Range Ambiguity Characterization and Mitigation for the NASA D3R

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The NASA dual-frequency, dual-polarized, Doppler radar (D3R) is a fully polarimetric, matched beam, scanning weather radar system operating at the nominal frequencies of 13.91 GHz (Ku-band) and 35.56 GHz (Ka-band) with an operational maximum range of approximately 40 km. The relatively short operating range, coupled with the high sensitivity of the D3R, frequently results in echoes from previous transmitted pulse to be mistaken for targets in the radar's operational range. These "second trip" echoes result in biased estimates of the radar moments.

Prior works to mitigate second trip echoes have considered using techniques such as waveform phase coding schemes or multiple pulse repetition periods (PRT). These techniques have been evaluated for radars operating at S, C, or X-band. These have shown good results when the first trip and second trip echoes do not overlap with each other, but present a challenge when the echoes overlap. The primary difficulty with applying these techniques is due to the limited unambiguous velocity (which limits the available spectral width).

In this work, an algorithm is discussed to detect and suppress second trip contamination for operational use on the NASA D3R. The technique leverages both a random phase-code and a staggered PRT. Using these methods, the unambiguous range of the D3R can be extended and overlapping echoes can be separated to substantially reduce the bias in the estimated moments. Simulated weather signals are considered to quantitatively characterize the moment estimator's performance (and limitations) over a wide range of realistic weather scenarios. Additionally, a variety of observations from the NASA D3R Ku-band are considered to demonstrate the techniques performance with and without overlapping echoes.