OPERATIONAL QPE APPLICATION DEVELOPMENT FOR CANADA S-BAND DUAL-POLARIZATION RADAR NETWORK.

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Environment and Climate Change Canada has currently replaced 5 of its operational radars to S-band dual-polarization and is on schedule to have a total of 12 by the end of 2019. Replacements will continue at approximately 7 per year and would result in a network by 2023 of up to 32 S-band dual-polarized weather radars covering the major population centres of the country.
Quantitative precipitation estimation (QPE) algorithm is rapidly becoming important for the network. Algorithms developed on the King City C-band dual polarization data are currently being adapted for the S-band systems. An important part of the methodology is assessing the data quality of the S-band polarimetric radar measurements and the removal of non-precipitation echoes prior to applying rainfall retrieval algorithms. The quality assessments used to separate precipitating from non-precipitating echoes relies on measurements of cross correlation coefficient (ρ_{HV}), signal quality index (SQI) and gradients of differential phase (Φ_{DP}) to determine rainfall regions in the radar scans. Depolarization ratio is estimated from ρ_{HV} and differential reflectivity (Z_{DR}). It is also used to separate meteorological and non-meteorological echoes like birds and insects for QPE estimation. This method is being tested in place of hydrometeor classification algorithm (HCA) which has not been fully implemented and tested operationally at S-band wavelength. The signal processor applies Doppler filters to remove ground clutter contamination in the polarimetric measurements and also applies low signal to noise correction to ρ_{HV} and Z_{DR}. The depolarization ratio and or SQI thresholding was effective at removing contamination from radio interference while second trip removal mostly relied on SQI thresholding. In storm situations, with significant directional shear, the broad range of velocity (V) in the beam can produce abnormally low SQI which removes valid horizontal reflectivity (Z_H) pixels. The wide variety of weather conditions and clutter environments across the country requires careful application of the post-processing techniques.
The new S-bands collects data at 6 minute cycles for 17 elevations and the lowest scan at 0.5^0 elevation is used for QPE. Systematic Z_{DR} biases are monitored by sun measurements and occasionally under light rain conditions. It was found that biases in Z_{DR} was variable among radars and unstable in time, thereby not meeting the criteria of a 0.1-0.2 dB requirement for QPE applications. Rain-rate algorithms requiring Z_{DR} measurements are not utilized at the moment for this reason. The prototype operational QPE algorithm utilizes rates derived from $R(Z_H)$, $R(A_H)$, $R(K_{DP})$ where A_H and K_{DP} are specific attenuation and specific differential phase respectively. Each relationship was applied independently of rainfall intensity, hail contamination and radome wetting effects to evaluate against rain gauge accumulations. $R(K_{DP})$ and $R(A_H)$ algorithms performed better in pure heavy rain, rain hail mixtures and wet radome situations but were very noisy at lower rain intensities. Whereas $R(Z_H)$ were better at lower intensities. The individual retrieval relationships were not sufficient to capture the large variability of rainfall rates and accumulations in time and space. A blend of these algorithms demonstrates a better unbiased rainfall estimate in the operational environment.

Keywords: qantitative precipitation estimation, dual-polarization, hydrological application, specific attenuation, depolarization ratio, rain-rate relationships