

Interactive comment on “Wind turbine impact on operational weather radar I/Q data: characterisation and filtering” by Lars Norin

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General Comments

The author presents an analysis in the time/range domain of I/Q signals near and around masts and wind turbines using a C-band weather radar. Many of the pre-existing studies look at different domains, meaning that this manuscript is a useful contribution to the literature. Of particular note is the presentation of exceptionally robust signal characteristics, especially with changes in blade yaw. The phase gradient plots are particularly interesting.

The manuscript is well-written, has a logical flow, and maintains excellent graphical presentation. The graphics are clear and well-labeled and will allow a casual reader to quickly identify the usefulness of the manuscript. I have some concerns about citations

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and the general claims of performance that I have addressed in my Major Comments, and I have listed several Specific Comments for the author's attention. I know that I have made a lot of comments, but please don't be discouraged; I think the manuscript will be more than acceptable for AMT after a round of revisions, and I fully support its eventual publication. Great job!

Major Comments

1. In general, too many of your citations are from conference presentations. Many of these presentations have resulted in journal publications afterwards, and those are much more appropriate to cite. This is especially relevant for the AMS conferences, as those papers and abstracts are not heavily peer reviewed. There are also areas where inappropriate references were made; I have tried to mention some of these areas.

2. The main issue I have with the manuscript is that it isn't made clear until the very end that the filtering is only applied near "known" locations of wind turbines. I may be wrong, but don't many other cited works in your manuscript assume that the locations are not known? This is important for several reasons. Of course, new wind turbines may be installed; wind turbines may be in an "on" or "off" state, changing their signature; and different atmospheric conditions will change the propagation characteristics of the beam, meaning not only could the signatures change, but they may be non-existent during cases of sub-refraction, or more prominent during super-refraction or ducting, for example. The distinction of whether or not you know where the targets are is important, and can be misleading to the reader. For example, on Page 3 / Line 8, you say that the feature can be exploited to "identify" and remove the turbine. But really the signature is just being used to remove the turbine where you expect it to already be, correct? This doesn't change the usefulness of the manuscript, but I think you should set up the reader in such a way that this will only be applied in the appropriate places. It may be appropriate both in the abstract and the introduction.

3. The removal of contaminated data in precipitating echoes is not quantified. We don't

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see “before” and “after” spectra in precipitation; this is something I would expect to see. We also don’t have an easy truth to compare with, meaning there would need to be a way to quantify the added and removed bias. This is all ok, but it means that using words such as “significantly” improved data is inappropriate. If the improvement is only shown qualitatively (i.e., before and after pictures of the data) rather than quantitatively, the claims must be quelled to what the data actually show. If we don’t have clues regarding the quantitative decrease in bias in precipitating echoes, claims regarding “significant” improvements should not be made.

Specific Comments

1. Page 2, Line 4: I think there are better references you can cite here; the Ridal and Dahlbom paper is still in review, and there are older references you can cite. Here are some examples I would recommend instead:

Sun, J. and J. Wilson, 2003: The assimilation of radar data for weather prediction. *Meteorological Monographs*, 52, 175–198.

Xue, M., D. Wang, J. Gao, K. Brewster, and K. K. Droegemeier, 2003: The Advanced Regional Prediction System (ARPS), storm-scale numerical weather prediction and data assimilation. *Meteorology and Atmospheric Physics*, 82, 139-170.

Zhao, Q., J. Cook, Q. Xu, and P. Harasti, 2006: Using radar wind observations to improve mesoscale numerical weather prediction. *Wea. Forecasting*, 21, 502–522.

2. Page 2, Line 5: Similar to previous comment; the Berg et al. citation isn’t really appropriate here. Cite the seminal papers. Here are some examples:

Corral, C., D. Sempere-Torres, M. Revilla, and M. Berenguer, 2000: A semi-distributed hydrological model using rainfall estimates by radar. Application to Mediterranean basins. *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere*, 25, 1133-1136.

Carpenter, T. M., K. P. Georgakakos, and J. A. Sperflagea, 2001: On the parametric

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and NEXRAD-radar sensitivities of a distributed hydrologic model suitable for operational use. *Journal of Hydrology*, 253, 169-193.

Ganguly, A. and R. Bras, 2003: Distributed quantitative precipitation forecasting using information from radar and numerical weather prediction models. *J. Hydrometeor.*, 4, 1168–1180.

Gourley, J. and B. Vieux, 2005: A method for evaluating the accuracy of quantitative precipitation estimates from a hydrologic modeling perspective. *J. Hydrometeor.*, 6, 115–133.

3. Page 2, Line 6: I would make it clearer why a conventional ground clutter filter doesn’t work here. Mention that a notch filter at zero Doppler doesn’t work due to the blades being in near-constant motion during any existence of wind.

4. Page 2, Line 11: Add a comma between “weather radars” and “several studies”

5. Page 2, Line 13: Change “US” to “United States” (this applies across the manuscript, e.g., Line 27 on the same page). Another option is to use “U.S.” (with periods).

6. Page 2, Lines 20-21: The final sentence of this paragraph is a run-on sentence. Break it up with appropriate commas.

7. Page 2, Lines 23-24: It is misleading to say that I/Q data are collected at much higher resolution. What about a short-pulse radar that doesn’t use any range oversampling? The sampling rate could easily be identical to the range resolution of the radar. If you mean that there are more samples in time (which I wouldn’t really consider temporal resolution, per se), say that instead. Changing this sentence may require changes to the following sentence.

8. Page 2, Line 34: The Nai et al. reference is from an older conference paper. I would cite their most recent journal paper as follows instead:

Nai, F., S. Torres, and R. Palmer, 2013: On the mitigation of wind turbine clutter for

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weather radars using range-Doppler spectral processing. IET Radar, Sonar & Navigation, 7, 178-190.

9. Page 3, Line 4: Add a comma between “of the radar” and “the I/Q data”
10. Page 3, Line 18: Change “1990ies” to “1990s”
11. Page 3, Line 21: Add a comma between “two polarisations” and “the modernised”
12. Page 2, Line 22: No change necessary here, but note that your higher sampling rate is not a universal standard for weather radars (see back to Specific Comment 7). So maybe back on Page 2 you can specify that this is the case for the Swedish radars, specifically.
13. Page 3, Line 26: “radars” should be “radar” and a comma is needed after “radar systems”
14. Page 4, Line 9: Rather than provide the number of pulses by “scan,” it would be preferable to mention roughly how many pulses are used for a given azimuth, for example. In other words, how many pulses did you use to process the individual gates that were contaminated? The number of pulses in the scan is irrelevant in my opinion.
15. Page 4, Line 17: Define the SMHI acronym for the unfamiliar reader.
16. Page 4, Line 20: Same as above for the LFV acronym.
17. Page 5, Lines 1-3: This is a run-on sentence. Break it up with commas in the appropriate locations.
18. Page 5, Line 13: Can you explain why the maximum amplitude is so far “behind” the mast location rather than at the mast location? Maybe I missed something.
19. Page 6, Lines 7-8: It sounds awkward to start back-to-back sentences with “As for the mast...”
20. Page 7, Lines 6-7: It should be made clear that, so far, you have only indicated

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that these targets can be easily recognized without the presence of weather or other echoes.

21. Page 7, Line 16: Change “due to width of the radar main lobe” to “due to the width of the radar main lobe”
22. Page 9, Lines 7-8: Can you comment on why the “centers” of the amplitudes change by nearly 150 m? Is this a sampling issue? I wouldn't think so with a sampling rate of ~15 m.
23. Page 9, Line 10: Change “is out of the scope of this paper” to “is beyond the scope of this paper”
24. Page 9, Lines 13-18: I think it is quite a stretch to say that the point target signatures are “robust, albeit slightly different” when changing the pulse length. The difference between pulse lengths is significantly higher (Figure 7) than in your previous comparisons. Maybe just acknowledge this difficulty and move on; but I don't think they are similar enough to use the same descriptors from earlier sections.
25. Page 10, Lines 33-34: Change “it may a good idea” to “it may be a good idea”
26. Page 11, Lines 9-15: Was this case during precipitation? If so, it should be noted.
27. Page 11, Lines 21-23: This is a run-on sentence. Add commas where appropriate.
28. Page 12, Lines 3-4: Regarding the final sentence in this section; the improvement of the reflectivity factor data is qualitative at best; no bias estimation is provided, especially in the precipitation regions. You have suppressed turbines in some instances, but it's not appropriate to conclude that you have made a “large improvement” on the data. The subjectiveness of this means the sentence should be removed.
29. Page 12, Line 24: “amplitudes” should be singular
30. Page 12, Line 33: Remove “significantly” – it is subjective, as we have seen nothing quantitative to suggest a statistically significant removal of clutter, especially in precip-

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itation. The results are simply plots of before and after; they are qualitative in nature.

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