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Atmospheric Measurement Techniques Discussions

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Interactive Comment

Interactive comment on "On differentiating ground clutter and insect echoes from Doppler weather radars using archived data" *by* S. J. Rennie et al.

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The principal criticism of the manuscript was the lack of an assessment of the proposed method. This has been addressed with the addition of Section 6: *Assessment of clutter detection method*, detailing assessment and comparison with other methods. Reference is given to the assessment of insect-derived winds (Rennie et al., 2010) and the problems found with ground clutter contamination. We also discuss the potential success of single-polarization and dual-polarization methods where other parameters may be available to allow dynamic clutter detection. For UK radar data, it was possible to compare results using a polarimetric method, from a small amount of data collected from a dual-polarized C-band weather radar (which data were published in Rennie et al., 2010).

Only one representative example is given of implementing the new clutter map. We considered the inclusion of additional examples, but we felt that these did not illustrate any additional points not adequately demonstrated by the first example. However, the method has been used during the preparation of VADs and radial winds used in analyses (Rennie et al., 2010 and Rennie et al., submitted) so has been well tested and the results have been documented. We have now included a discussion but not repetition of the information that is published elsewhere.

Referee 2 commented that “Additionally, the use of the standard deviation of velocity is not a new concept. It is used in both the dual polarization and single polarization classification algorithms”. The literature regarding use of ‘std. dev. of velocity’ only considers statistical analysis of velocity over sequential pulses (like the spectrum width), or analysis of velocity of a spatial domain within one scan (e.g. Dixon et al., 2005, Ellis et al., 2002). The former is a spectral analysis method which was not available to us, and the second was not useful for our clutter/insect differentiation although it can be useful in QC. Additional text has been included in Section 1 citing use of the spatial standard deviation of velocity, and the use and limits of texture parameters. The most important difference is that the above two methods can be accomplished with one scan in real time, unlike the new method. Our new technique takes the velocities derived from a scan (calculated using all the pulses) and compares it with the velocities from other scans, separated by at least 5 minutes in time, for many scans over many days.

Referee 2 numbered various issues to be addressed, for which responses are below, following quotes of the referee’s comments.

1. Page 1844, Line 2, 18. Use of colloquialism should not appear in formal writing (i.e. fine weather). Is “fine weather” a weather event? What are the conditions that make it “fine weather?” . The term ‘fine’ has been replaced by the word ‘dry’.

2. Page 1845, Lines 23 – 24. “However, the effectiveness of these methods must be reduced for weak signals ...” This statement is unsupported. We have

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reworded this sentence and added a reference to Sugier et al. (2002) regarding ambiguity of clutter and precipitation signals for some spectral parameter values.

3. Page 1845, Lines 25 – 29. The authors indicate that the treatment of "white clutter residue noise" is an important factor to detect insects. How does the proposed technique treat "white clutter residue noise?" The statement indicated that the treatment of a noisy clutter signal is important in detecting insects, and was not meant to refer exclusively to the "white clutter residue noise" or Bachmann's work. This reference now gives a second example of secondary processing in this paragraph (see previous comment). The end of the paragraph has been rephrased with the intention of noting the potential use of others' work removing 'noisy' clutter signal, and observes that clutter mapping methods may be the best solution in the absence of spectral data, such as with the proposed technique. We hope this has clarified the paragraph.

4. Page 1847, Lines 13 – 27. The authors use the term weak signal and low reflectivity almost interchangeably. The term weak signal refers to the signal-to-noise (SNR in dB) level not the reflectivity level (water equivalent reflectivity factor in dBZe). We have carefully considered the wording of this section. In line 14, 'weak signal' is used because the low SNR is the subject of the sentence. The reference to reflectivity on line 18 is meant to refer to Z not SNR. However, it is necessary in practice that any Z threshold at a particular range is consistent with the minimum SNR required. This point is now made more explicitly at the end of this paragraph (see next comment).

5. Page 1847, Lines 19 – 20. The authors state that "the radar detection threshold increases with range due to beam spreading." This statement is incorrect. For distributed targets such as weather the received power drops off as the square of the range. This is due to the increase in radar volume with range and the assumption that distributed targets fill the beam. In range-corrected dBZ space, the detection threshold (for some SNR) increases with range, whereas in count space, the detection threshold is constant with range. Effort has been made to clarify that

that the detection threshold in dBZ will increase with range, since the received power decreases for an identical target at increasing range. Text now reads:

> "Additionally, the detection threshold in dBZ must increase with range as received power decreases for equivalent targets, so a reflectivity threshold should also ensure that a minimum SNR is maintained at long ranges."

6. Page 1847, Lines 25 – 27. The authors state that the SQI and noise threshold techniques are mostly coincidental in identifying ground clutter. Explain the use of the noise threshold option in the proposed technique and the validity of the statement that these parameters (SQI and noise threshold) are coincidental? Yes, the SQI and noise threshold were mostly coincident in identifying sample volumes that would be classified as 'noise' i.e. containing little or no signal, a small SNR. This collocation of SQI- and reflectivity-flagged sample volumes has now been quantified. The noise threshold option was chosen to demonstrate that the proposed clutter detection method required only Z and V (SQI is not necessary). We have included a quantitative analysis of the coincidence of SQI-flagged and noise-flagged sample volumes in Section 2.

7. Page 1848, Lines 6 – 10. The authors indicate that obvious ground clutter registered a velocity of 10 m s^{-1} in their analysis requiring more discriminating methods than just mean velocity. Yet, a basic assumption for the calculation of the standard deviation on page 1850 is that stationary ground clutter velocity is zero. This seems to contradict their earlier statement. Explain. The mean velocity of stationary ground clutter for many measurements is expected to be 0. This does not preclude that one scan's velocity measurement is non-zero where the signal is attributed to clutter. For example, the probability of one scan finding a velocity of 10 m s^{-1} is the same as the probability of a scan finding a velocity of -10 m s^{-1}, in any cluttered location. The standard deviation is calculated over many scans, so the assumption that the mean is zero is valid for clutter.

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8. Page 1851, Line 21. This formula is inconsistent with the radar equation for distributed targets such as weather (see comment 5). The noise threshold equation is a reflectivity threshold in dBZ, with a user-defined minimum value at minimum range, and which increases non-linearly with range. It does not need to correspond with the radar equation, provided that the Z value is lower than the desired values to keep and the signal is higher than the minimum SNR. Such a threshold was described in the response to comment 5 and in the text at the end of the third paragraph in section 2 (Data and Processing), which has been quoted in the response to comment 5.

References

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