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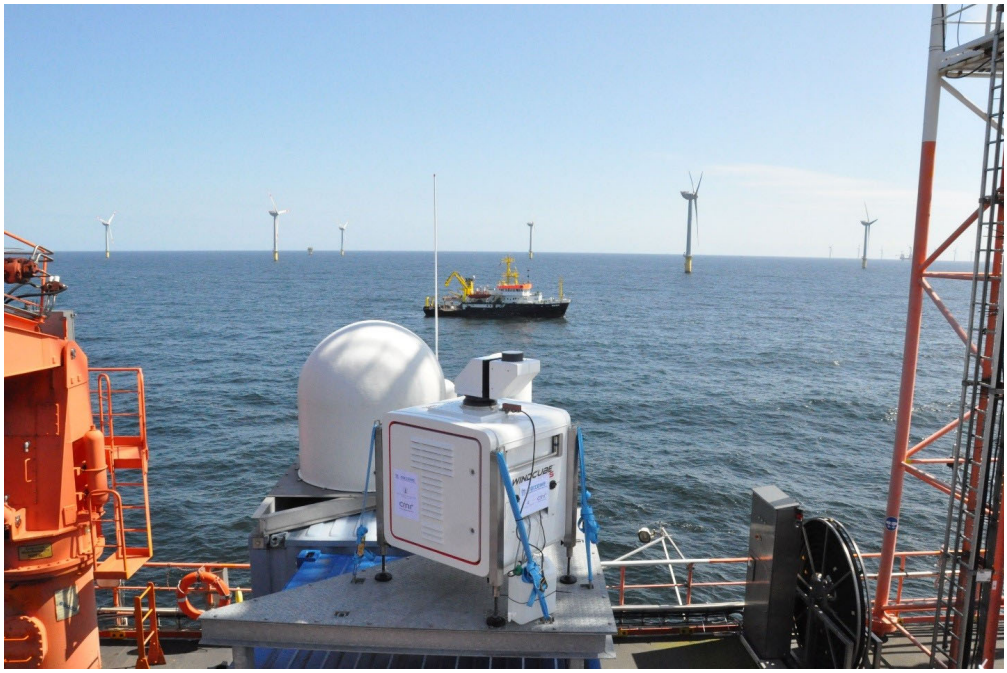
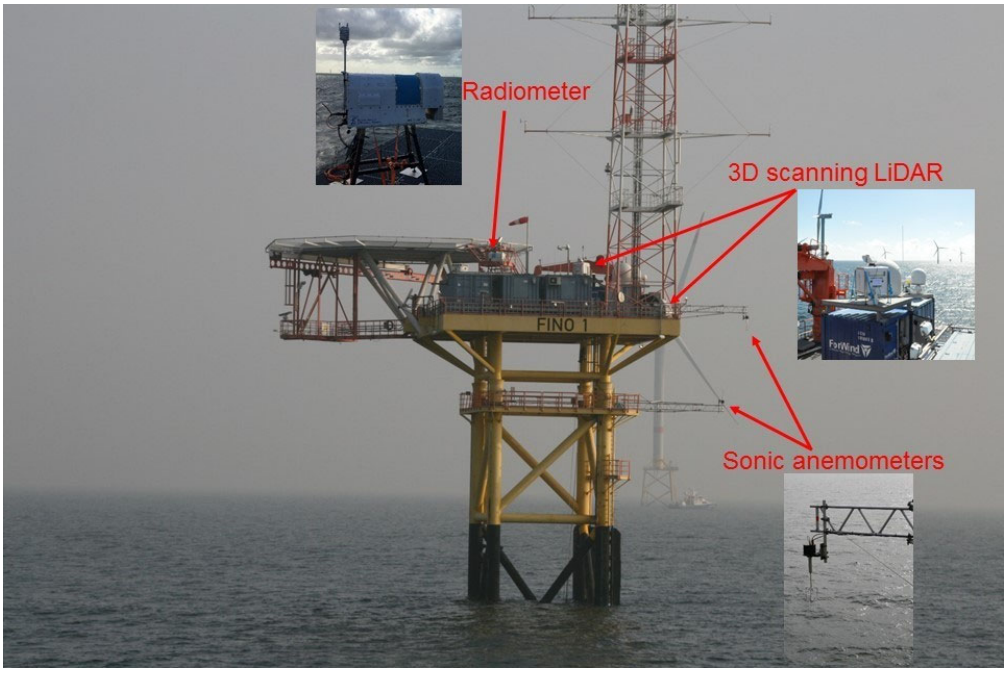
The Offshore Boundary-Layer Experiment at FINO1 (OBLEX-F1)

By Martin Flügge, Annette Stephansen and Benny Svardal

NORCOWE has performed an extensive measurement campaign at the German wind energy research platform FINO1, which is situated closed the Alpha Ventus wind farm. The campaign took place between May 2015 and September 2016 and was carried out by Christian Michelsen Research and the University in Bergen, in close collaboration with the other NORCOWE partners and German research institutions.



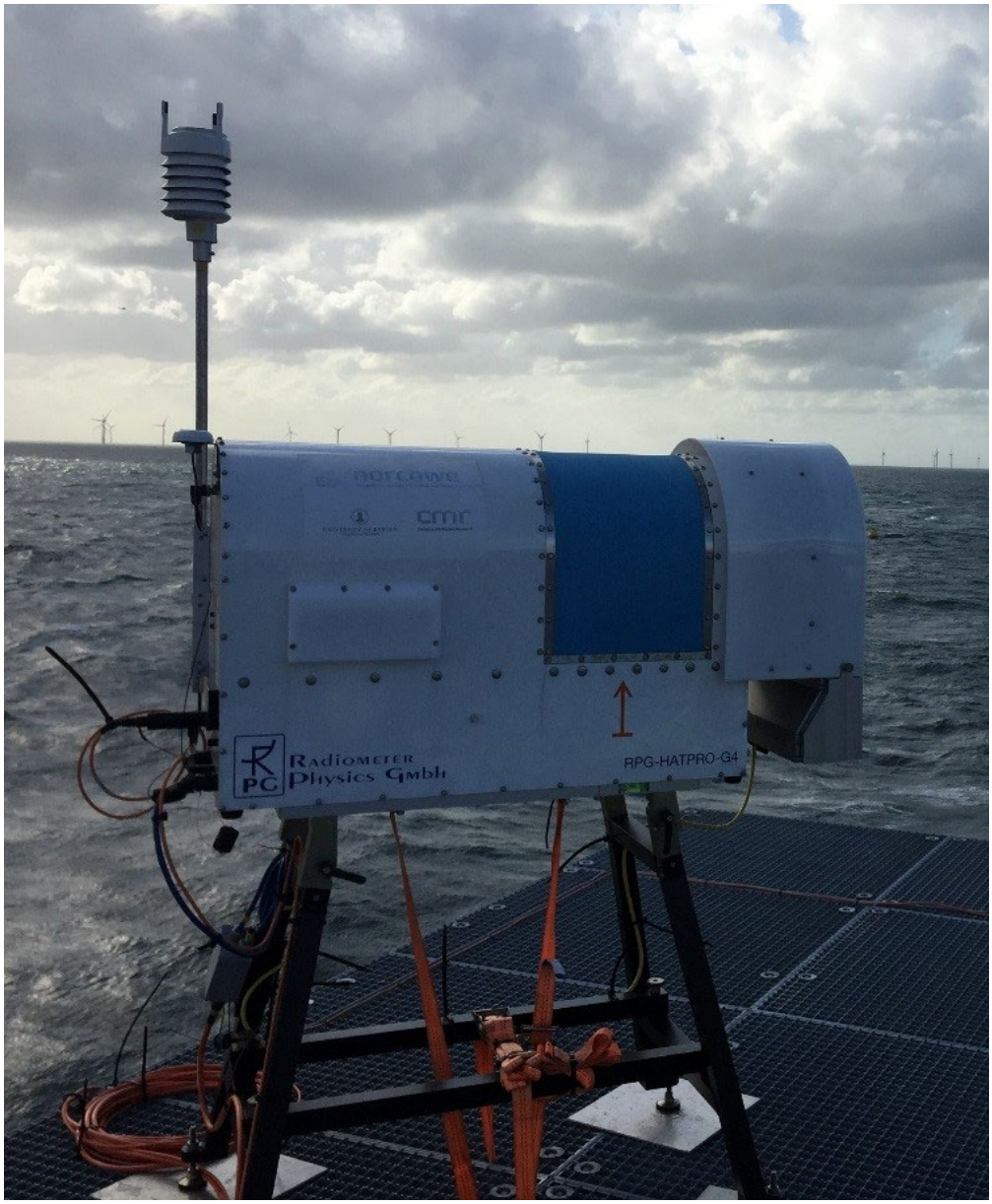
The key purpose of the campaign was to improve our knowledge of the marine boundary-layer in the vicinity of an offshore wind farm with respect to wind speed profiles, atmospheric stability regimes, single turbine and wind farm wake propagation effects, horizontal coherence and air-sea interactions under real offshore conditions. The collected observational data will be used to validate and improve numerical models and tools, i.e. power performance and wind farm layout, turbulence simulators, weather forecasting and marine operations.



To complement the instrumentation at the FINO1 met. -mast, NORCOWE installed two sonic anemometers, two WindCube100s scanning LiDAR systems and a passive microwave radiometer at the research platform. The LiDAR systems were programmed to run in a variety of scan modes covering the Alpha Ventus wind farm to provide data on turbine wake effects. NORCOWE also applied a series of specialized LiDAR scan patterns in order to investigate horizontal coherence for low intensity turbulence regimes, and to estimate simultaneous wind speed profiles ahead and behind single wind turbines. Generally, the LiDAR systems were able to perform scans with a range up to 2500 m at a range gate of 25 m. The passive microwave radiometer provided vertical profiles of both temperature and humidity with a temporal resolution of 1-minute and spatial resolution of 25 – 30 m resolution, up to 2000 m. To our knowledge, a measurement campaign at an offshore wind energy site which applies remote wind field, temperature and humidity measurements for a duration of 15 months has never been performed before. This makes the OBLEX-F1 dataset unique in the field of offshore wind energy research. The dataset includes seasonal information on wind speed profiles in addition to temperature- and humidity profiles at an offshore wind energy site. Simultaneously remote measurements of the wind, temperature and humidity provide a unique opportunity in accurately portraying the interaction of wind turbines with the marine atmospheric boundary layer. This includes investigation of wind speed dependency as a function of atmospheric stability and sea-state, turbine wake effects and large-scale and small-scale turbulence processes.

NORCOWE also deployed several oceanographic instruments close to Alpha Ventus between June and October 2015 to examine the coupling between the atmosphere and the oceans. Three mooring systems were placed upwind and two moorings were positioned downwind of FINO1 to record undisturbed measurements of currents, waves, temperature, salinity and ocean turbulence. These measurements provided important information on changes in the upper ocean variability caused by the wake effects of the wind turbines. The oceanographic data will also contribute to distinctly improve our understanding on turbulent air-sea interaction processes in the vicinity of wind turbine installations.

With exception from of some expected down periods due to platform power failure and maintenance, the NORCOWE instrumentation has collected an extensive data set which covers quite varied weather conditions. First analysis of the LiDAR data clearly shows that our measurements resolve wind farm inflow conditions and the structures in the turbulent wind turbine wake. Also, data from the passive microwave radiometer show good agreement with coastal radiosonde measurements at Norderney and Schleswig in Germany.



Currently, several NORCOWE partners have started to utilize the OBLEX-F1 data in both academic research and industry projects. Also, the data are under consecutive review with regard to the data quality. In order to make the OBLEX-F1 data available to a wide range of users, NORCOWE is developing a data extraction portal which allows researchers to efficiently access the data set. This web based portal allows users to search and filter the raw data according to a custom output resolution. The resulting filtered data subset is of manageable size and can be downloaded for further analysis in netCDF format. The OBLEX-F1 data will first be made available to NORCOWE partners and collaborating external institutions and partners.

Contact centre director Kristin Guldbrandsen Frøysa (Kristin[at]cmr.no) for more information about the data.

Presentation of the atmospheric data from OBLEX-F1 (held at NORCOWE 2016 by scientist Martin Flügge, CMR)

Presentation of the oceanographic data from OBLEX-F1 (held at NORCOWE 2016 by Dr. Mostafa B. Paskyabi, University of Bergen)