

## General Comments

The topic of this study is both interesting and timely as the weather radar community seeks to find mitigating actions to cope with the increasing number and size of wind turbines. One of them is to understand how the wind turbines are seen in the observations and can this information be used to identify and remove the wind turbine echoes as simultaneously keeping the precipitation echoes. The polarimetric variables has generally proven to be a useful metric for the classification of clutter and there have not earlier been many studies of the polarimetric signatures, one comes to mind Hall et al. 2017, where the dual-pol variables are used to classify the wind turbine echoes at C-band with a fuzzy logic - based methodology.

I find this study important, and it provides new insights that can be used to develop classification algorithms. However, in my opinion, this manuscript and the presented research are not yet scientifically mature enough to be published, and I would recommend major changes. The authors acknowledge that these are preliminary investigations in the title, and I would encourage them to analyze their dataset more thoroughly to provide more conclusive results, including the second period of still wind turbines (March 19, 2020), which would strengthen their findings.

Thank you for your stimulating and encouraging comments and the helpful information regarding the interesting study of the polarimetric signatures by Hall et al., of which we were not aware. Yes, there is still potential in our dataset, for not only polarimetric measurables, but also regarding Doppler and Spectrum width. Not limited to still conditions (March 19), but also for the other days. We hope we will be able to exploit it thoroughly in future years.

Regarding March 19, following your stimulating input, we have 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. In particular, from 03:30 UTC to 05:10 UTC, there were ten 10-minute periods characterized by 0 rotor speed. As you will see in the preliminary analysis presented at the end of this document, they confirm the main findings of the present short note:

- $\rho_{hv}$  always equal to 1.000 (to be precise, DN=255, namely rhoHV larger than  $\sim 0.996$ ); this means a 2-way biunivocal ( $r_s=0 \leftrightarrow \rho_{hv}=1$ ) correspondence (so far) during eleven 10-min periods (ten on March 19, one on March 4).
- Very small dispersion and temporal variability of Zh, Zv and Zdr.

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.

As noted by Anonymous Referee #1, the title is quite complex, and I agree that it could be shortened. Additionally, the use of the word "peculiar" to describe the polarimetric signatures is confusing, and I suggest using another adjective, such as "distinctive." Checking the Merriam-Webster dictionary the word peculiar is defined as characteristic of only one person, group, or thing: DISTINCTIVE or different from the usual or normal: ECCENTRIC, UNUSUAL. I assume the authors have meant the first interpretation, but I and I assume also the other Anonymous Referee #1 interpreted the second option and it was slightly confusing to read the manuscript. The language throughout the manuscript should be checked for any phrases or words that are more appropriate for spoken language than written language. While I am not a native speaker, I can provide some examples in the minor comments section.

Thank you so much. It has been so kind of you and Reviewer 1 to clarify this important aspect and to help us in finding a better title. Indeed, we meant "distinctive" rather than "eccentric"; however, we think that the best way to avoid any confusion is to follow the suggestion of both Reviewers: avoid using the adjective "peculiar".

Thank you also for the patient help with the English language, as none of us is a native speaker, too. We appreciate very much your help and are grateful for the valuable suggestions in the "Minor comments" section at the end.

In the detailed theoretical explanations or definitions, such as in section 2.3, the authors should pay attention to using precise definitions. For example, the authors should distinguish between radar reflectivity and reflectivity factor, which

have different dimensions. I suggest providing an exact definition of these terms in the manuscript and then stating that the authors will use reflectivity to refer to reflectivity factor throughout the manuscript, as is common practice in the field. In the manuscript, we have always used the 1-word term “reflectivity” for  $z$  instead of the more complete form “radar reflectivity factor”. Yes, as stated in the manuscript  $[z] = \text{mm}^6/\text{m}^3$ , while using a Logarithmic transformation  $[Z] = \text{dBz}$  (see line 163 of the original submitted manuscript). Similarly, I have seen that in many papers/books the 1-word term “reflectivity” is used for  $\eta$ , which is the total equivalent backscattering cross-sectional area per unit volume. However, in the paper, there is no need to use  $\eta$ .  $[\eta] = \text{m}^2 / \text{m}^3$ . In Sec. 2.3.1 we have adopted your helpful suggestion above. Up to that point, we have always used the complete form “radar reflectivity factor”. After that, in a few cases, we have used reflectivity, as it is common practice in the field.

## Major Comments

As Anonymous Referee #1 noted, the abstract is way more detailed with the specific numbers. I would suggest rewriting the abstract by firstly providing a brief description of the measurement setup and then main conclusions without referring to specific periods.

We have rewritten the abstract following the suggestions of both Reviewers.

The suggestions of Referee #1 were good to clarify the periods of interest, the authors should name them and indicate them in the figures. Referring to the chosen names in the text will make the manuscript easier to read.

Thank you, yes, we have “labelled” the “distinctive” periods of interest following the suggestions of Reviewer 1: P1, from 17:08 to 17:10, which corresponds to a still WT; P2 to P4, for the successive three 10-min intervals, up to 17:40. The four labels “P1” to “P4” appear now also in the titles of the four subsections.

Line 42: The authors state that research on polarimetric signatures of wind turbines is rare, which is true. However, it would be helpful to see a comparison with at least one other study, such as the one by Hall et al. 2017

Yes, it would be helpful to link some results of the 2019 campaign (both PPI and RHI, see Lainer et al. 2021) with the interesting results of Hall et al. 2017; while it is not at all straightforward to find such link with the stare mode part of the 2020 campaign, especially for the still and quasi-still conditions, which are investigated in this study and linked with observations of Bright Scatterers.

In lines 80-100, a schematic picture showing how the radar is located in respect to the wind turbine with the distances and stated elevation angles would be beneficial.

Thank you, this is a helpful comment. We forgot to explicitly mention in the text Fig. 1.c from Lainer et al. (2021), which shows what you are asking. Now it is referenced in the manuscript.

As stated in general comments, especially the section 2.3.1 (lines 156-171) should be rephrased with correct terminology. The authors should be careful when using reflectivity and reflectivity factor, and “Log-transform” should be changed to e.g. “in logarithmic units.” The lines 166-171: The authors should clarify the explanation of the range of reflectivity values that can be measured with Meteo Swiss radars, as it is currently unclear and DN is not defined.

We have adopted your helpful suggestion above (“stating that the authors will use reflectivity to refer to the radar reflectivity factor”).

The authors should explain why they performed an extrapolation of 8 minutes in lines 251-253.

Thank you for this sensible and legitimate question. While trying to answer, I have realized it is a proper example of your relevant remark above: “a phrase that is more appropriate for spoken language than written language”.

Consequently, we decided to delete it. Well, we have tried to express something similar at line 135 where we wrote "Unimportant if during 8 minutes no radar data are available ...", (see your helpful comment below); also there, we have decided to delete the colloquial and unnecessary sentence.

In lines 296-302, the authors should rephrase the section and add references to the correct figures.

Yes, thank you very much, we apologize for this mistake. Obviously, we meant small dispersion of  $\Psi_{dp}$ ; unfortunately, we wrote  $\rho_{HV}$ . Now it is corrected.

## Minor Comments

Lines 51 – 64: Section about the BS. I do see the need to explain BS in general, but I cannot really see how a wind turbine could be used for monitoring hardware due to its varying signatures, at least operationally, and now the section reads as to justify the campaign set up by using then wind turbines as BS. Maybe considering rephrasing this section.

The former 51-64 paragraph has been shortened. However, please note that the paragraph does not intend at all to justify the campaign in view of a better understanding of BS. It rather intends to show that even the 10-min intervals with 0 rotor speed, which are apparently useless to characterize the typical signatures of an energy production WT (hence, a "rotating and moving" WT), can still be useful to a better understanding of BS.

Line 59: Clarify the meaning of "hit" in the context of the sentence, "However, since it is hit during the operational weather scan program...."

The sentence has been rephrased and the citation has been updated (the new link is now with a peer-reviewed Journal).

Lines 65 – 78: Rephrase this section and provide a brief description of the manuscript structure rather than providing detailed results.

These paragraphs have been rephrased and made shorter following your suggestion.

Line 100: Consider changing the word "peculiar" when referring to the stare-mode strategy.

Yes, and following your helpful comment and interpretation at the previous page, we have used "distinctive". An alternative would be to delete "peculiar" and use no adjective at all.

Line 116: Rephrase the title: "Wind turbine data and metadata collection: a very peculiar 40 min interval under detailed investigation." [Rephrased](#).

Lines 121 – 123: When listing parameters, use "e.g." instead of "...", and write temperature with a lowercase letter. [Implemented, thank you](#).

Line 135: Rephrase "Unimportant if during almost 8 minutes no stare mode radar data are available" as it is unclear. [The sentence has been deleted](#).

Line 139: Use a lowercase letter for "maximum." [We now use lowercase letter for "maximum"](#).

Line 145: Rephrase the sentence to make it complete. [Rephrased](#).

Check that equations are styled consistently throughout the manuscript.

[Eq. 1 has been changed accordingly](#).

Line 185: Remove "very" in "A very important...." [deleted](#).

Line 191: Clarify if the numbering "e06.1" is referring to a chapter.

Yes, "e06.1", which is the first part of the electronic supplement number six accompanying the book by Fabry. [Clarified in the text, too](#).

Lines 208 – 211: Rephrase the example of quantization of co-polar correlation coefficient as it seems redundant and not necessary. Remove the extra "use" in line 209.

This is indeed a good suggestion. We have now rephrased it and shortened it.

Line 232: Clarify the meaning of "a standard deviation of  $360^\circ/12^{0.5}$  would be expected."

The standard deviation of a uniform distribution varying from 0 to B is by definition  $B/\sqrt{12}$ .

Lines 235-238: Rephrase and remove the detailed results in this section.

This is shortened, rephrased and the details moved now to a more appropriate section(Sec. 3.2).

Line 242: Suggested to use "radar variables" instead of "backscattering properties."

Great suggestion, thank you. We have used "polarimetric radar measurables", consistently with the title of subsection 2.3, line 154.

Line 251: Remove "amazing" as it is not typically used in a scientific context. Replaced.

Line 277: Remove "very" in "at the original (very high) temporal resolution." Deleted.

Lines 307 and 336: Replace "remarkable" as it is not typically used in a scientific context. Replaced.

Lines 308: Replace "huge" as it is not typically used in a scientific context. Replaced.

Line 371: Use a lowercase letter for "maximum." We now use lowercase letter for "maximum".

Paragraph 421 – 433: Remove "very" statements. The two "very" have been deleted.

Line 433 avoid using IF and THEN in capital letters in this section as it is not suitable for a scientific context, in my opinion.

If and then are now lower case.

In the Summary section, rephrase lines 472 – 477 without the exclamation marks and questions such as "How comes?" and "Well, because, to our great surprise."

Another good example of your relevant remark above: "a phrase that is more appropriate for spoken language than written language". Consequently, we have rephrased line 472-477.

In Figures and their corresponding captions (Figures 2. - 5.), could you clarify why "MAX" is written in capital letters while the other terms such as median, mode, and minimum are written in lowercase letters. I suggest to state somewhere in the text that the mean is not shown in these figures, since the text is often referring to mean.

Following your recommendation above regarding line 371, we have now used lowercase letter for "maximum".

In the introductory lines 240-244, it is stated that we are using the "central and most probable locations of the original 125 echoes available every 8 s: the median and the mode." Please note, that now the mode is omitted in the Figures 2. -5, also to make them visually clearer.

## REFERENCES

Hall, W. et al. (2017), Offshore wind turbine clutter characteristics and identification in operational C-band weather radar measurements. Q.J.R. Meteorol. Soc., 143: 720-730. <https://doi.org/10.1002/qj.2959>

## 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  $\rho_{hv}$  values were equal to 1 (DN=255).

Table 1: Values of  $\rho_{hv}$  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  $\rho_{hv}$  below 1. During this 10-minute period, the range of  $Z_h$  ( $Z_v$ ) 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.

