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First Identification and Quantification of Detached Tip Vortices Behind a WEC Using Fixed Wing UAS

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The MASC MK 3 (Multi-purpose Airborne Sensor Carrier Mark 3) UAS (Unmanned Aircraft System) by the University of Tübingen measured meteorological quantities in the lower atmosphere during the HeliOW campaign in July 2018 data behind a wind energy converter (WEC) (Enercon E-112) north of Wilhelmshaven, Germany, at the Jade Wind Park. By evaluation of the wind components, detached blade tip vortices were identified in the time series. From these measurements the circulation and core radius of a pair of detached blade tip vortices is calculated using the Burnham-Hallock wake vortex model. The presented data were captured under a dominating marine stratification about 2 \unit{km} from the North Sea coast line with northern wind direction. The measured vortices are also compared to the analytical solution of the Burnham-Hallock model for two vortices spinning in opposite direction. The model has its origin in aviation, where it describes two aircraft wake vortices spinning in opposite direction. An evaluation method is presented to measure detached tip vortices with a fixed wing UAS. It will be shown that the BH model can be used to describe wake vortex properties behind a WEC. Also an improvement for the model in WEC wake use will be proposed.
Quantifying blade tip vortices helps to understand the process of vortices detaching from a rotor blade of a wind turbine, their development in the wake until finally dissipating in the far wake and contributing to overall turbulence. This is especially interesting for set-ups of numerical simulations when setting the spatial resolution of the simulation grid.