Case study 7

Energy logistics: wind and wave conditions

Focus: Wind and wave conditions during seasonal ‘shoulder’ months in the North Sea and energy logistics

Industrial and research partners

The SECLI-FIRM project aims to demonstrate how improving and using long-term seasonal climate forecasts can add practical and economic value to decision-making processes and outcomes, in the energy and water sectors. To maximise success, each of the nine SECLI-FIRM case studies is co-designed by industrial and research partners.

For this case study, the industrial partner is Shell – an international energy company with expertise in the exploration, production, refining and marketing of oil and natural gas, and the manufacturing and marketing of chemicals. Their strategy is to strengthen their position as a leading energy company by providing oil and gas and low-carbon energy as the world’s energy system changes. Safety and social responsibility are fundamental to their business approach. Shell’s purpose is to power progress together with more and cleaner energy solutions.

Boosting decision making

The main objective of this case study is to illustrate the application of long-range forecast data (longer than that typically used by the offshore oil and gas industry) to identify calm weather windows in autumn and spring months, facilitating earlier decision-making and reduced operational costs for the marine energy sector.

The seasonal forecasting context

- Seasonal forecast evaluation will consider the skill of predicting calm weather windows in autumn (September to November) and spring (March to May) months in the North Sea within the years 2016 to 2018.
- This will be illustrated from the point of view of the Asset Manager or Metocean Engineer planning operations such as those involving drilling, large infrastructure installation or decommissioning activities.

Sectoral challenges and opportunities

- The expense of working in the offshore environment places special emphasis on the requirement to reduce supply chain costs, such as those related to vessel charter and personnel management, through efficient operational planning.
- At present, the application of the latest weather science developments by the offshore oil and gas industry is traditionally very conservative, with limited use of fortnightly, monthly and sub-seasonal outputs, or even climate projections and teleconnections.

Wind and wave conditions

Logistics for the marine energy sector are governed by strict environmental limits under which work may safely be conducted, with the significant wave height, mean wave period and 10m wind speed representing the most important parameters.

Ocean currents also affect the station-keeping capabilities of vessels; however, since in the North Sea these are dominated by the tides (and therefore inherently predictable) they do not generally represent a significant issue or source of uncertainty within the decision making.

Offshore operational planning

The case study will be presented from the view of the Asset Manager or Metocean Engineer planning operations dependent on a sustained period of low wind speed and significant wave height in the North Sea.

Since these activities utilise vessels with estimated daily rates up to £500,000 (in addition to associated mobilisation and demobilisation costs), the benefit of avoiding costly downtime can be determined in industry-relevant economic terms – with a particular focus on those vessels on long-term charter, and facilitating the earlier booking of auxiliary capability.

Companies are keen to optimise the use of vessels when contracted out at sea. In the North Sea, these are typically booked from June until August, when wind and wave conditions are, statistically, the mildest – increasing the likelihood that weather-sensitive operations will be successful due to reduced odds of key thresholds (e.g. 10 m/s wind speed or 2m significant wave height) being breached (Figure 1).

However, the result of this is to constrain complex activities to a 3-4 month period, with the use of the existing 3-day forecast (primarily employed in safety-critical decision-making at short-range) providing limited opportunity for effective planning.

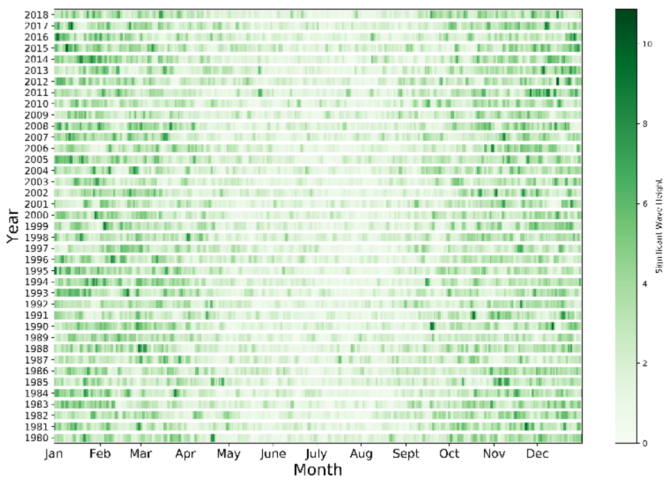


Figure 1: Hindcast values for daily maximum significant wave height (m) 1980-2018

Climate event

Workable weather windows in the North Sea for logistics operations

Sector impact

Reducing costs by improving operational efficiency

Industry context

Asset Manager or Metocean Engineer planning operations

Demonstrating value

In the planning of any new operation, it is typical for the Asset Manager to enlist the services of a Metocean Engineer or Engineering Team for outlining the scope of work, resourcing and scheduling the various operations for example pipe laying, crane lifting and vessel supply while considering their associated weather-sensitive thresholds. It is the role of the Metocean Engineering Team to establish when each component activity, necessary for the overall completion of the project can be performed based on metocean data.

Such an analysis includes interrogating weather information for weekly, monthly or annual milestones and refining or revisiting this information during the course of the work as these events draw nearer in time. Within this process, for project stages involving marine data, long-range strategic planning typically uses statistical analysis of past conditions, with the final approval as to whether to initiate a planned operation.

The offshore oil and gas industry is traditionally very conservative due to the hazardous nature and safety focus in offshore operations. It is unrealistic (at least within the timescales of this research) to expect to convince asset managers to replace their business processes for long-range decision-making (based on analysis of historical data). There is however significant potential to extend the planning horizons considered in-year up to at least monthly lead-times, using seasonal forecasts.

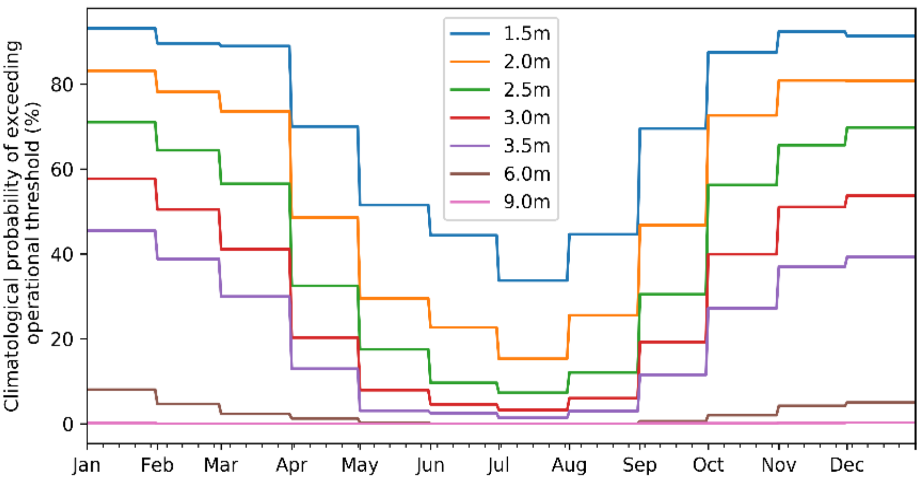


Figure 2: Monthly probabilities of exceeding specific significant wave height thresholds (1.5 to 9 m) based on climatology.

Demonstrating value

Extend planning horizons considered in-year up to at least monthly lead times using seasonal data

Progress update: forecasting probability of wind/wave thresholds with weather patterns

In an attempt to elicit skill on timescales of several days to several weeks ahead, the work conducted to date has looked to exploit weather pattern typology as a means of characterising the large-scale circulation, which is more predictable than the actual weather itself at long lead-times.

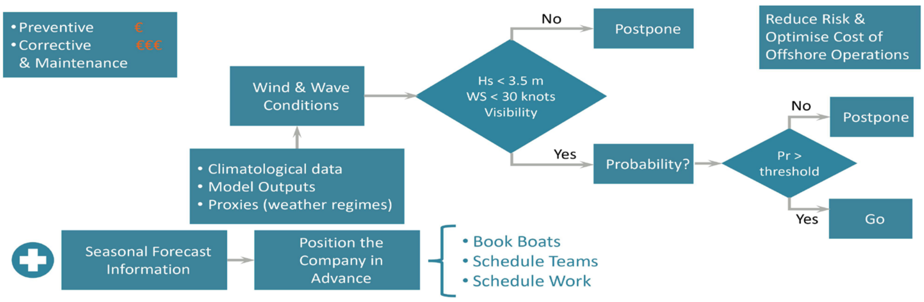
A weather pattern is defined as one of many broad-scale atmospheric circulation types over a particular area (that differs in characteristics from other weather pattern classifications over the same domain) and can vary on a daily basis. For effective decision-making, the occurrence of a particular weather pattern 'definition' may be linked to the viability of offshore operations at a local scale, via the process of statistical downscaling.

Building on a very preliminary outline of the concept, developed previously with the industry partner (see Steele et al., 2018), significant improvements have been made to better account for seasonality in the wave climates used for the downscaling, where a probability distribution for each weather pattern is computed using a rolling three-month window centred on each day. Appropriate ways of presenting the forecasts have been developed with Shell to align with their decision-making process. These show the difference between forecast probabilities and the climatological probabilities that Shell is currently using as the basis for their longer-range decision making.

Long-term verification statistics have also been calculated to complement the specific case study events (March and September 2018) to establish how early adverse weather events could have been identified. This will provide the basis for beginning to build industry 'trust' in these types of longer-range products, as well as demonstrating their use in application for previous/historic examples.

Going forward, the main next steps are to focus on operationalisation, to allow real-time forecast to be delivered to Shell.

Decision Tree



The Added Value of Seasonal Climate Forecasting for Integrated Risk Management (SECLI-FIRM)

For more information visit:

www.secli-firm.eu or contact us at:**info@secli-firm.eu**

Forecast Evaluation

The data will be used to explore the use of weather patterns for improving longer-range decision making.

Reference: Steele ECC, Neal R, Dankers R, Fournier N, Mylne K, Newell Pm, Saulter A, Skea A and Upton J. (2018) Using weather pattern typology to identify calm weather windows for local marine operations, Proceedings of the Offshore Technology Conference, Texas, USA, 30 April – 3 May 2018

For more about this and the eight other case studies, visit www.secli-firm.eu

Grant Agreement n. 776868