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Atmospheric Measurement Techniques Discussions

Interactive comment on "Automated Wind Turbine Wake Characterization in Complex Terrain" *by* Rebecca J. Barthelmie and Sara C. Pryor

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Reponses begin with » See also tracked changes version of the manuscript (attached).

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-461, 2019 Interactive comment on "Automated Wind Turbine Wake Characterization in Complex Terrain" by Rebecca J. Barthelmie and Sara C. Pryor Anonymous Referee #1 Received and published: 14 February 2019 In this manuscript, new analyses from the Perdigao experiment are presented. Specifically, the authors analyzed lidar measurements carried out for different wind conditions and atmospheric stability conditions. A procedure for automatic detection of wake centers from lidar measurements is proposed. This work in novel and of high interest for the wind energy community. Some

results are in contrast with a previous study from the Perdigao experiment (Menke et al., 2018a), which may deserve a deeper discussion. A very comprehensive introduction on flows over complex topography is provided in Sect. 1, followed by a description of the test site. An interesting discussion about optimal design of lidar scans is presented in Sect. 3.1. However, the selection of the used scanning parameters is not clearly justified (P8, LL 35-43). In Sect. 3, the use of the narrow PPI scans to define the background flow in not clear. I guess some details are missing in the description of the flow analysis. This paper states that higher wake centers are observed under stable conditions and lower under convective conditions, which is the opposite of the previous results from Menke et al., 2018a. A more detailed comparison between these two works should be provided. One of the motivations for this disagreement is that the LiDAR scans performed for this work penetrate deeper into the valley and, indeed, the wake flow evolving within the inner layer should have been measured. However, the wake centers are still in the middle/outer layer, if I am not mistaken. I suggest to provide a clearer description of the results presented in these two works, their differences and motivations for this disagreement. More details are listed below.

Comments: 1. Table 1. I am not sure retrieval of all the parameters in Table 1 is described in the text. For instance, provide details how z0 is calculated. »L 23 and Table 1. The results from using two appropriate roughness lengths are given. It is made clear now these are assumed values: "For the terrain specifications of Perdigão and flow from the southwest (i.e. inflow for wind turbine and thus wakes that potentially will enter the Galion lidar scanned volume), the inner and middle layer heights of l$\sim$50 m (equation 1) and hm$\sim$ 284 m (equation 6) for near-neutral stability and with z0 assumed to be either 0.3 m or 0.1 m (Table 1)."

2. P8, L 22, what is an arc scan? A PPI scan over an azimuthal range smaller than 360 degrees? Please specify. » P8 L30. It is defined now as: "Most frequently used scanning patterns comprise; one or more arc scans (in each arc scan the scan elevation angle is held constant while the azimuth angle is varied i.e. it is a pseudo Plan Position

Indicator (PPI) scan in which the azimuth angle<360ïĆř) information, and/or Range Height Indicator (RHI) scans (varying elevation, fixed azimuth angle) and/or Vertical Azimuth Display (VAD) (high elevation angle, 360ïĆř scan at fixed azimuth angles).

3. IMPORTANT: The deviation in wind direction between met-tower and lidar data is a bit puzzling. Please provide more details why such big discrepancy between the two measurement techniques, which I am not sure is only a consequence of the complex topography. » We checked the direction in this sector 200-250ïĆř between the data from sonic at 60 m height on tower 20 and data from the sonic at 55 m height 333 m along the ridge. The mean difference is 3.1ïĆř and the standard deviation is 14.3ïĆř indicating substantial variability. We've added to and clarified the following text: 'There is less good agreement for wind direction. There are three main reasons for the scatter beyond the spatial offset between the mast-based 'point' measurements and the use of the average direction from the arc scan (Figure 3); i) the discretization of wind directions from the lidar is a function of the scanned azimuth angles ii) there are fundamental differences in volume-average observations from lidars and sonic anemometers (Wang et al., 2015), iii) heterogeneity in flow conditions along the ridge and turning of the flow as it summits the crest of the hill (see for example Figure 4 in (Vasiljević et al., 2017)).'

4. P3, L11: equation "(X D _ 2)" might be incomplete. »P13 L11 This X was intended to represent the different distances but given that does not seem to be clear we've changed (X D $\pm$ 20 m) to ($\pm$ 20 m).

5. Fig. 4. Cross-check this figure. There are few typos in this chart. »We found one typo 'WTHHH' which was changed to 'WTHH' and we've changed PPI to arc scan for consistency.

6. P24 – Figure 13: cross-check median z/L of Case A in the bottom plot (-0.22 instead if 0.22) »Figure 13. Thanks for pointing this out. This was checked and corrected.

7. P25. These results on the height of the wake center are very interesting. In particular, it is interesting that these results are in contrast to those of Menke et al.

2018a, which are related to the same field campaign. I guess a more detailed discussion should be provided to understand possible justifications for these discrepancies. »We've expanded the comparison but the fundamental difference is given; we have tracked the wind turbine wake centre over a distance of 4.5 D while Menke et al.'s results include the hill wake tracked over 30 D distance from the wind turbine. We've added Supplementary Material to allow additional description and please see also the new Table S1. in Supplementary Information. âĂČ

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-461/amt-2018-461-AC1-supplement.pdf

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