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An innovative weather downtime tool for offshore wind marine operations

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BACKGROUND

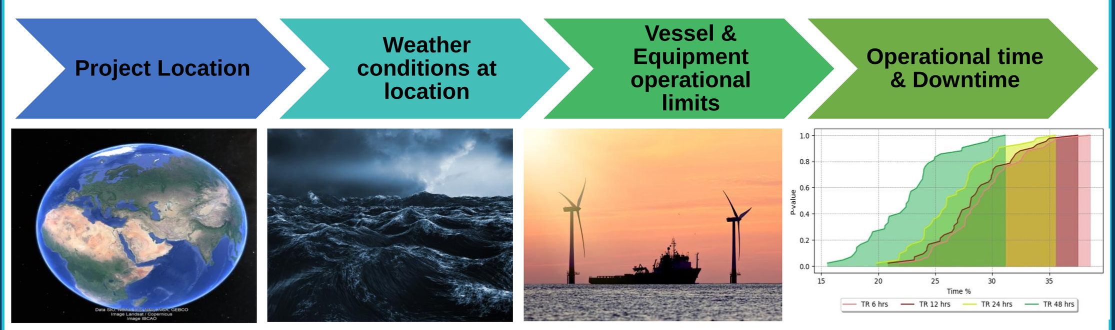
Weather downtime is a major factor in any offshore operation as it affects both the project program and budget. Therefore, knowledge of potential weather downtime for a given site is valuable for all offshore operations undertaken by developers and contractors.

This poster presents the development of a novel tool, by Gavin & Doherty Geosolutions (GDG), that enables a reliable and quick assessment of weather downtime for any offshore site.

OBJECTIVE

Implement and improve the methodology for assessing weather downtime at any offshore site by using either publicly available ERA5 data, or the site-specific hindcast time-series, and vessel operational specifications. Include the "waiting on current" time.

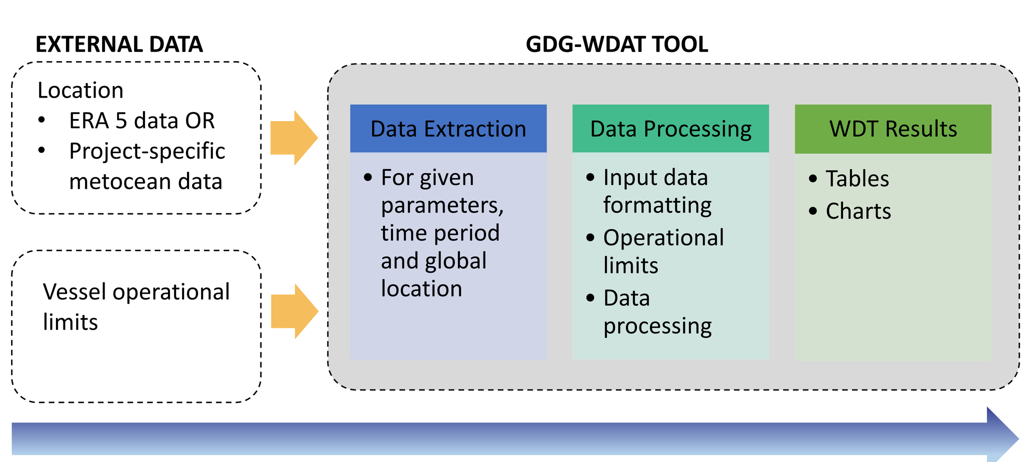
The methodology is implemented in an in-house tool developed in Python 3 capable of interacting with the ERA5 database, enabling selective downloads for any site across the globe.



METHODS

The weather downtime (WDT) assessment methods are based on statistical analysis of weather data compared with the operational limits of the vessel, where the weather time series is mapped into a binary workability sequence marked as "1" if below the limit (workable) and "0" if above the limit (non-workable) at each discrete data point (most often at every hour).

WDT assessment provides information on the time (usually given as percentage, hours or days) lost during the offshore operations due to bad weather, i.e. due to weather above the operational limits of the vessel.



RESULTS

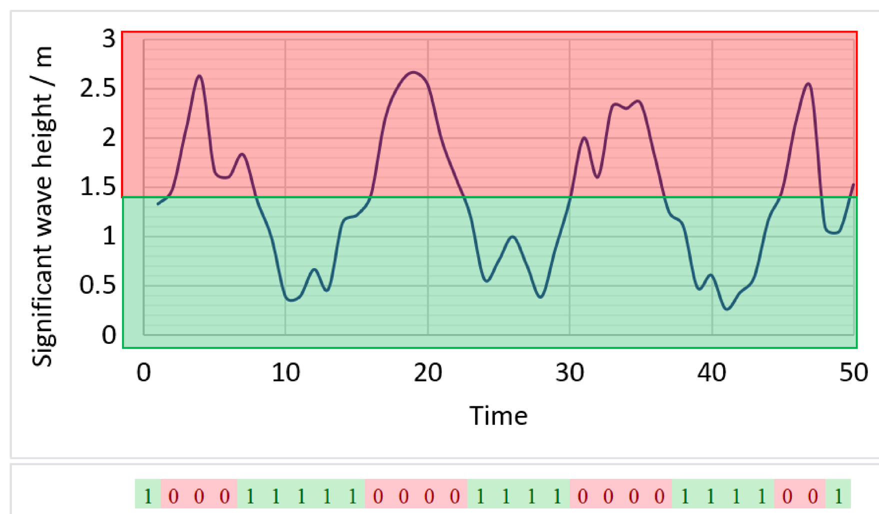
WEATHER DOWNTIME OVERVIEW

There are three widely used methods for WDT assessment:

1. Method 1: Joint probability distribution/wave scatter or exceedance
2. Method 2: Empirical persistency distribution or weather windows and
3. Method 3: Simulation based approach

The first step of any method is to evaluate discrete time points when the weather is below given limits, see below figure. In the first method the sum of the non-workable hours divided by the total number of hours will indicate the weather downtime percentage, while in the second method another step is performed where only those time periods that have all the metocean parameters below the installation limits for at least a given time period will be evaluated as workable (which is why it is also termed the weather windows). The simulation-based methods simulate the installation programme at different start dates to obtain the empirical cumulative distribution function which is used to estimate the weather downtime with a certain P-value.

The principle of mapping the wave height record into a binary workability sequence



THE EFFECT OF CURRENTS

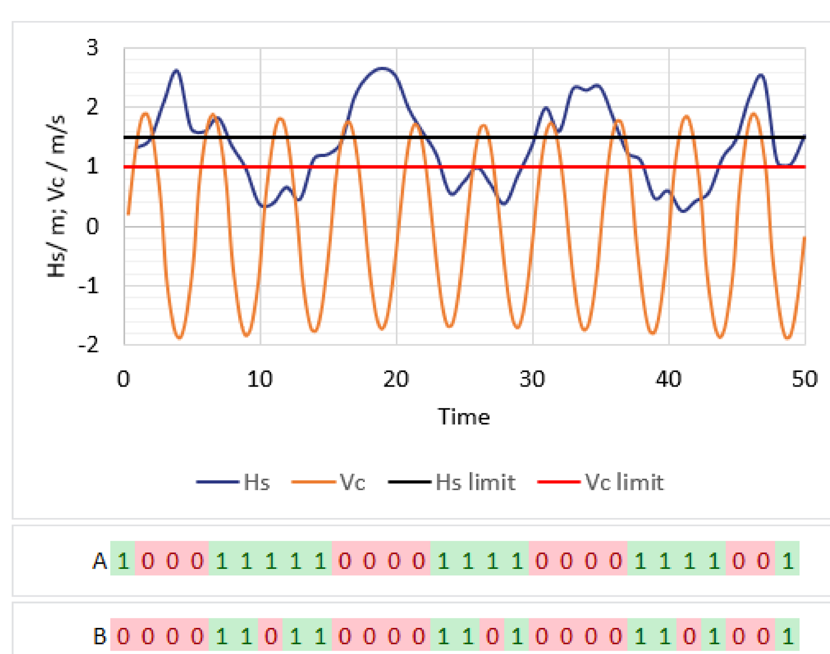
The effects of currents (mainly tidal) can have a significant impact on the weather downtime. Here, two different operational situations are distinguished and methods of accounting for the steady currents are given for:

1. Operations that must be performed when the current is below given limits, e.g. operations with a remotely operated vehicle (ROV). The weather windows are driven by the current conditions, which is illustrated with binary sequence "B" below.

2. Operations that can continue only when the current is below a given limit, but may be "on hold" when the currents are above the limit, e.g. a cable installation vessel's DP system is generally unable to keep the required tolerance in currents higher than 1.5 m/s, in which case the operations stop, and the vessel will weathervane to remain in position, waiting for the current to reduce to continue cable laying, which is illustrated with binary sequence "A" below.

Illustrative example of the current effect

Hs - Significant wave height (m)
Vc - Current speed (m/s)
Hs limit - Operational Hs limit
Vc limit - Operational Vc limit



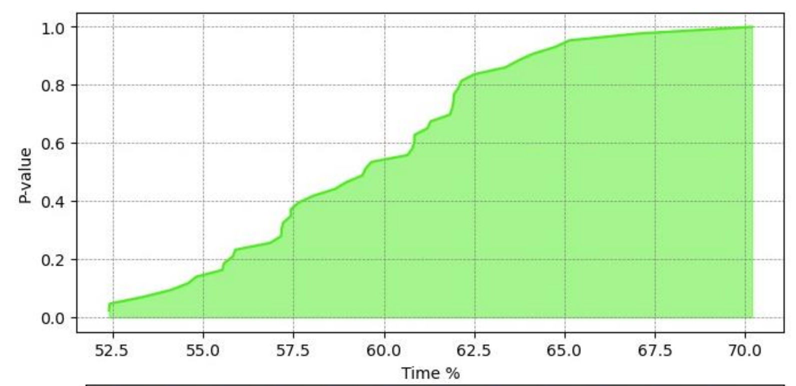
CASE STUDY

Project location

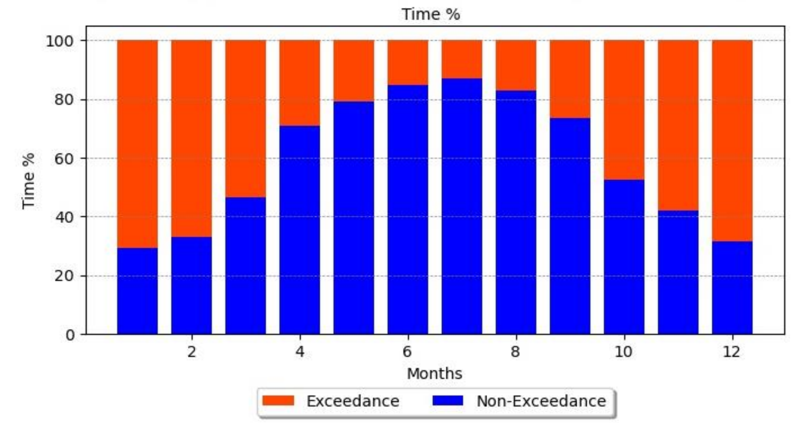
Criteria for Weather downtime

- Significant wave height, Hs = 2.0 m
- Wind speed, Vw = 15 m/s
- Duration of one cable installation: 16 hrs
- Number of cables: 20

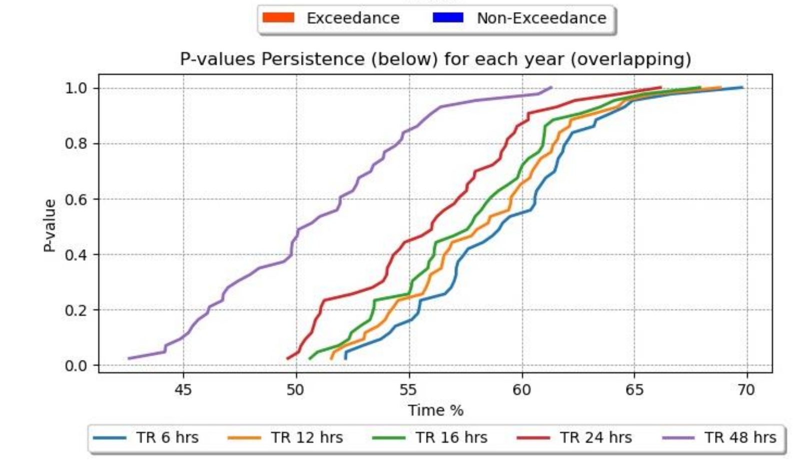
Non-exceedance plot for all years (Method 1)



Non-exceedance plot for each month, all years (overlapping, Method 2)



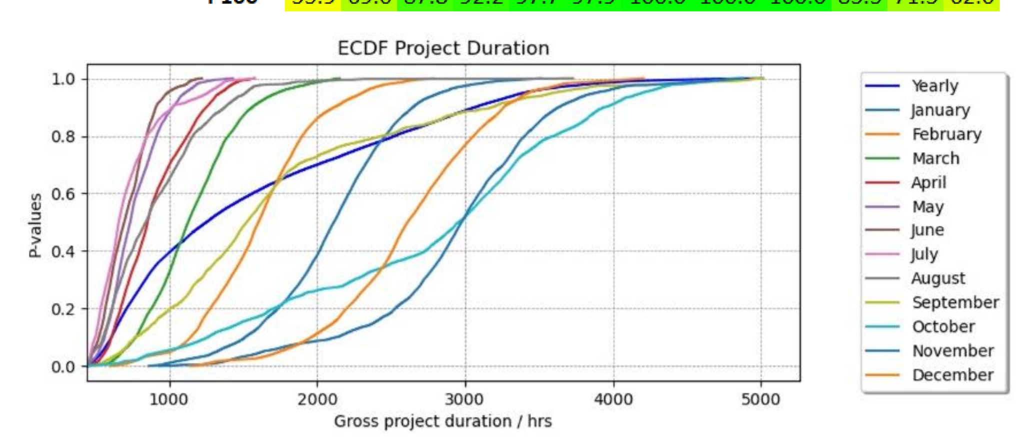
Persistence plot for each year (overlapping, Method 2)



Persistence table for each month for a period of 16hrs (non-overlapping, Method 2)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P0	0.1	0.0	10.8	33.9	46.4	59.0	46.4	37.8	33.8	20.0	9.0	0.0
P20	8.7	7.3	24.8	47.2	59.3	66.5	75.8	67.7	53.1	33.9	20.2	12.1
P50	18.7	24.7	38.7	68.0	73.0	81.7	85.7	80.6	66.7	43.4	32.5	23.4
P80	42.7	42.1	53.2	78.6	85.8	90.1	91.6	88.2	78.5	53.8	44.6	34.4
P100	55.9	69.0	87.8	92.2	97.7	97.9	100.0	100.0	100.0	85.5	71.5	62.0

Simulation-based ECDF curves (Method 3)



Comparison of results

P-Value	Project Duration in Hours		
	Method 1 Non-Exceedance	Method 2 Weather Windows	Method 3 Simulation based
50	367	392	383
80	426	481	460

CONCLUSIONS

- Information about potential weather downtime (WDT) is essential for appropriate planning and costing of the offshore works.
- While in the past the challenge was to obtain sufficient data for a meaningful statistical analysis, with recent advances in weather modelling and the possibility of creating hindcast time series for many years, the focus is switching to creating more sophisticated models for WDT assessment.
- There are three common methods of WDT assessment, and each can be applied to different problems.
- In general, it can be concluded that the first two methods of WDT assessment are more straightforward to implement, but not so intuitive. On the other hand, implementing the simulation based method is significantly more demanding, but the results can be more readily used and understood.
- Simulation based method has several advantages, some of which are: possibility to simulate the schedule of activities with each activity defined by unique duration and weather limits, easily understood more realistic predictions of project duration, more realistic accounting for the current effects, can easily simulate long projects that extend through several months, can better inform on the optimal project start date etc.
- The offshore wind farms are often located in shallow water areas with relatively high currents, so that currents might become the key factor in weather downtime, more significant than waves or winds. Therefore, accounting for the current in weather downtime assessments is crucial for planning the offshore activities.
- A case study was presented to show some of the output capabilities of the newly developed "GDG-WDAT" tool.
- Weather downtime assessment enables a cost-effective project execution.

REFERENCES

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