



# The Five Essentials of Weather Optimized Routing for Marine Vessels

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# What is Weather Optimized Routing?

Plotting a course from Gulf of Mexico [A] to Port of London [B] is not so hard. But getting from A to B, while managing costs, keeping fuel consumption down, and maintaining safety is more of a challenge.

Weather optimized routing provides a solution. It enables vessels to take the most efficient route, by combining the latest weather data, with information on sea conditions and the ship's profile. It's not necessarily the shortest route; it's the most effective way for a vessel to meet its key performance indicators. In this guide, we explore the five essentials of weather optimized routing, and clear business benefits.

## Understanding the Five Essentials of Weather Optimized Routing

Weather optimized routing is point-to-point safe route planning. It includes speed and heading recommendations, taking into account impacts from environmental forces on a vessel's performance. The essential essentials for weather optimized routing are:

- Weather Data
- Vessel Profiles
- Unique Routing Algorithm
- Weather Optimized Route Network
- Master Mariners

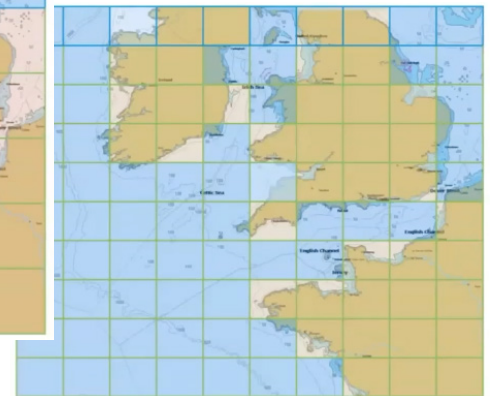
Combining the essentials makes it possible to offer a genuinely optimized service — a real strategy for success.



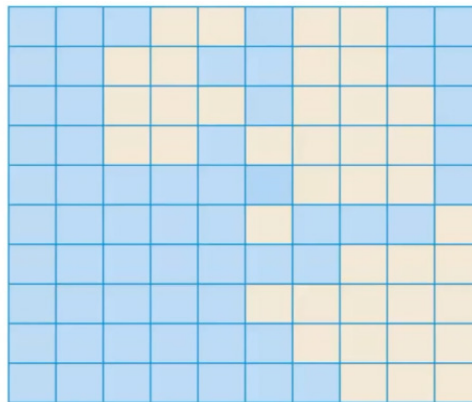
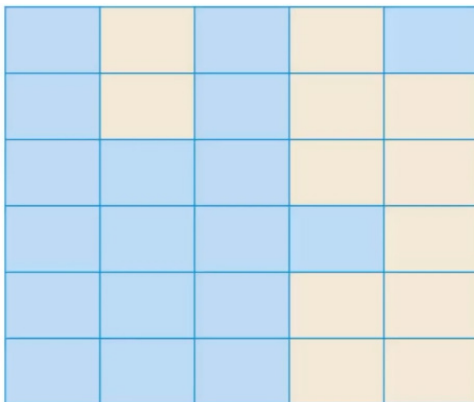
# #1 Weather Data

High-resolution data is better for data analysis, but what is weather resolution, and why is it important?

This example shows a grid over Great Britain. Pay particular attention to the English Channel. Each box's color designates whether it is land or water. If the box contains 50% or more land, it's green. If it's 50% or more water, it will be blue. The high-resolution on the right provides almost twice the boxes offered by the low-resolution



Take away the land from under the grid, and what is left doesn't resemble the British Isles anymore. However, with the higher resolution on the right, the Channel is still visible. Dividing the cells again brings further clarity to the features.

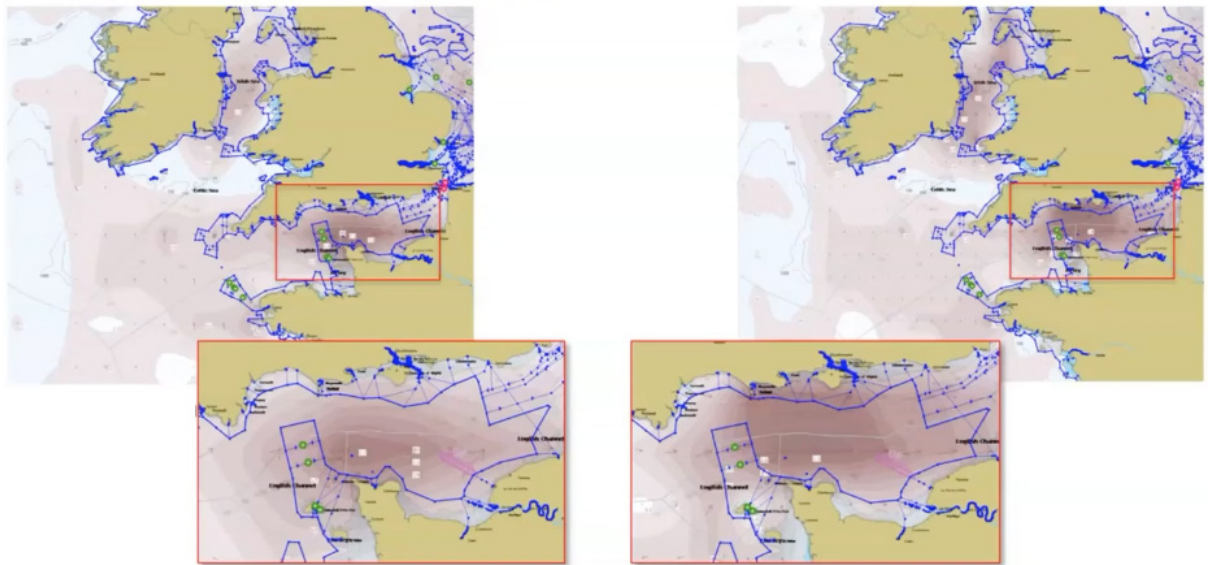


This example shows the differences in model resolution. The higher the resolution, the better the model can resolve geographic and weather features. If the model can't even see the English Channel on the low-resolution view, how will it predict the weather accurately?

## Impact of resolution on a real forecast

Here is a prediction of currents at the same moment in time, using both a high- and low-resolution model for the same area. Again, take note of the English Channel. The low resolution on the left has a limited area of maximum current. The high resolution on the right has a better-resolved channel and shows the stronger currents throughout the entire channel.

The different resolutions could influence decisions on whether to depart earlier or later in the voyage plan. Alternatively, it might alter the route chosen through the channel. Either way, speed calculations and vessel performance through this area will be affected by this currents difference by using the higher resolution forecast model.



## #2 Vessel Profiles

The next essential weather optimized routing is vessel profiles. A ship model depends on many items, including hull design, propeller, and engine.

For weather optimized routing, what is important is how the vessel model responds to the environment. Its profile includes waves, wind, and swell. It also considers the angle of the impact versus vessel heading, which is essential for resistance calculations.

DTN has a strong partnership with Marin, who provides a library of precision profiles that are used for route calculations. These profiles are selectable throughout the DTN product suite. Additionally, profiles can be customized for vessel draft, beam, and LPP, as well as for speed and fuel curves.



## #3 Unique Routing Algorithm

The DTN unique routing algorithm is the glue that holds all the essentials together. It must be fast and efficient to return a prompt result and enable vessels to optimize by speed, fuel, or cost.

Stepping through the routing process, it starts with the weather ingest. Importantly, at this stage, always use the latest weather data — using the highest resolution data available also helps.

Safety settings come next, which set limits on 30+ parameters. These can be direct parameters, including wind, waves, cyclone distances, or visibility. They can also be derived parameters, such as motion, roll, pitch, and more. These can be tailored by selecting warnings versus avoid. A warning setting will return a route through dangers, warning when and where it exceeds limits. The avoid option completely avoids the conditions set.

Next are restrictions, like ice, vertex, or customized areas, to avoid in the route. Then there are custom way points, which can be inserted and included in the route.

Then comes the vessel characteristics, including vessel model and profile, laden versus ballast voyage, adjustments to the fuel/speed curve, and trim setting.

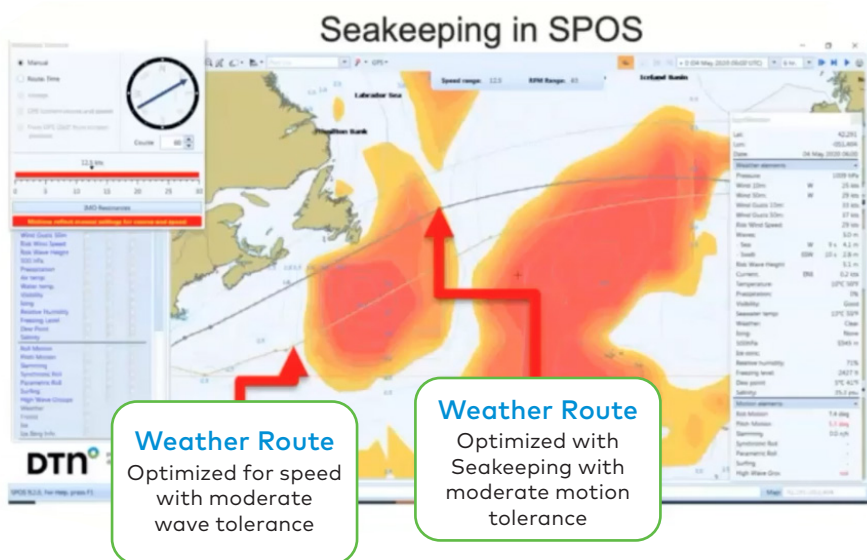
There are several routing types available:

- **Fixed Speed:** Set single speed, as designated in charter party
- **Flexible (Variable) Speed:** A speed range used in the routing calculation
- **Fixed ETA:** Speed range allowing variable speed to avoid weather, while still getting to the destination at a set time.

All of these types are useful for multiple needs, including traditional charter party agreements and slow steaming. Routes can be optimized by speed, fuel, and cost.

Here is an example of SPOS using seakeeping. The light grey line is the fixed speed with standard wave tolerance thresholds. The dark grey line, using seakeeping, is set to avoid moderate motions through the voyage. In this case, the weather over this route was already marginal.

But with the impact on the vessel, via the motion predictions, the recommended route was altered to stay within the voyage, vessel, and cargo limits. By using seakeeping, it made a better decision, based on the impact of the weather on the vessel versus just the weather. This example indicated the flexibility and power of the unique routing algorithm.



# #4 Weather Optimized Route Network

In a simplified view of a route, the inshore waters — TSS, Safety Corridors, Bathymetry, other restrictions — give little room for optimization. However, open waters provide freedom and flexibility to avoid the weather.

Embedding the route network within SPOS is a revolutionary feature that treats oceans and coastal areas as broad highways. This insight gives the master mariner the possibility to navigate safely from A to B. It enables safe navigation around the globe, with 20-meter safe water depth and a 1-mile safe distance from coastlines. The hyper-accurate route network safely navigates through shallow areas and mid-sea obstructions.

The incredible value of this weather optimized route network comes from opening navigable waters for routing. The route network enables the unique routing algorithm to route a ship around significant weather safely.

## Optimizing weather routing with the route network

The goal of the weather optimized route network is to maximize the area that a vessel can travel in "open waters" to enable navigational freedom in both speed and heading and minimize the effects of environmental forces on a vessel's performance.

At all times, safety is the most important factor. Knowing a vessel can safely travel in given areas, the route network maximizes those areas to avoid headwinds, which results in the negative influences on performance from the weather.

## Comparing route network in the marketplace — How different services deal with routing?

### Best practice routes

A widespread approach is using the best practice routes. These are preset and never changing. These are the "because we have always done it" type of route.

**Benefits:** Safe, knowledgeable, known to the industry.

**Issues:** It's not possible to optimize when always on the same track.

### Automatic identification system routes

These types of routes are becoming more common. They work by looking at routing trends with AIS traffic. The thinking is that "Where everyone else is going, it must be good for me too."

**Benefits:** Guidance updated with the latest routes used.

**Issues:** Are the routes safe? What vessels are using them, and are they optimized?

### Weather optimized route network

This approach also uses AIS trends to identify changes in route behavior but it's regularly checked against the latest ENC's by master mariners to ensure the legs are safe.

**Benefits:** Maximizes open areas for the ability to route vessels for performance optimization. It's also a step towards Automated Vessel Intelligence.

Weather optimized route networks have fewer dangers that help for a faster and more accurate voyage planning process.

# #5 Master Mariners

In weather optimized routing, accurate weather data is only part of the puzzle. Managing uncertainty and risk is also critical. This scenario is where master mariners, who have navigational knowledge and are familiar with vessels' characteristics in various wind and sea conditions, can add real value. Their knowledge and skills enable the shipping team to deliver premium route advice.

They are aware of the navigational features, including the obstacles, sea currents, and waters affected by pirates. Plus, they understand the processes onboard the bridge. So, they know when it is feasible and practical to issue new routes or speed.

## Interpreting the complex weather data to advise customers

In extreme weather events, like typhoons or hurricanes, the standard model data alone is not enough. To combat this, the typhoon data is overlaid onto the standard NMB data, to enhance the view.

When there is uncertainty in the forecast of the system; the development of travel is not guaranteed because the wind strength, the speed of the system, and the development of intensity are uncertain. These factors need to be taken into account by the experts when advising the master mariner. As there is a risk, the weather system might follow a different course, so routing options need to ensure the vessel doesn't become trapped by the direction of the system. It's a risk assessment that has to be made with all routing advice.

## Increasing updates in heavy weather

The experts usually advise vessels once per day. But if they think the situation needs more attention (like this scenario), then it will be added to the heavy weather list. The list ensures the ship has additional checks and additional updates could be sent, based on what the experts in shipping operations think is necessary.

## Strength of experience helping clients optimize their routes

The master mariners and ex-seafarers are a real strength. They speak the same language as the crews onboard the vessels and understand the realities of life at sea, as well as and the responsibilities of the master mariner.

They are aware of the routes at sea, the obstacles, sea currents, straits controlled by pirates, and they understand the processes onboard. They understand how the bridge is utilized to change routes, fuel or speed. They are also conscious that it's impractical to advise different speeds and courses all the time, so they provide feasible advisories.

Sometimes this means helping customers to make the fastest crossing; other times, the customer needs to arrive at a specific ETA or may need to cover the route as economically as possible. Regardless of the priority, master mariners will use their expertise to guide the ship.

The master mariners also learn everything they need to know about a client's fleet of vessels to tailor their advice to the ship's specific capabilities.

# How the Five Essentials Improve Performance

Route-planning is a balancing act. Ship captains must manage conflicting constraints to optimize each route, such as safety, efficiency, navigation, costs, port rotation, ETAs, and speed ranges. Add additional factors like trim and seakeeping into the mix, and it's easy to see how route-planning quickly becomes complicated.

Weather optimized routing, built on the five essentials, offers a solution for captains and operators to overcome these challenges. Navigate the globe safely, with minimal fuel consumption and emissions.

## Save fuel and time

The five essentials help to calculate routes with the lowest voyage cost, by reducing time at sea and total fuel consumption. Route choice can make a massive difference to the profitability of a voyage. For example, when vessels are passing Skagerrak on their way to the east coast of the United States, they will typically ask for advice on the next part of the route. They can either pass just above the British Isles or sail through the English Channel. In theory, a vessel can knock 35 hours off the journey by not going through the English Channel. But the weather can be worse on the alternative route, mitigating the time saved. Knowing which route is best will vary depending on sea conditions, weather forecast, and how the vessel will perform in those circumstances -- which is why the five essentials are so important.

Gain further savings through the industry's first variable speed algorithm to help bypass severe weather. Use voyage trim optimization to further reduce fuel consumption.

## Improve sustainability

Weather optimized routing can provide fuel savings between 2- 5%, depending on the type of vessel, the season, and the conditions. Using less fuel helps reduce the environmental impact of each voyage.

With growing focus on [sustainable business](#), it's no surprise that reducing fuel consumption remains at the top of the list for the shipping industry. Ocean-going ships contribute [3% of global carbon dioxide emissions](#). While regulations like IMO 2020 are already helping, the five essentials help shipping companies to reduce fuel consumption and improve sustainability.

## Unburden captains

The weather optimized route network builds on decades of experience, with the pre-built ship models designed to support captains make accurate routing decisions. Combined with accurate weather data and advances in technology, it means captains have more data onboard than ever before — supporting efficient and effective decisions.

The variable speed algorithm can be used to lock in the appropriate speed to arrive on time, avoiding severe weather. Other tools, such as voyage trim optimization, specifically help reduce fuel consumption and increase the utilization of the fleet.

Adverse weather alerts can let captains know if conditions are changing on the planned route. This insight enables them to plot an alternative route before it affects the performance of the voyage or becomes a safety risk.

## Improve safety onboard ships

Using weather optimized routing, it's easier to avoid adverse weather conditions. Route vessels around severe weather, like gale force or higher wind fields, that impact the ability to maneuver the vessel. Have confidence that ships can withstand the conditions along the chosen route and ensure the safety of the crew and cargo.

# Conclusion

Choosing the most direct route isn't necessarily the most efficient. If vessels route through adverse conditions, it can quickly add time — and increase how much fuel is required. Forward-thinking shipping companies use weather optimized routing to ensure voyages meet their KPIs, without compromise.

Weather optimized routing is essential to ensure each voyage is fuel efficient and cost-effective, while avoiding adverse or dangerous weather. The five essentials of weather optimized routing are vital for safe, sustainable, and cost-effective shipping.