The large investment in large offshore wind farms requires accurate analysis of the wind resource. In this respect, it is critical to take into account the energy yield penalty produced by the wake effects of neighbouring wind farms. For this, wind farm models are used which need to be thoroughly validated in far distances (>200) from the wind farm. This poster shows analysis of simulations and measurements of the far wake of the offshore test field ‘alpha ventus’. Three models have been applied, namely flapFOAM, VENTOS*/2 and WASP. The simulations are compared against measurements performed by Fraunhofer IWE with a lidar vertical profiler installed on a ship moving through the far wake.

**INTRODUCTION**

Within the EU project EERA-DTOC the Fraunhofer IWE carried out a measurement campaign from 4th to 9th of October 2013 with a ship based VAD lidar system. The wind speed, wind direction and turbulence intensity have been measured on the ship trajectory in heights from 40 m – 200 m.

![Ship course](image)

**TEST CASE**

In the time period from 5th of October from 9:50h till 10:30h the ship travelled the distance of ca. 4000 m from north east to south east of ‘alpha ventus’ with an average speed of 1.67 m/s. From the figures below it can be seen, that the conditions changed slightly within the 40min of measurement.

![Wind speed profile](image)

In a first consideration averaged inflow conditions, like the wind speed profile, wind direction at 90 m height and atmospherically turbulence intensity at 90 m height, measured by the meteorological measurement mast FINO1 in the inflow were used as input parameters for the different simulations. In this first approach the slightly changes of inflow condition were not taken into account and representative mean values were used instead.

**RESULTS**

While the magnitude of the deficit can be simulated in average within a tolerance of 7 % for 40 m and 90 m in heights, there are larger deviations up to 140 m height. The position of the wakes from the simulations show a trend for AV07 – AV12 to match the measurements in a better manner than AV01 – AV06. An average offset in the wake center of 3° can be observed between measurements and simulations.

**CONCLUSION**

It is challenging to simulate the far wake of ‘alpha ventus’ turbines with engineering models in the range of 1500 m to 2000 m in downstream direction. Main influencing factors for the mismatches are most likely the lake of dynamic by averaging inflow conditions and the artificial thrust coefficient curve. While the magnitude of the wind speed deficits can be partly depicted in a appropriate manner, the positions of the wakes can not yet be simulated accurate with steady wake models.

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**Fig. 1:** Measurement coordinates on ship trajectory in the east of ‘alpha ventus’

**Fig. 2:** Wind speed profile as the time period of the test case measured at FINO1

**Fig. 3:** Wind direction at 90 m height in the time period of the test case measured at FINO1

**Fig. 4:** 40 min average – Comparison of relative wind speed at 90 m height

**Fig. 5:** 4 x10 min averaged comparison

**Fig. 6:** 4 x10 min average - Comparison of relative wind speed at 90 m height

**Fig. 7:** 4 x10 min average – Difference of relative wind speed at 90 m height