amt-2022-316 Authors answers to Reviewer 1 comments.

General Comments

As with the earlier paper from Lainer et al. (2021) it was a fun for me to read this manuscript. It is the first time I find my review to be cited in the next publication :-).I strongly recommend to publish its content. Nevertheless, some improvements are necessary and among them are important issues.

We warmly thank the Reviewer for their positive feedback and appreciation of our work. We answer below point-by-point to the concerns and suggestions.

The most important issue is the interpretation of the presented measurements. I do not see anything "peculiar". Let me describe my point of view a bit more detailed; A WT is a scatterer that is neither small compared to the radar wavelength nor is it small compared to the diameter of the main lobe of the radar beam. It is - in general - not of constant shape but changing its properties with (i) nacelle orientation, (ii) rotor angle, and (iii) blade angle. The shape of the rotor blades even changes with (iv) wind speed, as the blades are bended by the wind. The echo "seen" by the radar further depends on the (v) elevation under which the radar "looks" at the WT and the exact (vi) height and (vii) horizontal position and (viii) the diameter of the radar beam at WT position. Furthermore, the (ix) position of the WT within the recent range gate of the radar has to be considered. --- There are more but minor dependencies that impact the echo from a WT, as the distance between radar and WT which is implicitly included in (v) to (ix) but further indicates how well the radar beam can be approximated by a plane wave.

We thanks the Reviewer for this relevant and well-phrased input, which is kindly appreciated. Indeed, we find this clear and exhaustive scheme very helpful for a better understanding not only of the present results; of which we are confident, but also for a future, exhaustive and detailed analysis of longer temporal intervals during which the WT rotor speed was zero (e.g., on March 19).

Regarding March 19, following the input of the Reviewer we conducted a preliminary analysis of 93 minutes (nine 10-min intervals plus one lasting 3 minutes and 5 seconds) characterized by zero rotor speed, which confirms the main results of our short paper. Most of all, it confirms also your interesting above-listed interpretation scheme. The last page of the present document presents a short summary of this preliminary analysis. Because the results agree with our current findings we decided not to include them in the revised version extensively, in order to keep the message of the manuscript as easily conveyable as possible and to keep the paper short.

To give a more intuitive description I cite an engineer who once told me: Imagine the WT was coated with polished chromium and you light the WT with a spotlight. You see the reflections gliding over the surface of the WT, occurring and vanishing with the motion of the WT. At visible wavelengths the surface of a WT is mat but at radar wavelengths it appears to be glossy.

We thank very much the Reviewer for this intuitive and illustrative description. We are glad that Reviews are public in this journal, so that they are available to the readers.

For the antenna we call the dependency on azimuth and elevation its directivity pattern. We know, the larger the antenna the stronger the (possible) gradients of the directivity pattern. For the scatterer the corresponding term is "differential scattering cross section." Which, in the end, is nothing else but the directivity pattern of a scatterer. The differential scattering cross section of a WT is at least(!) dependent on the nine parameters mentioned above (i to ix). As the WT is much larger than the radar antenna, we have to expect very strong gradients of the differential scattering cross section to occur.

The presented study investigates variation due to the first four parameters, keeping all radar related parameters constant. The stability of the echoes during periods where the WT is standing still (condition "a" in the discussion) indicates that WT and radar are very reliable. The variations of the echoes of different "type a" periods simply show the dependency on rotor angle and blade angle. As these two angles are random but constant the measured values are random but constant.

For a slow rotating rotor the experiment measured the differential scattering cross section at high resolution, mostly regarding rotor angle. We see all the extreme values. With increasing rotational speed (and constant temporal resolution) the angular resolution at which we see the crossection is reduced/coarsened. Thus the extreme values are smoothed out, everything looks smoother. This is immediately seen in the figures.

On the other hand: rotor speed is totally unimportant for an instantaneous (single) radar beam and its echo. The integration over several pulses (here 128) introduces changes in the echoes due to rotational speed.

Again, very kind of you to share with us your explicative interpretations of the figures: we are glad that Reviews are public in this journal, so that they will be available to all the readers.

There is nothing peculiar but the scattering cross section of a WT is complicated. So, please, shorten the title and remove the term "peculiar". (E.g.: "On the polarimetric backscatter of a still or quasi-still wind turbine.")

We entirely agree with this comment (and with Reviewer 2): we have shorten the title following this suggestion.

Dealing with the partially very precise time information is difficult and inconvenient. I propose to add two different indicating schemes:

1. Mark the four 10-min periods for which you have WT properties as I to IV in the figures. (Introducing e.g. black vertical markers at 17:10, 17:20, 17:30 and creating the four different "WT time steps".)
2. Mark those periods with comparable rotational speed and blade angles as indicated as a) through d) in the discussion by e.g. blue vertical markers and indicate the periods as a_1, a_2, a_3, b_1, and so on.

Thank you for the suggestion: indeed, we have “labelled” the “distinctive” periods of interest, also in each Sub-sec title. P1, from 17:08 to 17:10, which corresponds to a still WT; from P2 to P4, the successive three 10-min intervals.

Most of the precise time indicators in the text could be replaced by these indications of time periods. The markers can occur in the figures 2 to 5. Figure 6 and 7 should then be assigned to the corresponding periods.

We thank the Reviewer for the suggestion, that we included in the revised version of the manuscript A thick line in Figure 2 introduces the sub-period P2.a, which is shown in Fig. 7. P2.a is thoroughly described in Sec. 4 “Discussion (despite it lasts only 8.96 s!)

Two “start” and “stop” markers are associated with P2.b, which lasts 80 s, are shown in Fig. 6 and is thoroughly described in the same Sec. 3.2 (rotor partial rotation equal to 72 deg and blade pitch angle changed from 70 deg to 65 deg).

The authors expect the differential reflectivity to be close to 0 dB (line 435: "easier to understand"). If we recall that photographers use a polarizing filter to reduce reflections on (glossy) surfaces we know that reflections at (glossy) surfaces may introduce polarization effects. Especially, multiple reflections (internally, only from the WT) will cause strong polarization of the backscattered signal. (Review also Line 387 f.)

Indeed, we are deeply grateful for this explicative and clarifying comment: we agree that the exclamation mark at line 388 is certainly misleading. Furthermore, this comment helped the authors to shorten al the three “bullet-sentences”.

Minor remarks

The abstract shows already very detailed information which is not necessary. If the authors insist on having these details in the abstract, they should add the distance between radar and WT.

We agree with the suggestion and we have rewritten the abstract following the suggestions of both Reviewers.

Gabella et al. (2008) (line 90), Gabella and Perona (1998) (line 92), and the book by Fabry (line 191) do not show up in the references. I did not check more entries but obviously the references have to be controlled.

We apologize about the omission. We have checked the references in the revised version. We thank the Reviewer for spotting this issue.

In line 108 it needs to be 180 m x 180 m x 75 m. We have added twice the units (m) after 180.

Line 182: remove one "that" Removed, following the suggestion of the Reviewer.

Line 373: red curve in Fig. 2 (not inf) “f” has been deleted.

Line 412: Shouldn't it be "It could have been caused"? Thank you for correcting my mistake.

Line 430: The comma is falsely shifted to line 431.We corrected the typo and thank the Reviewer for spotting it.

Line 452: Remove "have". Deleted

Line 473f: Use Z_v as introduced in 2.3.1 and not ZV. (Same for ZH) The variables appear now as Z_h and Z_v, thank you.

ADDENDUM

PRELIMINARY ANALISYS REGARDING 92 MINUTES OF PERFECTLY STILL CONDITIONS ON MARCH 19, 2020.

From 3:30 UTC to 5:10 UTC, none of the 3 most relevant parameters for the backscatter have changed.
Both nacelle orientation and blade pitch angle have remained the same. Most of all, the 10-min average (and even max.) rotor speed was constantly equal to 0. Not surprisingly, all 86250 ρ_{hv} values were equal to 1 (DN=255).

Table 1: Values of ρ_{hv} during 102 minutes on March 19

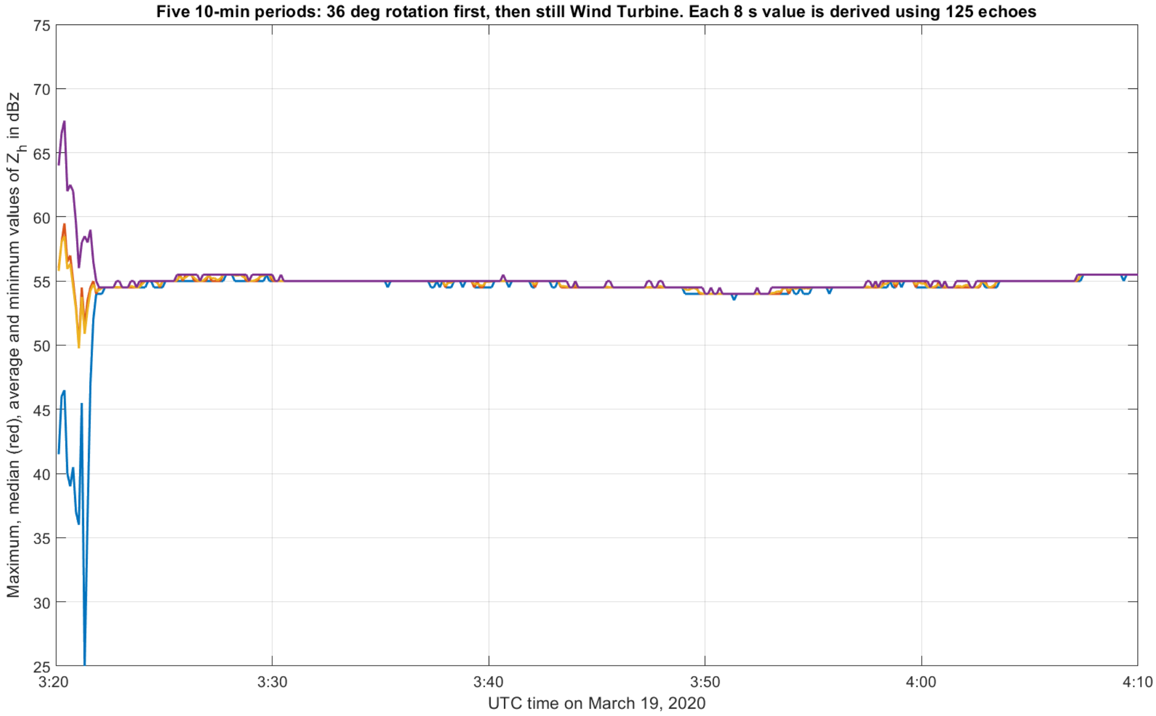
UTC time	10-min average rotor speed in m/s	10-min average	10-min median	10-min MAX.	Sequential # of intervals
03:20-03:30	0.01	0.9854	1.0000	1.0000	1
03:30-03:40	0.00	1.0000	1.0000	1.0000	2
03:40-03:50	0.00	1.0000	1.0000	1.0000	3
03:50-04:00	0.00	1.0000	1.0000	1.0000	4
04:00-04:10	0.00	1.0000	1.0000	1.0000	5
04:10-04:20	0.00	1.0000	1.0000	1.0000	6
04:20-04:30	0.00	1.0000	1.0000	1.0000	7
04:30-04:40	0.00	1.0000	1.0000	1.0000	8
04:40-04:50	0.00	1.0000	1.0000	1.0000	9
04:50-05:00	0.00	1.0000	1.0000	1.0000	10
05:00-05:02	0.00	1.0000	1.0000	1.0000	11

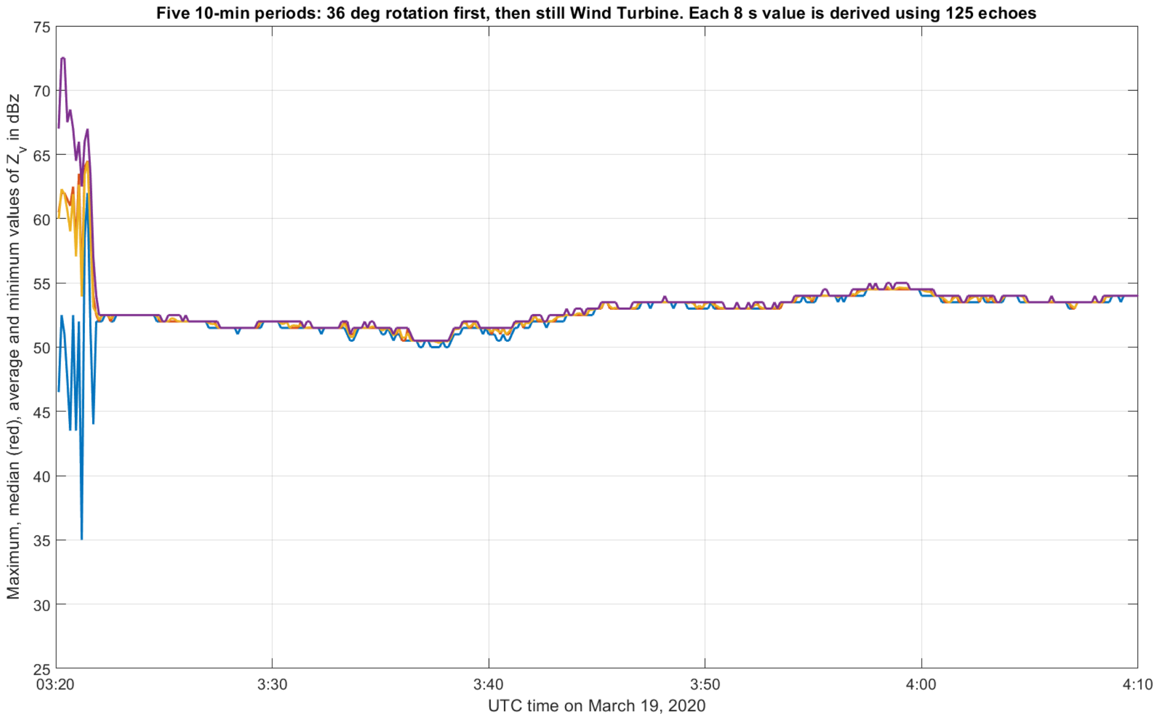
From 3:20 UTC to 3:30 UTC, only a partial rotation of 36 degree has occurred, which has caused several “drops” of ρ_{hv} below 1. During this 10-minute period, the range of Zh (Zv) goes from 25 (35) dBz to (72.5) 67.5 dBz, as it can be seen in Table 2.

Table 2: Minimum and maximum values of the radar reflectivity factors during five 10-min intervals.

UTC time	10-min average rotor speed in m/s	Z_h 10-min minimum	Z_h 10-min Maximum	Z_v 10-min minimum	Z_v 10-min Maximum
03:20-03:30	0.01	25.0 dBz	67.5 dBz	35.0 dBz	72.5 dBz
03:30-03:40	0.00	54.5 dBz	55.5 dBz	50.0 dBz	52.0 dBz
03:40-03:50	0.00	54.0 dBz	55.5 dBz	50.5 dBz	54.0 dBz
03:50-04:00	0.00	53.5 dBz	55.0 dBz	53.0 dBz	55.0 dBz
04:00-04:10	0.00	54.5 dBz	55.5 dBz	53.0 dBz	54.5 dBz

Finally, the figures in the next page show the minimum, median, average and maximum values of the radar reflectivity factor every 8 s during 50 consecutive minutes (see table 2 above) for horizontal (top picture) and vertical polarization (bottom picture). Being the original sampling time 64 ms, 125 “echoes” have been used to derive such four statistical indicators, two for the central location and two for the envelope. In turn, each echo has been derived by the Radar Signal Processor using 128 pulses (128 I and Q values) for each polarization state.


Five 10-min periods: 36 deg rotation first, then still Wind Turbine. Each 8 s value is derived using 125 echoes
Maximum, median (red), average and minimum values of Z_h in dBz
UTC time on March 19, 2020
75
70
65
60
55
50
45
40
35
30
25
3:20
3:30
3:40
3:50
4:00
4:10


Five 10-min periods: 36 deg rotation first, then still Wind Turbine. Each 8 s value is derived using 125 echoes
Maximum, median (red), average and minimum values of Z_v in dBz
UTC time on March 19, 2020
75
70
65
60
55
50
45
40
35
30
25
03:20
3:30
3:40
3:50
4:00
4:10