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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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This paper deals with aerodynamic characterisation of a soft kite. A lot of work has been done until now on soft kites, especially on kite control along a given trajectory and on the experimental measurements of kites. The data obtained from measurements are then very useful to compare and adjust kite modelling. For example, several models of kite flight like "zero-mass model" or "point-mass model" were developed and integrated in kite control systems. All these models need the aerodynamic coefficients (lift, drag, fineness) as inputs. The most sophisticated models may use lift and drag polars to take into account the variation of the lift and drag coefficients with angle of

attack. Unfortunately, it is very difficult to obtain good estimations of the lift and drag coefficients. The measurements were generally made in static flight and then integrated to dynamic models. Nevertheless, there are big differences between lift and drag coefficient in static and dynamic flight conditions. Therefore, several numerical models were developed in order to obtain the aerodynamic characteristics of a kite. The most sophisticated models are based on Fluid Structure Interaction taking into account as much as possible the real geometry of the kite. For example, the model developed by Maison et al. (A. MAISON, A. NÊME, J.-B. LEROUX, De la problématique du dimensionnement de grands kites, ATMA, 2017) for example takes into account the aeroelastic behaviour of the canopy, with an orthotropic modelling of the fabric but also the inflatable structure, the bridles and the lines. Unfortunately, these models are very difficult to validate due to the lake of measured data. Therefore, the work presented in this paper is very interesting for the validation of kite numerical models. In this work, a relatively complete set of measures were performed. The apparent wind velocity is measured using pitot tubes and the attack and drift angles were measured. This paper points out the fact that the angle of attack may substantially vary during flight manoeuvres. One fact that is shown in this paper is that the lift to drag ratio drops during turning phases. This phenomenon that was expected is already studied at ENSTA Bretagne, and these data will be very useful for the validation of these models. Another interesting point is that the angle of attack will adjust depending on the orientation of the kite within the wind window. All the measured data show the importance of taking into account the aerodynamic characteristics of a kite more precisely in the kite flight modellings. Therefore, these data will be very helpful to improve the kite flight models and the control laws. These data will also be useful for the validation of Fluid Structure Modelling of Kites.

Remarks p13 Back line force Measurement: It may be possible to calculate the back-line force from measurement of instantaneous power consumption of the motors and knowing the rotation velocity of actuator. Is this method feasible? This would allow a more precise estimation of the shift in center of pressure. p13 Was the ratio of 3:1

for the forces in front and back bridles already measured on the kite? For example, in (Xaver Paulig, Merlin Bungart, Bernd Specht, "Conceptual Design of Textile Kites Considering Overall System Performance", AWE Book, 2013), a ratio of 10:1 was measured on a parafoil kite. Recently, a ratio of 2:1-1:1 was measured by Behrel in ("Investigation of kites for auxiliary ship propulsion: experimental set-up, trials, data analysis and kite specs novel identification approach", Ph.D. Thesis, 2017) p13, l.10 senors' => sensors p13 Is it possible to have the formula to calculate lambda1 and lambda2? p14 How is determined the projected surface because it may vary during kite flight?

General Remarks: Do you have access to Kite modelling data, and more precisely on the lift and drag coefficient obtained? Can you compare it with the measured data?

Is it feasible in the future to measure the wind velocity with a 3 directions ultrasonic sensor in order to have more precise data?

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