Offshore wind farm far field - Results of the project WIPAFF

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Wind farm far wakes are of particular interest for offshore installations, as turbulence intensity, which is the main driver for wake dissipation, is much lower over the ocean than over land. Therefore, wakes behind offshore wind turbines and wind parks are expected to be much longer than behind onshore parks.

In situ measurements of the far wakes were missing before the initiation of the research project WIPAFF (Wind PArk Far Fields) in 2015. The main results of which are reported here. WIPAFF has been funded by the German Federal Ministry for Economic Affairs and Energy and ran from November 2015 to April 2019. The main goal of WIPAFF was to perform a large number of in situ measurements from aircraft operations at hub height behind wind parks in the German Bight (North Sea), to evaluate further SAR images and to update and validate existing meso-scale and industrial models on the basis of the observations to enable a holistic coverage of the downstream wakes.

A unique dataset from airborne in situ data, remote sensing by laser scanner and SAR gained during the WIPAFF project proves that wakes up to several tens of kilometers exist downstream of offshore wind farms during stable conditions, while under neutral/unstable conditions, the wake length amounts to 15 km or less. Turbulence occurs at the lateral boundaries of the wakes, due to shear between the reduced wind speed inside the wake and the undisturbed flow. Data also indicates that a denser wind park layout increases the wake length additionally due to a higher initial wind speed deficit. The recovery of the decelerated flow in the wake can be modeled as a first order approximation by an exponential function. The project could also reveal that wind-farm parameterizations in the numerical meso-scale WRF model show a feasible agreement with the observations.

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