

# Non Mesocyclone Tornadoes in Hungary

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## I. INTRODUCTION

Most violent tornadoes develop usually from supercells (Fujita, 1981), but in Hungary there were also observed damaging tornadoes in the past years developed in environment not favorable (low vertical wind shear, small SRH) for supercells (Wakimoto et. all., 1989; Brady et. all., 1989; Caruso et. all., 2005; Davies et. all., 2006). A total of 41 visual vortices were studied in 2009, 2008 and 2006 using data obtained from reports of storm spotters and ESWD database. Those cases were not associated with supercell thunderstorms. 11 of these vortices can be classified as tornadoes (eight F0, two F1, one F2) and the others were funnels.

## II. PRESENTATION OF RESEARCH

To investigate these cases, several analysis fields (MSL, moisture convergence, 0-2 km vertical temperature gradient, 0-3 km section of Sbcapc, LCL, 0-3 km SRH) and vertical profiles were obtained from GFS and from hydrostatic run of WRF ARW 3.0 with horizontal resolution of 10 km and the assimilation of surface information (provided by an automatic measurement network including approximately 100 instruments operating in HMS) (FIG. 1).

## III. RESULTS AND CONCLUSIONS

All tornadoes developed directly for hours on stationary wind shift boundary, that generate strong convergence and pre-existing vertical vorticity circulations. The boundary could be an occluded fronts developed ahead or behind of surface cold front, along the weak quasi-stationary front or in a flat pressure area. The generally flat and dark parent clouds of these tornadoes were usually developing cumulonimbus. The intensive precipitation started usually for a short time after the observation of the intense vortices. So it may be assumed, that the smaller scale thunderstorm outflow boundaries can enhance the pre-existing vertical circulations along wind shift boundaries. By event the low-level lapse rates within the lowest 2 km was greater than 7-7.5 C/km, the 0-3 km Sbcapc was greater than 60-70 J/kg, the LCL height was 600-1750 m, the 0-1 and 0-6 km shear was usually less than 5-10 m/sec. These conditions of the environment are not so significant, so it may be assumed, that these types of tornadoes can give the majority of relatively weak tornadoes in our area.

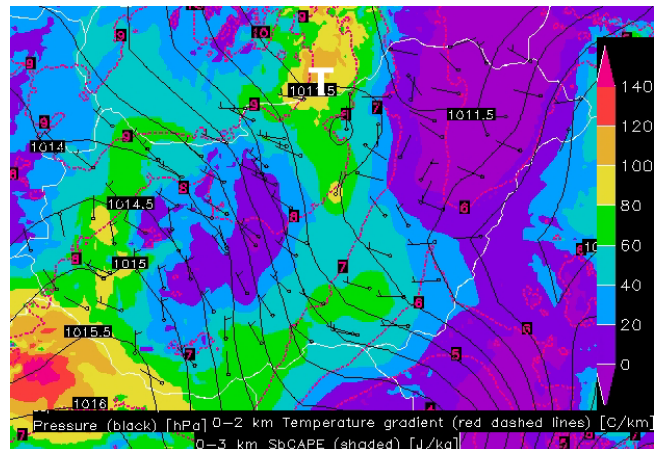


FIG. 1: F 1 tornado in Ipolytarnóc (2009.08.24. 12 UTC): T . The typical case of tornado behind the cold front on the lee side of Carpathians

## IV. ACKNOWLEDGMENTS

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