WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Aerodynamic characterization of a soft kite by in situ flow measurement" *by* Johannes Oehler and Roland Schmehl

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Thank you for your comment. This answer will deal with the main question 'mounting of the sensors' and the two minor comments seperately.

Firstly, mounting of the sensors: The rigid frame attached to the front bridle lines, also called power lines remained our favourite choice after exploring several other methods. In Fig. 1 of the paper you see a previous attempt with additional lines and a drag shuttle which proved to require much time for installation and did not yield satisfying results throughout the flight. We also used the same sensors described in this publication (wind vanes and Pitot tube) in a more conventional, longitudinal air data boom setting

in the symmetry plane of a surf kite. The setup is described in our recent publication [Oehler, J., van Reijen, M., and Schmehl, R.: Experimental investigation of soft kite performance during turning maneuvers, Journal of Physics: Conference Series, 1037, 052 004, http://stacks.iop.org/1742-6596/1037/i=5/a=052004, 2018.], see also Fig. 1 attached to this comment.

Such a mounting has the advantage that the sensor setup is always aligned with the center chord of the kite which avoids the calculation/estimation of a 'depower angle' α_d. However the center chord and also the possibilities to attach an air data boom vary from kite to kite. Some do have an inflated strut at the center, some (like our kite in Fig. 1 of this comment) have struts left and right to the center chord. As consequence such a mounting is more dependent on the particular kite model than the mounting in the power lines which we chose. Another clear advantage of our current mounting is that we could directly derive the kite's lift-to-drag ratio. The suggested comparision of two or more different mountings during one flight which you suggest would of course be ideal to derive a better conclusion on the pros and cons of different sensor mounging strategies, however this was not undertaken in this study.

Secondly, elevation angle: We chose β mainly to be consistent with the publications of our own group where β is used for elevation and β_s for the sideslip angle. We also found θ widely used as polar angle but since there was no dominant notation we chose to keep it with this notation. Γ is in aerodynamic literature common for the circulation which we also used for this paper.

Thirdly, polar for lift and drag coefficient: We did not include such a plot but it would for sure be worth a further study. We did not measure lift and drag separately but only the lift-to-drag ratio directly. Since the lift-to-drag ratio (see Fig. 15) shows a behaviour which is qualitatively similar to the one of a profile or 3D airplane we would expect to get a curve which is close to a parabolic curve. Lift-to-drag ratio has its maximum at a medium angle of attack and lift coefficient and is lower for low angles of attack and high angles of attack. This is similar to what we expect for a 2D profile.

What hinders us from measuring a full polar is that we cannot freely chose angle of attack and lift coefficient like it can be done for profiles or aircraft models in a wind tunnel or full aircraft with the elevator. A kite only flies and keeps its shape as long as it creates a considerable amount of lift. Measuring drag and lift at zero lift condition or for very low C_L is therefore not feasible. Specifically for our test setup and the flight described, the airspeed measurement was of low quality for low flight speeds. Since all the flights in depowered state with low lift, low drag and low lift-to-drag ratio show low flight speeds we could not measure this part of a lift drag polar. Since lift and drag coefficients depend crucially on precise measurement of the flow velocity we did not calculate and plot these values for the depowered kite. In Fig. 16 and 17 the lift coefficient C_L is only shown for the powered kite with comparably high angle of attack and lift coefficient.

Since different angles of attack are usually achieved by changing the power setting which deforms the kite and further higher loading changes the shape of a kite, the polar would need an additional parameter describing the deformation for a complete description. Similar parametrized polars are used for rigid polars which have e.g. Reynolds number or flap extension included. This requires first a better understanding or at least a common parametrization of the deformation of a soft kite.

Fig. 1. Center chord parallel air data boom as it was used in [Oehler, J., van Reijen, M., and Schmehl, R.: Experimental investigation of soft kite performance during turning maneuvers]