Multiple Wake Vortex Lattice Method for Airborne Wind Energy Membrane-Wing Kites

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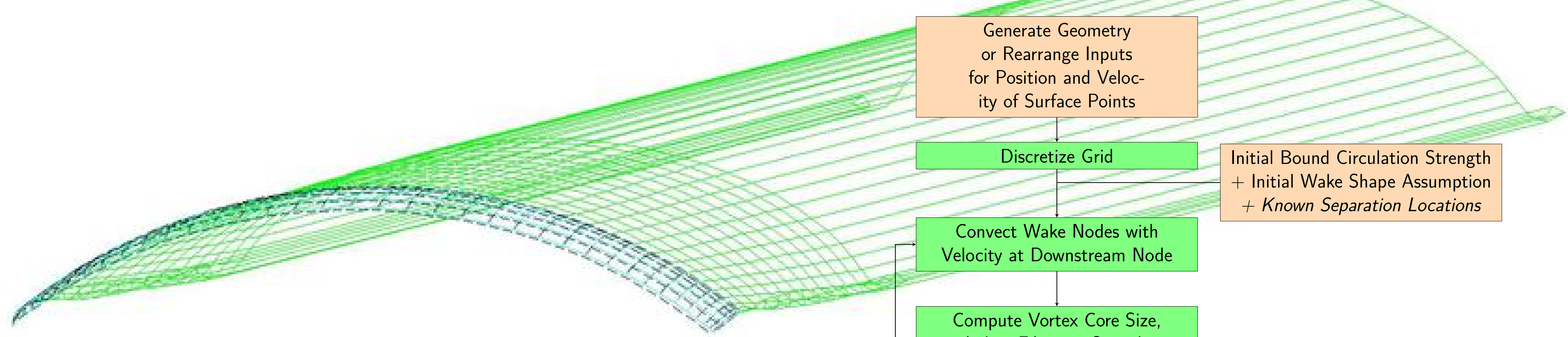


Figure 1: Wake Deformation on a Clark-Y-Profile Paraglider found with a Single-Wake VLM at $\alpha = -4^o$.

Problem Statement

The proper modelling of Fluid-Structure Interaction (FSI) effects (aeroelasticity) of LEI tube kites requires the aerodynamic surface pressure distribution on the wing. FSI modelling requires an aerodynamic model that is fast and accurate, but flow separation is the primary source of modelling error when potential-flow models are applied to membrane wings like the LEI kite (Rojratsirikul et al, 2009).

With a measured range of angle of attack α of 50^o and a geometry containing a backwards-facing step, the degree of flow separation is significant though the kite does not exhibit the characteristic behavior of full-stall during normal operation.

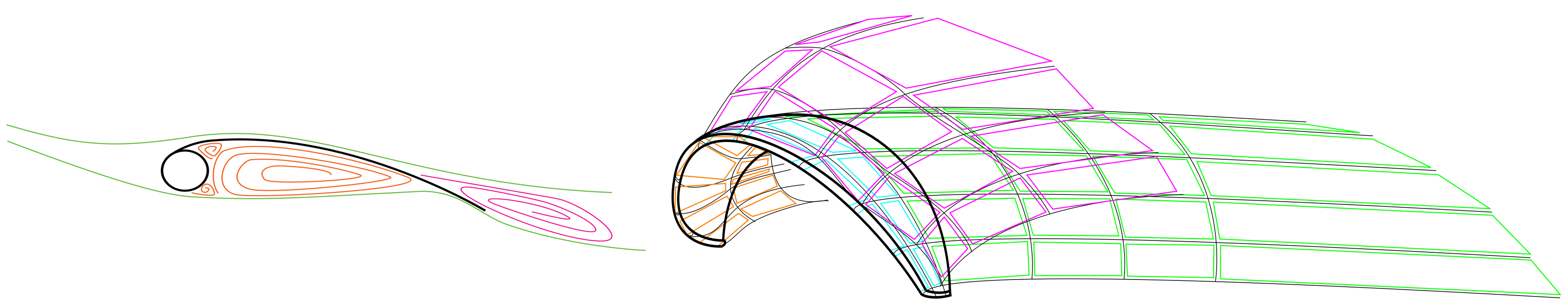
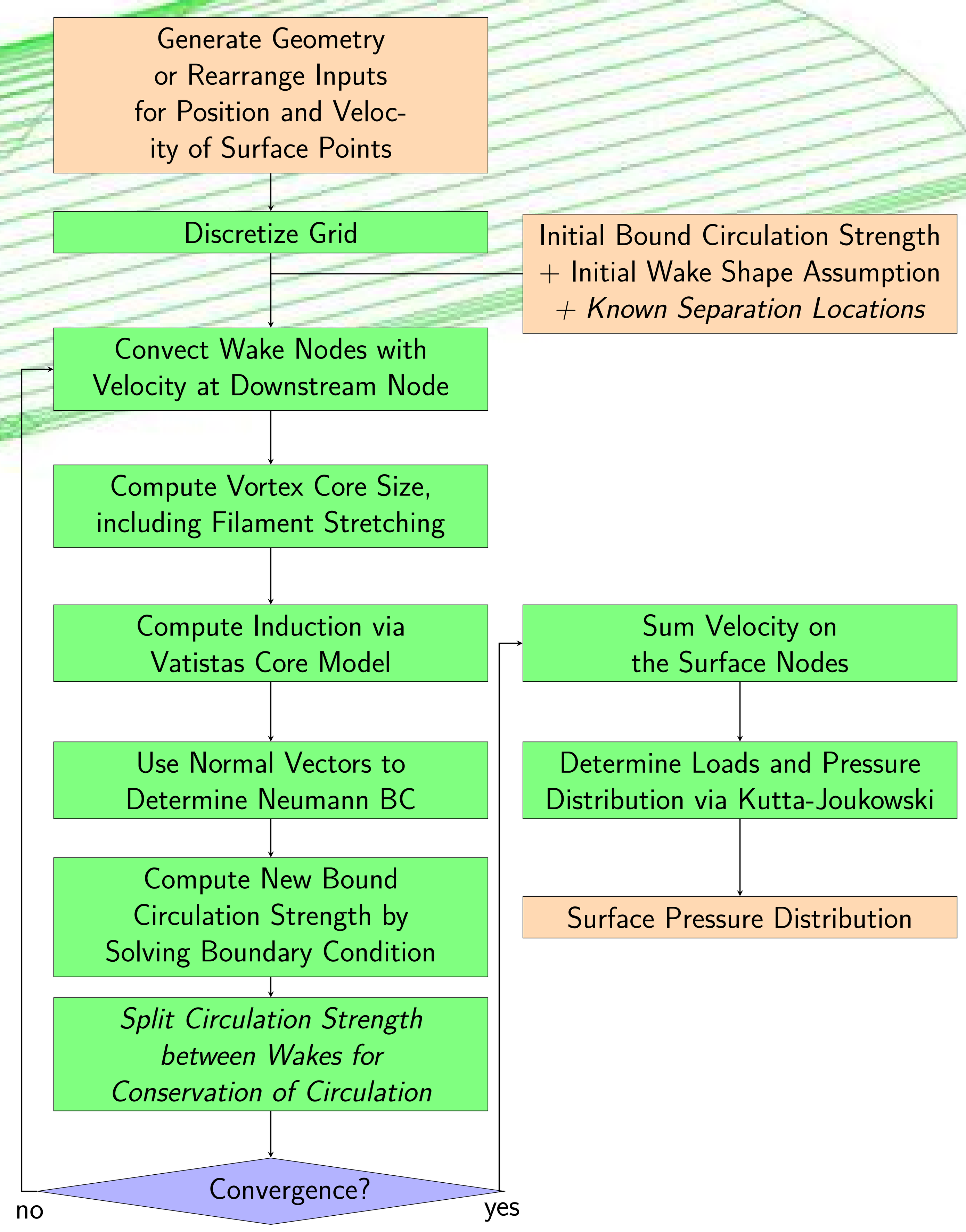


Figure 2: Flow Separation Regions on the LEI Profile, and VLM_{MW} Vorticity Discretization into Vortex Rings

Multiple-wake potential-flow vortex models are well established to model flow separation for 3D rigid wings and for 2D membrane wings, leading to the hypothesis that a quasi-steady multiple-wake vortex lattice method (VLM_{MW}) can quickly and accurately model surf-kite aerodynamics to generate aerodynamic surface load distributions.

Multiple-Wake Vortex Lattice Method



First Results: Single-Wake Clark-Y-Profile Paraglider

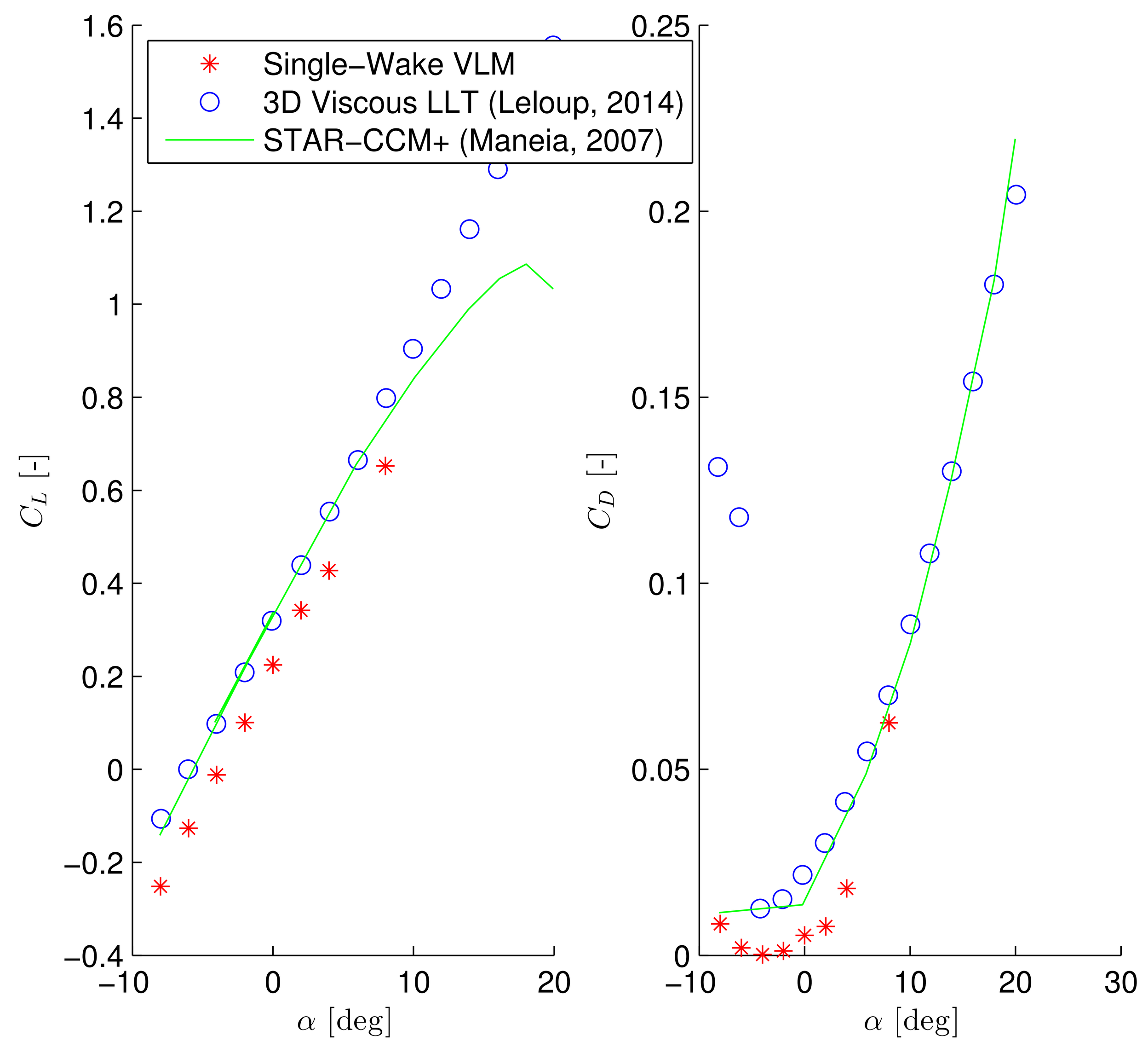


Figure 3: Lift and Drag Polars found with a Single-Wake VLM.

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