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# NowCastMIX – optimized automatic warnings from continuously monitored nowcasting systems based on fuzzy-logic evaluations of storm attributes

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The German Weather Service's AutoWARN system integrates various meteorological data and products in a warning decision support process, generating real-time warning proposals for assessment and possible modification by duty forecasters before dissemination to customers. On nowcasting timescales, several systems are continuously monitored to capture rapidly developing mesoscale events, including radar-based cell tracking methods, 3D radar volume scans, lightning strike locations, calibrated precipitation extrapolations and live synoptic reports. Numerical forecast model data is also monitored to provide assessments of the near-storm environment. To help the forecasters manage this large volume of rapidly changing data, NowCastMIX processes it into an integrated grid-based analysis, providing an optimal warning solution with a 5-minute update cycle. Inputs are combined using a fuzzy logic approach for estimating likely storm attributes, deriving optimized estimates for the storm cell motion vectors. An adaptive ensemble clustering optimisation is then deployed to reduce the spatial complexity of the resulting warning fields and smooth out noisy temporal variations to a manageable level for the duty forecasters to deal with. NowCastMIX thus delivers an on-going real-time synthesis of the various input data to provide consolidated sets of most-probable short-term forecasts for the whole of Germany, with an extension to a wider European domain being envisaged for the near future. The system has run over four summer convective seasons, yielding a comprehensive, high resolution dataset of thunderstorm analyses and corresponding warnings. This provides a valuable research resource for developing methods to improve quality. A verification of NowCastMIX forecasts against its own analyses indicates how the trajectories used for determining the areas requiring imminent storm warnings can be optimized from weighted combinations of the three different available tracking methods. Hence, the impacts of newly developing cells, which tend to form somewhat rightwards of the existing raw trajectories before optimization, can be then captured more effectively.