9B.2 AIRBORNE DOPPLER RADAR CLUTTER AND RANGE SIDELOBE SUPPRESSION

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1. INTRODUCTION

The NCAR ELDORA as well as other airborne Doppler radars exhibit artifacts when strong multi-trip ground clutter overlays a weaker first trip weather echo. These overlaid clutter echoes prevent any extraction of meteorological information from the desired weather echo (typically at elevation angles a beam width above and below the aircraft flight altitude) unless the weather echo is at least 10 dB stronger than the clutter interference. Thus, the desired first trip weather echoes are contaminated by ground clutter from second and higher trip echoes.

Furthermore, we often want to measure relatively weak clear air structures near the surface. The ELDORA radar generates a contiguous sequence of pulses spaced 10-50 MHz apart for a multi-frequency (stepped chirp) waveform (Hildebrand et al., 1994). Ideally, these frequencies are isolated enough from each other that no interference occurs and the frequencies may be treated independently and averaged, in the autocorrelation domain, to improve accuracy of the measurements. This in turn allows more rapid rotation rates and higher spatial resolution in the flight direction. Unfortunately, when the pulse intercepts the ground below the aircraft, the first subpulse at f1 intercepts the ground and causes a leakage signal into the following sub-pulses at f2, f3, and f4. Thus, the near surface boundary layer echoes are contaminated by ground clutter leakage via range sidelobes of the multi-frequency pulse (Loew and Lee, 2003).

2. PHASE CODING

Fortunately, there appears to be a relatively straightforward pulsing and processing technique to mitigate both this contamination factors. Phase coding each frequency of each pulse allows suppression of the interfering signal, either second trip clutter or range sidelobe interference, by several 10s of dB depending on the spectrum velocity width of the echoes normalized by the Nyquist velocity (Sachidananda and Zrnic, 1999). NCAR/ATD is validating the technique using recorded WSR-88D data from 2 NEXRAD sites plus from our S-Pol research radar. Recently, a commercial processor (Sigmet RVP8) has been installed on S-Pol for validation of the technique using the likely future NEXRAD Open RDA processor (Keeler et al., 2003). This paper proposes to use the same phase coded pulsing and spectral processing technique to minimize Eldora interference from both second trip clutter and range sidelobe leakage.

3. EXAMPLES

Two typical examples of the contaminating artifacts are shown in Figures 1 and 2. Figure 1 shows the horizontally oriented clutter lobes obscuring any close echo in weather or clear air return. These clutter lobes are always present and typically edited out of the data set. Figure 2 shows a detailed close up view of the range sidelobes near the surface. A similar contamination occurs near other large reflectivity gradients in weather, for example a heavy rain or hail shaft. These data are also typically edited out of the data set. Both these regions are extremely important for understanding convective initiation, boundary layer structure and evolution, cloud physics, and other scientific studies. If phase coding and spectral processing suppresses the artifacts by even 20-30 dB the data sets will be much more useful. Once IQ data are routinely recorded from the airborne radars, we expect analysis to show at least this suppression. Ground based radars exhibit 40-50 dB suppression of second trip clutter echo (Hubbert and Meymaris, 2002).

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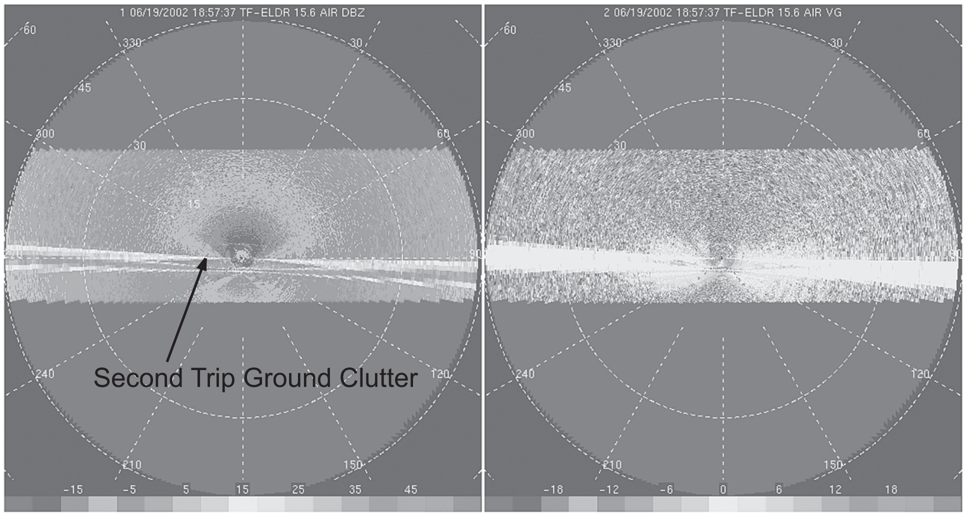

Figure 1. Eldora data from IHOP on 19 June 2002 showing second trip clutter echo contamination. Aircraft altitude is about 3 km AGL and range rings are 15 km.

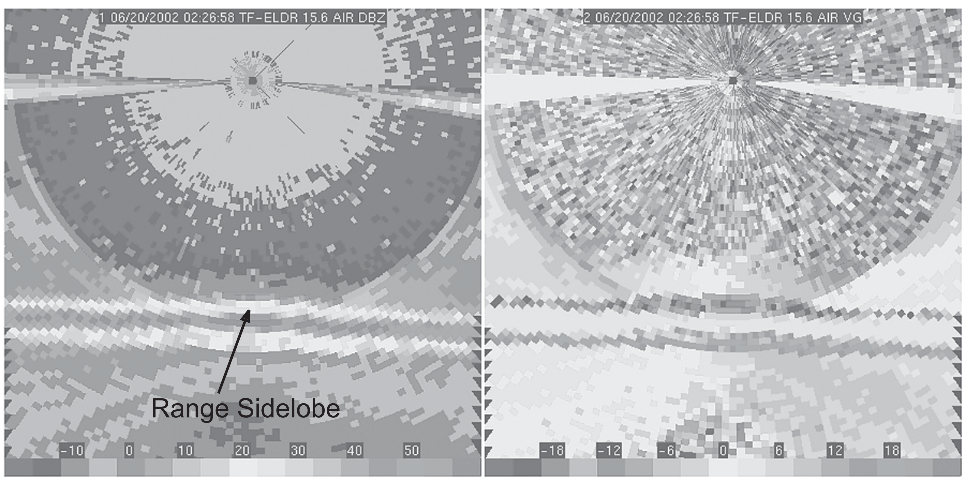

Figure 2. Eldora data from IHOP on 20 June 2002 showing range sidelobe contamination near the surface. Aircraft altitude is 3 km AGL.

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