DHI CASE STORY

CONDUCTING A FULL HINDCAST STUDY FOR THE NORTHERN NORTH SEA

Providing Statoil with more detailed data on currents

Statoil Petroleum AS has a lot of exploration, development and production activities in the Northern North Sea. To support these, they wanted to increase their knowledge of currents, which have a direct impact on the design – and subsequently the cost – of oil- and gas-related structures. To ensure that Statoil had access to detailed and accurate currents data, we conducted a full hindcast study of the Northern North Sea. The data we provided to Statoil will enable them to more accurately design their offshore structures by taking accurate current conditions into account. This could result in considerable costs savings in the future.

IMPROVING KNOWLEDGE OF NORTHERN NORTH SEA CURRENTS

When designing oil and gas structures located at the seabed – several hundred meters below the water – taking current conditions into account is of the utmost importance. Without detailed information from models and measurements, conservative data on current conditions must be applied. This can make designing, building and placing structures at the seabed more expensive.

Oseberg Field Centre. Photo by Øyvind Hagen / Statoil ASA © Statoil

SUMMARY

CLIENT

Statoil Petroleum AS

CHALLENGE

Need for detailed data on currents in the Northern North Sea – especially at the seabed level – over a long period of time in order to accurately design offshore oil- and gas-related structures

SOLUTION

Conducting a full hindcast study that includes meteorological driven-, oceanographic and tidal currents covering a longer period of time

VALUE

Enabled the client to:

- take accurate currents data into account when designing and building future offshore oil and gas related structures
- potentially save money due to having more accurate data on currents when planning offshore oil- and gas-related structures

LOCATION / COUNTRY

Northern North Sea, Norway

While measurements provide good general information, they only cover short periods of time and a limited number of locations. For this reason, numerical current models are used to generate long-term current data for large areas.

Statoil is heavily involved in exploration, development and production activities in the Northern North Sea. In order to support these activities, they wanted to increase their knowledge of currents in that area. They initiated a measurement campaign and prepared for a current hindcast modelling study to do just that.

IMPROVING MODELLING OF CURRENTS NEAR THE SEABED

The modelling study – Northern North Sea Current Hindcast (NoNoCur) – was divided into two phases. First, Statoil invited a number of institutions to provide a current hindcast for the year 2011. Statoil provided a selected number of measurements to the institutions for model calibration.

They then chose the institution that provided the most accurate hindcast – when compared to additional measurements – to perform the full current hindcast study. Based on the current hindcasts for the year 2011, Statoil chose us to perform the full NoNoCur modelling study.

Most aspects of our 2011 hindcast received high scores during Statoil's evaluation – however bottom currents received an average score. Before doing the full hindcast study, we used Statoil's feedback to improve our current model with respect to bottom currents – at our own expense. This was done by implementing 'cut-cells' in the numerical scheme and optimising the use of combined sigma- and z-layers.

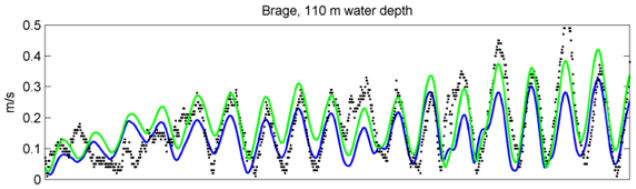


Illustration of improvement of current speeds when implementing cut-cells and optimising transition depth. Black dots show measurements, while the blue line and the green line show model results before and after model improvements, respectively.

We used sigma-layers in the top part of the water column, which was divided into layers with a relative thickness – for example, each layer was 2% of the depth until a transition depth of 50 m. These layers followed the bottom contours in depths more shallow than the transition depth. Thus their thickness varied.

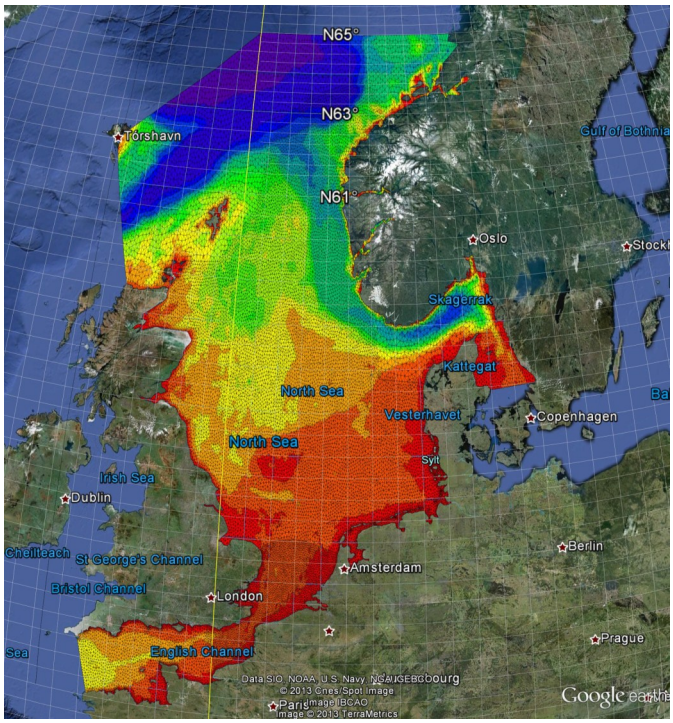
In deeper water, sigma-layers have an almost constant thickness. Below the transition depth, we used z-layers with a fixed thickness. These z-layers did not follow the bottom contours. Consequently, they did not represent the seabed and the seabed currents well. We cut a slice from the bottom-most cells of the sigma-layers to make the bottom of those cells followed the bottom contour. By using these cut-cells and optimising the transition depth, we improved the model's simulation of bottom currents considerably.

POTENTIAL FUTURE COST SAVINGS

We carried out the full NoNoCur hindcast study using our three-dimensional (3D) hydrodynamic model MIKE 3 Flexible Mesh with the 'cut-cells' improvement. Our hindcast – which included both meteorological driven-, oceanographic and tidal currents – covered:

- a five-year period from 2008-2012
- 13 selected storms for the period 1993-2007

From our hindcast, we provided current data to Statoil for 17 selected depths – ranging from the surface down to 300 m – for the entire Northern North Sea area. This data will become part of Statoil's Metocean database that will be used for future projects in the Northern North Sea. The detailed data will enable Statoil to more accurately design offshore oil- and gas-related structures, which could result in potentially large cost savings.



Computational mesh for the NoNoCur MIKE 3 FM model

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