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The impact of reflectivity correction and conversion methods to improve precipitation estimation by weather radar for an extreme low-land Mesoscale Convective System

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Between 25 and 27 August 2010 a long-duration mesoscale convective system was observed above the Netherlands. For most of the country this led to over 15 hours of near-continuous precipitation, which resulted in total event accumulations exceeding 150 mm in the eastern part of the Netherlands. Such accumulations belong to the largest sums ever recorded in this country and gave rise to local flooding.

Measuring precipitation by weather radar within such mesoscale convective systems is known to be a challenge, since measurements are affected by multiple sources of error. For the current event the operational weather radar rainfall product only estimated about 30% of the actual amount of precipitation as measured by rain gauges. In the current presentation we will try to identify what gave rise to such large underestimations.

In general weather radar measurement errors can be subdivided into two different groups: 1) errors affecting the volumetric reflectivity measurements taken, and 2) errors related to the conversion of reflectivity values in rainfall intensity and attenuation estimates. To correct for the first group of errors, the quality of the weather radar reflectivity data was improved by successively correcting for 1) clutter and anomalous propagation, 2) radar calibration, 3) wet radome attenuation, 4) signal attenuation and 5) the vertical profile of reflectivity. Such consistent corrections are generally not performed by operational meteorological services. Results show a large improvement in the quality of the precipitation data, however still only ~65% of the actual observed accumulations was estimated.

To further improve the quality of the precipitation estimates, the second group of errors are corrected for by making use of disdrometer measurements taken in close vicinity of the radar. Based on these data the parameters of a normalized drop size distribution are estimated for the total event as well as for each precipitation type separately (convective, stratiform and undefined). These are then used to obtain coherent parameter sets for the radar reflectivity-rainfall rate (Z-R) and radar reflectivity-attenuation (Z-k) relationship, specifically applicable for this event. By applying a single parameter set to correct for both sources of errors, the quality of the rainfall product improves further, leading to >80% of the observed accumulations. However, by differentiating between precipitation type no better results are obtained as when using the operational relationships. This leads to the question: how representative are local disdrometer observations to correct large scale weather radar measurements?

In order to tackle this question a Monte Carlo approach was used to generate >10000 sets of the normalized dropsize distribution parameters and to assess their impact on the estimated precipitation amounts. Results show that a large number of parameter sets result in improved precipitation estimated by the weather radar closely resembling observations. However, these optimal sets vary considerably as compared to those obtained from the local disdrometer measurements.