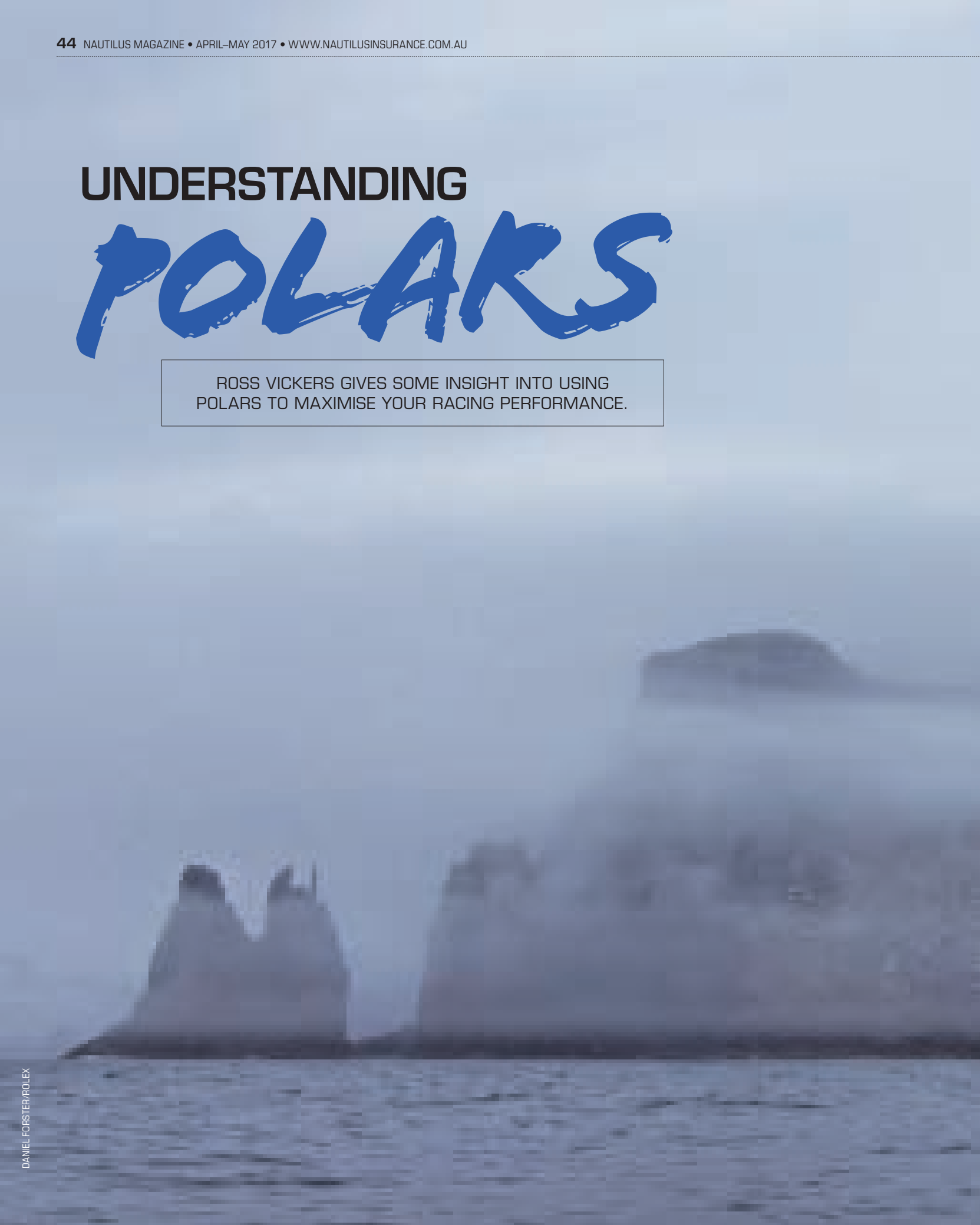
UNDERSTANDING POLARS

ROSS VICKERS GIVES SOME INSIGHT INTO USING POLARS TO MAXIMISE YOUR RACING PERFORMANCE.



DANIEL FORSTER/ROLEX

SAILING TECHNIQUE: POLARS

Ensure the timing on your navigation polars is correct or it will throw off your routing and where you will meet weather systems in long races.

Polars in their simplest form are nothing more than "How fast I will go at a certain wind speed and at a certain angle." However, the wealth of information contained within them is actually much more than that once you fully understand them.

From these graphs, we can see key performance elements such as when a boat starts to plane downwind vs when we should sail deep. Tactical navigation software relies heavily on various types of polars in order to give accurate feedback on laylines, times to waypoints and also weather routing.

There are three main polar types used by grand prix yachts, with some polars requiring multiple versions to give meaningful data.

PERFORMANCE POLAR

The first type of polar that most people are aware of is the performance polar. The function of this polar is to give a "Target" to aim for. Designers often provide a starting point polar from their Velocity Prediction Programs (VPP). The accuracy of these theoretical predictions varies greatly between designers and is largely dependent on the amount of investment into their VPP. The most accurate designers seem to be those involved with large campaigns such as for the America's Cup and TP52 Med Cup circuits.

What does "Target" mean? This is the Boat Speed (BSP) and True Wind Angle (TWA) that you are aiming for while sailing. If everything goes 100% right in ideal conditions (sea state, wind sheer, best sails, etc.) then this is the performance you should get. In the real world, we can expect performance somewhere around 96 to 98% of this figure. We are looking to this polar to push performance and give you a set of goal posts to aim for. This applies not only to BSP, but also to TWA. In the real world you will sail slightly slower and slightly lower upwind or slightly higher downwind.

This polar is also the reference polar for performance analysis, giving a consistent frame of reference on which to compare performance from day to day, week to week, season to season. For this reason this polar is not updated on a whim, but only after careful analysis and consideration.

NAVIGATION POLAR

The second, very important polar is the navigation polar or nav polar as it is often referred to in tactical navigation software. The primary function of the nav polar is to provide real world performance figures to the software. The nav polar is a "live" polar, often updated by navigators to give real world laylines, times to marks, and weather routing. The layline angles, layline times, and opposite tack angles all come from this polar rather than the performance polar.

Navigators will invest large amounts of time in getting these polars right across a wide range of conditions, many times utilising multiple versions of the navigation polar to

SAILING TECHNIQUE: POLARS

LEFT: You can use your navigation polar to figure out laylines, layline angles and tacking angles.

READING A POLAR

The three elements making up a polar are:

True Wind Direction (TWD): This is represented as angles radiating out from the centre of the graph. Upwind (TWA = 0) is generally up.

Boat Speed (BSP): This is represented as concentric rings around the graph.

True wind speed (TWS): This is represented by the coloured performance lines, each line representing a TWS usually in steps of 2 knots.

At any given TWS you can then follow the line around the curve to match a given TWA and find your expected BSP.

FIGURE 1

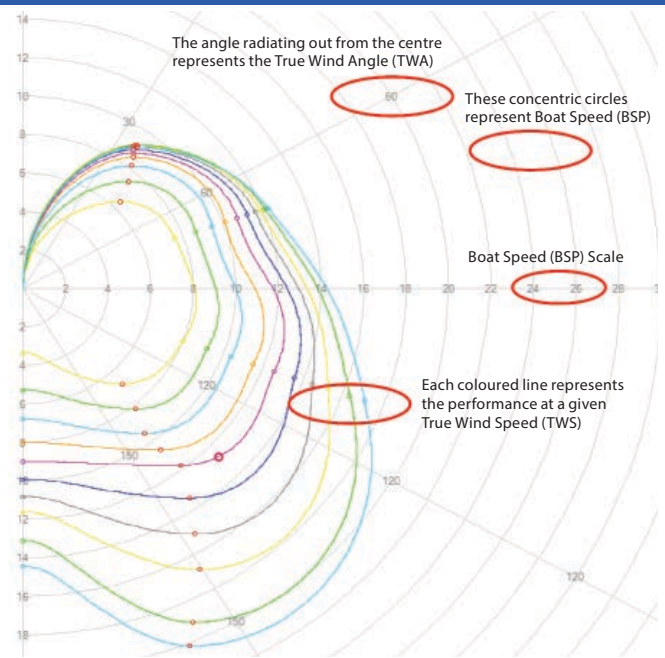
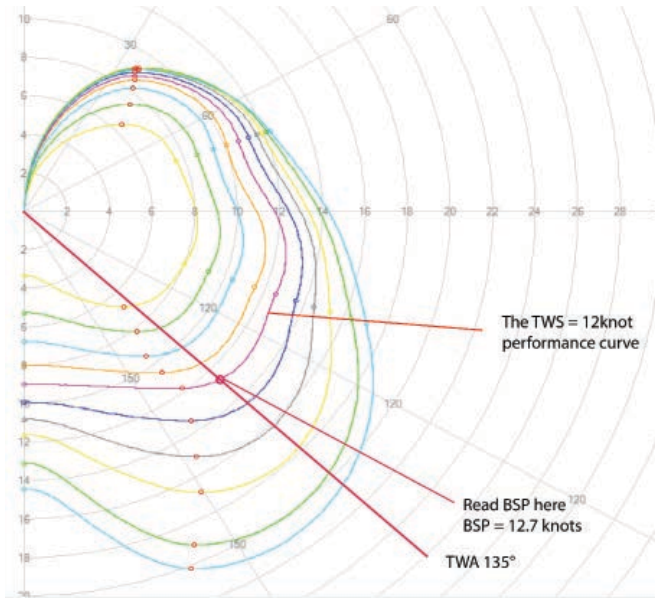


FIGURE 2



SCALING

Wind speed broadly speaking increases with height. Why is this important to know? Weather information and polars often differ from your actual mast height where your onboard wind speed is measured. Most grib files, and many designers' polars, are given at 10m above sea level. This is great if your mast height is 10m but if you are a 50 footer with a mast height of 22m then the wind you measure will be 9-12% more.

This can be hard to keep track of wind switching between gribs, mast head measurements, and polars. One simple approach is to do everything scaled to the mast height of your boat. Most routing software allows you to also scale the grib files by the factor so that you only work with the mast head values.

Scaling Formula:

TwsMasthead = Tws10m . (h/10) a

where "h" is masthead height in metres and "a" is a constant which is normally around 0.11 to 0.14.

For example: TWS at 10m of 15 knots would be

TwsMasthead = 15 . (22/10) 0.12

TwsMasthead = 16.4 knots for a 22m rig height

And for a 100 foot super maxi with a 47m rig height it would be 18 knots at the mast head in the same breeze.

"IT IS OF NO USE RUNNING A POLAR THAT HAS THE BOAT PERFORMING 10% FASTER THAN IT IS IN THE REAL WORLD"

USEFUL HINTS FOR UPDATING THE NAVIGATION POLAR

Invest in performance analysis. Gathering and reviewing real world data will get you closer to a perfect nav polar.

If your software is getting to the layline earlier than real layline, widen the target angle in the nav polar. Conversely if you get to the real layline earlier than the software's layline, narrow the target angle.

If the time to layline is ticking down slower than the real world clock, (ie: the software thinks it will take 9 minutes to sail to the layline, but it really takes 10) then slow down the BSP target in the nav polar to give a longer theoretical time.

Some software has a toggle switch to use the nav polar or the measured BSP/TWA for laylines. Switching between them can give a good indication of changes you might need to make to the nav polar.

compensate for sail inventories, sea states and even different helmsmen. For example offshore a boat tends to sail wider angles due to different sails and sea states, whereas inshore in flat water sails can be flatter and the best VMG will be at a higher angle because you don't lose momentum in the same way as you would when sailing in waves.

Many amateur navigators simply copy the performance polar across to this polar within the software. I often find crews saying the laylines in the "box" are wrong. Nine times out of 10 tacking on the box's lines puts the boat around three or four degrees under the layline. This is due to the performance polar numbers being a target rather than real world.

Weather routing also depends on this polar. The more accurate the polar, the more useful the weather routing information you can generate. It is of no use running a polar that has the boat performing 10% faster than it is in the real world because that polar will have you arriving at weather features earlier. You are likely to miss the timing of a shift or front when you finally arrive at it. During a long offshore race it is not unusual to find a navigator tweaking the nav polar and re-running routing on the fly in order to get better data for decision making.

START POLAR

As the name suggests this polar is used during the starting sequence. It is a rather tricky polar to get right because it reflects the real world boat speeds in a prestart. This is the boat speed you can expect to achieve without a spinnaker, without every single person hiking, and given the disturbed airflow in a prestart situation. To get good data takes a lot of time and careful review of the starting sequence.

The start polar is then coupled with acceleration and rate of turn tables to help the software determine your prestart timing. The more accurate the polar, the more accurate the software will be in the prestart.

SAILING TECHNIQUE: POLARS

Start polars will show you boat speed to help determine your prestart timing.

DANIEL FORSTER/ROLEX

FIGURE 3

HOW TO GET YOUR VMG TARGETS FROM A POLAR

The first step is to identify the desired TWS.

Second, follow the TWS curve until you find the point where you are making the best ground to upwind (top of the curve), or downwind (bottom of the curve).

From this you can read both the BSP and TWA giving your best VMG performance.

For example (see figure 3): Here, looking at the blue 10 knot TWS performance curve, we can see that the top of the curve (Best VMG) is at BSP = 8.1 knots at a TWA of 39°.