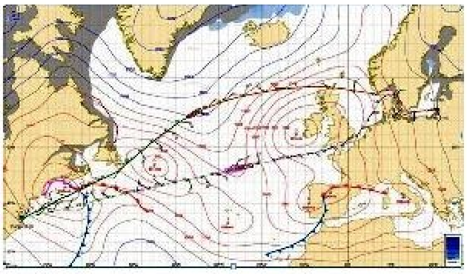
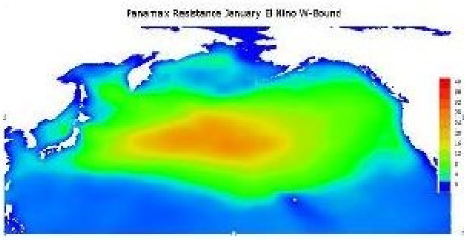
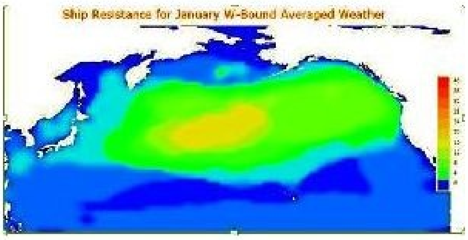
GAINING OPTIMUM EFFICIENCY AND REDUCING GREENHOUSE GAS IN THE SHIPPING INDUSTRY

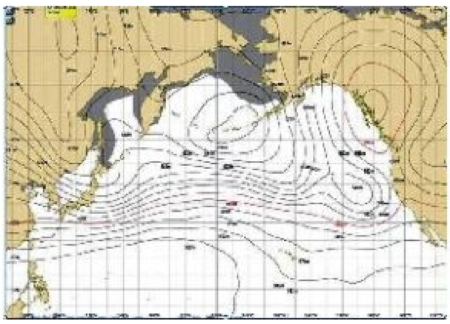
Strategic Weather Routing

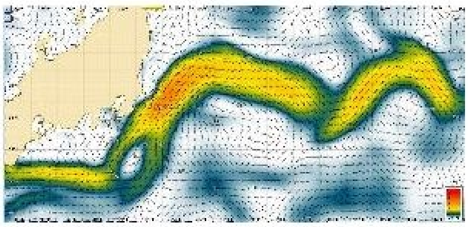


	En-Route Time (days)	Fuel Oil Consumption (mt)	Overall CO2 (mt)
Captains original route (south)	15.1	426	1356
AWT route (north)	13.2	372	1184
Savings	1.9	54	172









For centuries mariners have relied on their experience, following â€˜rules of thumbâ€™ regarding the current weather conditions, to estimate the weather ahead and what course of action to take. Over the past several decades, numerical weather models have been developed and now short-to-medium range weather forecasts are available. Despite this, the majority of captains still use short-range forecasts to make their routing decisions. Although this can be beneficial in situations such as avoiding an individual low-pressure system, only using a short-range forecast without considering long-range ones and historical climate data could easily put vessels in locations where they might be exposed to prolonged adverse conditions. Ships in these situations are often delayed for days at sea, causing unexpected, unnecessary, and excessive fuel consumption and carbon emissions. But these problems can often be avoided with strategic weather routing.

To effectively route a vessel, strategic weather routing uses the short-range and long-range forecasts, detailed current data along with climatological data to evaluate the best route to minimise time en-route, fuel consumption and exposure to prolonged adverse conditions that could lead to safety issues, damage, delays and excess carbon emissions.

Sixteen Day Forecasts
AWT uses the combination of 16 day weather forecasts, proprietary Climatological Ship Resistance Models and detailed current data to strategically provide the optimum time or fuel route. Some people might say that the 16 day forecast will not verify, which can be true. However, beyond 10 days, the key is evaluating the storm track rather than where an individual storm will be on a specific day. By understanding the storm's intensity and where the systems are developing and moving, a captain or route analyst can determine where the worst adverse conditions are most likely to occur and strategically pick a route to minimise exposure to these conditions. Then once a vessel is within three days of a specific gale or storm, small tactical route adjustments can be made to safely circumnavigate the system. In many cases there is a need for shore-side weather routing assistance. Some captains are not properly trained to use these weather tools as they often sail only one to two trans-ocean voyages a month. On the other hand, shore-based route analysts will review hundreds of voyages during this same time period. This gives the route analyst a distinct advantage since they will see routes continuously crossing the ocean(s) in all different weather patterns and can see what routes are most successful in these patterns.

The examples above (Figure 1 and Figure 2) shows a classic example of where a captain intended to use a good route but not the optimum one. One of the rules of thumb used by captains is 'the further south you sail the better the weather'. The captain may not have considered the option of passing north of the UK. In this case, there was a strong high pressure over Greenland and a storm track that extended from the east coast of the USA to just west of the UK, then to the Norwegian Sea, the route passing north of Scotland stayed further away from the storm track while reducing the distance by over 400nm. The captain followed the north route saving 1.9 sailing days, 54 metric tonnes (MT) of fuel, and reduced greenhouse gas emissions by 172 MT.

Proprietary Technology

AWT utilises new proprietary technology to improve safety and ETA projections when selecting the optimum route. Climatological Ship Resistance (CSR) uses the speed loss due to historical wind and wave data for different ship types and stratifies the data based on weather patterns of El Niño, La Niña and Neutral. The results provide significant improvement over simulating or optimising a route using climatological weather. The speed loss of a ship is like an exponential curve, for wind speeds of 0-25 knots the speed loss is very gradual, but from 26-50 knots the speed loss increases very rapidly. By averaging the weather first, the average wind speed is always at the lower end of the scale so implies much less speed loss than will actually occur.

Above are examples of the differences between using CSR and climatological weather when calculating the speed loss due to weather. Figure 3 using CSR shows significantly higher speed losses throughout the North Pacific, but especially in the central ocean. For vessels sailing from the west coast of the USA to Asia, the CSR model would imply that they should sail either via the Bering Sea or sail a southern route extending almost to the Hawaiian Islands, while the climatological weather resistance implies much shorter distance routes could be sailed on both the northern and southern routes.

Medium-range Forecast

Using the medium-range 16 day forecast is a great tool for optimising a route if used properly. Although the verification of the specific surface location or intensity of a storm may be no better than 50-50, using the jet stream is very useful. AWT uses the jet stream at the 500 millibar (mb) pressure level which is at approximately 5600 metres above sea level. The jet stream steers the movement of storms, and knowing where storms are developing and where they are heading indicates the areas where heavy weather and waves are most likely to occur.

The example on the next page shows the 500mb level with the jet stream indicated where the lines are closest together. The jet stream extends from Japan east-northeastward to 45N just past mid-ocean, curving northward then northwestward, and weakening with a secondary track from 40-45N from the central Pacific extending to California. This pattern indicates prolonged periods of gale to storm weatherly winds extending 300 – 500NM south of the storm track. For voyages from the west coast of the USA to Asia, the optimum route would be via the Bering Sea to avoid prolonged head conditions.

NCOM Current Data

AWT uses the latest technology in ocean currents – the Naval Coastal Ocean Model (NCOM) combined with tidal currents at three hourly time steps. NCOM is the operational model of the US Naval Oceanographic Office and uses input from the Navy Layered Ocean Model (NLOM) and the Modular Ocean Data Assimilation System (MODAS). The model is used to support search and rescue operations and the Navy's optimum track ship routing, as well as other military needs.
Using this real-time, high-resolution data now provides the capability to precisely determine the direction and intensity of the currents globally. AWT has also created daily climatological NCOM data using multiple years of historical data to be used beyond the short-range NCOM forecast.
This enables voyages to be more effectively optimised.

Strategic weather routing plays a significant role in reducing greenhouse gases. For every metric tonne (mt) of fuel consumed by a vessel approximately 3.183mt of greenhouse gases are created. AWT's studies have shown that strategic weather routing improves fleet efficiency by approximately 5%. Extrapolating this over the approximately 38,000 voyages routed each year by AWT we estimate a fuel consumption savings of approximately 400,000mt and reduction in greenhouse gases of approximately 1,260,000mt.