

Interactive comment on “First Identification and Quantification of Detached Tip Vortices Behind a WEC Using Fixed Wing UAS” by Moritz Mauz et al.

Anonymous Referee #1

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1 General comments

The manuscript by Mauz et al. describes in-situ measurements of wind turbine tip vortices with a UAS. From these measurements, circulation of the vortices is calculated using the Burnham-Hallock wake vortex model. These measurements are unique and I do not know of any other study in which a UAS operated in such close proximity to an operating wind turbine and even in its wake. The authors can convincingly show that wake vortices can be measured with the UAS. The presentation of the methods of analysis and the results however needs some significant improvement:

- In the introduction and throughout the text I miss more thorough references to the

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state-of-the-art. For example, other methods to measure full-scale wind turbine wakes with remote sensing are not mentioned at all, but are carried out all the time and in multiple ways. What can a UAS do that is not possible with remote sensing?

- The structure of the text is sometimes confusing and much information is given in the results and discussion and outlook section that should have been introduced before. I provide details in the specific comments.
- A major problem of the manuscript is that all the analysis is only done for a single sample of a wake vortex pair. If possible at all I would strongly urge the authors to investigate if they can maybe use some other flights. Maybe even flight levels above or below hub height could still be valuable.
- It is known that the estimation of the UAV attitude is a major source of error for the wind calculation. It is also known that navigation systems are less precise in dynamic flight maneuvers. I would therefore at least expect that attitude angles as well as airspeed and flow angles during the flight through the vortex are shown. The authors raise the issues themselves in the discussion, but I think it is necessary to include a proper analysis of this in the manuscript, including an estimation of uncertainty of the wind vector and thus the circulation.
- I recommend some copy-editing to be done on English grammar and expressions.

For these reasons, I suggest a major revision of the manuscript before considering it for publication in WES.

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2 Specific comments

2.1 Abstract

The abstract should be rewritten with more statements about the hypotheses that were investigated in the study. A description of the results / conclusion is missing.

p.1, ll.1ff.: wind converter should be either wind turbine or wind energy converter. Preferable: "rotor blade of a wind turbine". The whole first sentence is very hard to read and grammatically wrong. Starting with the relevance for numerical models in the abstract is misleading, because numerical models are not the topic of the paper.

p.1, l.6.: what is the difference between atmospheric and meteorological quantities?

2.2 Introduction

p.2, ll.9-13: this paragraph should go into the description of the aircraft (Sect. 2.1)

p.2, ll.14-21: this paragraph could go in the experiment/site-description in Section 2

p.2, ll.22-31: here, a lot more literature should be referenced. Wake vortices are a major field of research and the state-of-the-art has not been evaluated at all

2.3 Section 2

- I miss a detailed description of the atmospheric conditions during the flight. Stratification, turbulence in the inflow, etc. which are important for the wake development are not given but should be available from the data.
- A list of available flights and an explanation why only a single flight leg is analysed is missing.

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p.3, ll.3-8: Here, description of the aircraft is mixed with operational procedures. I feel like this should be separated.

p.3, l.11: Since RTK GPS is mentioned here and is not a standard feature of UAS in atmospheric research, some additional information would be appreciated: what kind of receiver is used (L1 or L1/L2 phase); is a local base station or RTCM-services used for correction data / what is the baseline? What is the advantage of the very accurate flight path in atmospheric measurements?

Fig.3: I think a more schematic background (not Google Earth) with a better scale and legend would help

2.4 Section 3

Fig.6: It is unclear how TKE has been calculated. How large is the averaging window?

Fig.7: Nice figure, but watch out for which lines cross in front of or behind other lines to get the 3D visualization right. I think the red rectangle encloses the blue vortex, right? And "distance" should probably get a variable name or could even be left out

p.9, l.5: Except that the vortices along the horizontal axis are not generated at the same time for the WEC.

2.5 Section 4

p.14, l.1: What is the vortex coordinate system and which angles are used for the rotation? This has not been introduced before.

p.14, ll.26ff.: this needs to be introduced and explained in more detailed in the methods section. Why can this correction not be done for other flight levels to increase the number of samples of tip vortices?

Fig.16: I think this figure is not necessary

p.15, l.5: "rotated slightly" -> what does that mean?

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p.15, l.10ff: It is said that the wind speed deficit plays an important role for the tip vortex, but this is not discussed any further. Is BH even an appropriate model under these circumstances?

Fig.18: not sure if this figure is necessary

2.6 Section 5

p.19,l.7f: These are too strong statements for an experiment with a single sample

p.19,l.15ff: The issues that are raised here are not insignificant and call for some more analysis and quantification.

2.7 Section 6

p.19,l.21: What is the equation by Sorensen et al. (2014) that is meant here?

p.19,l.23: "aggravates an evaluation" - what do you mean by that?

p.19,ll.27ff: The information about the 5-hole probe calibration range and why other flights could not be used should be given in Section 2 already. In section 2, it was said that the UAV operated with RTK GPS which is contradicted here.

3 Technical corrections

p.1,l.1ff: wind converter should be either wind turbine or wind energy converter. Preferable: "rotor blade of a wind turbine". The whole first sentence is very hard to read and grammatically wrong. The second sentence raises problems of numerical simulations that are not the topic of the paper.

p.1,l.6: what is the difference between atmospheric and meteorological quantities?

p.1,l.8: *u,v,w*, italic please

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p.1,l.18: "their individual capacity and diversity" (what do you mean by diversity?)

p.2,l.3: underestimate

p.2,l.4: "Another way" or "Another method"

p.8,l.7: "several analytical models are available"!?

Fig.8: x-axis should be labelled *r*

p.11,l.18: *L* is not proportional to the velocity ratio -> The velocity ratio is a function of *L*.

p.14,l.10f: "In Fig.14 shown as a solid purple line." What is?

p.14,l.21: "clear and sharp jump" - strange expression

p.14,l.22: Fig. 16 appears before Fig. 15 in the text.

Fig.17: What is *u* and what is *v* should be mentioned in the caption. the same line style should be used for the same analysis method, i.e. dashed line for simple BH, and dotted for corrected version for example.

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