Atmospheric Measurement Techniques Discussions

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CommeComment on "On the peculiar polarimetric signatures backscattered by a still or quasi-still wind turbine acquired by an X-band radar in stare mode at high temporal resolution (64 ms): preliminary investigations"nt on amt-2022-316

Anonymous Referee #1

Referee comment on "On the polarimetric backscatter by a still or quasi-still wind turbine" by Marco Gabella et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-316-RC1, 2023

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.

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 aproximated by a plane wave.

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.

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.

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.")

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.

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.

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.)

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.

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.

In line 108 it needs to be 180 m x 180 m x 75 m.

Line 182: remove one "that"

Line 373: red curve in Fig. 2 (not inf)

Line 412: Shouldn't it be "It could have been caused"?

Line 430: The comma is falsely shifted to line 431.

Line 452: Remove "have"

Line 473f: Use Z_v as introduced in 2.3.1 and not ZV. (Same for ZH)