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Mesocyclones in Central Europe as seen by Radar

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Mesocyclones are known to be accompanied by phenomena such as tornadoes, severe gusts or hail which may cause significant damages. An example is a mesocyclone that moved along the Alps in Southern Germany on 6 June 2011. Hail with diameters of 7.2 cm as well as 20 cm thick hail layers were observed, which caused the second highest loss ratio (in long insurance records) in the effected county. Another example is a mesocyclone that occurred in Central Germany on 10 August 2014. A F2 tornado and a F1 tornado have been observed along the mesocyclones path. The damages reported in the ESWD include: 50 houses damaged, cars destroyed, trees downed, forest area destroyed. Additionally, severe wind gusts and heavy precipitation are reported.
While mesocyclones have been studied intensively in North America, less is known about the occurrence and characteristics of mesocyclones in Central Europe. Thus, the focus of the study presented here is Germany and its surroundings. The results of the mesocyclone detection algorithm implemented at Deutscher Wetterdienst (DWD, German Weather Service) are used in the present study.
The occurrence and characteristics of mesocyclones is analysed. As expected, the three-year analysis shows a typical annual and diurnal cycle. However, the diurnal cycle of mesocyclones features a wider maximum in the late afternoon/evening compared to the diurnal cycle of general thunderstorms.
For all of the six strong tornados (F2) that are reported in Germany for the years 2012, 2013 and 2014 a mesocyclone was detected. As shown for an example, a mesocyclone was detected in radar data well before the first tornado. Even though not detectable in each radar scan a mesocyclone was detected for a longer time period that includes a F2 and a F1 tornado.
The analysis of over hundred hail storms that occurred in various parts of Germany reveals that about half of all hail storms in Germany are associated with a mesocyclone detected in radar data within 10 km and 10 min. Some mesocyclone attributes, e.g. depth and maximum shear, are shown to have predictive skill for indicating the occurrence of hail. However, the reflectivity related parameters vertically integrated liquid-water content (VIL), VIL density (VILD) and echotop, even though no attributes of the mesocyclone itself but of the associated storm have the strongest predictive skill.
The mesocyclone detection algorithm may support the analysis and nowcasting of severe weather events and thus support the warning process.