the warning of further accompanying convective phenomena.

The lightning characteristics of severe thunderstorms in Germany and neighbouring areas measured by the LIghtning detection NETwork LINET are presented. The lightning data are analysed in conjunction with measurements from MSG satellite and 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.

Besides detailed case studies a set of six hundred hail storms that occurred on 169 different days in an 8-year period is analysed. On average hail storms have higher lightning densities than ordinary thunderstorms. The local lightning density of the hail events with larger observed hail diameter is higher. The higher lightning density was observed on the left flank of the hail streak.
A feature that is shown to occur in many of the analysed 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 half of the analysed hail storms show a pulsating lightning activity.

Hence, the lightning density as well as its temporal development should be easily visible to the forecasters for operational severe weather warning. Traditionally, lightning detections are presented to the weather forecaster on their meteorological workstation by displaying individual strokes or flashes with a symbol. In convectively active situations it can be difficult to distinguish cells with strong and weak lightning activity and to see whether lightning activity increases or decreases. Therefore, at Deutscher Wetterdienst (DWD) new lightning density and lightning density track products have been implemented. These products were evaluated at the European Severe Storms Laboratory Testbed with positive feedback by forecasters.