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Severe Weather Identification based on LINET Lightning Data

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Consideration of lightning data from whatever source allows and improves nowcasting of thunderstorms. The present contribution highlights the particular benefits that can be drawn from utilization of LINET lightning data. Besides the measurement of cloud-to-ground strokes (CG) LINET also reports cloud lightning (IC) in terms of VLF/LF strokes that occur both in the very initial phase of a discharge and, thereafter, inside already formed discharge channels. The precise nature of these IC strokes is not yet understood. Still, for sensor baselines of up to 200 km LINET provides ample data for IC strokes along with their emission heights. It is well known that severe weather is characterized by particularly strong convection, large and high-rising convective volumes. Thus, measured rates of CG and IC strokes show distinctive increases when a cell matures and produces severe weather. In parallel, the increasing height of cloud tops results in an increase of the measured IC emission heights. Consequently, LINET can recognize the development of severe weather by exploiting IC rates and registering the increase of IC heights as a function of time. Likewise, subsequent decrease of these parameters signals the decay of severe weather conditions.

For verification of the severe weather detection potential of LINET we compare the lightning characteristics with the polarimetric Doppler radar measurement of thunderstorms taken by DLR's POLDIRAD. From these measurements we obtain information on hail formation and fallout, on intense updrafts in connection with supercooled raindrops, on overshooting cloud tops or on downdrafts. The IC stroke components are connected to the graupel and ice mass within the storm and so the vertical structures are expected to be correlated to each other. Another type of stroke verification is from video recordings of storms and lightning as taken from the POLDIRAD location. Observations from different kind of storm systems have different kinds of IC/CG ratios. In the case studies shown, LINET flash rate is in excellent agreement with the video flash rate. Especially in the limiting cases of very low IC emissions as often observed in aged decaying storm systems, LINET strokes may be more difficult to categorize.

Several case studies will be presented that demonstrate the nowcasting power of LINET lightning data. Particular events of severe weather will be analysed in terms of the quoted lightning parameters. In order to verify the significance of the physical lightning parameters and to exclude trivial influences, e.g. from spatially varying network efficiency, non-severe storms are also analysed in the same area where the considered severe storms have occurred. It can be concluded from the results that the quoted lightning parameters are indeed reliable indicators for severe weather.