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Interactive comment on "Automatic Measurement and Characterization of the Dynamic Properties of Tethered Membrane Wings" *by* Jan Hummel et al.

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Thank you for your review. In principle, your comments regarding the experimental data are justified. The scope of this work was to demonstrate the proper functioning of the test bench, specifically the repeatability of the test procedure. Indeed, to fully characterize flexible membrane wings, more sophisticated maneuvers are needed. Due to the time constraints it was not possible to implement further maneuvers within the scope of this work. At the moment, however, the department is working on exactly this functional enhancement and on a fully automation. In the abstract we therefore mention: "On the basis of this work, more complex maneuvers and a full degree of automation can be implemented in subsequent work. It can also be used for aerodynamic parameter identification. "

And within conclusion and outlook: "in order to increase reproducibility and perform aerodynamic parameter identifications, it is necessary to implement and automate more sophisticated maneuvers"

2 Scientific questions and issues

Referee: *"One big advantage of the setup is that the wind speed can be directly adjusted by just setting the cruising speed of the towing vehicle. Why are only results for one wind speed presented. Could you specify and discuss range of wind speeds which could be examined by this setup?"*

The main reason for presenting data recorded at the same wind speed was to demonstrate the repeatability. Otherwise, from the authors point of view, an assessment of repeatability is not feasible.

The range of wind speed which could be examined is only limited by the cut-in wind speed of the kite (minimum wind speed for flying the kite) as well as the maximum tensile forces resulting from the kite, acting on the test bench (the design force was set to $5000N$, which is described in Sec.3.1). Caused by the weight of the test bench the maximum vertical force is actually limited to $3000N$, which could be increased by increasing the weight of the trailer, if necessary.

Assuming a force coefficient of $C_R = 0.7$ (which is the maximum value in Fig. 14), surface area of $A = 10m^2$, air density of $\rho = 1.184kg/m^3$ and apparent wind velocity of $v_a = 50kt$ ($v_a = 25.7m/s$), the resulting Force is $F_R = 2837N < 3000N$ (see Eq.4). But since the aerodynamic coefficients investigated so far should be wind independent, the authors see no need to test in higher wind speeds to compare the wings against each other.

As can be seen from Eq.4, the tensile force mainly depends on the wing size and the

apparent wind velocity. For the presented maneuver “Linear Power” and the presented wing sizes, a maximum testing speed of $50kt$ can be given, which can be increased, if necessary.

With crosswind maneuvers an enormous increase in power is expected. If the tensile force exceeds $5000N$ the design of the test bench has to be adapted or the wing has to be smaller.

Referee: *“AWE setups require a dynamic flight mode of the kites. How will dynamic flight test be implemented in the existing setup?”*

Dynamic flight maneuvers are currently being implemented and have (partialy) already been successfully tested, but this exceeds the scope of this paper. Automated maneuvers can be implemented by newly developed control algorithms with the help of the presented sensors as well as additionally developed sensors.

Referee: *“The Abstract should be shortened. In parts, it resembles an introduction but should provide a condensed summary of the own work presented in the paper.”*

We will shorten the abstract and move some content to the introduction part.

Referee: *“The ’Conclusion and Outlook’ section has a partly confusing structure and should be reworked. In the first two sentences, it is stated, that ’dynamic flight...was not feasible...is essential’. Two sentences later, the authors claim that ’...presented work fills this gap...’. Subsequently a lot of issues are addressed but in arbitrary order in one long paragraph. Please state clearly what has been achieved. Then it would be nice to have a summary of future work to be required by AWE applications and a brief discussion of the ideas to extend the setup.”*

We will revise the section “Conclusion and Outlook” for a more clear structure.

Regarding future work, a rough outlook can be given. When writing this paper the recommendation to subsequent research was that more complex and automated maneuvers have to be implemented and the testing method has to be improved (e.g. flying figures of eight to determine the turn rate). At the moment we have made great progress in terms of automation, improvement of the sensor system as well as maneuver enhancement, but this is the subject of current activities and can therefore not be further detailed.

Referee: *“the line sag is mentioned in the outlook, but shouldn’t it be discussed in the error analysis (3.3.3), especially for static depowered flight?”*

I did not consider the line sag to minimize the post-processing. Since we use the same bar every test run, the line sag is similar for every kite, which means the repeatability can be clearly demonstrated with this method and the kites can be compared against each other (see p.6 “In order to facilitate an easy assessment of the measurement results as well as the reliability of the method, post-processing calculations to optimize the estimation of the properties were not carried out”).

One of the central tasks of the subsequent work is the systematic investigation and improvement of the measuring method e.g. by performing post-processing calculations, which includes the line sag. We will incorporate this in the revised outlook.

Referee: *“are the errorbars in Figure 14 realistic as the C_L coefficient depends on wind speed, for which an error of 20% is assumed (3.3.2)?”*

the error of wind speed is mentioned as $\delta v_{w,real} <= +20\%$ for a worst case scenario (wind vector $v_{tw}(z_{REF})$ pointing exactly towards the opposite direction of travel, a static wind velocity of $3m/s$ as well as an overestimated coefficient of friction α), whereas at the presented day the wind conditions where much better.

3. Technical corrections

Thanks for the advice, we'll rework it.

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