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Mesocyclone detection at Météo-France

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Supercells are particularly long-lived thunderstorms known for their capacity to produce damaging weather phenomena such as large hail, heavy rain, severe wind gusts or tornadoes. They are characterized by the presence of a deep and persistent rotating updraft called mesocyclone, whose diameter usually ranges from 2 to 10 km. The rotation can be seen as a symetric dipole of inbound/outbound velocities in the radial storm-relative velocity field of Doppler weather radars. Several mesocyclone algorithms have been developed in the past (e.g. Zrnic 1985, Stumpf et al 1998, Hengstebeck et al 2018) for operational nowcasting.

At Meteo-France, the Doppler information from the radar network is used to produce a wind-shear mosaic (Augros et al, 2013) that provides to forecasters an estimation of the maximum horizontal wind shear detected in low levels (between 0 and 2 km AGL). This product is suited for the detection of gust fronts, or strong convergence areas inside thunderstorms but is not well adapted for the detection of azimuthal shear that characterizes the mesocyclones in radial velocity images.

In 2018, we started the development of a new mesocyclone algorithm, for the Meteo France radar network. Following the “pattern vector approach” from Zrnic et al (1985) and applied by Hengstebeck et al (2018), the algorithm looks for sequences of azimuthal shear grouped in one-dimensional “pattern vectors”, which are combined to build two-dimensional “features”. Adjacent “features” in consecutive elevation angles or neighbouring radars are then merged into 3D mesocyclone objects. The last improvements of the algorithm include the combination of the informations from all radars from the network, and a new visualization tool. A few case studies will be shown to illustrate the performance of this new version of the algorithm.

Augros, C., et al., 2013: Development of a Nationwide, Low-Level Wind Shear Mosaic in France. Wea. Forecasting, 28, 1241–1260.

Hengstebeck, T., et al., 2018: Radar Network–Based Detection of Mesocyclones at the German Weather Service. J. Atmos. Oceanic Technol., 35, 299–321, https://doi.org/10.1175/JTECH-D-16-0230.1

Stumpf, G. J., et al., 1998: The National Severe Storms Laboratory mesocyclone detection algorithm for the WSR-88D. Wea. Forecasting, 13, 304–326.

Zrnić, D. S., et al. (1985). Automatic detection of mesocyclonic shear with Doppler radar. Journal of Atmospheric and Oceanic Technology, 2(4), 425-438.