13.7 THE DEVELOPMENT OF A CANADIAN OPERATIONAL DUAL-POLARIZATION RAINFALL ESTIMATION ALGORITHM

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Environment and Climate Change Canada embarked on its weather radar replacement program in 2016. The network will be completed in 2023 and be comprised of up to 32 S-band dual-polarized weather radars covering the most populous regions of the country. In the interim the network will be a hybrid one comprised of dual polarized S bands and Doppler C bands, two of which are dual polarized. Data from the dual-polarized C-bands collected at regular 10-minute frequency are being used to develop operational quantitative precipitation estimation (QPE) algorithms with a methodology which will later be adapted to the national radar network. A significant part of the methodology is assessing the data quality of the polarimetric measurements and the removal of non-precipitation echoes prior to applying rainfall retrieval algorithms. The quality assessment 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 at 0.5° elevation. Since the hydrometeor classification algorithm (HCA) has not been fully implemented and tested operationally at different frequencies, removal of ground clutter contamination is handled by Doppler filters in the signal processor and applied to the polarimetric measurements in addition to low signal to noise correction of ρ_{HV} and differential reflectivity (Z_{DR}). SQI thresholding was effective at removing contamination of radio interference radials and second trip echoes but care in the choice of value was required in some rain storm situations with directional shear. The broad range of velocity (V) in the beam produced abnormally low SQI and removed valid horizontal reflectivity (Z_H) pixels in the precipitation field. Systematic Z_{DR} biases are monitored by sun calibration and vertically pointing measurements. However, radome wetting complicated Z_{DR} measurements and introduced dynamic positive mean variations in Z_{DR} that are accounted for before applying attenuation corrections to Z_H and Z_{DR} and subsequently the rainfall retrieval algorithms. A method of monitoring and quantifying these Z_{DR} deviations in rain has been implemented.

Rainfall retrieval algorithms $R(Z_H)$, $R(Z_H,Z_{DR})$, $R(K_{DP})$, $R(K_{DP},Z_{DR})$ and $R(A_H)$, where K_{DP} and A_H are specific differential phase and specific attenuation, were applied after pre-processing with standard C-band coefficients. The 10-minute retrievals were summed to produce hourly and 24 hour accumulations to evaluate against a network of tipping-bucket and automated rainfall gauges within 100 km of the radar′s location. Each relationship was applied independently of rainfall intensity, hail contamination and radome wetting effects to evaluate against the 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. R(ZH) were better at lower intensities, provided that radome attenuation and path attenuation effects were minimal. R(Z_H,Z_{DR}) showed slightly improved performance than R(Z_H) in these conditions. The individual retrieval relationships were not sufficient to capture the large variability of rainfall rates and accumulations in time and space. A combination of algorithms demonstrated better unbiased rainfall estimate in an operational environment.