Radar-based Hail Statistics Over Belgium, 2003-2012

M. Lukach and L. Delobbe
Royal Meteorological Institute of Belgium

an abstract for
the 11th International Precipitation Conference,
Ede-Wageningen, The Netherlands,
30 June-3 July 2013.

Key words: C-band weather radar, hail detection, severity, statistics.

The Royal Meteorological Institute (RMI) of Belgium operates a C-band Doppler weather radar in Wideumont for more than ten years. This long term archive of high resolution volumetric reflectivity measurements is an extraordinary source of information that can be used in different statistical studies. It is of particular interest when the data is being post-processed with more extended evaluation techniques. A hail detection algorithm based on the Waldvogel's criteria (Waldvogel et.al., 1979) is one of many operational applications of the high resolution volumetric reflectivity measurements. In this algorithm the Probability Of Hail (POH) is calculated as a function of the radar echo-top and height of the freezing level. POH is convenient in operational mode and can serve as a source of empirical probabilities in the statistical analyses. However, it does not allow to assess the severity of hail events. For this reason, the Severe Hail Index (SHI) algorithm proposed by Witt et. al.,1998 was implemented and applied to the archived radar data.

In this study the radar data from 2003 to 2012 of the C-band weather radar are used. The radar has a range of 240 km and covers Belgium, Luxembourg, parts of the Netherlands, France and Germany. A ten elevations scan (0.5º-17.5º) with the best volume coverage and without Doppler filtering was chosen for the application of the hail detection algorithms. Such a scan is performed every 15 minutes. The archived data are combined with the temperature profile data extracted from the Numerical Weather Prediction model ALARO-0 currently operational at RMI. The historical temperature profiles were obtained by dynamical downscaling of the ERA-interim re-analysis; applying a double nesting technique to achieve a high resolution grid. From the temperature profiles, the heights of the (-20ºC)-isotherm for the SHI algorithm and zero-isotherm for SHI and POH algorithms were interpolated. The heights of the (-20ºC)-isotherm and the zero-isotherm are required in the SHI algorithm for the calculation of the temperature-based weighted function, which is later vertically integrated together with the reflectivity-based weighted function and the hail kinetic energy function in the product.

SHI estimates a Probability of Severe Hail (POSH) and a Maximum Expected Size of Hail (MESH). Those two outputs are analysed together with the output of the POH algorithm for the temporal and spatial analysis of the frequency of hail events. It allowed to draw conclusions on the frequency of severe hail events in Belgium. Inter alia was established that: 1) most of the hail storms independently of their severity occur in the period between April and September and this period of the year can be called the Hail Season (HS) for Belgium. 2) At least one out of three hail events per hail season is severe (with the diameter of hail stones ≥ 20mm), however this proportion varies from year to year. 3) On average for the hail seasons in ten years hail storms more often occur within the range of the radar in June, but the severe hail is more frequently detected in May. 4) Hail storms with the largest spatial extension are most often detected by both algorithms around 16:00-18:00 UTC. We conclude that for the accurate spatial statistical analyses inclusion of some quality information is required. This will allow to exclude artefacts related to scanning geometry and non-weather targets (ground echoes, air-planes and interferences) from the spatial analysis.

The statistics obtained in this study and conclusions based upon give insight in the severity of hail events, their frequency, and offer additional opportunities for further statistical analysis and also for statistical verification of regional climate models.

References:

1) Waldvogel, A., B. Federer and P. Grimm: 1979, Criteria for the detection of hail cells. J. Appl. Meteor., 18, 1521-1525.

2) Witt, A., M.D. Eilts, G.J. Stumpf, J.T. Johnson, E.D. Mitchell, and K.W. Thomas: 1998, An enhanced hail detection algorithm for the WSR-88D. Wea. and forecasting,13, 286-303.