**WESD**

Interactive
comment

# *Interactive comment on* "Digitizing scanning lidar measurement campaign planning" *by* Nikola Vasiljević et al.

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## General comments

In the manuscript by Vasiljevic et al. a software library is presented which allows campaign planning for wind farm site and yield assessment with Doppler wind lidar measurements. The tool seems to be a benefit for people who have experience with lidar measurements and need an initial guess for good lidar positions in the field and for these reasons the work is technically significant and important.

*Dear Referee,*
*We would like to thank you for your time and for your insightful comments which*

*were used to revise and improve our manuscript. We made major changes to our manuscript. The revised manuscript follows a classical IMRAD structure and it has now been oriented on addressing research questions instead of the description of the tool. Also, we have made a change of the title from "Digitizing scanning lidar measurement campaign planning" to "Digitalization of scanning lidar measurement campaign planning", since the term 'digitalization' better suits the work we have done .Find our detailed responses below which are provided in the italic text formatting.*

However there are some major concerns that can be raised with regard to its scientific significance: Experience with meteorological measurement campaigns, especially in remote locations, shows that logistical constraints are often dominating the site selection for instrument placement. The authors mention this issue, but only suggest to generate multiple layouts and select the one that is feasible in the end. In my opinion, the logistical constraints should be included in the selection process a priori, because it is a criterion for exclusion, while other criteria like the elevation angle and representative radius only increase the uncertainties which could potentially be negotiated.

*We agree with the referee that as the site constraints have large impact on the final layout of measurement campaign, especially constraints in terms of access roads and power sources. We have now explicitly stated on page 5 and 6 in the reviewed manuscript that we are creating the fifth main GIS layer (aerial image of the site) for the purpose of identifying existing road and power infrastructure. The satellite imagery is usually the first source of information a campaign planner has when he/she needs to assess whether there is necessary infrastructure for the campaign, to the very least access roads.*

*On page 11, line 7 - 11 in the reviewed manuscript we state that: "In practice, we would generate several layouts, and assess their feasibility by inspecting aerial images, e.g. looking for access roads and nearby power lines or houses."*

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Discussion paper

*To demonstrate that we followed this approach we have published the CPT outputs for the three sites in the paper.*

*Since the CPT is modular, one can use the tool in a reversed way, i.e., knowing in advance where you can place lidars and building towards identifying where you will be able to accurately perform measurements. This is now explicitly stated in Section 2.6 of the revised manuscript.*

To my understanding the three examples for campaign planning are not actual campaigns, but generic cases. It is not shown if the defined positions would be realistic at all, neither if the tool proofed to be efficient compared to a "normal" planning by site visits and expert knowledge. The manuscript does not show if and how the tool and process improves energy yield assessment at all.
*We stated in Section 3.1 of the reviewed manuscript that these are real wind farms. In the revised manuscript links to the CPT outputs for the three sites are now enclosed.*

*Using the CPT it takes roughly 5-15 minutes to generate a preliminary campaign layout, which otherwise will take longer if only Google Earth is used for this type of activity. The workflow and the tool does not exclude site visits, we have stated that in the reviewed manuscript (page 7 line 11 - 13). Actually, the workflow and tool should aid the process of site visit.*
*Also, the workflow and the tool are reducing the need for lidar expert when assessing a potential site for multi-lidar measurements.*

*Our manuscript is focused on facilitating the process of measurement campaign planning, and not about whether this process improves the AEP of future wind farm; we have adapted the abstract to avoid this confusion.*

A great benefit would be generated if the tool allowed inexperienced users to design scanning lidar campaigns, but in multiple places in the manuscript, the authors state themselves that expert knowledge is necessary to define for example the expected range of the lidar.

*The workflow and corresponding tool has been made to allow inexperienced users to design scanning lidar campaigns. Indeed, there are several input parameters which are necessary to utilize the CPT tool, specifically: representativeness radius of measurements, maximum allowed elevation angle of laser beams, minimum allowed intersecting angle between laser beams and expected lidar range. With the exception of the expected lidar range, the other three parameters have suggested values based on the existing body of knowledge. In the reviewed manuscript suggested values are stated on several locations, e.g. :*

*Representativeness radius: Page 3 Line 29*
*Maximum elevation angle: Page 2 Line 27*
*Minimum intersecting angle: Page 2 Line 29*

*We state on Page 24 Line 16 to 18 in the reviewed manuscript that we intend to extend the 'Lidar range' module to be able to perform such a task. However, this does not restrict inexperienced users of using the current version of CPT. In the revised manuscript we have provided a suggestion for the inexperienced lidar users regarding the estimation of range on Page 24 Line 17 - 21.*

A part of the software that is very useful is the optimization of complex trajectories. I think this part is not presented very well. A mathematical description with a definition of the variables that are included in the optimization instead of the text-based description would be much better in my opinion. I also wonder if existing python

libraries (or-tools) that are available to solve traveling salesmen problems could not be applied. What is special about this problem and what makes the developed algorithm better or more suitable than others?
*Following the referee's suggestion, the revised manuscript includes an improved description of the TSP.*

In general, the manuscript is very text heavy, describing simple or trivial problems in much detail while the challenging problems are not targeted. Especially the topics mentioned in section 4.2 are scientifically challenging and significant and I think that at least one of those should be tackled in a scientific paper. A topic that could be added to the list is the question of how many separate measurement points are reasonable to get a representative average wind measurement, i.e. what is the required sampling rate?
*The revised manuscript has been improved in comparison to the initial submission and also the length has been reduced. The revised manuscript follows a classical IMRAD structure and it is now oriented on addressing research questions instead of the description of the tool.*
*The topics presented in Section 4.2, which is a subsection of Discussion, outlines our future work, and thus will be the focus of our future publications.*

A major concern about the paper is that in many parts it reads more like a manual and advertisement than a scientific report and therefore could be considered inappropriate for the Wind Energy Science journal.
*See our previous comment.*

For all these reasons I want to encourage the authors to resubmit a manuscript that focuses on a specific research topic associated with yield assessment and lidar measurements which can be solved with that useful campaign planning tool.
*We have taken into account the referee's suggestions and improved our manuscript.*

**Specific comments**

2.1 Introduction
p.2,ll.8f: Some references should be given here. In general the introduction and manuscript are rather weak on citing relevant work.
*The introduction contains citation to 14 communications related to the topic that the paper addresses. Nevertheless, we are eager to improve the introduction and therefore, we kindly ask the referee to suggest a list of references that needs to be reviewed and cited in the introduction.*

2.2 Section 2
p.3,l.12: The optimal measurement positions...!?
*The whole Section 2 in the revised manuscript has been rewritten.*

p.3,l.29: Some references for the radius limits that are given should be provided.
*We have added a references (MEASNET) to the line stating the radius limits.*

p.5,ll.11-19: This seems trivial and does not need that much explanation.
*The whole Section 2 in the revised manuscript has been rewritten.*

p.5-6,ll.30-10: Public landcover maps can be quite erroneous and with a low resolution. The canopy heights can be particularly wrong, which would then lead to completely wrong results for possible lidar locations or unnecessary constraints.
*We agree, they are however often the starting point for any resource assessment*

*before site visits are conducted. Conservative land-cover translations, e.g. using tall tree-heights are recommended initially and the data can subsequently be corrected by the site engineers after consulting aerial imagery or conducting a site visit.*

p.6,ll.29ff: Very technical and not really relevant in this context.
*The whole Section 2 in the revised manuscript has been rewritten.*

p.7,l.7: There are many other older and peer-reviewed references for that.
*We have added the oldest reference we found when comes to the dual-radar/dual-Doppler measurements setup in the list that is Davies-Jones 1979.*

2.3 Section 3
Tables 1-9: I do not think that these tables are actually necessary. The actual numbers for the measurement positions, the lidar angles etc. are irrelevant to the reader. The information that the authors want to convey should be condensed and given explicitly.Figures 2,6 and 10: It is very hard to read the small white numbers in these plots. The red circle is not visible for colorblind people on green background.
Figures 2,6 and 10: The symbols should be a bit larger and/or in better contrast to the background. *In the revised manuscript we have removed tables, nevertheless data which was in tables are now provided as a supplementary material. The commented figures have been improved.*

**Technical corrections**

p.1,l.1: Strange grammar in the first sentence.
*The abstract has been modified.*

p.1,l.2: .. wind turbine locations.

*Corrected accordingly.*

p.1,l.23: I do not think that 'produce' is the right word here
*The sentence has been rewritten to:*
*The local measurements are used to produce the observed wind climate of the site.*

p.2,l.10: ease of deployment
*Corrected accordingly.*

p.2,l.15: lays?
*'lays' replaced with 'lies'*

p.2,l.23: something is wrong in this sentence
*The sentence has been rewritten to:*
*This impacts the positioning of scanning lidars since we need an unobstructed passage of the beams towards measurement points, i.e. clear line-of-sights (LOS)*

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