

Rebuttal of: "Flow Field Analysis of a Leading-Edge Inflatable Kite Rigid Scale Model Using Stereoscopic Particle Image Velocimetry"

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1 General comments (RC1)

The paper has undergone a significant revision, which has improved the quality somewhat. Please find below my comments on the rebuttal.

Dear reviewer,

- 5 Thank you for your constructive assessment and for recommending the manuscript for publication after minor corrections. We go into detail below about how we incorporate the additional corrections in the paper. All changes are documented in the attached tracked-changes manuscript.

We look forward to publishing this paper, which has greatly improved with your feedback.

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Best regards,

J.A.W. Poland, on behalf of the authors

1.1 Technical corrections (RC1)

The rebuttal of my first remark circles mostly around the relevance of the TU Delft V3 kite geometry as reference test case, which deflects from my actual point of criticism, namely that the quality of the presented data is too low for being used as such. My central comment regarding the quality of the PIV measurements is addressed but the authors refuse to provide improved measurement data. I appreciate the additional uncertainty analysis presented in the appendix. It still appears to me that the data quality presented in figure 6 (and 7) would deter interest in the dataset as a reference. To resolve this without providing better data, it would be my suggestion to rethink the masking approach entirely, such the masked pattern is less scattered and the obviously incorrect near-airfoil data is removed. This will result in relatively large and connected masked regions, which however seems consistent with the amount and the location of the useful data.

15 First, we agree that the original masking approach produced spatially scattered valid regions, particularly near the airfoil surface, thereby reducing the dataset's perceived reliability. In direct response to your suggestion, the masking strategy has been revised to prioritise spatial coherence over local data retention. The introduction of an inverse coefficient of variation (ICV)-based mask removes erroneous near-wall vectors and produces larger, contiguous masked regions in reflection-affected zones.

20 Second, Fig. 6 has been extended with an additional column showing the absolute velocity deviation. This demonstrates that, outside masked regions, the PIV and CFD fields agree within approximately 5% of U_∞ over the majority of the domain.

Third, a bug in the data-quality table has been corrected; Table 4 now reports the fraction of retained vectors accurately, which is substantially higher than previously stated.

In addition, the manuscript has been revised to improve clarity and interpretation. The results section has been restructured, 25 the uncertainty analysis has been refined, Reynolds-number effects are now explicitly discussed, and sectional force results are presented graphically. The discussion has been strengthened to more clearly articulate measurement limitations and their implications, and the appendices have been expanded to include additional tabulated results and analytical context.

Importantly, the positioning of the dataset has been revised. Rather than presenting it as a high-precision reference, it is now explicitly framed as a novel flow-resolved dataset with clearly defined validity bounds, which are documented in the Discussion 30 to guide appropriate use.

We have therefore addressed the concern by revising both the masking strategy and the presentation: erroneous near-wall data are consistently removed, valid regions are spatially coherent, and the retained flow field shows agreement with CFD. The circulation distributions exhibit consistent spanwise trends between PIV, CFD, and VSM, with PIV values within approximately 35 10–15% of CFD inboard and converging towards the tip. Sectional lift estimates show similar agreement in both trend and magnitude. These results indicate that, within the retained regions, the dataset captures the dominant flow structures and aerodynamic loading trends with consistent quantitative accuracy.

On this basis, and given the agreement in spanwise circulation, lift, and mean-flow topology between PIV measurements and CFD predictions across multiple approaches, the dataset is considered a flow-resolved validation reference for aerodynamic 40 models of LEI kites, albeit not a definitive one. (This last point was also added explicitly to the Conclusion)

Another comment that is not yet addressed adequately is related to the discussion of Noca's method (line 179). The rebuttal does not convince me that the used method is the most adequate. The integral momentum balance for incompressible flow could be used, assuming steady flow (eliminating the volume integral term) and irrotational flow at the control surface (simplifying the pressure computation drastically). The latter assumption would of course be completely inadequate in the wake, but that would only affect drag computations, which are currently also not achieved accurately. Perhaps this can be most effectively resolved by extending table 6 with a quantitative indication (percentage) of the difference between the methods, using the most reliable estimate as the reference. This may require some modifications of the table to maintain readability.

We agree that, under steady and irrotational conditions at the control surface, the integral momentum balance reduces to a Bernoulli-type formulation, in which pressure can be recovered directly from the velocity field. In that limit, the force evaluation becomes

$$45 \quad \mathbf{F} = \oint_S \mathbf{n} \cdot \left(\frac{1}{2} \rho u^2 \mathbf{I} - \rho \mathbf{u} \mathbf{u} \right) ds, \quad (1)$$

which corresponds to the inviscid, non-rotational component of Noca’s formulation (terms 1 and 2 in Eq. 8).

We respectfully disagree, however, that violations of the irrotational assumption would affect only drag. In the present near-field configuration, the control surface intersects vortical and shear regions, such that Bernoulli-based pressure reconstruction is not strictly valid, and both streamwise and transverse momentum balances are affected.

50 At the same time, our results support the reviewer’s suggestion: the inviscid, non-rotational contribution—equivalent to the Bernoulli-based formulation—provides the most robust lift estimates in practice.

Accordingly, we have revised the analysis to explicitly decompose the Noca formulation and assess the individual contributions. To improve clarity, Table 6 has been moved to a new Appendix F and replaced in the main text by a graphical comparison. This comparison shows that selective use of contributions is more robust: the inviscid, non-rotational term (equivalent to the

55 Bernoulli-type formulation) yields consistent lift, while the inviscid, rotational term is required for physically meaningful drag.

The discussion of these results has been comprehensively revised to clarify the observed discrepancies. In particular, it now explains why the CFD pressure-integration values are generally lower and why the Kutta–Joukowski-derived lift values are systematically higher. These interpretations are further supported by an additional table provided in Appendix F.

References