The Offshore Weather Forecasting Guide

How It's Made

For offshore companies, accurate and reliable weather forecasts are essential to make informed business decisions, through all stages of a project lifecycle. These companies typically rely on forecasts delivered by professional meteorologists. But why? What makes the experts stand out from the crowd?

We asked the offshore weather experts to share their experience and insights on what makes a highly accurate weather forecast. In this guide, we cover everything that goes into making an accurate forecast for offshore applications, showing exactly how your weather forecast is made and why highly accurate weather forecasts make a positive difference for offshore companies.

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Weather Forecasts Throughout the Offshore Project Lifecycle

It's perhaps obvious that the offshore companies require some form of weather data during project execution. But using it just at this stage undermines the real value that can be unlocked when it is used throughout the project lifecycle. Here is how you can use weather data throughout an offshore project.

Tendering:

Use weather data to establish when projects can take place

Regardless of the location, there are certain weather conditions where vessels cannot operate. For example, bidding companies in some regions (including the EU and Norway) analyze their requirements based on Alpha Factors, such a maximum wave height, wind speed, and wind direction.

They then put all of this information in the metocean database. This information determines the limitation of the job. Bidding companies submit their tender with this information included.

Planning:

Analyze the design, location, and structure of your offshore operations, to minimize risks

Planning is all about ensuring the right vessels, equipment, and crew are lined up for the project. Every consideration from capital to operational expense establishes how to get people back and forth during the project, down to which vessel to use, and that needs planning.

What are Alpha Factors?

Alpha Factors (DNVGL-ST-N001) are the maximum ratio of operational criteria/ design environmental condition to allow for weather forecasting inaccuracies. The metocean limits used when assessing weather forecasts to determine the acceptability of proceeding with (each phase of) an operation beyond the next Point of No Return. For a weather restricted operation these equal the Operational Limiting Criteria multiplied by an Alpha factor.

Start-up:

Plan safe and reliable offshore operations, with accurate weather data

For offshore companies, start-up means mobilizing teams and beginning the work. For the weather company, it is a shift from providing data for analysis, to issuing daily forecasts. It's a two-way communication. The offshore company briefs what they're trying to achieve; for example, they need a 72-hour weather window to complete a job from start to finish.

The decision of whether to work or not will still lie with the offshore company, but the weather company will help them identify when to work and when to stop based on weather conditions.

Execution:

Access reliable weather data to ensure optimized operations

After identifying the weather window, the project moves to execution. Now it's about continuous monitoring of the weather, querying any discrepancies and establishing if it's marginal or continuous.

It's at this stage that companies need confidence in the weather data. If one forecast shows a 72-hour weather window, but other data sources show it will only be 60 hours, you need to know who to trust.

These are tough decisions to make. Sometimes the weather window isn't there; but sometimes it is, you need to have trust in the data to keep projects on track. But it's also where you can make real gains during your project.

Review:

Evaluating performance and lessons to be learned

At the end of many offshore projects, there is a review stage to evaluate the weather forecasting accuracy. It's about establishing and analyzing the performance of the forecasted weather compared to the actual weather. Key questions to answer at this stage include:

- What impact did the weather forecast have on the project?
- Could the company make more go decisions, rather than no go decision based on the forecast?
- What lessons can be learned?

Not every weather company offers a post-project analysis service, but it is an essential bridge to closing the loop and maintaining trust.

How Weather Impacts the Key Stakeholders in Offshore Projects

Knowing the likely conditions at each project phase is important. But, alongside this, another consideration is the way that different people and teams utilize the weather data within their role.

In the offshore sector, both strategic and operational roles can engage with weather data. Typically they sit in one of six roles:

Strategic Roles

General Management: Understand weather data is critical to project success. They recognize the need to work with credible partners. Business profitability and sustainability is one of their key priorities.

Risk Assessors | Third Party Advisors: Use weather data strategically to ensure project meets the mandatory requirements. They plan risk mitigation without ever compromising on safety.

Operational Roles

Commercial Team: Reach for global partners and manage multiple projects. They keep costs under control, seek accurate and reliable forecasts in the shortest available sales cycle.

Technical or Marine Operations Planning Team: Understand the technical aspects of the project and create plan within the provided weather window as efficiently as possible with minimal downtime.

Project Operations Planning Team: Aims at efficient and effective project completion with zero hassle on and off-site. Crew and asset safety is of utmost concern.

Users

Onsite: Their primary goal to keep the operations running while keeping the crew and vessel safe within the provided weather window.

The core business essence is that same weather data, but it is packaged in a manner that suits the respective teams in the Decision Making Unit. So how can you ensure you have the right data to make these marginal decisions, regardless of their roles and priorities because they can change depending on the size of the company or project? The answer lies in the Five Categories that Create a Highly Accurate Weather Forecast.

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The Five Categories to Create a Highly Accurate Weather Forecast

The weather experts agree, there are Five Categories to a high-quality professional forecasting service. To start, we'll outline how these Five Categories relate to weather forecasts in offshore, before diving into more detail on each Category.

1. Observations

Meteorologists utilize data from thousands of observation points. There are two main types of observation networks:

Physical locations: Weather stations (on land) and buoys (on water) but also modern IoT techniques to capture data e.g. car sensors

Remote observations: Radars detecting precipitation, lightning sensors triangulating thunderstorms and satellites, which include altimeters and scatterometer data to analyze waves.

For weather forecasts in the offshore industry, observation data typically comes from weather stations. This includes data collected from buoys, rigs, and other offshore structures. Offshore companies can opt to share observation data from their location, giving forecasters precise, on-site data to use.

2. Meteorological and oceanographic (metocean) models

Experts use meteorological and oceanographic models to forecast weather conditions, waves and currents in the coming hours, days and weeks. These models are often complex, as they're built on the laws of physics, chemistry and fluid motion, and a coordinate system that divides the Earth into a 3D grid.

Atmospheric motion, pressure, temperature, and humidity are calculated per grid cell, and the interactions with neighboring cells are used to predict future atmospheric properties. Each weather model comes with its own characteristics performing better in certain weather conditions and worse in others. This means there's no such thing as the ultimate weather model providing always the best predictions, which is why weather experts use a combination of models to optimize accuracy.

3. Statistical post processing

By combining several weather models and conducting statistical analyses on them, meteorologists can create an optimized forecasting system. Such a forecasting system is the foundation for predicting future weather conditions and can be adapted to specific requirements. Within offshore, specific requirements call for a tailored approach to statistical post processing. For the weather experts at DTN, the main flavor is proprietary Marine Forecasting System data which predicts marine weather and the state of the sea.

4. Quality control and data management

Weather data comes in different forms. All this data needs to be structured and organized, so it can be analyzed and transformed into valuable information. As data volumes grow and technology gets better every day, data specialists will continue to use new technological solutions to handle future data volumes.

5. Meteorology and forecasting expertise

To truly "know" the weather, you need a team of experts. This includes, of course, meteorologists and weather forecasters. Alongside this, you need a services team that deals with customer feedback and draws up reports. Third, you need a research team that innovates new scientific and technical methods, develops customer-specific solutions, and defines algorithms to verify forecasting quality.

Achieving forecast accuracy

In terms of accuracy, there are clear differences between freely available sources and high-quality data. This improvement is due to the combination of data sources, weather models, forecasting systems, specialists and technologies, which weather experts rely on to improve the accuracy of their forecasting.

These factors are why companies choose to work with specialist weather companies. For the offshore sector, less accurate data typically results in fewer weather windows and more false alarms, which can result in project downtime, damaged equipment or, in the worst case, live-threatening situations. Average offshore companies can make decisions using data from low cost weather vendors, but leading companies prefer using more accurate weather data in their decision making processes.

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Category One: Weather Observation Networks

Whether you're working on an offshore wind farm construction, an oil rig, or dredging navigation channels, it's no surprise that the weather impacts your operations. As a result, monitoring the weather is part of many people's daily routine at work. They do this to understand the safety risks for crew and equipment and understand the steps required to keep projects running profitably.

Meteorologists are also observing the weather on a daily basis because they need to know what is happening now to forecast what the weather will do. But where weather experts differ from casual observers is on the scale of their observations. They rely on weather observation networks, drawing on a broad range of high-quality data from multiple sources to ensure they know what is happening.

What phases of offshore projects rely on forecasts using observational data?

When it comes to observations, these are particularly important during the project start-up and execution phases. When an offshore company briefs their requirements to their weather company, for instance when they need a 72-hour weather window, the weather company can then make a specific recommendation based on the weather data.

After work starts, it's about continuous monitoring of the weather, establishing if it's marginal, and helping them analyze the false alarms. This is because accurate weather data, which enables operations in the margins, can help uncover additional weather windows to work.

> "DTN uses observations weather stations, radar, satellite and lightning networks worldwide to analyze the actual weather conditions, to adjust the forecast for the next hours and to validate and statistically correct our forecasts using a quality checked archive of observations"
>
> Wim van den Berg,
> Senior Meteorological Consultant,
> Weather Tech Team

How are weather observation sources used by weather experts for offshore weather forecasts

1. Weather stations

Planning is all about ensuring the right vessels, equipment, and crew are lined up for the project. Every consideration from capital to operational expense establishes how to get people back and forth during the project, down to which vessel to use, and that needs planning.

Weather stations provide observation data readings of atmospheric conditions at their physical location. The data provided will depend on where the station is based. Marine buoys, for instance, will give nautical weather information like wave height. Weather stations on oil rigs provide local data for offshore operations.

Observation data is available from organizations operating networks of weather stations. Some information is even accessible as open data; however, the level of detail and accuracy of this observation data varies.

How do weather experts improve the data from weather stations?

Weather experts use reliable data sources. Where possible, they invest in multiple sources to correlate results. This approach helps to improve the location coverage and quality of data. They complete the observational data from weather stations with other sources to create an accurate view.

How is this improved data used to create a forecast?

Weather experts use this data to identify situations where the weather can pose a risk to safety, equipment damage, and impact the day-to-day operations. They understand the weather window decision criteria required to keep the business running profitably and safe.

The data alone is not enough to determine the forecast, it's the combination of data and subject matter expertise that creates an accurate forecast.

2. Weather satellites

A weather satellite monitors the conditions of the atmosphere, clouds, and the Earth's surface. Images are taken either by the infrared spectrum or by the visible spectrum, (which requires daylight but provides a more realistic visualization). For offshore companies, observations from satellites include scatterometer and altimeter data for waves.

How do weather experts improve the data from weather satellites?

Weather experts process the satellite data, combining data from multiple satellite sources to create a global view. They integrate it with data from other observation sources, to provide a complete picture of what is happening.

Weather satellite help minimize weather-related risk for offshore businesses

In offshore, satellite data is beneficial for predicting squalls: short, heavy bursts of weather that result in the rapid onset of near to zero visibility and strong gusty winds. Knowing when squalls or any other weather phenomena will occur is critical for offshore companies because they have a significant impact on equipment and operations.

3. Lightning detection

During a thunderstorm, lightning strikes create electromagnetic waves that travel through the atmosphere. Ground-based (terrestrial) antenna networks can detect these waves. Regional networks play a vital role in accurately identifying lightning with terrestrial systems and satellites. Lightning can also be detected by satellites – while terrestrial networks have a higher level of accuracy, satellite data offers better coverage over the ocean.

How do weather experts improve the data from lightning?

Weather experts improve the data by using their own end-to-end lightning data-processing system; they can offer near real-time visualization of the data, across different parameters. They also combine the lightning data with weather radar to help identify active thunderstorms.

Creating forecasts from observation data

The knowledge and experience of weather experts enhance the data gathered from weather observation networks. Their skills mean they can bring together multiple data sources, to improve the observation data and use this to provide a complete picture of the forecast for the next few hours. Where forecast accuracy is critical, these experts make the difference between a good weather forecast and a great weather forecast.

Weather data can be an effective driver for cost-savings in the offshore sector. To support your offshore projects and ensure they're successful, it's critical that your team understands how accurate weather data can help you to optimize operations, decrease project costs and increase the weather on window period.

Category Two: Meteorological and Oceanographic (Metocean) Models

Picture an offshore wind farm located off the Belgian coast. Sandbanks can cause high or long waves to break early or induce waves to bend. These sea conditions make it harder to predict wave height, which is a real challenge for offshore projects in this area.

In the past, forecasts at the Belgian coast have been up to half a meter off because global wave models do not account for the sandbanks. This situation causes a challenge for vessels working close to their safety threshold. When faced with challenges like this, the weather experts utilize metocean models to solve the problem.

How do the metocean experts use metocean models?

Meteorological and oceanographic models (metocean models) help experts forecast the conditions in the atmosphere and ocean over the coming hours, days, and weeks.

Metocean models use a coordinate system to map the earth onto a geospatial grid of latitude and longitude coordinates. This mapping includes properties like elevation, land-use, and the depth of water in oceans, seas, or lakes. Different models have different use-cases.

For example, a spectral wave model uses wind, ice and current, and bathymetric data to predict waves on each cell of the grid.

"DTN provides tailored metocean forecast and historical datasets at any desired resolution and area on the globe. For that purpose, we make use of a new cloud infrastructure that enables us to respond to customer requests quickly. We owe ourselves to provide the best quality datasets, assessed against both our own station observation network (including public observations) and customer observation data"

Dr Hugo Hartman,
Senior Meteo Scientist

By using the coordinate system to map the earth onto a grid, metocean models can be used by the experts to provide:

- Analyzed metocean conditions: these are the actual environmental state and latest observations for a specific point in time.
- Forecasted metocean conditions: these follow the analyzed conditions and are usually provided in the coming hours or days (though, in individual cases, it can be weeks or months ahead).

External metocean models: what you need to know

External metocean models offer a range of different datasets. Weather companies will buy specific datasets, depending on their requirements.

External metocean model data is a key component of your weather forecast. Data from the models contributes to long-term forecasts. In offshore, for example, this information is used by bidding companies during tenders to state when they would be able to undertake the work, within the constraints of the likely conditions.

External metocean models also support near real-time monitoring of the weather. This insight is essential for companies to keep project operations on schedule, ensure crew safety, and equipment maintenance.

But the data from the external models alone is not enough. A specialist weather company will advise you on how to use the model data. Plus, help you understand how to avoid bad decisions made when using misinterpreted model output data. A specialist weather company will offer several key benefits, including:

- (Statistical) multi-models approaches, enhancing data from external providers;
- Ensemble forecasts that aggregate 50 scenarios for probabilistic forecasting and estimate risk and confidence to the forecasts; and
- Two-or three-year archives of model forecasts.

> "Modeling is both an art and a science. Where science delivers the empirical formula that forms the basis of the models themselves, it is up to the metocean modeler to simplify the complex world into an optimal configuration that ensures maximum quality while using as little resources as possible."
>
> Sander Hulst
> Senior Oceanographic Researcher

In-house metocean modeling: what you need to know

External datasets, which are readily available in the market, are a valuable part of the forecaster's toolkit. However, they are just part of the puzzle. For example, wave spectra from ECWMF (an external model provider) are available every 3 to 6 hours.

But this might not be the required temporal resolution for your specific use case. In-house models can provide a higher resolution with insights for every hour - or even intra-hourly. Or provide spatial resolution down to hundreds of meters.

What is the difference between external and in-house metocean models?

External models are purchased datasets. In-house models are custom configurations, which allow experts to select source terms (physical equations) and grid resolutions for particular use cases. To translate global data to your specific area of interest, the experts nest one or more feature-resolving grids in regional grids and then the regional grids in the global grids. This is called physical downscaling, an alternative to statistical downscaling.

How do the experts create a numerical metocean model?

Reliable forecasts are essential but complicated to produce. Taking the example of a specific oceanographic / wave model, we can see how the experts both produce the model and apply it to real-life situations.

Returning to our offshore wind farm example, to provide an accurate forecast in such a challenging location, required the development of an in-house model using an innovative approach. By coupling atmospheric forcing with in-house wave models, it not only looks at the conditions at sea but also incorporates the atmospheric winds that drive the waves.

Furthermore, it includes detailed tidal information, a prerequisite when working in shallow water. The model was calibrated both with local observations (in-situ) and remote sensing data. The model runs on a cloud-based High-Performance Cluster. This approach ensures there's always enough computing power for it to run and new models can be set up for any desired offshore operational site around the world.

What is the added value of in-house metocean models for offshore companies?

Different models have different strengths. Where a coarse model is set up to perform well in the deep ocean, a more detailed model is required closer to shore.

Offshore companies, that need to plan operations in marginal weather conditions, benefit from specific in-house models and combinations. In the case of the wind farm, a SWAN model, run on a high-resolution grid, can take spectral wave data from the regional WAVEWATCHIII, surface winds from WRF, tidal data from harmonic components, and ocean circulation data from Mercator, to accurately capture the wave-current interactions over complex seafloor features. The resulting dataset provides unique insights into current and future conditions.

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Category Three: Statistical Post Processing

Statistical post processing is a technique used by weather experts to enhance and improve their forecasts. It's an umbrella term, describing multiple statistical methodologies, which each have a unique purpose and application.

It works by combining metocean model data and high-resolution environmental data, exploiting the strengths of each. It also applies locally observed weather from observation networks. Post-processing is used to correct the quite coarse-scale nature of model output; these corrections are necessary to ensure that local effects are taken into consideration and the most accurate forecast is produced.

> "For site-specific forecasts, raw model data is not accurate enough. By applying smart statistical corrections, based on local observations and terrain data, our forecasts gain about 20% in accuracy"
>
> Wim van den Berg,
> Senior Meteorological Consultant,
> WeatherTech Team

The what, why and how of nautical meteobase for the offshore industry

Metocean conditions affect all phases of offshore projects, so reliable and accurate forecasts are essential. This data helps address the main concerns that come with working in offshore: managing costs, keeping projects on track, and ensuring the crew and assets are safe.

For companies working in offshore, DTN offers its proprietary Marine Forecasting System. It is the critical forecast data engine that feeds all marine-related products used by the industry. The Marine Forecasting System draws on various sources of atmospheric and oceanographic model forecast data, to deliver accurate weather forecasts.

The unique technology enables offshore companies to interact with the forecast data in a way that easily integrates into their daily operations. They can accurately plan for weather-related downtime, avoiding unnecessary or last-minute scheduling changes, and reduce operational costs.

Users have visibility of changing conditions plus an inbuilt threshold alarm, leading to improve safety at sea and reduced risk of damage to equipment or environmental disaster. Data is delivered using standard maritime communications systems, minimizing communication cost.

For critical offshore operations, the weather experts also provide derived elements like risk wind speed and risk wave height. The output data refreshes four times each day.

How the experts combine models to create the best forecasts for offshore companies

Weather experts improve the forecast by combining data from different weather models, including ECMWF, UKMO, KNMI, and NCEP/NOAA. Each model is given its weight, based on its relative performance. The weights are variable depending on the forecast lead time.

Through model mixing, the Marine Forecasting System then enhances the strong points of the input models and reduces the weak sides, which improves the accuracy and reliability of the forecast.

The raw Marine Forecasting System data can be improved further through:

- A near-shore post-processing module called Rose, which can incorporate meteorologist expert knowledge to reduce localized model imperfections
- Automated local calibration using observations with a Kalman filter – an algorithm that reduces systematic errors
- Manual adjustment by meteorologists interpreting and combining multiple additional data sources, e.g. observations and satellite

The Marine Forecasting system output is made available on a global 0.1x0.1-degree grid and coarser resolutions where performance demands it. These fine mesh grids are available as standard in highly used areas but can also be produced for any point in the sea globally on customer request. On request, the weather experts can also run high-resolution SWAN wave forecasts for specific near-shore locations.

> "Standard metocean models provide a great starting point. However, to improve accuracy, it requires weather experts to combine different models, apply corrections for near-shore locations, and make manual adjustments. This is especially important in areas where there are limited or no observations."
>
> Maurits Geuze,
> Application Domain Expert - MarineWeatherTech Team

What is a Kalman filter?

The Kalman filter is a post-processing technique that minimizes systematic errors in model forecasts. It is self-learning, recursively combining new measurements with model forecasts.

This allows the filter to learn and apply corrections on-the-fly, reducing the mean error (bias). Because of the dynamic character of the filter, it can adapt to changes in measurements (e.g. seasonal shifts) or changes/upgrades in the model used.

The weather experts can apply a Kalman filter to the significant wave height forecast produced by the Nautical MeteoBase for offshore clients. This requires a live observation data stream between the client and the experts. To use the filter's full potential, the stream should deliver new measurements (via FTP) at a high-frequency stream every 10-60 minutes.

How is the Kalman filter applied to waves?

Step 1: System data

First, a check is done to establish whether the Marine Forecasting System data for the client offshore location is stored in the database.

Step 2: Measurement data

If a live data feed is not available, this needs to be set up by the client. If it has already been set up and is running, the experts will work on the automatic ingestion of this data into the database.

Step 3: Training

Before a Kalman filter can be deployed for a marine client, it needs to be trained over a period of approximately three weeks. If historical measurement and forecast data are both available, a hindcast study can be done – this not only reduces the training period substantially, it also indicates in advance how much the filter can improve the forecast. Any forecasts the client receives during the training period won't have the Kalman filter calibration applied yet.

Step 4: Application of the Kalman filter

The training period ensures that the Kalman filter coefficients, which calibrate the Marine Forecasting System, are stabilized. Once that's done, the filter can become operational.

The Kalman filter uses up-to-date measurements, taken just before a new forecast is released. Because of this approach, the filter can further improve the short-range wave height forecast.

Experience shows that coastal locations benefit most from the significant reduction in the mean error of the model forecast. These locations are sometimes not well represented within the Marine Forecasting System, due to factors such as sea-floor levels, currents, and tides. When tides and currents dominate the working conditions for a client in a coastal (shallow water) area, deploying a SWAN domain instead of a Kalman filter is also an option, although both work well.

The approach taken to create a detailed and bespoke forecast will ultimately depend on the specific requirements of each client. Working with weather experts, offshore companies can ensure they have access to the right data for their needs.

Model output statistics (MOS) and meteobase

In addition to the Marine Forecasting System, MOS - also known as the MultiModel-MOS as the technique is applied to several weather models - is used in forecasting for offshore. MOS provides data for feeds and APIs, which are used for a wide range of applications. Specifically, in offshore, MOS is used for forecasts at land stations.

What is MOS?
It's a statistical post processing model that is used to correct for local influences and, as a result, get closer to the actual situation. The MOS takes account of two years of historical data and compares local observations with the model data issued. MOS techniques add value to the raw model forecast, especially for "local" weather parameters like temperature, wind speed and amount of rain.

How the experts add value to MOS
By using two years of training data, experts ensure forecasts are adjusted to local observation sites. As well, combining data from several models improves skill. Experienced meteorologists put the finishing touch to the MOS forecast, allowing for extreme weather conditions. This adjusted version is called the MeteoBase.

How MOS is used in forecasts by offshore companies?
MOS is typically used to deliver forecasts for land stations used by offshore companies.

Case Study

Working in the Margins: How Climatology and Metocean can Transform Offshore Profits

For one leading global offshore jack-up company, the weather is a crucial part of operational planning. A customer since 2011, they've worked with DTN to ensure they have the weather data they need to make smart, informed decisions and minimize the impact of the weather on their projects.

It all started with weather forecasts for rig moves - moving rigs between one location to another - and has since developed to include climatology and workability analysis, to assist with tenders and project planning.

How one offshore jack-up company uses weather data

Rig moves can take up to a month to complete if weather conditions are unfavorable. Sometimes, it can take weeks before there's an appropriate weather window and the rig can even start to be moved. Although they're often only moving short distances (10 to 20 miles), stringent safety thresholds relating to wave height and wind speed means they have to stop, wait, then pull-anchor, move on, stop, pull anchor again and repeat. Combined with the fact that a jack-up rig might only travel along at one knot, it's clear to see why even short distances can take days or even weeks.

When one of these rigs has to move from location A to B, they need to know what the weather will be at location A, to see if they can depart from the location. But they also need to know what the weather is on the route itself, and at location B. This is where NowcastingPro comes into play, giving a regional overview of weather conditions on an online display.

DTN provides various forecasts between the start and end point. The jack-up rig company then use NowcastingPro to fill in the gaps where there isn't a weather forecast, and they can monitor the weather around the route and the rigs.

Sometimes they need more than the weather forecast alone.

When they're due to move to an entirely new location at sea, where they don't have any previous knowledge or data, they need climatology to understand conditions at the new site. In these scenarios, DTN provides an overview of the weather in this precise location over the last 25 years. From that data, they can then understand the typical conditions at their new location.

Using climatology and metocean data during the tender phase

Understanding the weather conditions isn't just crucial for active operations. It also has a vital role in tender responses. Say an oil company is going to build a new platform. The offshore jack-up company will be invited to tender for the installation of the platform. As part of this, they want to develop a picture of how long they think it will take to work on a platform construction in that specific location because the risk of the construction work overrunning is all put on the bidding company.

Many delays during the project execution phase will be weather-related. So what the company wants to know before tendering is how many days during the project they can expect to be unworkable. This process is called a workability analysis.

The workability analysis is an overview for a particular period based on operational limits, i.e. the safety limits where they can and cannot work. For example, during a planned five-month construction period, the workability analysis may tell them that there will be ten days on average, based on climatology, that they cannot work due to the conditions. This insight means that in their bid to the oil company, they have to go for five months plus ten days. If they risk bidding for just five months and the project lasted for five months and ten days, then these extra ten days will be to the cost of the bidding company. The main thing is that all the risk is for them and they have to include that in their bid, so they can mitigate against it.

Investing in weather data while producing a tender helps plan effectively, and gives them confidence in the downtime that they can reasonably expect during a project. It reduces the risk of unplanned downtime and helps to maximize efficiency and profitability.

Where companies choose not to use a professional weather service and rely on free online weather data, previous experience or anecdotal data, it can lead them to miscalculate the weather risk: a potentially expensive mistake.

Detailed climatology, supported by experts

For excellent climatology, you need to have at least 25 years of data and a very dense, high-resolution database. DTN has the highest resolution database available, which is updated every month. Most other companies run at a lower resolution. This means they have locations every 25 kilometers in the North Sea, whereas DTN has them every 10 to 15 kilometers.

It's also hourly data, where most of the companies rely on three hourly data. As well, the database is automatically updated after every month, where most companies will update their database once a year.

Importantly, the data is also supported by specialist engineers that can advise the customer. It's metocean specialists, people who understand the conditions and the data. There are not many companies that provide a full workability analysis with the highest resolution climatology database available.

Reducing time and costs on projects

The results are clear: they don't overrun on projects, they ensure safety levels are maintained, and they help keep personnel motivated.

Through climatology reports and workability studies, they know how long it should take to install or to run a project. It saves them on unforeseen costs due to weather-related delays and also means the company has a good reputation in the industry for finishing projects on time or early.

By using accurate weather forecasts, they minimize non-workable days and reduce the number of false alarms. It gives them the confidence to make close calls to carry on work when the conditions are marginal. Less accurate forecasts have more significant inaccuracies, which result in more days not working where the weather conditions would have allowed work to continue. Stopping work means delays on the project and extra costs because the vessel stays out and the crew on board can't work.

Accurate weather also helps to keep personnel motivated. There's nothing more awkward than sitting on a vessel and being unable to work because the forecast said conditions would exceed the safety threshold, but then seeing the forecast was wrong. This scenario erodes trust in the weather forecast. Next time it says the wave height will be too high, do you believe the forecast and stop work, or do you continue working?

Accuracy is a big part of building trust in the weather forecast and ensuring they continue to benefit in the future. The team at DTN is continuously innovating and investigating in ways to make an even more significant difference to our clients, enabling offshore companies to make even more informed decisions at critical moments in their operations.

Category Four: Quality Control and Data Provisioning

The non-meteorologist's guide to weather data quality control

The difference between somewhat accurate data and highly accurate data can make or break a business. False alarms in offshore operations can unnecessarily add days to projects and increase costs, while, on the other hand, under-forecasted winds or waves put the lives and safety of personnel at risk.

What is quality control?

Quality control is a key step for all elements of the weather forecasting process. It's a way of maintaining standards, by testing the outputs against the expected output. It typically takes place in two stages:

- Incoming observation data, which is checked for accuracy, completeness, and irregularities; and
- Forecast performance, which is verified before being used for reporting, and also provides input for both learning and improving forecast systems.

How the experts apply quality controls to observations

Observations are subject to intensive quality control procedures. For instance, weather stations are checked to remove errors to standardize the data for universal use and provide quality-checked accurate historical observation data. Algorithms are used to declutter the radar data and reduce the number of false precipitation signals.

> "When processing over 20,000 weather stations on the globe with hourly updates of the observation and the forecast, and adjusting all these forecasts with fresh data from several weather models up to 360h, operating a timely and well-designed automated quality control is a must"
>
> Wim van den Berg,
> Senior Meteorological Consultant

How the experts apply quality controls to weather models

The experts draw data from multiple weather models to improve the accuracy of their forecast systems. This includes monitoring performance and establishing a baseline for model verification, which is the on-demand analysis of forecast against observation data for specific sites, periods, and elements.

They also measure the impact of their proprietary forecasting systems against the baseline. Here is how they apply the checks to forecasting systems:

Marine Forecasting System: Forecasts for grid points near reporting buoys or platforms are archived in the Verification Database for:

- Daily verification for a subset of buoys and platforms in the North Sea
- Verification for specific sites, periods, and elements on (customer) demand
- Monthly client-specific verification of quality-checked offshore observations

Why the experts are essential for quality controls

The verification system used by the experts is well defined and transparent, providing context around quality and performance. But not every weather company offers this level of detail. The learnings are applied by the experts to raise the bar on forecast-specific and generic value parameters to help you get the accuracy levels you need to make informed decisions.

"The Data Provisioning team is taking care of processing weather data to the highest standards, to give the weather experts the most accurate and reliable information they need."

Dr. Marco Radke-Fretz,
Data Manager (Data Provisioning)

How data provisioning adds value to weather data

The Data Provisioning (DP) division is responsible for ingesting, processing and storing all incoming data; both sourced and generated. If something goes wrong in that processing, if parameters are missing or lacking, then DP will look for the leak and get it sorted as soon as possible.

However, the senior software engineers do much more than just solve problems. They streamline data processes, construct the transition of all data processes into the cloud, and extract all kinds of derived weather data from the incoming information, ensuring that it's ready for the weather room.

The data is processed by the team to the highest standards, to give the weather experts the most accurate and reliable information they need. The data is shared with internal departments, to form the backbone of each and every forecast.

The technology continues to evolve and innovate at a rapid pace, but there are four fundamentals, where data provisioning adds real value:

Trust: 99.9% data availability, Migration to the AWS cloud, and continuous monitoring of servers and services by the Operations Center all help instill trust in the team

Availability: data is delivered in industry-standard formats including SI (Système international) and WMO-approved units (e.g. Celsius)

Speed: Over 90% of the data is available within a few minutes of it being received from a third party

Visualization: usability of forecasting data is vastly improved thanks to the ability to data and prepare it for online and on-screen presentation

Category Five: Meteorology and Forecasting Expertise

One person alone cannot do everything that's needed. Or, at least, they can't if you want to do it right. In this chapter, we tell you about the five (!) teams that together form the ultimate weather forecasting squad.

The ultimate weather forecasting squad - 5 teams you need

Team 1. Data provisioning

First up is the data provisioning team. Here is where you find data analysts that document all incoming weather data – ingesting and processing it in a way that other teams can understand. The members of the data processing team speak the required technical languages and know how to decode weather data, no matter where it comes from.

Team 2. Weather forecasters

Where the data provisioning team focuses on information that's already been gathered, the weather forecasters look for information on future events. They monitor the weather 24/7, so they can inform customers of upcoming weather conditions. They're also responsible for adjusting the forecasting systems when observations differ from actual weather conditions. In addition, the weather forecasters report on extreme weather, such as heavy storms.

> "As a professional weather company, you rely on timely and accurate processing of incoming weather observations and raw data from numerical weather models by a joint effort of your data team, your developers and your forecasters. Each team contributes with its own skills and expertise"
>
> Renny Vandewege
> VP of Weather Operations

Team 3. Meteorological services

There's a difference between accurate weather forecasting and gathering weather-related information that's valuable to your company. This is why the meteorological services team is so talented. They're in close contact with customers and know which specific weather information they need. They collaborate with the weather forecasters and the data provisioning team and use their data to create accurate reports. This can be a metocean report, for example, which informs an offshore company on conditions like wind speed and wave height in a specific cell on the grid.

Together, team 4 and 5 form the meteorological research team. However, as their priorities cover two distinct areas, let's explore these separately:

Team 4. Professional services

Although the meteorological services team provides customers with specific weather information, customer-centricity is taken one step further by the professional services team. Here, customer-specific data from the meteorological services team is used to create solutions that add immediate value to the customer's product or service. For example, a wave analyses for offshore companies.

Team 5. Weather systems

Data has to be checked for accuracy, completeness, and irregularities. This is why the other half of the meteorological research team concentrates on the testing and verification of forecasting reports. The weather systems team defines and tests algorithms to improve the quality of observations and forecast verification. They maintain and conduct research on the existing forecasting systems and integrate new developments and improvements. You might say the weather systems team is the R&D department of the weather forecasting squad!

Improving weather data one industry at a time

The work done by the weather experts across all industries can be categorized into two disciplines: the meteorological researchers and forecasters. The first specializes in researching and developing products, which ingest quality-controlled data, for specific industry use-cases. The latter is in direct contact with customers and interprets the models for the specific customer use cases.

This data enrichment process applies to all industries. However, some industries depend more on model data or automated solutions and platforms, while others depend more on forecaster expertise. This has a huge impact on the way that weather experts work. In most cases, companies need a combination of meteorological research and the expertise of forecasters.

In offshore, 80% of the work is done by forecasters, who deal with text writing, data enrichment, monitoring (but this time, think squalls, wave heights, and wind speeds), routing, briefing, and long-term forecasting. Forecasters spend a lot of time on client training. 20% revolves around meteorological research, focused, in particular, on metocean studies.

The 16 Weather Observation and Forecasting Value Parameters, Explained

If your forecast isn't reliable, you won't be able to access the insights you need to make informed business decisions. Inaccurate weather forecasts lead to offshore companies missing weather windows during projects.

But how do the weather experts know when it is actually good? And how can you recognize when the weather data you receive is held to the highest standard? Enter into the ring the weather observation and forecasting value parameters.

These value parameters are a framework, used by the weather experts, to ensure each and every step that they take adds value to the weather data. Quite simply, success comes down to measuring the results against the following value parameters.

What are the weather observations and forecasting value parameters?

There are 16 weather observation and forecasting value parameters, which are grouped into four areas:

- Generic meteorological value parameters
- Forecast specific value parameters
- Meteorological quality value parameters
- Technology quality value parameters

They are applied (as applicable) to the Five Categories that are essential to a high-quality professional forecasting service. Let's explore the parameters in more detail and share how they add value to every category.

"In a probabilistic forecast you cannot take one case and say the forecast is right or wrong. You will have to take many, many forecasts and then compare.... Suppose 92 percent of the minimum temperatures forecasted were correct and our competitor says: 'we had 95 percent correct'. It is not that plain and simple. Maybe they took a boundary of 2.5 degrees, where we took 2.0 degrees. Well, in that case, you cannot compare the results. We are very open with customers when we are in direct contact with them. However, if we would just put numbers on our website, they could be misinterpreted and misused."

Renny Vandewege
VP of Weather Operations

Generic meteorological value parameters

Value Parameter 1: Frequency
Definition: How regularly the observation data or model data is delivered
How the experts put it into practice: The weather experts invest in higher-frequency updates from weather stations for specific locations.

Value Parameter 2: Resolution, temporal
Definition: The time span between two shared values
How the experts put it into practice: The experts can use an algorithm to reduce the 5-minute interval between radar images to 1-minute.

Value Parameter 3: Resolution, spatial
Definition: The density of the grid (radar, satellite, and model), as well as the granularity of the weather station network
How the experts put it into practice: Standard grid sizes are 10km, 25km or 50km but the density can be increased to hyper-local or downscaled for weather station using an algorithm. In-house metocean models can have a spatial resolution down to hundreds of meters.

Value Parameter 4: Coverage
Definition: Areas where the experts can provide observations or forecasts
How the experts put it into practice: The experts provide global coverage through weather stations observations, with access to a network of 20,000 stations. Global coverage is also available for models including Nautical MeteoBase.

Value Parameter 5: Completeness
Definition: To what extent the element is defined
How the experts put it into practice: All MOS forecast locations have hourly forecasts for all elements, with downscaling algorithms used to compensate when a station is unable to deliver data on a particular element.

Value Parameter 6: Uniqueness
Definition: The Availability of non-standard elements and derived elements
How the experts put it into practice: The in-house metocean models provide the ability to access output parameters that are inaccessible in external data sources (i.e., spectral moments, effective cloud cover).

Forecast-specific value parameters

Value Parameter 7: Accuracy
Definition: Forecast is correct (within a margin) for deterministic values
How the experts put it into practice: 98% of the forecasts are within a 2-degree margin. The MOS provides high-quality forecasts for many stations, while ScaDo improves the temperature forecasts in valleys and mountains.

Value Parameter 8: Reliability
Definition: Forecast is consistent
How the experts put it into practice: The forecasts follow the correct pattern, even if there is a bias (structural over- or under-forecasting). Two years of training data ensure the MOS can be adjusted to local observation sites.

Value Parameter 9: Skill
Definition: Forecast is a hit, miss or false alarm
How the experts put it into practice: The experts measure whether the forecast is a hit (correct forecast), miss (exceeding the defined threshold but not forecasted), or false alarm (not exceeding the defined threshold, but forecasted). The MOS combines data from several models to improve the skill, as it takes out inconsistencies.

Value Parameter 10: Sharpness
Definition: Precision of the forecasts in time and space
How the experts put it into practice: The experts apply sharpness by ensuring the specificity of the forecast. It is the difference between it is going to rain versus it is going to rain at 10am in Amsterdam.

Value Parameter 11: Uncertainty
Definition: Spread of the probabilistic / ensemble forecast plume. Historic cases can sometimes be used to estimate the level of uncertainty
How the experts put it into practice: 25-50 ensemble forecast scenarios determine the outlines of the plume.

Meteorological quality value parameter

Value Parameter 12: Correct
Definition: Errors are corrected where necessary
How the experts put it into practice: Forecasters edit the MOS forecast after comparing it with new observations and new model data. And, when it comes to data management, the experts carry out observation decoding, weather model changes, radar/satellite changes.

Technology quality value parameters

Value Parameter 13: Trusts
Definition: Access to data always available, with no outages
How the experts put it into practice: The experts provide a redundant network, with 99.9% data availability. The migration to the AWS cloud, and continuous monitoring of servers and services by the DTN Operations Center, further supports this value parameter.

Value Parameter 14: Availability
Definition: Data is accessible in standard formats
How the experts put it into practice: The formats include SI (Système international) / WMO-approved units (e.g. Celsius) and industry standard data formats.

Value Parameter 15: Speed
Definition: Data is accessible for customers within minutes
How the experts put it into practice: More than 90% of data is ingested, processed, and delivered within a few minutes of being provided by a third party.

Value Parameter 16: Visualization
Definition: Improve the usability of the data
How the experts put it into practice: The experts visualize the data and prepare it for online and on-screen presentations, which improves its usability.

Conclusion of the Offshore Weather Forecasting Guide

The same weather conditions can mean very different things to different companies in the offshore sector. Knowing what the weather will be, and, more importantly, how it will affect you, relies on the right information.

As a company that knows the weather, DTN does everything possible to deliver customers accurate weather forecasts. But achieving this goal relies on blending the right mix of data, expertise, and customer insight.

Getting the weather right isn't easy or cheap. It's about managing and processing the data, bringing together the right experts, and building the infrastructure to support all this work – not a straightforward task.

Forward-thinking offshore companies are already leveraging accurate weather data, delivered by the expert, as part of their decision-making toolkit. These forecasts and insight from expert meteorologists, ensure that, whatever the conditions, they are prepared.

Learn more at **www.dtn.com/offshore-forecasting-services**