Multi-scale meteorological modelling and prediction

This work is undertaken by the Environmental Flow Group at Uni Research Computing. (http://uni.no/en/uni-computing/). It involves **downscaling** from regional- or global-scale models, to obtain detailed wind, wave and current **climatologies**, fit for the purposes of **site assessment**. A second, more recent focus is **ensemble forecasting,** for identification of site- and route-specific **weather windows**, and associated decision-making in marine operations such as turbine installation or maintenance.

The Group's mesoscale atmospheric model of choice is the Weather Research and Forecasting model (WRF: www.wrf-model.org). The surface-wave model of choice is from the international Wave Modelling group (WAM), or a variant of this for Simulating Waves Near-Shore (SWAN: www.swan.tudelft.nl). The ocean model of choice is the Bergen Ocean Model (BOM), developed in-house in a collaboration with the Mathematics Institute at the University of Bergen (www.mi.uib.no/BOM). The WRF forces the wave and ocean models (with feedbacks having been accommodated online). The large-scale synoptic forcing at model start-up and domain boundaries derives from reanalysis or forecast data from the European Centre for Medium-Range Weather Forecasts (ECMWF: http://www.ecmwf.int/) and MyOcean (http://www.myocean.eu).

Key aspects of downscaling met-ocean simulations for wind-energy purposes are conducted

Lorenz and Barstad (2013; 2015, *Wind Energy*, in review) downscale up-to-date atmospheric reanalyses over the northwest European shelf. The 2015 study involves a ten-year period from the ECMWF ERA-Interim reanalysis, of horizontal resolution ~70 km, downscaled to 3 km using two telescoping nests. Verification is to satellite-derived 10-m winds and wind-velocity profiles measured at the FINO1 met mast and Ekofisk oil platform in the North Sea – Barstad and Jenkins (2012, *Mod. Energy Rev.*, **4**) show verification is best done well away from coastal terrain, where strong horizontal flow gradients impede accurate comparison of model and measurements. Barstad (2015, *Wind Energy*, accepted) verifies static-stability parameters from the downscaling at FINO1 and Ekofisk. Lorenz and Barstad (2015) also develop a metric more closely related to wind-power production, the power from an isolated variable-speed turbine as a fraction of its rated power, evaluated using the hub-height wind speed.

Jenkins (2014) downscales the surface wave field using the wave model, WAM, forced by WRF (one way, without feedback), over a one-year period and a spatial domain that lie within the period and domain of the WRF simulations of Lorenz and Barstad (2015). The horizontal resolution is 9 km. A second, multi-nested, downscaling, all the way down to about 250 m at a selected study and validation site (the location of the FINO3 met mast), is underway. By accommodating the forcing from downscaled winds and bathymetry of progressively finer scale as the site is approached in this way, the sort of variation in surface-wave parameters that might arise within a large offshore wind farm will be resolved. Jenkins and Lorenz (2014) furthermore experiment with a two-way coupling of the models, to examine how the degree of wave development impacts on wind profiles and hub-height speed.