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Radar based Analysis of convective storms: Detecting mesocyclonic rotation and depicting paths of severe cells

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The radar network of the Deutscher Wetterdienst (DWD) provides 3D-Doppler data in high spatial and temporal resolution, supporting the identification and tracking of dynamic small-scale weather phenomena. The volume scan pattern comprises 10 sweeps with elevation angles from 0.5° to 25° and is repeated every 5 minutes supplying reflectivity and radial velocity as well as a set of polarimetric moments.
The quality assurance of the volume scan data includes a polarimetric clutter filter for both reflectivity and radial velocity sweep data. A dual PRF unfolding error correction is additionally applied to the radial velocity data giving a sound basis for shear calculations in follow-up algorithms.
Within the mesocyclone detection algorithm rotation signatures (features) found in the azimuthal shear matrices derived from the radial velocity sweeps of all radar sites are evaluated. Features with similar coordinates are merged into the same mesocyclone objects, which are ranked according to a severity metric taking into account properties like shear, momentum and cell-based VIL (vertically integrated liquid water).
Further means for analysing potentially severe cells are offered by the Rotation-Track and VIL-Track products. A Rotation product is created by averaging the azimuthal shear as obtained from the radar volume scans in the vertical, so that random noise is suppressed while rotation is amplified in case of well developed "rotating columns". A grid-based VIL product is generated by vertical integration of the 3D-reflectivity data. Both VIL and Rotation algorithms operate on the radar sweep data of all DWD radar sites and directly produce composite products. So called Track products are finally obtained by accumulating the VIL and Rotation composites over a time interval of typically 3h to yield a VIL-Track and a Rotation-Track composite, respectively.
Mesocyclone detections and in future also the Rotation- and VIL-Track composites are made visible to the forecaster at DWD by means of the NinJo meteorological workstation system. Meteorologists can judge the significance of mesocyclone detections using the severity scale as guidance and applying persistency and consistency checks (track of mesocyclone detections, additional occurrence of typical weather features e.g. hook echoes). Furthermore, cells with high severe weather potential in from of persistent vorticity (Rotation) and hail or heavy precipitation (VIL) show up as line structures in the respective Track products.
The mesocyclone detection and Rotation-Track as well as VIL-Track algorithms will be introduced and the performance will be discussed by means of selected weather cases.