Quantitative Precipitation Estimation (QPE) from C-Band Dual-polarized radar for the July 08 2013 Flood in Toronto, Canada

Sudesh Boodoo
Environment Canada, Canada

Hudak, David (Environment Canada, Canada)
Ryzhkov, Alexander (Cooperative Institute for Mesoscale Meteorological Studies/ University of Oklahoma/ National Severe Storm Laboratory, Oklahoma, Unites States)
Zhang, Pengfei (Cooperative Institute for Mesoscale Meteorological Studies/ University of Oklahoma/ National Severe Storm Laboratory, Oklahoma, Unites States)
Donaldson, Norman (Environment Canada, Canada)
Reid, Janti (Environment Canada, Canada)

E-mail: Sudesh.Boodoo@ec.gc.ca

A heavy rainfall event on July 08th 2013 caused significant flash flooding in Toronto. Areas of the city experienced more than 100 mm in 2 hours with the highest recorded amount of 126 mm at Toronto International Airport. The objective of this paper is to evaluate the quantitative precipitation estimates from the King City C-Band dual-polarized radar located 30 km from the airport. High temporal resolution rain-gauge data for roughly 50 sites provided surface rainfall rates and accumulations over the affected area.

C-Band radar rain-rates were derived from both single and dual-polarization algorithms. Dual-polarization-based attenuation correction techniques were applied to the C-Band reflectivity measurements and rain-rates were calculated using both Marshall Palmer and WSR88D convective relationships. Specific differential phase (KDP) were re-calculated from the C-Band differential phase measurements using a least squares method and rain-rates were derived using the Brandes (2002) R(KDP) algorithm. Also, a rainfall algorithm for C-Band based on the specific attenuation, R(A), was utilized. The accumulations were also compared to the NEXRAD dual-polarimetric QPE algorithm from the Buffalo, New York S-Band radar located 100 km from Toronto.

This storm highlighted many issues associated with radar QPE for C-Band. In particular, heavy rain at the King City radar resulted in radome wetting which meant additional complications and compromised the attenuation correction techniques. The rainfall estimation from R(KDP) and R(A) algorithms were superior to R(Z) methods because of their inherent immunity to the wet radome and path attenuation effects. Storm total radar-gauge correlations were greater than 0.9 for the dual-polarimetric methods and the normalized mean bias was 4% under-estimation for the NEXRAD dual-polarimetric QPE algorithm and 7% over-estimation for the C-Band R(KDP) algorithm. This study demonstrates the potential for C-Band dual-polarimetric radar to provide good QPE estimates in the presence of strong attenuation and radome wetting.