A new method to identify and correct range sidelobes from pulse compression

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The use of pulse compression to improve the sensitivity of meteorological radars is common. An unavoidable side-effect of pulse compression techniques is the formation of range sidelobes which lead to spreading of information across several range gates. These artefacts are particularly troublesome in regions where there is a sharp gradient in the echo power as a function of range. These sidelobes affect not only the reflectivity, but also the Doppler spectrum and its moments. Unfortunately there has been no objective way to identify and correct/remove affected data until now.

We present a simple new method for identifying and correcting range sidelobe artefacts. We make use of the fact that meteorological targets produce an echo which fluctuates at random as the particles being probed reshuffle relative to one another. This echo, like a fingerprint, is unique to each range gate. Identification of range sidelobes therefore reduces to the problem of finding traces of the echo from one range gate in another. By cross-correlating the pulse-to-pulse echo time series from pairs of range gates we can identify whether information from one gate has spread into another, and hence flag gates where there is range sidelobe contamination.

We demonstrate the principle using time series measurements from a 35GHz cloud radar at Chilbolton in the UK which interleaves compressed and uncompressed pulses. For uncompressed pulses, where we expect no range sidelobes, there is almost no correlation between any pairs of range gates. For compressed pulses, range sidelobes are easily identified as well-defined stripes of correlation between pairs of range gates. Correlation coefficients of up to 0.7 were measured in this work.

Mathematically we find that the correlation coefficients contain quantitative information about the fraction of power leaked from one range gate to another, and we propose a simple algorithm to correct the corrupted reflectivity profile. The algorithm is applied to case studies in boundary layer and mid-level ice clouds, and appears to work well, with the corrected profile in good agreement with the profile from the uncompressed pulses. Preliminary results from a real-time correction algorithm, and application of the technique to a 3GHz scanning weather radar will also be presented.