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# Study of strong tornados in Germany: Various aspects of Forecasting and Nowcasting

Marcus Beyer and Kathrin Wapler
German Weather Service, Offenbach am Main, Germany (meteomabe@googlemail.com)

Tornados pose a significant threat to life, property, and economy. Thus, an analysis of tornadoes is of high relevance. An understanding of historical events, e.g. regarding the characteristics of tornadic storms compared to multi-year storm statistics, may help to improve the situational awareness of future tornado events.

In our study, weather cases of observed tornados with an intensity of F2 or stronger on the Fujita scale that occurred in recent years in Germany were analyzed in detail. The three F3 tornadoes (Bützow, Affing, and Bonndorf) and nine F2 tornadoes, which developed on 10 different days in various parts of Germany, occurred between May and the beginning of September in the years 2013, 2014, 2015 and 2016; mostly between 16 and 20 UTC.
The analysis concentrates on climatological aspects of the tornado events concerning forecasting and nowcasting, respectively.

Regarding forecasting, similarities and differences of the prevailing synoptic and mesoscale conditions will be highlighted. In addition, the convective environment of the events in which they occurred will be analyzed in detail. Another point of the investigation will be the type of convection. The goal is to anticipate typical characteristics that enhance the threat of a potential dangerous tornado situation. Using these findings may then help to strengthen the awareness of the forecaster.

Regarding nowcasting, a multi-source approach was applied to best analyze the events. For this purpose, radar reflectivity, rotation characteristics were combined with lightning activity.

Ten of the tornadic storms could be clearly tracked in radar reflectivity data; seven of those had a lifetime of more than 3 hours. In the remaining tornado cases, complex multi-cell developments occurred. The tornadic storms propagated with approximately 70km/h mostly towards the East. Only about 20% of all storms in the analysis domain propagate with 60km/h or more.
In many cases, radar radial wind data showed a persistent rotation track. The automatically detected mesocyclones had a vertical depth between 2.5 and 11 km at the time of the tornado, the diameter was above 8 km. The base of the rotation was low compared to multi-year statistics of all mesocyclonic storms.
The lighting activity of the tornadic storms was high. In three-quarter of the cases, a lightning jump occurred between 5 and 120 minutes before the event.