Paving the way to combine large scale accurate hindcast data and advanced statistical methods for future offshore applications

PP7

Maziar Golestani mgo@dhigroup.com and
Patrick Dich Grode pdg@dhigroup.com
DHI A/S, Hørsholm, Denmark

Introduction

A safe and cost-effective development of offshore wind structures require detailed and accurate meteorological and oceanographic (MetOcean) data and analysis, based on long-term hindcast data. Traditionally, it has been difficult to make high quality data available over a large domain together with advanced statistical analysis, ensuring lower risks and costs for the entire offshore wind farm design process.

This poster covers the solution implemented for the Dutch Government (RVO.nl) (but freely accessible globally) to provide state-of-the art modelling combined with sophisticated statistical analysis all in one package.

The product (world's first certified digital database) enables the offshore wind market to have access to consistent metocean data during all project phases.

The web-based database provides high resolution data in the Dutch North Sea, but also globally in other markets (North Sea, US, Taiwan, South Korea, Japan etc.)

Objectives

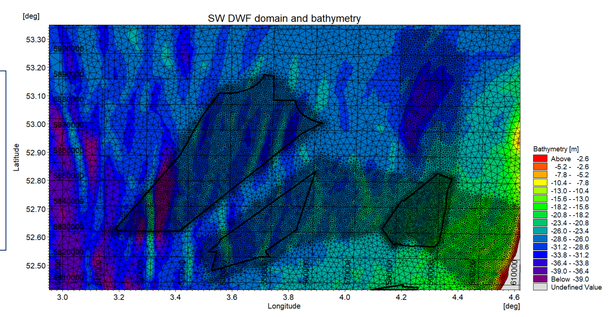
Deliver best in-class, validated and comprehensive metocean data covering 40 years (1979-2019), and:

- ✓ Provide high-resolution data for future wind farms in the Dutch North Sea
- ✓ For the first time in offshore industry, perform non-stationary extreme value analysis for the entire Dutch North Sea covering shallow, intermediate and deep water areas
- ✓ Combine DATA + ANALYSIS in a CERTIFIED user friendly WEB-BASED database

Methodology

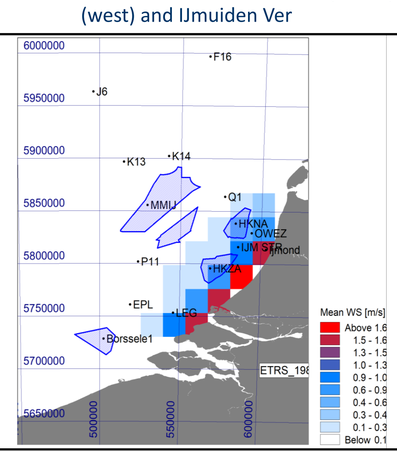
The success of the project was dependent on establishing a robust, accurate, consistent and validated long-term data basis. This was achieved by combining more than 20 available measurement stations and satellite data with extensive modelling of flow and wave conditions. Here are the highlights:

The models took advantage of flexible mesh with resolution of ~400m (wave) and ~200m (Hydrodynamic) at the Dutch offshore wind farms.



Wave model mesh around Hollandse Kust (noord) & (west) and IJmuiden Ver

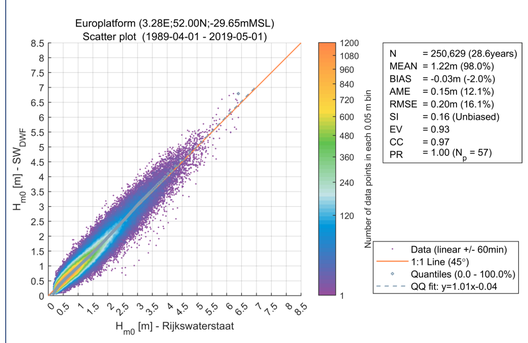
- ✓ Comprehensive comparisons between CFSR and KNMI's KNW wind atlas was carried out.
- ✓ CFSR was chosen to force the numerical models and then corrected for coastal effects



Difference of mean wind speed at 10m between original and corrected CFSR (2017)

State-of-the-are modeling was done by including:

- ➢ The effects of atmospheric stability and air-sea density ratio
- ➢ Effect of surface currents on the wave growth
- ➢ Applying the right CAP on wind friction
- ➢ Assimilation of water levels



Significant wave height validation at Europlatform (1989-2016)

Methodology Cont.

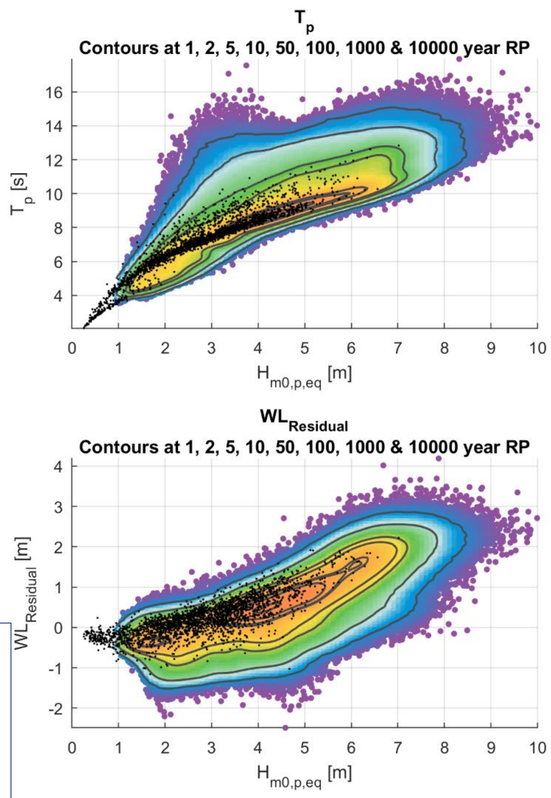
In order to push the offshore wind market and produce more accurate results and reduce costs, extreme value analysis was based on non-stationary extreme statistics based on DHI's J-EVA tools.

Such method is particularly well-suited in a complex area like the Dutch North Sea, where there are large variations in the available fetch and a number of different wave systems.

As a results, the extreme values for design were reduced compared to previous studies. Some examples are:

The 10-minute wind speed at 100mMSL, was reduced by 3.3 m/s for a 100-year return period.

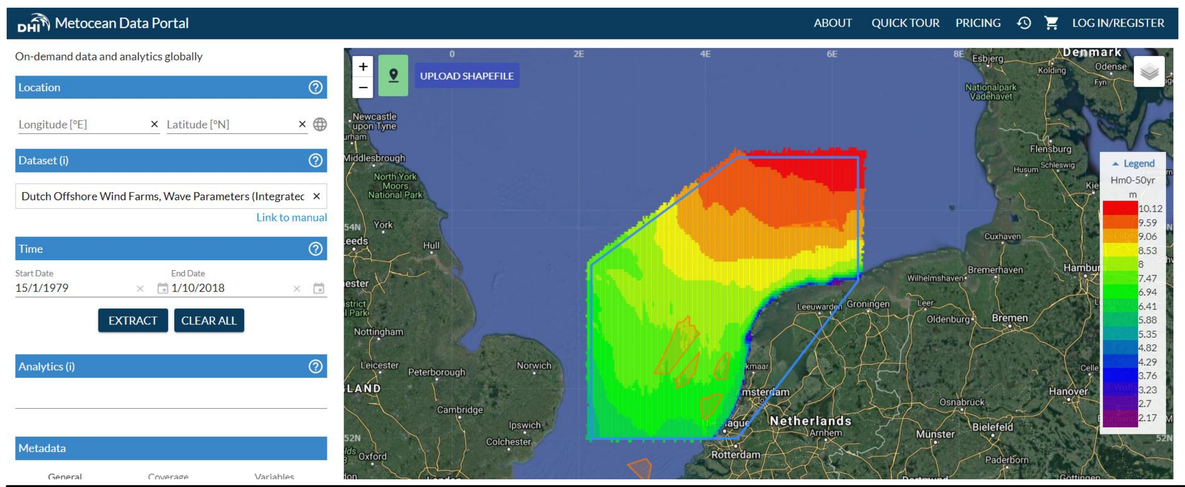
The 10,000-year Cmax & Hmax were reduced by ~1.0 &~2.0 meters, respectively.



Scatter plots show Tp (top) and residual water level (bottom) against Hm0, based on **1e+6** years of simulation

Results = Web-Based MetOcean Database + API

Apart from a comprehensive report describing methodology, validation, normal and extreme conditions at four sites, the main outcome from this study was the **ALL-IN-ONE web-based database and API**. Here are some of the features:



https://www.metocean-on-demand.com

- ✓Readily available certified data for developers, designers, modellers and more
- ✓Possibility to upload user defined shapefiles
- ✓Access to 40 years of high resolution data (wind, waves, currents, water levels) at +55,000 grid points within a large area
- ✓Access to both normal and extreme conditions (1, 2, 5, 10, 50, 100, 1000,10000 year) + associated parameters + joint probability results + NSS tables
- ✓Functionality to perform analyses: plot time series, rose plots, scatter diagrams, persistence tables, distribution tables
- ✓Access to normal and extreme surface maps
- ✓Functionality to download full directional and frequency spectrum
- ✓**Web API is available to provide all required data without the need to access the GUI**

The report + database + webinar is publically available from:

https://offshorewind.rvo.nl/windwaternh

Incorporating the 16th International Waves Workshop
10–15 November 2019
Sheraton Hotel, Melbourne, Australia

THE UNIVERSITY OF MELBOURNE