

## **Vortex identification methods applied to wind turbine tip vortices**

Reply to Referee #1

Received and published: 2 November 2021

Dear Referee #1, On behalf of all the authors, I would like to thank you for the review of our paper. All your comments will be addressed in the final version, you can find below the reply (blue) to each remark (black).

While the paper provides very interesting insights on the use of the different VIMs for vortex tracking, the novelty of the article is still unclear. The advantages of the Graftieaux's approach, which is hailed by the authors as the most suitable approach are already known. The authors should expand more on the novelty of their article in the introduction section since it is for now not very apparent.

- Reply: We see your point, thank you for highlighting that the novelty was not clear enough. We will clearly state that Graftieaux's method is applied to wind turbine tip vortices for the first time and that the application of the three VIMs to the wind turbine vortices is applied simultaneously with differentiation approaches, which provides explicit comparability in terms of several vortex properties. This will improve the paper and its novelty in the revised submission.

The effects of experimental uncertainty are lacking in the paper. The SPIV data has some level of uncertainty in the results and how this gets propagated in the methods that are being proposed is not very clear. At the very least, a discussion of these effects should be made. This could also have an impact on the Graftieaux approach used. The literature on the uncertainty on PIV should be thoroughly reviewed in order to be able to support your discussion of the effects.

- Reply: Thank you, a section will be added in the final manuscript addressing the uncertainty.

Figure 10 – It is recommended to remove the line plot and use a scatter plot for such representations.

- Reply: Thank you, this will be implemented.

Line 264-267 – The following sentence should be clarified further “Alternative methods such as the prediction from time series vortex locations might be also successful using the rest of the schemes due to the small discrepancy between the vortex center locations between VIMs and schemes; however, more than one vortex age is needed.”

- Reply: Thank you, the sentence refers to calculating the convection velocity between two consecutive locations of vortex centers or several consecutive locations by a fitting of the tracking (refer to: Schepers, J. G., & Snel, H. (2007). Model experiments in controlled conditions. ECN Report: ECN-E-07-042. or Soto-Valle, R., Alber, J., Manolesos, M., Nayeri, C. N., & Paschereit, C. O. (2020, September). Wind Turbine Tip Vortices under the influence of Wind Tunnel Blockage Effects. In Journal of Physics: Conference Series (Vol. 1618, No. 3, p. 032045). IOP Publishing.).

In this study, only one vortex age is analyzed, and the convection velocity is defined as the velocity in the vortex center. The application of the above-referenced methodology (with any VIM), described as “might be successful”, is because there are only a couple of grid points discrepancy between VIMs and therefore, the results would be similar independently of the VIM applied.

The sentence will be rephrased in a clearer manner.

Figure 17 – For completeness the figure needs a colorbar.

- Reply: Thank you, this will be implemented.

Line 333 – It is not very clear whether the authors are rejecting the uneven shedding effects on the observed double peak results.

- Reply: Thank you, an explicit sentence on this will be added.

Line 343 – Do you here mean for vortex kinematics analysis or do you really mean that the methods are simply not suitable for establishing both position and motion of the tip vortices? “In fact, both schemes ignore information either forward or backward from the grid on the implementation of differentiation. Therefore, they are not suitable for vortex analysis.”

- Reply: Thank you, the reviewer is correct to highlight the strength of this comment. The final sentence will be rephrased and reformulated accordingly within the findings of the work i.e. the large standard deviations.

Conclusion - For the most part it is felt that the issue of the double peak has remained unresolved in this work. The authors seem to attribute these to purely numerical artefacts. Do the authors feel confident about this conclusion? Could experimental uncertainties also be responsible for this?

- Reply: Thank you, this part will be updated accordingly to the uncertainty inclusion.

Line 25 – “It is shown, by using the vorticity to identify the vortices, a high variation in the position of the tip vortices.”

- Reply: thank you, it will be rephrased as follow: “A high variation of the position of the tip vortices is shown by using the vorticity in the identification”

Line 237 – Change “are originated” to “might originate”

- Reply: thank you, this will be implemented.

Line 269 – Sentence structure is poor here: “the Graftieaux 24-points as well only vorticity magnitude cases are presented.”

- Reply: thank you, it will be rephrased as follow: “[...] In the interest of clarity, only the Graftieaux 24-points and vorticity VIMs are presented [...]”

Line 365 – “The two peaks found in the jittering...” – please rephrase

- Reply: thank you, it will be rephrased as follow: “The two peaks, found in the jittering, are determined as an artifact produced by certain schemes.” Additionally, this part will be updated accordingly to the uncertainty inclusion.