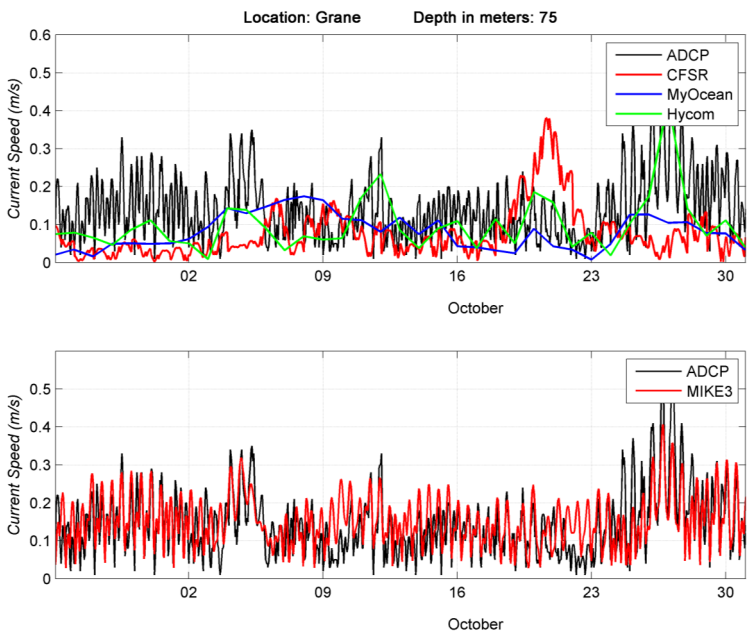
DOWNSCALING OCEAN GLOBAL MODELS

Providing high-resolution hydrodynamic data throughout the water column

Sources of high-quality and reliable flow data throughout the water column are scarce. Through our high-resolution regional models, we can provide this kind of fundamental data for the design and operation of offshore structures as well as other marine activities.

STATUS OF AVAILABLE 3D CURRENT DATA

Accurate and reliable knowledge of currents and related flow data throughout the water column has a direct impact on the design and operation of offshore structures and related activities. The source of this kind of accurate data is limited, and if measurements are available they have intrinsic space and time constraints.



Current speed at Grane Station (northern North Sea) at a water depth of 75 m from 25 September to 31 October 2011. Top image: measured data (black lines, not de-tided) is compared to CFSR (red), My Ocean (blue) and HYCOM (green). Bottom image: Measured data (black lines) is compared to MIKE 3 forced with MyOcean (red). ADCP measurements courtesy of Statoil ASA. ©DHI

CLIENT

- Oil and gas industry
- Offshore renewable industry
- Consultants and contractors
- Authorities and regulators
- Emergency response companies

CHALLENGE

- Limited access to accurate and reliable high-resolution three-dimensional (3D) ocean data
- Need to consider regional and local scales including tides

SOLUTION

- Numerical modelling with high-resolution
- Accurate long-term data
- Hydrodynamic information from bottom to surface of water column

VALUE

- High-resolution current data including global and tidal processes
- 3D flow information throughout the water column
- Robust design parameters in zones with strong vertical current shear
- Cost-efficient design of marine structures enabled by accurate modelling of environmental conditions

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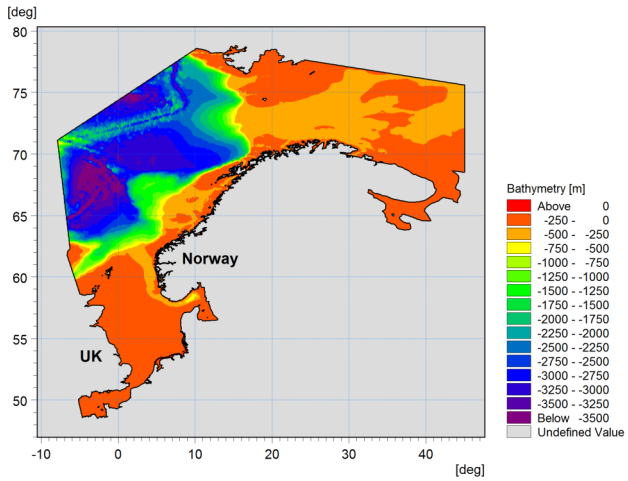
We deliver long-term hindcast of oceanographic variables for environmental impact assessments and to ensure the safe and sustainable design and operation of fixed or floating offshore platforms, subsea systems, and wind farms. Photos (clockwise from top left): ©shutterstock.com/Eyeidea, ©istockphoto.com/pixone, ©istockphoto.com/Matthew Rambo, ©www.medvind.dk/Bent Medvind

Hindcast using ocean models aim to reduce this information gap, however, the resolution and accuracy of present global ocean models are not enough for industry applications.

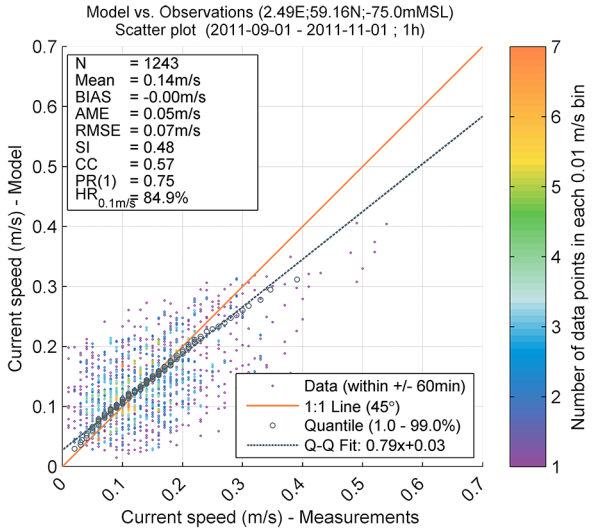
We are working with a number of global ocean models like Climate Forecast System Reanalysis (CFSR) ocean hindcast, HYbrid Coordinate Ocean Model (HYCOM) and MyOcean data. A comparison of these three global models with measurements in the North Sea during September and October 2011 outlines some of their shortcomings in describing tides and mesoscale events. Each model has its own strengths as well as limitations and each could be used as the base for downscaling, but not for describing local processes.

FILLING THE GAP: HIGH-RESOLUTION DOWNSCALING

The accuracy of global ocean models is limited therefore 3D, high-resolution downscaling is needed in order to properly model a specific area.



Computational domain for the MIKE 3 FM model. ©DHI



Scatter plot of measurements and MIKE 3 results at Grane Station at water depth of 75 m for September and October 2011. ©DHI

To illustrate this, we used MIKE Powered by DHI's MIKE 3 model in the North Sea and Norwegian Sea to simulate unsteady three-dimensional flows, taking into account:

- density variations
- bathymetry variation
- external forcing such as meteorology, tides, baroclinic flow
- other hydrographic conditions like river discharges

Sensitivity tests using the global models to force our MIKE 3 high-resolution model including tides showed that the density structure imposed at the boundaries and as initial conditions by the global oceans is much more important than the imposed current at the boundaries. Although currents from different global ocean models can differ greatly, their density structure is relatively similar and thus the results of the downscaling do not differ significantly for the different ocean models.

We evaluated the model data in terms of surface elevation, currents, temperature and salinity. MIKE 3 was shown to be capable of producing currents from the density gradients. Combined with MIKE tidal prediction, it produces significantly improved model results compared to those from global models, successfully reproducing local flow features.

With our technology, we can provide long-term detailed information on current data from the surface down to a water depth of about 4 km for the North Sea, the Norwegian Sea, and any other region around the globe. This data will allow the offshore industry to more accurately design and maintain marine structures at the surface and at the seabed – ultimately enabling more efficient performance of offshore activities. The database will be equally important for long-term environmental impact assessments from, for example, oil spills.

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