Recognition of severe weather by combining dual-polarization radar measurements and high-resolution 3D lightning data

Hans-Dieter Betz
nowcast GmbH, Germany

Hagen, Martin (Institute of atmospheric physics, DLR, Germany)
Höller, Hartmut (Institute of atmospheric physics, DLR, Germany)
Möhrlein, Matthias (nowcast GmbH, Munich, Germany)

E-mail: hdbetz@nowcast.de

Thunderstorms play an important role when defining natural threads to humans. Microphysical processes in the clouds may lead to severe weather phenomena like hail or strong wind gusts at the ground. The time scales of these processes can be so short that, for nowcasting purposes, one needs highly time resolved updates of the used data sources. This condition can be met by using modern radar or lightning data from ground-based remote sensing systems, which can measure atmospheric conditions in near real-time.

Radar data allow detailed information about the spatial distribution of precipitation particles, and dual-polarisation data provide discrimination of different hydrometeors, e.g. of water and ice particle that influence charge separation and, thus, cloud electrification.

Thunderstorms necessarily produce lightning discharges. Due to strong coupling between microphysical and electrical processes, and because lightning strokes can be measured very precisely in both, time and location, overlay between radar and lightning provides excellent assessment of the storm situation. The stronger the storm, the higher rises the convective core that produces and maintains the electric field leading to lightning discharges. As a consequence, intensification of the storm is accompanied by occurrence of increased number of cloud discharges, whereby a shift to higher altitudes serves as particular indicator for most severe weather.

Since 2004 a European ground-based 3D-lightning detection network is in operation that allows reporting of cloud strokes along with their emission altitudes („LINET"). Available additional lightning parameters, that correlate with severe weather, are total stroke rate, ratio of cloud- and cloud-to-ground strokes, discharge current amplitudes and polarities. A suited analysis of these parameters allows for a realistic description of lifecycle and severity of the storm, including nowcasting with respect to the expected motion of the storm cells. Combination of data from polarization Doppler radar and lightning detection systems like LINET provides considerably improved recognition and nowcasting of thunderstorms. Examples are presented, which demonstrate the usefulness of the outlined approach.