amt-2022-316.R2 Authors answers to Reviewer 1 comments dated 10.6.2023 (2nd Revision)

It is still my opinion that this manuscript should be published. In terms of its content, I do not have much more to criticize about the present manuscript. Only a few small things still remain that somewhat limit the readability. In addition, I still found some typos.

The more important issues are:

There are three angles that define the orientation of a rotor blade. Without a sketch it is difficult to make clear which angles are meant. "Nacelle orientation" is quite easily understood. Nevertheless, you did not specify what is meant by a "relative" nacelle orientation. We think that it is enough to use the expression ”orientation”, since a schematic view of two wind turbines in relative nacelle positions of 0° and 270° with respect to the radar angle of attack is presented in Figure 3a in Lainer et al (2021). Consequently, we have deleted the adjective “relative” in the caption of fig. 1. Furthermore, we have added in this revised version of the paper (line 140) a reference specifying that we refer to the same configuration of Lainer et al. 2021.
The second angle is normally the "blade pitch" or "blade pitch angle". You call it the "blade angle", but this could also be the angle of the blades rotation (being e.g. 0° when pointing vertically upwards, 90° when pointing horizontally, 180° pointing vertically downwards, and 270° when pointing horizontally to the other side). Furthermore, what is a blade pitch angle of 0° and one of 90°? I assume 90° is the feathered position of the blade. - Please, introduce a clear description. Sorry, in this revised version we now use the expression “blade pitch angle” everywhere. Yes, according to what we have learned from Hegauwind GmbH, the blade pitch angle, Θ, is the angle between the chord and the plane of rotation, so that it is close to 0 deg for average rotor speed, rs, larger than 6.5 rpm (most likely situation in Fig. 1, 12 hours) and around 70 deg for rotor rs≈0. In Fig. 1, a “rare”, 3rd “intermediate” configuration state can be seen, see e.g., P3 (rs=2.25 rpm; Θ=15 deg), P7 (rs=2.81 rpm; Θ=28 deg) and P8 (rs=4.63 rpm; Θ=27 deg). As stated, an explicit reference to the clear description of Lainer et al. 2021 has been added in this revised version of the paper at line zxc.

I am still missing the interpretation that during (comparable) fast rotation of the WT's rotor the radar measurement are averaged over a larger rotation angle. This leads to a more stable mean value of Zh and Zv while the range from minimum to maximum individual measurement is hardly reduced. We have added such interesting interpretation in Sec. 3.3, which is focused on period P3 (17:20-17:30); if we assumed that 30 rotations had occurred between say 17:24 and 17:28 (median rhoHV between 0.7 and 0.8), then one rotation would occur in exactly 8 s, which is exactly the interval of the running median (black dashed line), running minimum (blue) and running maximum (green) displayed in the plots.

On the other hand I'm missing a remark on the very high reproducibility of the measurement as long as the rotor is not moving. It proves how reliable your measurements are. There is (nearly) no unexplainable, external noise but variations are reliably representing changes in the measured signal from the WT. Both points are important as no operational radar can see what you measured in this experiment. It was fundamentally to keep the radar beam orientation fixed. With a scanning antenna you always see changes due to both: the WT movement and the radar antenna movement. Yes, indeed! We have modified/integrated the last paragraph of the manuscript accordingly.

In line 412 the "sufficient wind condition" lasts von 17:22 to 17:28, line 415 uses the same times, but in line 354 you refer to 17:23 to 17:28 - and I think you talk of the same period. Yes, sorry for such inconsistency: we have opted for changing (twice) 17:22 into 17:23, which seems more appropriate to us (according to Figs. 2-5).

I still have my difficulties with all these time information. Please, name the time periods and/or the times an refer to these names. There is no use to call 17:10 to 17:20 period P2 and then, two lines later, you again write 17:10 to 17:20 instead of P2. There are more then 50 references to some point in time within the manuscript. Each demands the reader to find

that time in the figures; sometimes in more than one. From my point of view, there are 7 main periods: from (i) 17:08 to 17:13 (still WT), (ii) P2b, (iii) 17:14:40 to 17:17 (still WT), (iv) 17:17 to 17:23 (slow movements), (v) 17:23 to 17:28 (fast movements), (vi) 17:23 to 17:39:20 (slow movements), and (vii) 17:39:40 to 17:40 (still WT). You may (and do) subdivide these periods in smaller details (especially Figs 6 and 7). But please, reduce the number of indicated times significantly. Yes, we have tried to reduce the number of indicated times; also Reviewer 2 has recommended to use the same time stamp format in the manuscript (see, e.g. lines 133-137, 145, 149, 151-154, 246, 255, 299, new lines 330, 337… , 351, 352, 363, 415). In particular, we have made Sec. 3.2 more concise. We are grateful to both Reviewers for their helpful and coherent suggestions.

Minor remarks

line 82: Type in the position. It is 47.700° and 8.664°. typo corrected.

line 110: Is it important that the electromagnetic field is not planar? It is nearly because the opening angle of the antenna beam is only 1.3°. The more important point is, that the surface of the WT is not "planar". We have rephrased the sentence: the focus is now on the not-planar, complex shape of the WT.

line 146: Please point out, that the rotation of 72° is not continuous during the 10 min interval. We have included this remark in the revised version of the manuscript.

line 163: "... measure two values that are orthogonal"? The values are not orthogonal. The corresponding polarization planes are. We have corrected the sentence, thank you.

line 168: Did you introduce DN? If not, you should not make use of it. Introduced.

lines 188f: You did not introduce HH and VV, so you should not use these terms. Removed in the revised version.

lines 194ff: "... of the backscattered electromagnetic field within the radar sampling volume ... " is a wrong reference. The scattering took place in the radar sampling volume. The measurement took place in the radar. We have rephrased the sentence. It is now shorter and simpler.

lines 225ff: The enumeration is a repetition of what is given since line 214. It should be removed. Removed.

line 233: The standard deviation of an equally distributed angle between 0° and 360° is 360°/sqrt(12). I recommend to rewrite as 60° sqrt(3). This has been rewritten. Now the square root is at the numerator rather than at the denominator.

line 245: "has already took place"? Shouldn't it be "has already taken place"? Mistake corrected, thank you.

line 305: Fig .5 should be Fig. 5; Typo corrected (“switching the blank”)

line 321: "..\Psi_{dp} was oscillation between 11° and +5°". Please, indicate if you meant -11° or +11°. When using the "+" for 5°, do it also for 11°. Yes, sorry, from +11 to +5 deg.

line 341: "in the figure shown in sec 3.2". Are you talking of Fig. 6 of this manuscript? Yes, sorry, I am exactly referring to Fig. 6; I have rephrased line 341 accordingly.

line 343: maximum (green (not red)), minimum (blue (not cyan)) Absolutely right: sorry for not having updated the color correspondence. Note that, following the suggestion of Rev. 2, we have opted for moving such info directly into the figure captions.

line 271: Please mention, that the value of 56.5 dBz is a random result. The important point is the stationarity. Excellent suggestion, thank you: this important observation has been added to the text.

line 470: The given range of Zv values is again arbitrary. The information is the small variation. Additionally, you should emphasize here that a moving radar will never observe this persistence. Same as above (text at line 271).

line 358: What is interesting in the fact, that Zh reaches the 3rd maximum? As you pointed out in (the green emphasized) lines 271 and 470, these values are somehow arbitrary, too.

lines 359f: "In correspondence... " This is no sentence. Additionally, I do not get, why you mix information on ZDR and Zh of the echoes before and after. Indeed, as you properly pointed out in (the green emphasized) lines 271 and 470,

such values are arbitrary. Furthermore, you are right, there is no need to mix Z_{dr} and Z_h information. Consequently, we have deleted the Z_{dr} related parts, thank you very much.

lines 371f: I do not find these ZDR values in the figures. What is wrong? There is nothing wrong. Since they do not represent neither the maximum, nor the minimum, nor the median value during 8 s, then nobody could find such "64 ms Z_{dr} values" in Fig. 5, which displays the running MAX., median and minimum with a sampling time of 8 s. Three lines before line 371, we have now added in the text that such echoes have a temporal resolution of 64 ms (as in the line before 371, where we wrote "In both cases "In both cases the two 64 ms echoes are consecutive").
line 371: Both times have typos. Indeed, sorry about that. Now they are correct.

amt-2022-316.R2 Authors answers to Reviewer 2 comments dated 10.6.2023 (2nd Revision, "R2")

General Comments

The authors have adequately addressed most of the comments raised in the Reviewers' documents, resulting in an improved readability of the manuscript. I appreciate the efforts made to redraw the images, which are now clearer to the reader. The text has also become more lucid, and the manuscript's structure has been logically organized.
However, there remain a few minor issues that I would like to bring to the authors' attention, which I believe should be addressed prior to the publication of the final paper.
We thank the Reviewer for the positive feedback and for the additional suggestions and remarks that we have implemented in this further revised version of the manuscript.

Minor Issues

The new abstract version is improved, just a few comments:

-In line 16, it is stated that "the copolar correlation coefficient between the two orthogonal polarization states was persistently equal to 1." However, in lines 23-24, it is reiterated that "the copolar correlation coefficient between the two orthogonal polarization states, ρHV backscattered by a still Bright Scatterer should be equal to 1." To avoid repetition, it is unnecessary to include the phrase "between the two orthogonal polarization states" in the second instance. And I suggest to include the symbol ρHV the first time the variable is mentioned, which is in line 16. However, the last sentence in line 24-25, which states, "It is confirmed that the copolar correlation coefficient between the two orthogonal polarization states, ρHV backscattered by a still Bright Scatterer should be equal to 1 if observed by a non-rotating radar antenna," feels somewhat awkward. Actually, it might be more effective to consolidate the information and state it in line 16 as follows: "The copolar correlation coefficient, ρHV, between the two orthogonal polarization states was persistently equal to 1, similar to the signature of a Bright Scatterer (BS) observed by a non-rotating radar antenna."
This is indeed a good suggestion, which we have gladly implemented.

-Line 34: yes, we now use "strong", which is better than "heavy".
-Line 47: the link has been moved to the References, thank you.

Last paragraph in Introduction, starting from 68. I would move all the description or statements of results from this section either to discussion or abstract, but not in this section. I suggest rephrasing. Sorry, if possible, we would prefer to keep such introductory part that helps the readers orienting themselves depending on their specific interests; for instance, a weather radar expert interested in the signatures of the WT, would skip Sec. 2 and go directly to Sec. 3.

The manuscript is quite burdensome to read due to the rigorous indications to the time stamps. To help the reader I would suggest always using the same time stamp format, i.e. the chosen e.g. 17:20 UTC. For example, in line 133: "followed by a quiet period that was approaching in the last twenty minutes preceding 17 UTC", why not 16:40 – 17:00 UTC. Another example in lines 422-423. Please rephrase the whole document accordingly. We have rephrased the document accordingly, thank you for the suggestion.

Equation 2: I believe the division sign is accidentally marked as subscript? You are right, sorry. Now it is correct.
I have a general comment regarding the Figure descriptions in the manuscript. It would enhance readability if the information about line colors and dots in the Figures are included directly in the Figure captions, for example, in lines 148 and 243. Lines and dots color is now described both in the text and in the caption.

-Line 340. Missing space before “Similarly...”. Space added.

-In lines 343 – 342 are referred to the colors of the old Figures. I suggest removing the color descriptions from the text and keeping them only in the captions as suggested above. Color description removed.

-In lines 351-352 are stated the mode and mean. Should these be removed or if not, maybe to add in parenthesis (not shown here). You are right, thank you very much. We have opted for removing such detail regarding mode and mean.

-In lines 406 and 468: The word “peculiar” is still used. We apologize for having forgotten to substitute peculiar with distinctive, as per your kind and helpful suggestion during Revision1. Now, it is done.

In line 409, “quite impressive”, I suggest e.g. the word significant instead. Done, thank you.

-Please ensure that each abbreviation is clearly defined upon its first mention, for instance, DN, RCS, rs, HH, and VV. Actually, I don’t think HH and VV are needed and as they are not used elsewhere, they could be removed. DN and RCS have been introduced. Rs, HH and VV have been removed.

-The paragraph starting 244 is already describing the first P1 period results. I suggest moving it to 3.1. If possible, we would rather keep it in such introductory part of Section 3, followed by detailed discussions in the sub-sections 3.1 to 3.4.

-The start and end of the P2a and P2b are plotted only to Figure 2. I would suggest adding them also to the Figures of the other variables. Now, we indicate the P2a and P2b periods in all four Figures (2-5).

Figure 2: “that contains the pole of the wind turbine” is confusing phrase. Does it mean that it doesn’t include the blades? Thank you for the observation. Since such geometrical aspect is thoroughly described in lines 106-108, we have simply shortened the text by deleting “pole of the”.

Spoken language is in lines 334-335 and the same questions are used again in lines 434. I suggest rephrasing. The paragraph (now lines 335-337) has been rephrased and shortened.

Figure 7. Are the lines e.g. maximum or mean, please specify. Fig. 7, just like Fig. 6, shows radar measurables at the original 64 ms sampling time (derived from 128 I and Q values acquired with a 2 kHz PRF).