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Estimating turbine rotor thrust using near-wake stereo-PIV data¹ ERIC LIMACHER, LIUYANG DING, ALEX PIQUE, LEX SMITS, MARCUS HULTMARK, Princeton University — This study presents a method to estimate turbine rotor thrust using near-wake velocity data. Traditionally, wake surveys for force estimation have been conducted far downstream where the gauge pressure tends to zero. Herein, the need for pressure information is avoided by using vortical impulse theory, permitting the use of a stream-normal survey plane just downstream of the rotor. The derived equations depend only on the three components of velocity and their radial and azimuthal gradients, such that stereo-PIV data on this plane is sufficient to facilitate force estimation. Two force formulations are presented, both of which depend on the assumptions of steady rotation, a steady freestream velocity, and a rigid wake. The simpler of the two formulations depends on the additional assumption that the trailing vortex sheet is thin. The estimated forces using stereo-PIV data will be compared with direct measurements using a force transducer to determine the accuracy of the proposed methodology.

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