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Detection, tracking, and nowcasting of convective storms using KONRAD3D

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In order to further improve the performance of German Weather Service's (DWD) automated warning decision support system AutoWARN, the development of a new tool for the automated detection, tracking and nowcasting of convective cells, called KONRAD3D, has been initiated. KONRAD3D represents the successor of the operational system KONRAD2D (KONvektionsentwicklung in RADarprodukten, convective evolution in radar products) used up to now. KONRAD3D is currently being newly developed from scratch within DWD's software framework POLARA (POLArimetric Radar Algorithms). Its main goals are to further reduce advance warning times, improve POD and FAR for cell detection, to enhance the performance of generated forecasts, and to give a more adequate classification into severity categories.
Within KONRAD3D, unlike its predecessor KONRAD2D, convective cells are extracted from three-dimensional radar reflectivity sweep data, which is also priorly quality controlled using algorithms based on dual-polarimetric radar observables. Issued hail and heavy rain warnings will be based on dual-polarimetric Hydrometeor Classification and Quantitative Precipitation Estimation schemes. It will further make use of state of the art techniques for detection, tracking and forecasting of convective cells. For instance, we resort to adaptive thresholding schemes not being bound to a single fixed threshold like in KONRAD2D (46 dBZ) anymore. In addition, cell tracking is supported by standard optical flow methods imported from the widely used OPENCV (Open Source Computer Vision) software library. Moreover, it is planned to combine detected radar reflectivity cells with features derived from lightning and satellite data as well as with objects created by German Weather Service's mesocyclone detection algorithm into consolidated storm cell objects. In all of these steps, particular importance is attached on a generic software design. Basic techniques, like, e.g., feature extraction and tracking algorithms, are linked into a software library called FTN (Fundamental Techniques for Nowcasting) which can be separately supplied to collaborating developers of other nowcasting tools.
In this work, we present the basic design of KONRAD3D in more detail and provide a first assessment of its performance. In particular, we compare KONRAD3D nowcasts with its own detections, and verify the core cell detection based on radar data against lightning data. In order to rate the benefit of the new development the same is done for the precursor KONRAD2D.