Retrieving tornado's like wind structure (20.07.2007, Czestochowa, Poland case) using singular radar Doppler velocity

Jan Parfiniewicz

Institute of Meteorology and Water Management
61 Podlesna str., PL-01673 Warsaw, Poland

1 Poland case, 20.07.2007

This is an addendum to Tornado Case, Parfiniewicz, 2008, presenting results of direct retrieval of Doppler radar measurements from Brzuchania. The applied method of retrieval resembles techniques known as ECUW (combination of Continuity with the uniform wind technique, Hagen,2002) and VVP (velocity volume processing, Koscielny et al., 1982) but was developed purely independently on experimental manner. The final algorithm consists of 3 main steps (the order is important):

1. Retrieval of tangential wind component on polar grid circles (or part of them depending on the domain) by solving differentiated continuity equation by tridiagonal TDMA solver.
2. Retrieving averaged Cartesian components from retrieved on the step 1 polar components, accounting strictly for proper metrics transformation from polar to Cartesian grid, when using least square method. The 3D volume estimated to provide best results is 1 km in vertical (3 levels) and 28 km ($\pm 14km$, 5 grids of 2.8km) in horizontal. It was necessary to apply this procedure twice (first for horizontally reduced volume) - possibly to compensate aliasing bias, Gao & Droegemeier, 2004.
3. Finally, instead of formal mixing (or smoothing) the 2D "Cartesian model" with nudging term on rhs (replacing pressure gradient) that assures convergence to radial measurements was introduced. 20 iterations (for $dt = \pm 20s$ with changeable sign every 3 iterations) were found enough, and confirmed stability of solution, even when tested for 1000 iterations.

The result is presented via 3D streamlines: Fig. 1

2 Post Scriptum

The result concerning tornado and presented above was obtained by merging modeled wind field (as a first guess) with embedded radial Doppler velocities. As for operational needs we were forced to test pure retrieval, without modeled wind on input. The same was checked on the tornado case, showing nearly identical results in vertical wind component while significant differences in horizontal ones - thus modifying 3D picture by enhancement of vertical movement. This is not presented here since it was recognized as less credible, thus confirming positive impact of modeled wind on Doppler radar retrieval. Acknowledgment: to Bogdan Rosa for stimulating talks.

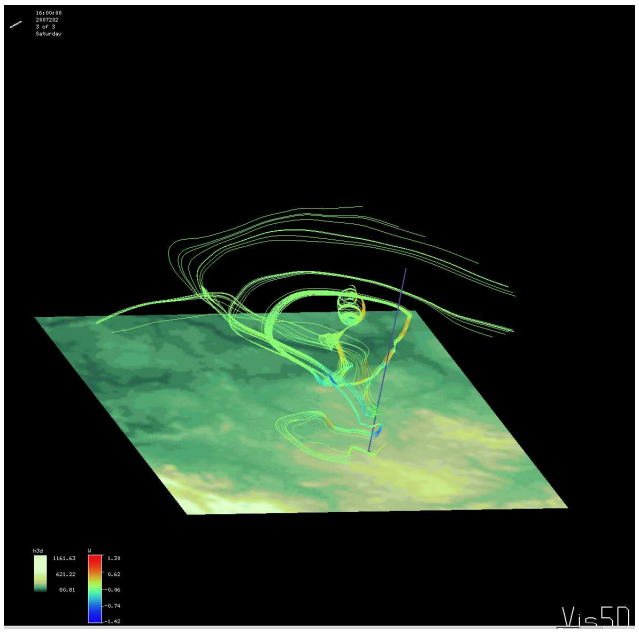

Figure 1: Vis5d was used to obtain 3D streamlines as set of characteristic trajectories. They are colored by w - vertical velocity in m/s. Scaling for w and topography (in m) is included. Vertical line indicates tornado localization. Descending spiral motion, that is beginning at about 7 km, is dominating it reaches maximum downward velocity just above tornado.

References

[1] M. Hagen, K. Friedrich, and J. Seltmann: Wind-field observations with the operational Doppler radar network in Germany, Proceedings of ERAD (2002): **195-199** Copernicus GmbH 2002, ERAD 2002

[2] Koscielny, A.J., Doviak, R.J., and Rabin, R., Statistical considerations in the estimation of divergence from single-Doppler radar and application to prestorm boundary-layer observations. *J. Appl. Meteorol.*, 21, **197-210, 1982**.

[3] Jidong Gao, Kelvin K. Droegemeier, A variational technique for daaliasing Doppler Radial Velocity data, *J. Appl. Meteorol.*, 43, **934 - 940**, 2004

[4] J. Parfiniewicz, 20th of July 2007 explosive convection over Europe. The COSMO perspective. *COSMO Newsletter No. 9*, **79 - 85**, 2008