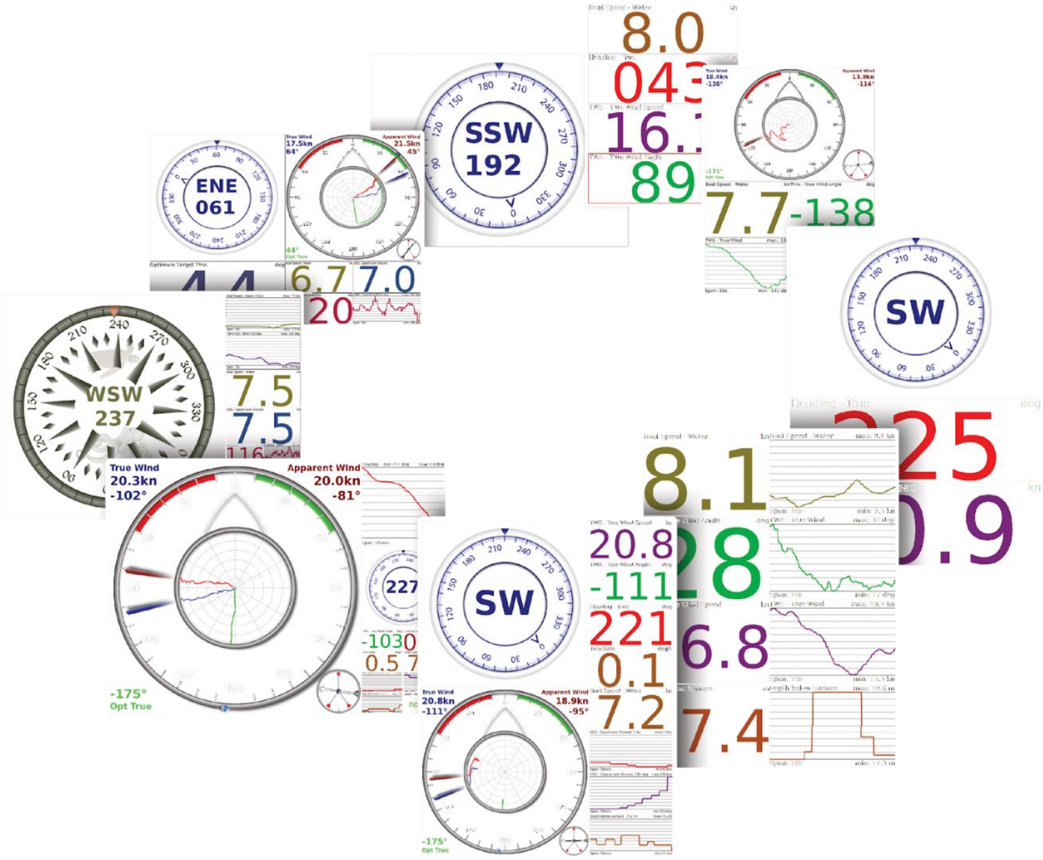


SAILMON

Calibration Manual and Data reference

2023- Version 3

Table of Contents

1. About this Manual

In this manual we will dive into the calibration theory, methods and systems used by Sailmon using the free Navdesk software available for Windows/Mac, iOS and Android. It is recommended not to use a smartphone for this as the displays are a bit too small and aprt of the screen might not be visisble.

Don't let the theoretical discourses discourage you, they will give you more insight of the difficulties of calibration!

2. Calibration Preparations

During the calibration you will have to go sailing and under power for boatspeed calibration. Choose a day with light to moderate wind and few waves. Best results are achieved when the tidal currents are at a minimum. Choose an area with low traffic and much space, and enough depth to allow safe navigation.This section gives details about everything you need for a perfectly calibrated system.

2.1 Calibration basics

Advanced calibration is necessary if you want accurate wind data and when you use velocity prediction and polar diagrams.

The most important values for a sailing yacht are True Wind speed, True Windangle and True Wind direction. Unfortunately, these are also the values which are most difficult to measure and calibrate since there are a number of physical effects which directly affect the accuracy of the measurement.

In addition, true wind is calculated out of a number of other values, which are not easy to measure accurately, like boatspeed and leeway.

So, what is the reason why true wind is such an important value? It’s simply the fact that polar diagrams and velocity prediction programs (VPP) always reference to true wind. This means during simulation the algorithms take a constant wind, which is simulated to flow over the surface. This is definitely not the wind your sensor will measure, since there are effects like upwash, mast twist, gradient, shear etc.

If you want to compare polar speeds and angles with your actual ships condition, you have to measure the true wind without the bad aero dynamical effects described before. The bad thing is that this is not possible in a direct way. Fortunately with tricks, it is possible to correct for these bad influences.

2.2 Sequence of calibration.

The ideal order for you first calibration is as follows:

-1 Depth mounting offset and draft.

-2 Heel and trimangles.

-3 Boatspeed- wthout a good boatspeed calibration all windspeed and windangle vaules will be faulty.

-4 Heading- Same, here, without good heading calibration and if necessary accurate headng correction table your TWD will be faulty.

-5 Windangle mounting offset- To cailbrate misalignment for the windesensor.

-6 TWA and TWS using the 3D tables.

3. Definitions

3.1 Wind Gradient

This is the difference in wind speed from the mast top down to the water surface. Due to friction of the air molecules over the (most times cooler) water the air is slowed down on the surface. There are two major environmental parameters which directly affect the amount of gradient; difference between water and air temperature and wind speed. Worse, there will even be turbulent air flow in extreme situations directly above the surface.

If the difference between air and water temperature is big, and the wind speed is not too strong (usually below 6kn in 10m altitude), the effect is likely to be obvious. It usually gets worse when the breeze starts to build after the sun is triggering the thermal lift ashore.

If one says there is much wind gradient, this means the difference between mast head wind speed and wind speed on the surface is significant. On the other hand one says there is little wind gradient if the difference is small.

As a result of the difference between wind speed on the bottom and on the top, there will be different apparent wind angles aloft and on deck. And apparent wind is finally the wind you sails are producing force with. You will experience problems sailing on polars if wind gradient is significant. The reason is simply that the wind on the mast height decreases more than usual down to the surface, generating less power on the lower sail sections.

Even if the effect is not experienced directly in wind greater than 6kn, there will always be a certain amount of gradient. Since sail makers know about this effect they will shape the sails to a standard gradient.

Therefore polars won't be accurate when excessive gradient occurs.

You now have two options. The first is changing your polars in high wind gradient conditions. The second is to leave your polars and expect slower boatspeeds than usual. Sailmon uses mast height correction to display the 10m altitude wind even if the mast sensor is mounted higher or lower. The correction uses standard wind gradient.

A proven method for measuring gradient is to use a deck wind sensor. This is an extra wind sensor mounted about 2m height above the deck. This sensor will measure AWS and AWA. TWS is calculated out of these values. The advantage is that you can now compare the TWS from the mast head unit and the one from the deck wind sensor. This value is given in %. It is calculated as:

$$Gradient = \left(\frac{TWS\ Mast\ Head\ Unit}{TWS\ Deck\ Wind\ Sensor} - 1\right) * 100\%$$

As greater the difference between TWS from the MHU and TWS from the deck wind sensor as higher the gradient. A gradient of 100% means the MHU sensor measures a TWS twice as high as the deck wind sensor.

Sailmon can show the gradient as a data value. Select Wind->Gradient

3.2 Wind Shear

A phenomenon which comes together with wind gradient is wind shear. In the lower layer of the air immediately over the water surface the wind direction changes as well. The physics behind this effect is rather complex and out of the scope of this manual.

Unfortunately this wind direction change directly affects our true wind angle. The result you experience is that your true wind angle you afford to sail with is not the one displayed from the sensor, mounted on the mast head and corrected to the 10m level.

In other words, you can't achieve your usual true wind angle on one tack, while you have incredibly low true wind angles on the other tack. This is because your sails "see" the result of the wind flowing across the complete sail. And since the wind direction is different aloft and on deck, there will be an "average" wind direction your sails experience.

You have again two options to consider. The first is to launch a calibration run in the wind shear condition immediately before the race. The main advantage is that you have reliable true wind readings. You might not achieve your polar speeds due to the also existing wind gradient, but at least you have the true wind angle to be the same on both tacks, making crew work much easier.

Make sure you understand that this calibration in shear condition run does not affect your calibration if the breeze increases during race. As you will see below, true wind angle calibration is done for a number of different true wind speeds. Since shear will likely occur below 6kn of true wind speed, only the calibration which is next to 6kn is changed, which is the calibration point of 5kn true wind. As soon as the wind increases the calibration is for winds without excessive shear, and therefore right. See the TWA calibration section for details.

The second option is to use your standard calibration and do not perform calibration runs below 10kn of true wind speed. The advantage is that you immediately recognize if wind shear occurs. The disadvantage is that if wind shear if present, you will have wrong true wind angle readings.

Sailmon definitely recommends calibration runs prior to race, even if you do not have excessive shear.

Shear could basically be measured with a deck wind sensor, but will be inaccurate due to very complex aero dynamical effects near the deck. Therefore, you should use the gradient value to detect shear.

3.3 Upwash And True Wind Direction Tacking

All sails will disturb free air flow over the water surface; there will be areas of slightly different air pressure near the sails which deviates the wind direction in the vicinity of the boat. This is called upwash. Since, again, polar files are referenced to the air flow without any obstruction, your true wind angle will be wrong if you do not correct for this effect. Perform TWA Calibration to compensate for upwash.

There are a number of effects which are bad for instrument sailing. However, one will directly be annoying, namely true wind tacking. Due to upwash and shear, your instruments will show different values for true wind direction on both tacks. You have to perform TWA 3D Calibration to compensate for this effect.

In other words, the displayed true wind direction value should not change when you change the heading. As it is unlikely that the real TWD changes in the moment of your heading change, you can check your system calibration in this way. If the TWD stays the same, your instruments are well calibrated for the current wind speed.

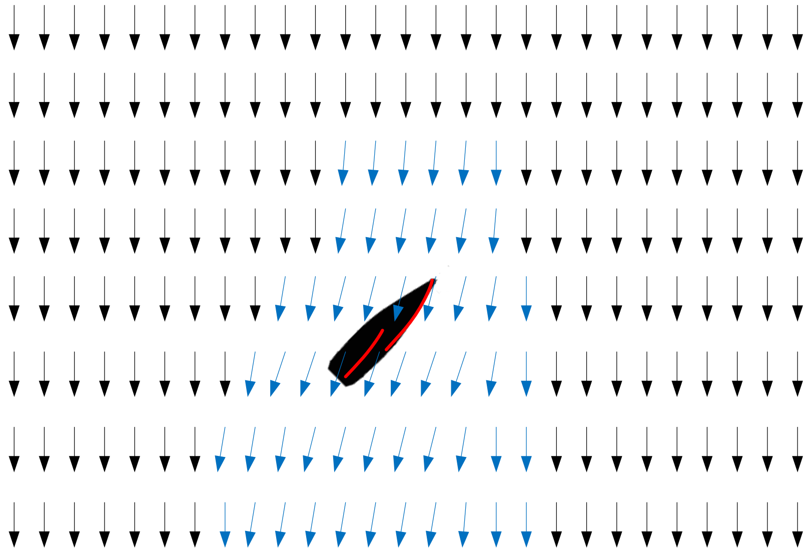
With this principle it is easy to discover that observing true wind tacking can be a great help to calibration. This is because your instrument is well calibrated for wind shear and upwash (and mast twist) if you do not experience true wind tacking. What we do during calibration is letting you sail on both tacks, for upwind, reacher and downwind. Then we compare the values for starboard and port and find out if there is any true wind tacking. If there is one, we correct the calculation for this specific situation, knowing that we have upwash mast twist and shear corrected with it.

We use the compass heading to see if the true wind direction (over the water surface) is the same for both tacks. If not, we know the amount of true wind tacking. This is the main principle for true wind angle calibration. Note that therefore it is essential to have a good and fast compass heading as well.

This is a very powerful approach since you do not have to determine the amount of gradient and upwash, which would be very difficult to measure. We just assume that both effects are compensated if we do not experience true wind tacking.

Since gradient and upwash change with wind speed, we have to adjust for a number of different wind speeds as well. See the TWA calibration chapter for details.

Consider a race boat sailing upwind:

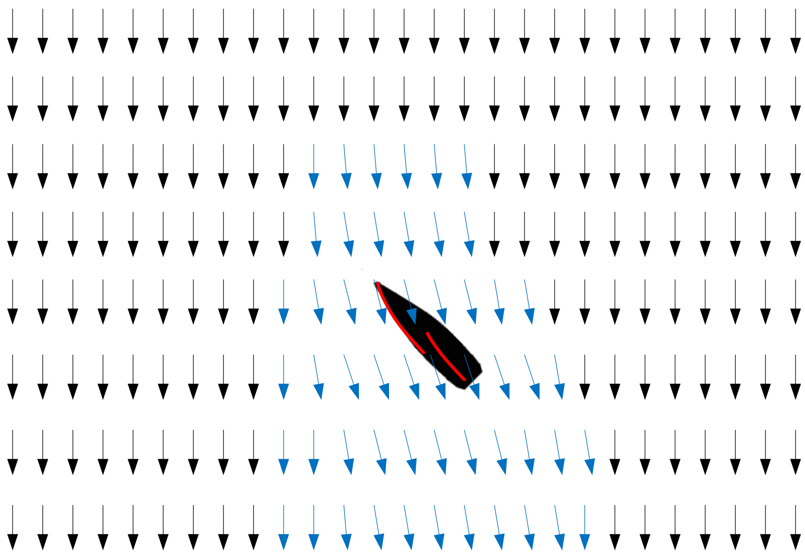


The sails and the hull form an obstruction for the wind. Due do aero dynamical effects, the direction of the wind will be deflected in the vicinity of the boat. In general, there will be a slightly higher pressure on the windward side of the sails, and a slightly lower pressure on the leeward side. As you see from the picture, the wind direction in the center of the boat, where the mast head unit is mounted, will be a few degrees different to the real wind direction without the obstruction.

Fortunately, since the cross section of the sails will usually decrease to the mast top, the effect will be not as significant as on the picture above, but will still be a few degrees. (Note that vertical mast head units will definitely improve wind readings, since they measure the wind angle well above the mast top. Smaller calibration values and more accurate results be the result)

The important fact is that, if uncorrected, your wind sensor on the mast top will sense a slightly deflected wind angle. If the TWD would be north, you instruments will probably show a value of 3-5° for the TWD.

Consider the other tack:



While experiencing the same effects, your instruments will likely show a TWD of 355° - 357° if uncorrected. Since the (measured) TWD has changed from tack to tack, this is called "true wind tacking". Obviously, this effect if very misleading and, worse, your TWA values do not represent the real TWA values your polars are made for (Remember, polars are calculated without these effects)

In detail, your TWA will be too low if you do not correct for this effect.

Example

On starboard tack, your uncorrected sensors will deliver the following values:

TWA: -39° (note the negative value means wind from the port side, = port tack)

Heading: 43°

Therefore, the TWD is calculated to be

TWD = TWA + Heading: **TWD = -39° + 43° = 4°**

On starbord tack, you uncorrected system shows:

TWA: 39°

Heading: 317°

TWD = TWA + Heading: **TWD = 39° + 317° = 356°**

You uncorrected instrument system will show a TWD of 4° for port tack and a TWD of 356° for the starboard tack. TWD tacking is obvious.

To solve the issue, we have to compensate. Imagine adding 4° to both TWA (make angle wider). We then get:

On the starboard tack:

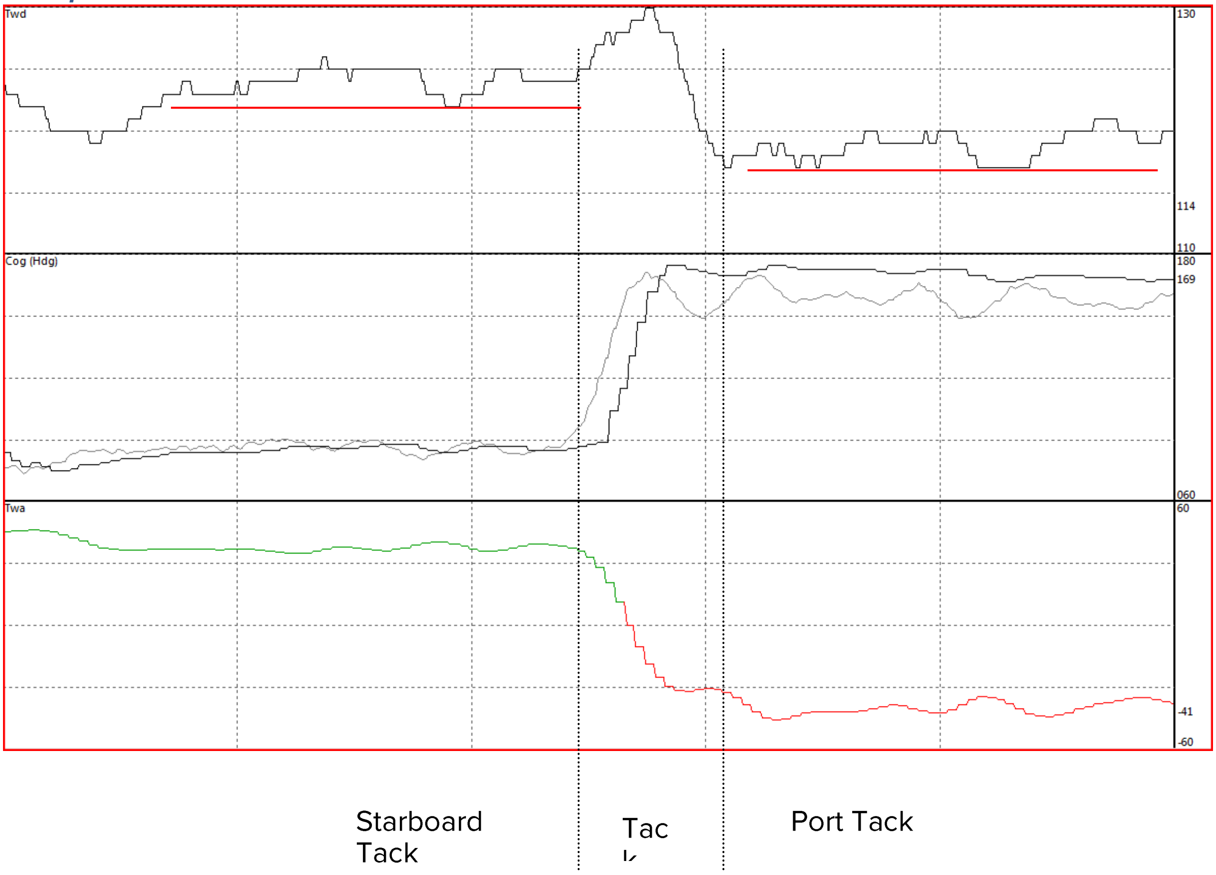
TWD = TWA + Heading: **TWD = -43° + 43° = 0°**

On the port tack:

TWD = TWA + Heading: **TWD = 43° + 317° = 0°**

Your system does not show TWD tacking if corrected and, ever more important, your TWA will be correct, on both tacks!

Example2



What you see on this graphs are recorded values from a tack. The top graph shows the TWD, the middle graph the compass heading (gray) and the bottom graph the TWA.

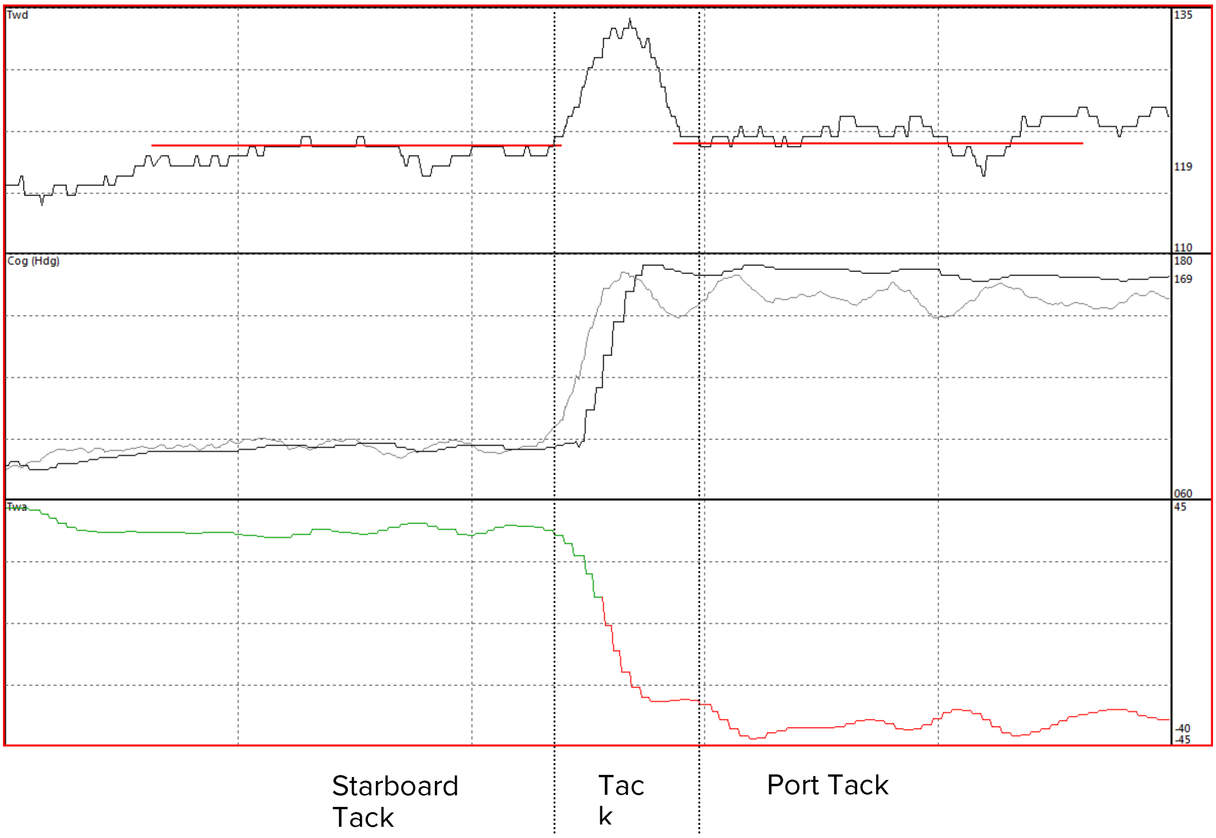
TWA 3D calibration is disabled in this example! Therefore, you see a significant change in TWD before and after the tack maneuver. This change is called true wind direction tacking. Obviously, the “real” true wind direction was not changing during the maneuver; TWD tacking is simply a result of a poorly calibrated system.

Note the peak during the tack is a direct consequence of a slow compass sensor.

Use the Sailmon TWA 3D correction described in ***Calibration Process Step 5: True Wind Angle Correction*** on page 39 for compensating this effect.

Example3

If TWA is calibrated, no TWD tacking occurs any more:



TWA is calibrated with the Sailmon TWA 3D calibration. You see, TWD is the same before and after the tack. This is the overall goal of TWA calibration.

The peak during the tack is again a direct result of a slow compass sensor. Improving the compass quality will minimize this peak.

3.4 Velocity made good (VMG)

VMG is the boatspeed you actually achieve in the direction of the true wind. In other words it is the speed you sail in direction of the windward or leeward mark. As better the VMG, as faster you reach the mark. VMG is defined to be a positive number for sailing upwind, and a negative number for sailing downwind.

3.5 Velocity made good on course (VMC)

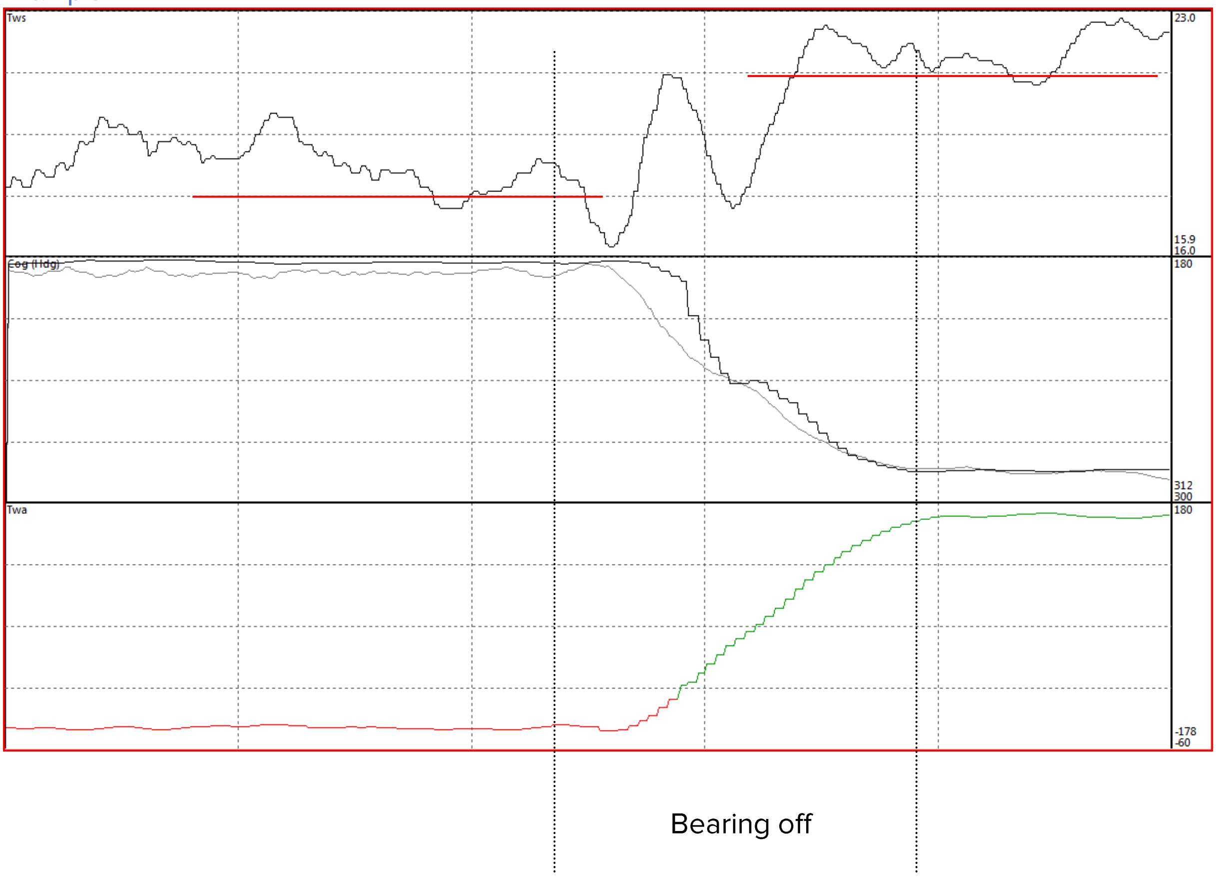
VMC is the amount of boatspeed you go in the direction of your course, and is therefore used when sailing a reacher to a waypoint. You might reach your waypoint faster if you go the true wind angle with the best VMC instead of sailing the exact course to the waypoint. The concept is to go in the direction of the waypoint as fast as possible, even if you do not directly head to the waypoint. This implies the fact that wind is likely to shift on long distance legs, and you will be faster at the waypoint then. If the wind will be steady you will be slower since you have to sail a longer distance. See the polar diagram description for details on VMG.

3.6 Downwind Acceleration

Another, mainly obvious effect occurs when sailing downwind. Since the sails form a rather big obstruction for the wind, and wind is likely to be accumulated in front of the main sail at high true wind angles, and the air will accelerate directly above the mast top. This leads to an over reading of the wind speed, and needs to be corrected. Use the TWS Calibration for this. Be aware that the acceleration can be observed as soon as the **apparent** wind angle is more than approx. 70°. On this Point you will likely experience a TWA of approx. 90°. Therefore, the Sailmon TWS calibration will only be active if TWA is greater 90°. With TWA lower than that, no offset is added to the TWS. Note that the offset can only be negative, since air flow can't be lower due to this acceleration effect. See the TWS Calibration section on how to obtain the correct calibration values.

The reason for calibrating downwind acceleration is that your polars are calculated from the actual TWS. So your polars would deliver the wrong values for sailing downwind.

Example 1



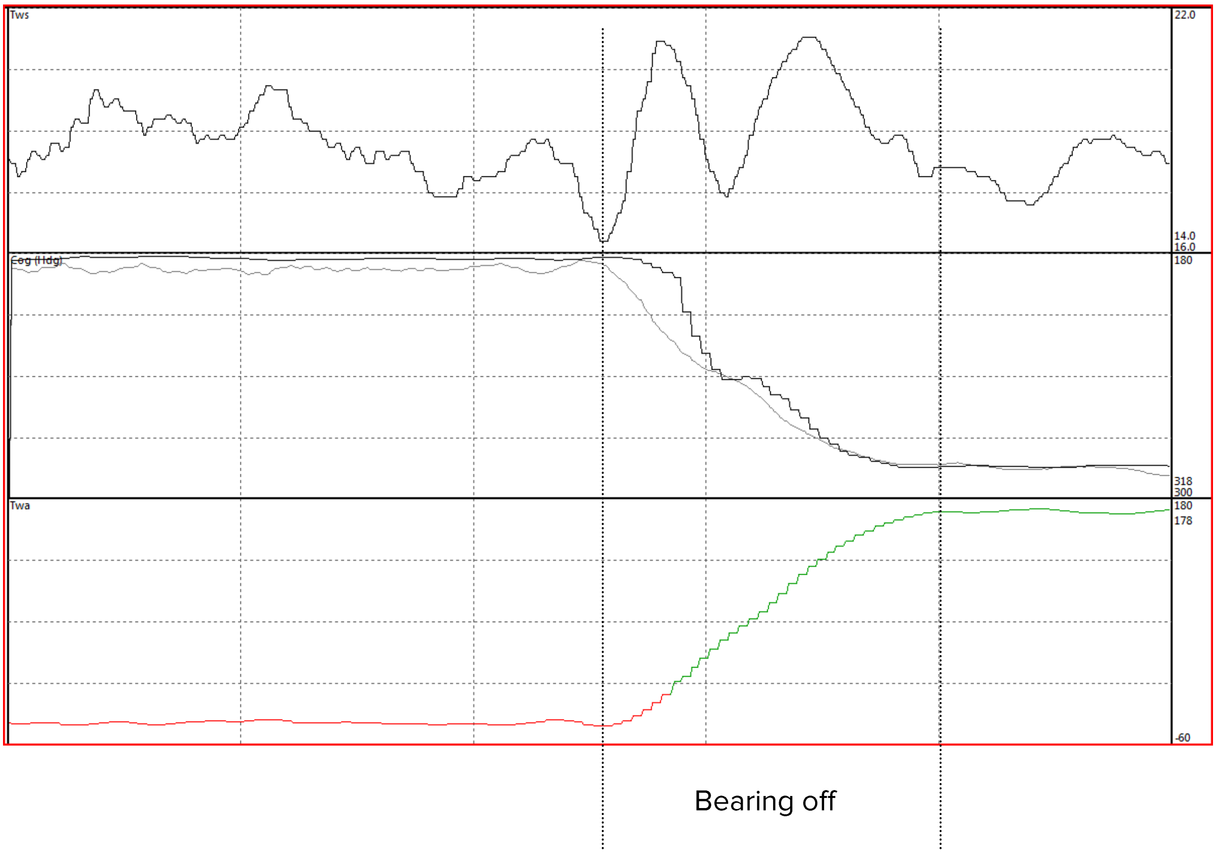
The top chart is the true wind speed (TWS). The middle chart is the heading (gray) and COG. The bottom chart is the true wind angle (TWA).

It is easy to discover, that after bearing off, the TWS has increased by about 4kn (with a TWS of approx. 20kn). This effect is called TWS – Downwind Acceleration.

Sailmon provides the 3D TWS calibration to minimize this effect.

Example 2

In this example, TWS 3D calibration is enabled:



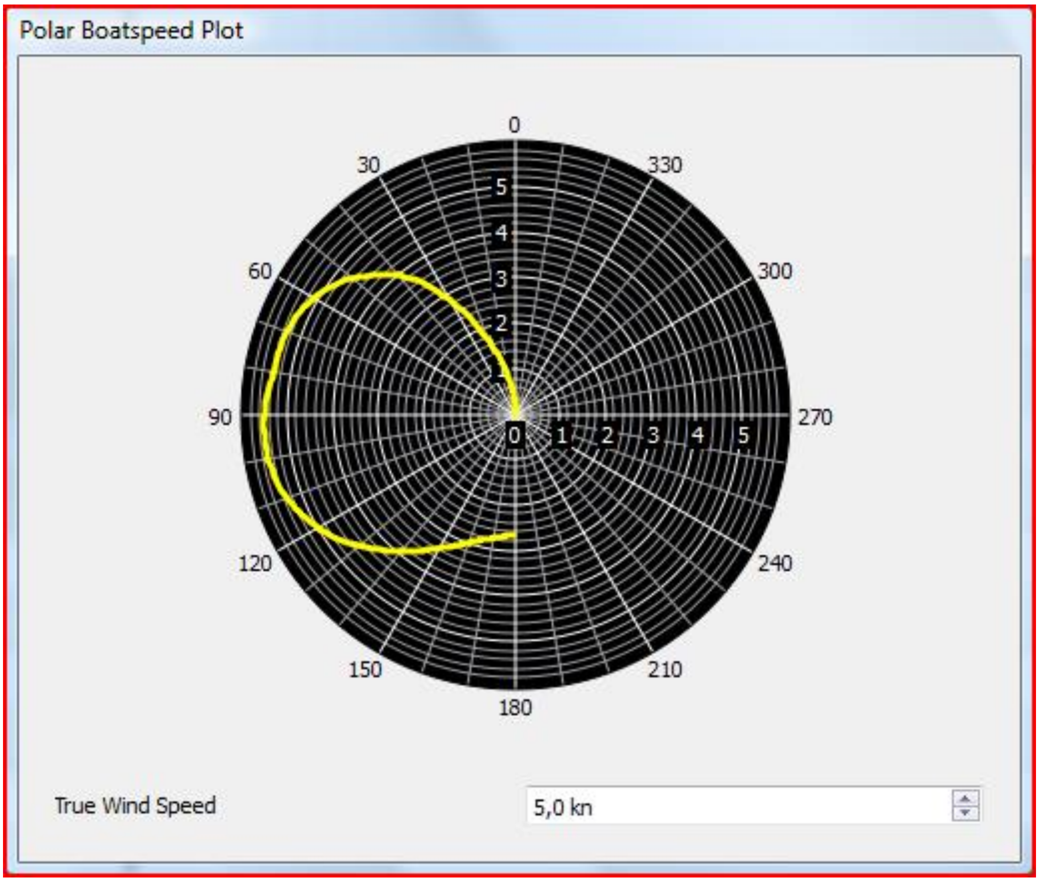
It is easy to discover that the TWS is the same before and after bearing off. So, this system corrects for downwind acceleration.

3.7 Velocity prediction and polar diagram

One nice fact about modern simulation programs, which are used by naval architects, is that they can predict how fast your ship can go under certain conditions. The result can be incredibly accurate if the simulation is supplied with exact data. The main advantage is that you immediately now if you do something wrong and your tactic software can calculate the best positions for tacking and gybing (Laylines). Even long distance routing uses polar data.

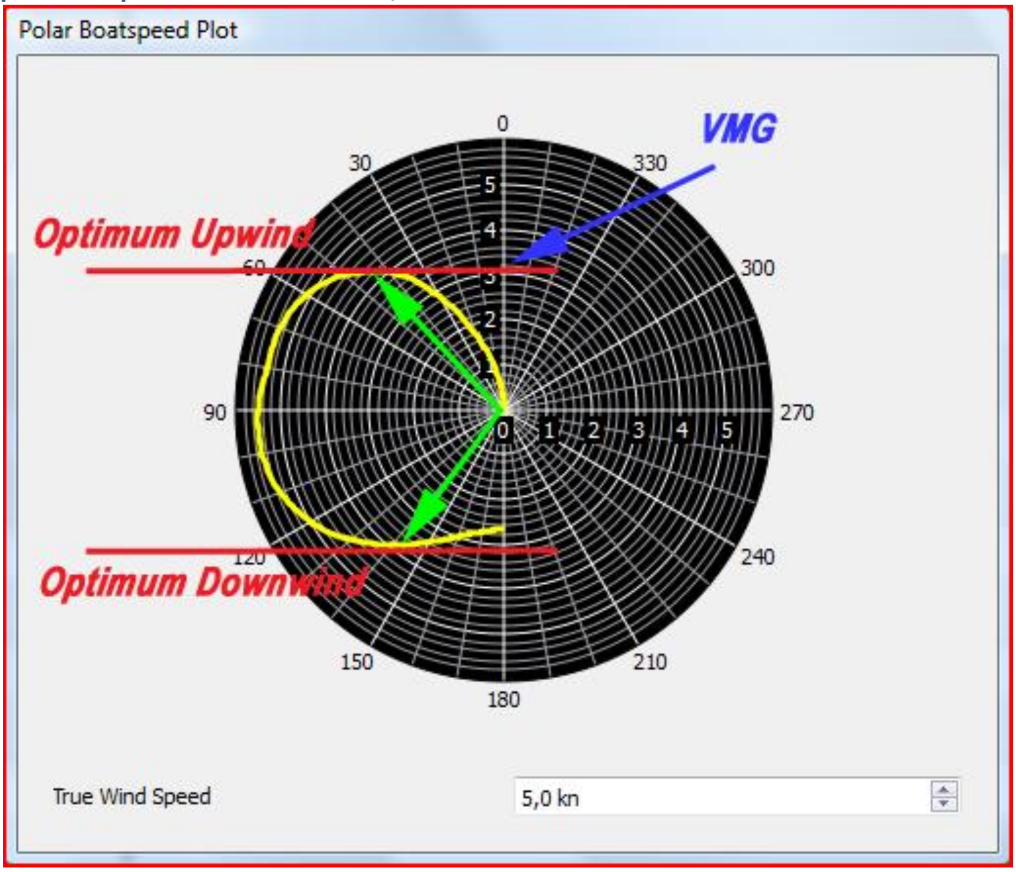
The data output from the simulation software is called velocity prediction. It can give you the best achievable speed for a reacher (target boatspeed) or, in case of upwind and downwind sailing, the optimum true wind angle and boatspeed values. The optimum values are calculated to be the points where the velocity mage good (VMG) is best. So, when sailing upwind or downwind and you want to achieve the best possible VMG, make sure that your actual TWA is equal the “Optimum True Wind Angle” value, and your boatspeed is equal to “Optimum Target Boatspeed” value.

The expression “polar diagram” refers to a special illustration of velocity prediction data. The values are displayed in a so called polar diagram, utilizing the fact that this type of diagram is used for showing data on an angular basis.



The maximum achievable boatspeed is the distance from the center point of the diagram to the respective point for the actual true wind angle. Polar diagrams are best if you want to find out your optimum true wind angle and optimum target boatspeed for upwind and downwind, since it is easy to spot the point with the best VMG. The graphical method is to draw a line, which is always parallel to the horizontal chart axis, to both the topmost and the bottommost point of the chart. The Point where the line touched the polar data is the optimum upwind point; the one where it touches the bottommost point is the optimum downwind point. See the figure below.

Optimum upwind and downwind, VMG

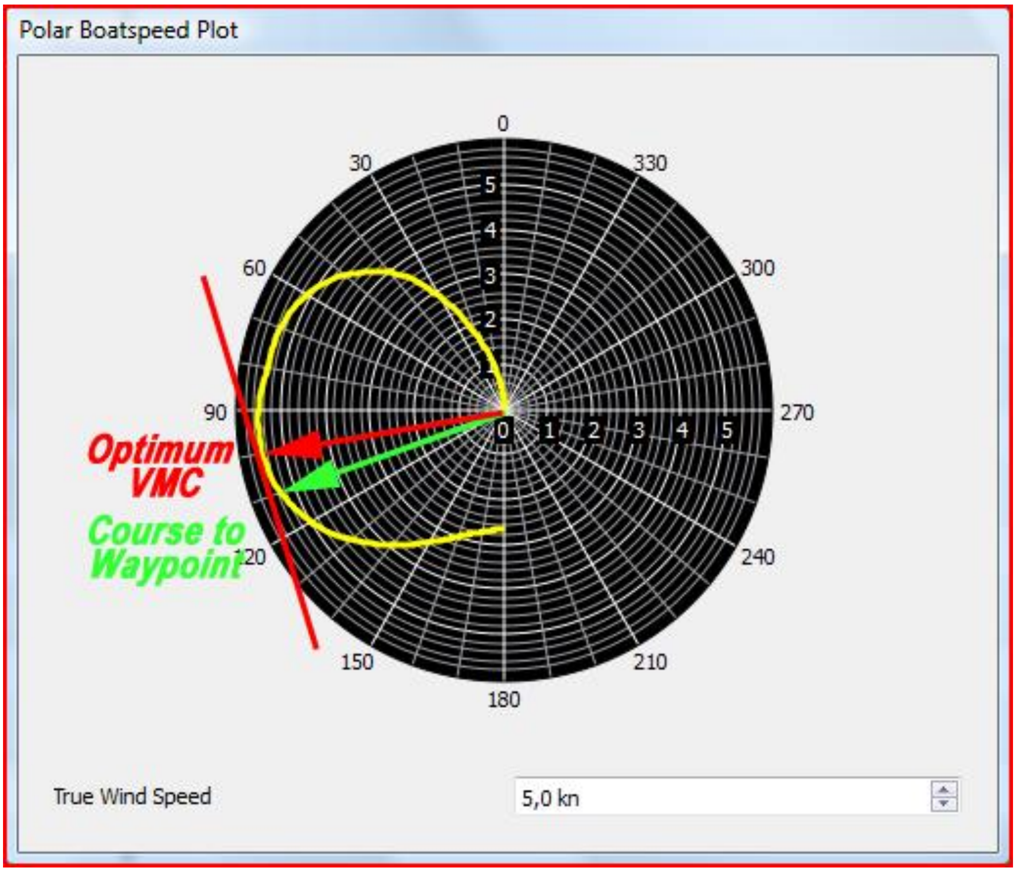


The Point where the horizontal line touches the polar data is the point (angle and boatspeed) where you will get the best VMG. In the example above the optimum true wind angle (upwind) would be approx. 43° with an optimum target boatspeed (upwind) of approx. 4.15kn. The VMG can be read by measuring the distance between the center of the diagram to the point where the horizontal line crosses the vertical axis of the diagram. In this example we would achieve a VMG of 3.05kn.

Note that every polar diagram is for one specific true wind speed. The example above is for 5.0kn of true wind.

The Sailmon System automatically performs the calculation of the optimum upwind and optimum downwind points with very high precision. Therefore there is no need to enter them manually.

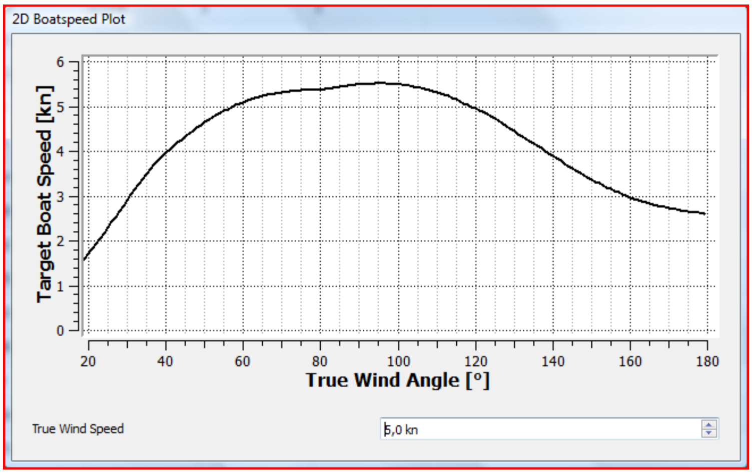
VMC



The VMC is the point where a line, which is perpendicular to the "Course to Waypoint" line, touches the polar diagram at the point where the boatspeed is best. Remember VMC sailing is only faster if the wind direction will change during the leg.

Linear velocity prediction illustration

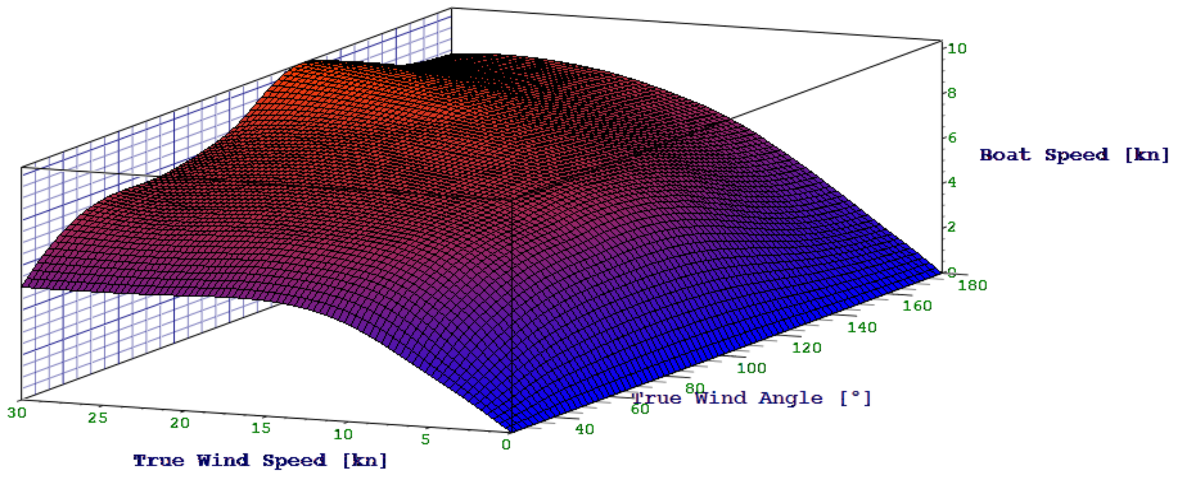
There are some major advantages using polar diagrams for displaying velocity prediction data, including the possibility to directly read out the optimum upwind, downwind and VMC points. Another way to display VPP data is to show them on a linear scale. The main advantage is that you immediately see the point where your boatspeed if best, for any given TWS.



In the example above the boatspeed is best at approx. 95° TWA. This is easier to spot in the linear diagram than in the polar format. Again, the data above are only for one dedicated true wind speed.

3D Presentation

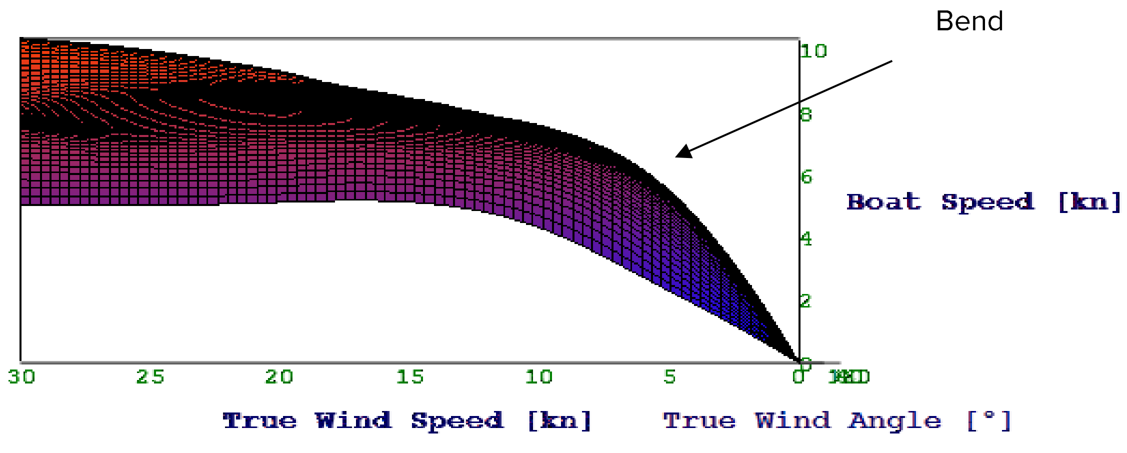
A very powerful illustration method is showing your polar data in a 3D diagram. This allows surveying the complete polar data for all true wind speeds on a single diagram.



A 3D diagram is very powerful to see if the data are feasible, this is when the surface is smooth. You might have entered points which you experienced during training, but they can be wrong for any reason. The surface will show peaks if so.

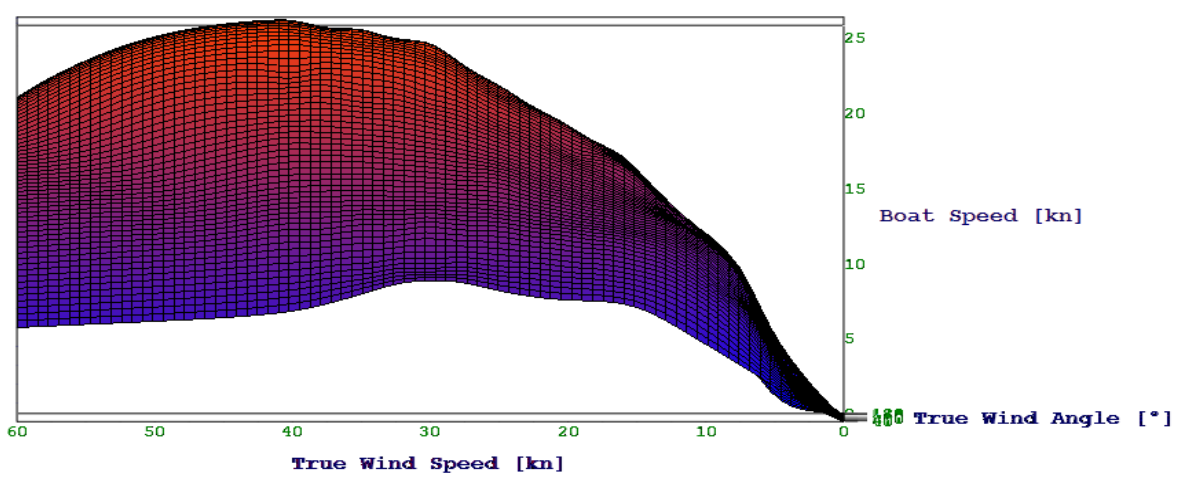
The main reason for Sailmon using the 3D plot is that you immediately see if something is wrong within your polar data.

Another interesting fact is that you easily see if the polars are for a glider or displacement hull. Turn the diagram to look directly in the direction of the true wind speed axis:



Picture 1: Typical displacement hull polar

As we know, displacement hulls have a hull speed. Excessive force is necessary to accelerate above hull speed. Unless the hull reaches the hull speed, increase of true wind speed leads to a nice increase in boatspeed. Above hull speed, which is approx. 7kn for this boat, the increase is much slower.



Picture 2: Typical glider hull polar

Some important facts you should know about polar diagrams and VPP

- Polar diagrams are referenced to True Wind almost all times. Even if polars for apparent wind exist, they are critical since they depend on another value, namely boatspeed. It is much easier to sail after true polars than apparent polars. Sailmon exclusively uses true wind polars.
- True wind is the wind which blows over the **water surface**, without tidal currents. It is not the wind which runs over the earth surface if there are currents. Tidal currents are not included in polar diagrams, and are not included in true wind calculation. This makes sailing with polar diagrams independent of current, which is good.
- Leeway is included in true wind. This means leeway adds to true wind angle. Sailmon performs a true wind leeway correction.
- Polar diagrams are, unlike stated otherwise, referenced to the wind speed in 10m altitude. This is the wind level the simulation software uses. Therefore, if your mast head unit is mounted lower or higher than 10m, you have to correct for the height. Beware that there exists a bad effect called wind gradient. (See the TWA Calibration section for details)

3.8 Sailmon wind calculation principles

There are 2 approaches for achieving apparent wind on a yacht. Both have advantages and disadvantages.

- Direct apparent wind angle
- Back calculated apparent wind angle

With the direct approach, the apparent wind displayed is the sensor reading corrected for masthead misalignment and heel. The good thing about this method is, that it really shows the wind your sails experience. Unfortunately this is only valid if no excessive gradient and shear exist.

This method is good to use if you want to detect situations with excessive shear and gradient. As you can sail very narrow apparent wind angles on the one tack and need to sail extremely wide angles on the other, excessive shear and gradient is likely to be present.

This might be good to know for the tactician, but your crew might prefer sailing to reliable angles.

The second method is called “back calculated”. The concept is that you take your apparent wind, correct if for heel and calculate the true wind. The true wind is then corrected for upwash, gradient and shear, and mast height.

You then take the calibrated and compensated true wind and calculate back to the apparent wind. This apparent wind can be slightly different compared to your sensor reading, but it has a huge advantage: Your apparent wind angles will be the same for both tacks, even if excessive gradient and shear are present.

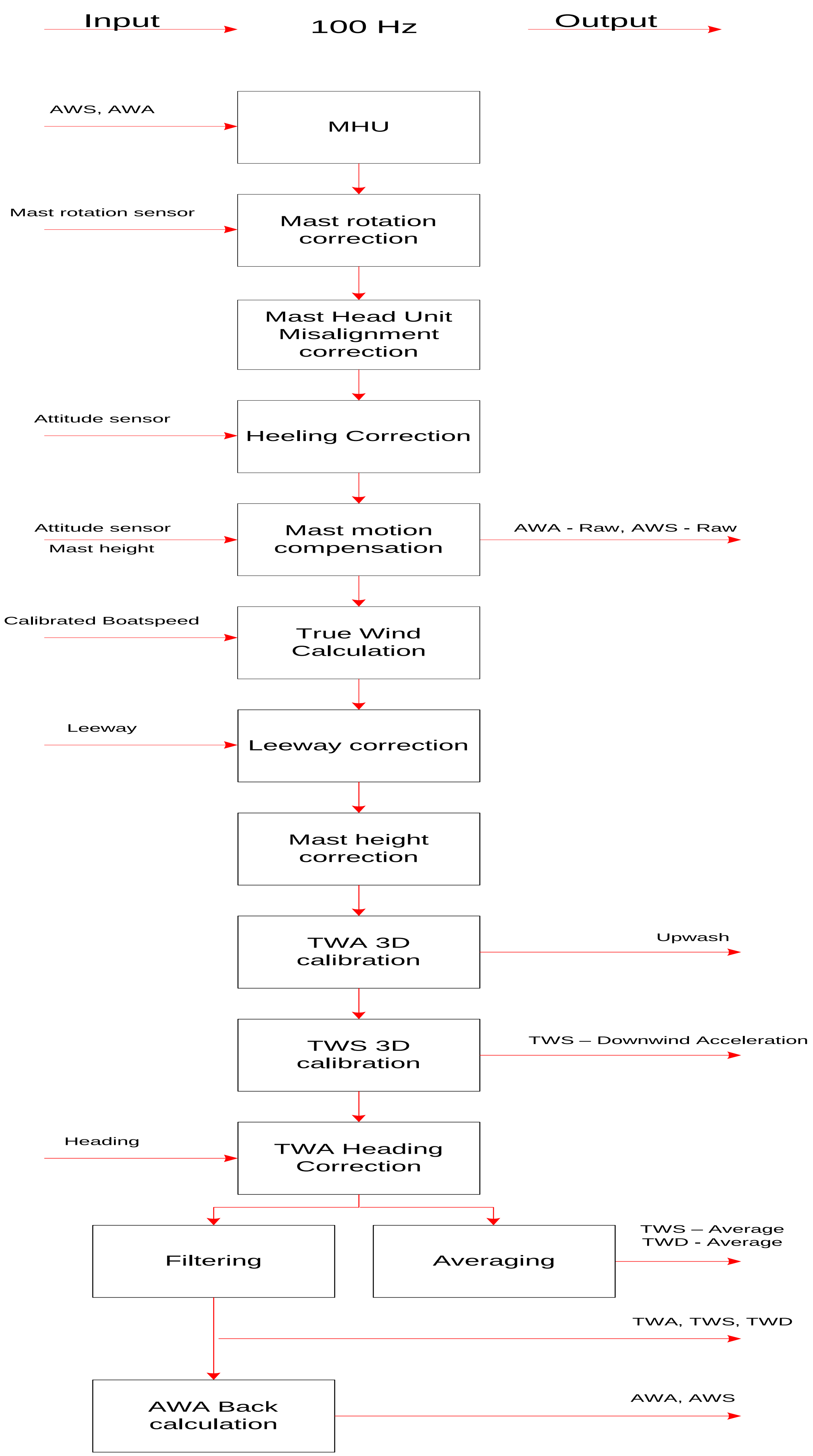
Some crews prefer the back calculated wind while others prefer the raw one. Sailmon recommends to use the back calculated wind if your true wind calibration is up to date.

It is possible to select either apparent wind value, the value “Apparent Wind Angle” is the back calculated version, “Apparent Wind Angle Raw” the one from the sensor.

If you are the tactician, you can display both values on your remote control. In case of major differences between these values, gradient and shear is likely to be present.

Sailmon uses very powerful algorithms to calculate wind data. Wind can be calibrated to avoid a number of bad errors. See the wind calibration section for details.

The data from the mast head unit are corrected for mast rotation and mast head misalignment. Misalignment usually occurs when the MHU is not mounted 100% straight to the bow. If a heel sensor is connected, AWA will be corrected for the skewed flow due to an inclined MHU. In case a Sailmon inertial sensor is connected, the apparent wind will be corrected for mast head movement.


Input
100 Hz
Output
AWS, AWA
MHU
Mast rotation sensor
Mast rotation correction
Mast Head Unit Misalignment correction
Attitude sensor
Heeling Correction
Attitude sensor
Mast height
Mast motion compensation
AWA - Raw, AWS - Raw
Calibrated Boatspeed
True Wind Calculation
Leeway
Leeway correction
Mast height correction
TWA 3D calibration
Upwash
TWS 3D calibration
TWS – Downwind Acceleration
Heading
TWA Heading Correction
Filtering
Averaging
TWS – Average
TWD - Average
TWA, TWS, TWD
AWA Back calculation
AWA, AWS

The direct values for AWA – Raw and AWS – Raw are generated now.

In the next step, true wind is calculated from the boatspeed value. The module takes the calibrated boatspeed and apparent wind and calculated the respective vectors for true wind data.

Since most polars are referenced to true wind including leeway, leeway is added in the next stage.

Now, TWA is calibrated for upwash, this module gives the upwash value as an output.

In the next stage, TWS is corrected for downwind acceleration. This module outputs the TWS – Downwind acceleration value.

If TWA heading correction is enables, the next stage will use the heading sensor to calculate a very stable while still highly dynamic TWA.

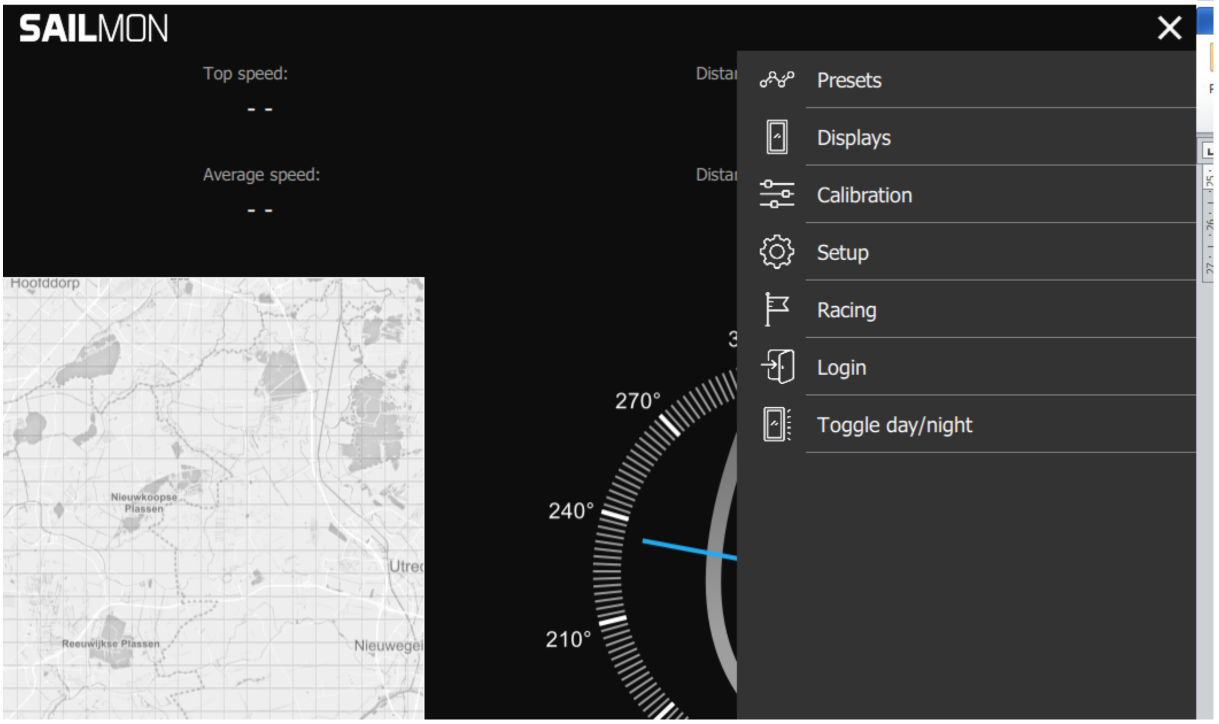
The true wind values are now filtered and averaged, and are used for back calculating apparent wind.

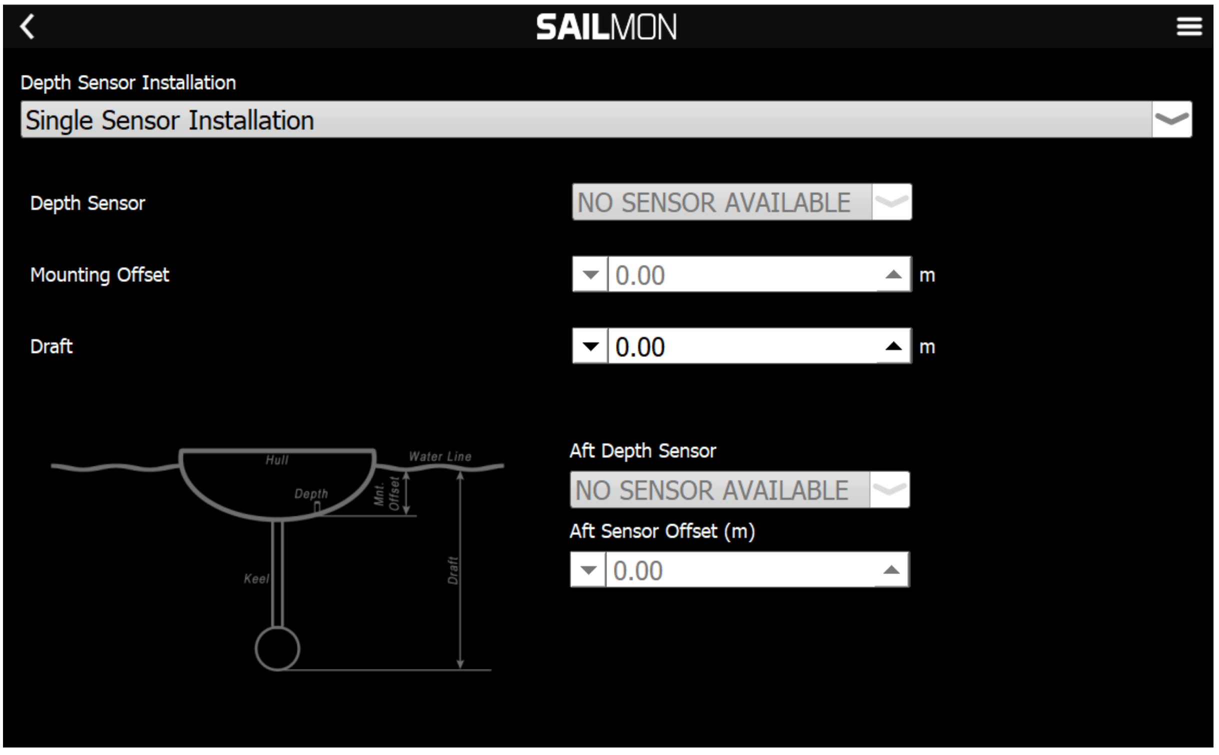
4. Calibration

4.1 Start NavDesk

You will need a PC or tablet with NavDesk to perform calibration. NavDesk will show the start window:

Click on “Calibration” to enter the Sailmon calibration menu.





You will see the main calibration menu on the right side.

The menu is organized in a way that you should go from the top to the bottom during the calibration process. This makes sure that calibration is only done with calibrated sensors.

It is important that you go step by step, starting with Depth and continuing down to Loadcell.

4.2 Depth Sensor calibration

Calibration Goal

Use the depth calibration to get correct "Depth below Surface" and "Depth below Keel" values.

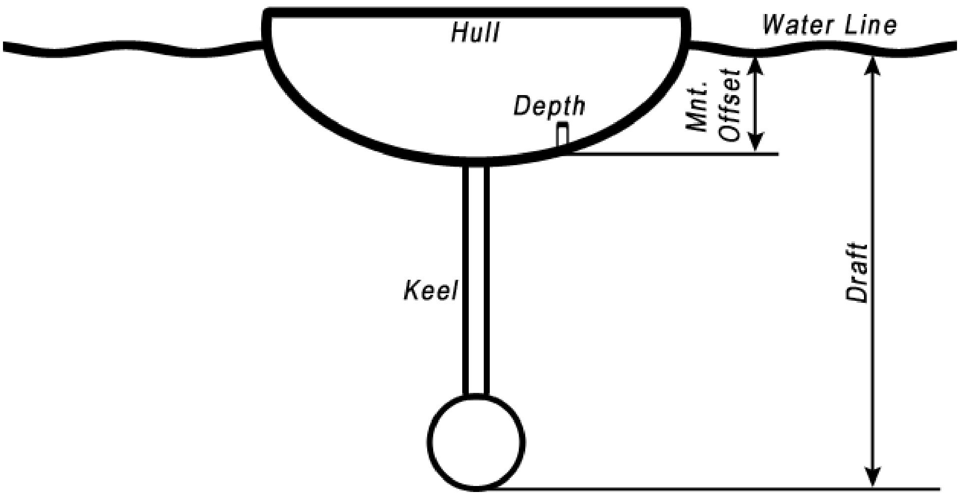
Calibration Process

The calibration process is simple. Depending on your installation, you might have one or two depth sensors equipped. Select "Single Sensor installation" or "Dual Port – Starboard Sensor Installation" and enter the draft of your yacht in the "Draft" field. "Draft" is the distance from the water surface to the lowest point of the keel.

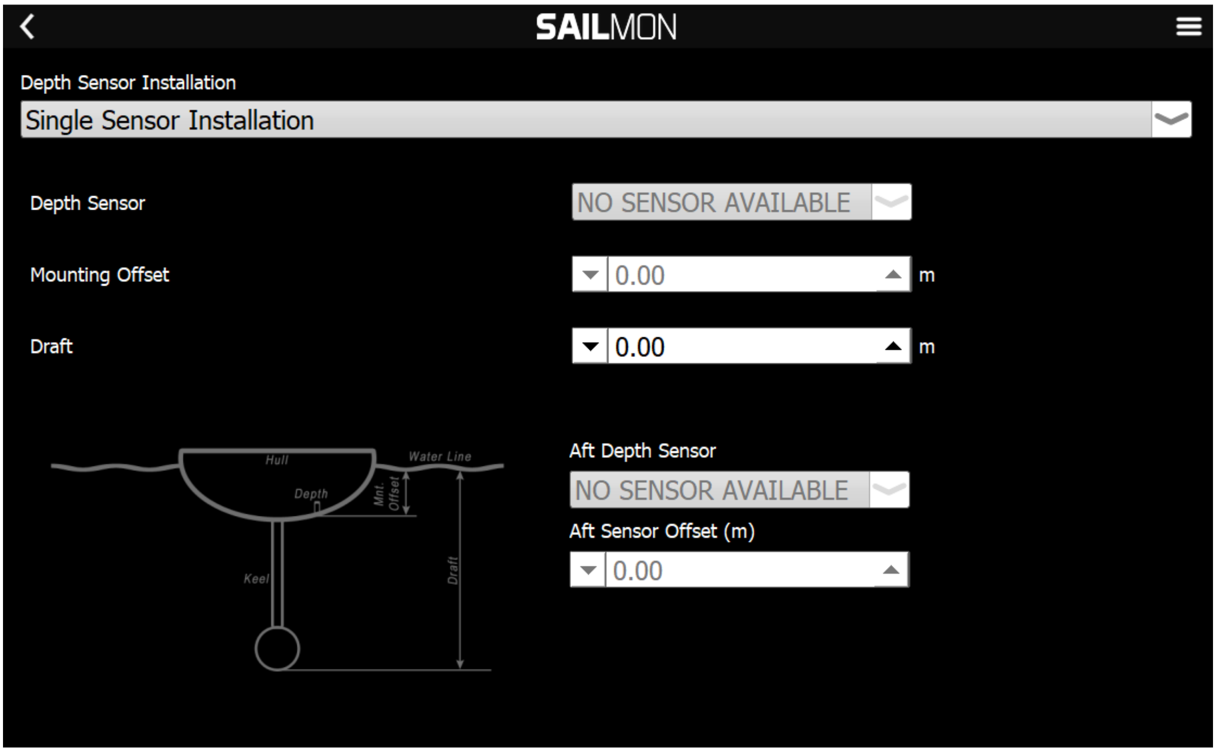
In the next step measure the distance between the water surface and the bottom surface of the depth transducer. Enter this distance in the "Depth sensor mounting offset" field. If you have a dual sensor installation measure and enter the sensor mounting offset for both sensors.

Please note, unlike in other instrument systems, the sensor mounting offset is always a positive number.

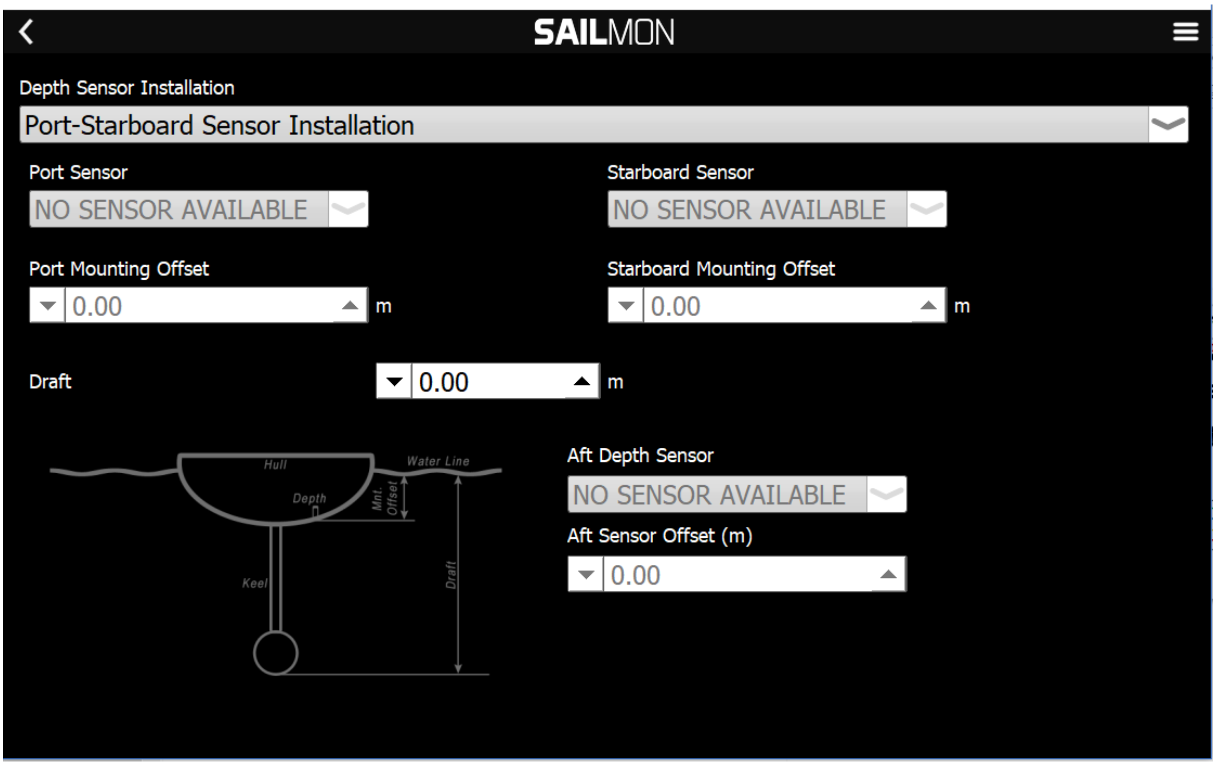
If your depth Sensor data come from another instrument system, like Raymarine Seatalk system or B&G etc, read below on how to set this up correctly.



Single Sensor Installation:



Dual Sensor Installation:



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Depth from other instrument systems: A special case occurs, when the source of your depth data is an instrument system which delivers already corrected data (for example ST60 Instruments, B&G etc). some instruments transmit the depth from the transducer including the depth offset the user has set on the Raymarine instrument, you have to follow the rules below to get correct readings for both “Depth below Surface” and “Depth below Keel” values:

- The depth offset of the other instrument system is set to show the surface depth (offset is positive):
    - In the Sailmon Depth calibration window, set the **“Mounting offset” to 0.0.**
- The depth offset of the Raymarine instrument is set to show the depth below keel(offset is negative):
    - In the Sailmon Depth calibration window, set the “Mounting offset” to be **Draft - Raymarine depth offset value**

Always set the correct draft of your ship in the “Draft” field of the Sailmon Calibration window.

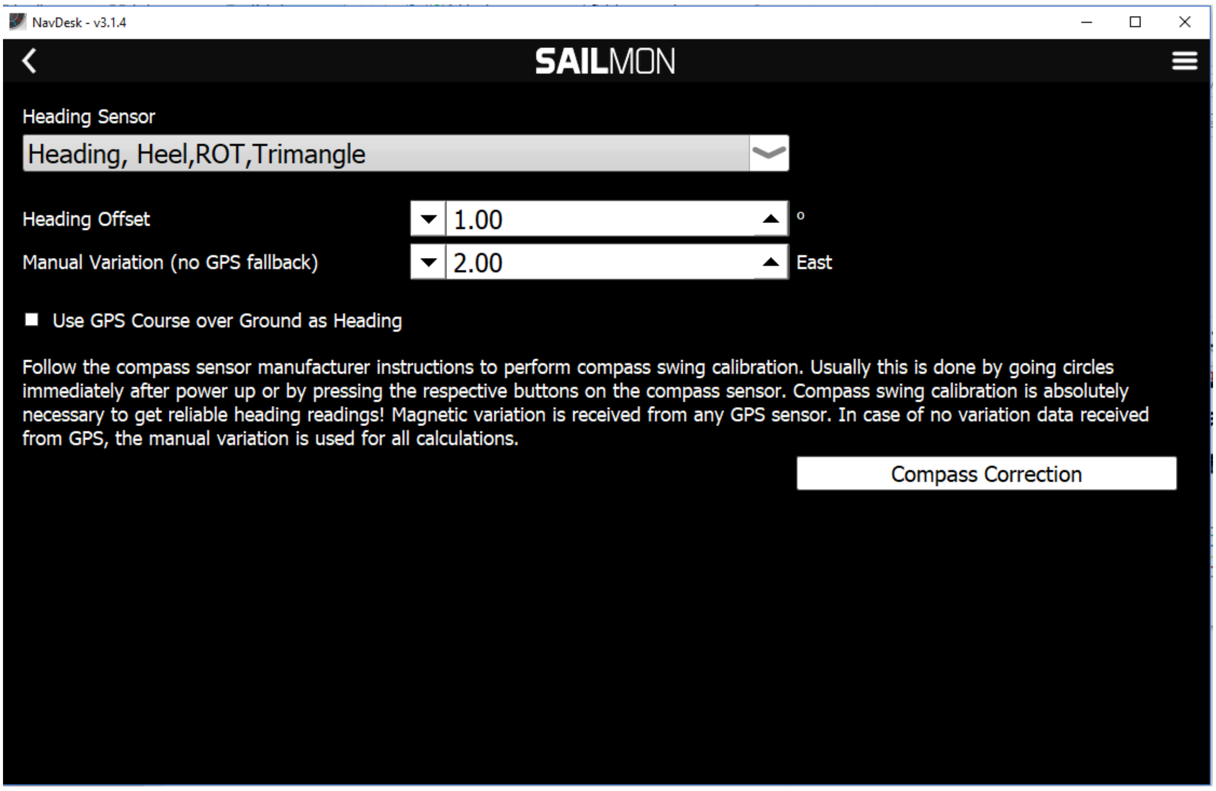
4.3 Heading Sensor Calibration

Calibration Goal

The goal is to compensate the heading sensor value for sensor misalignment and disturbances due to magnetic materials in the vicinity of the compass mounting location. (Deviation)

It also allows setting a manual variation in case the GPS sensor does not deliver magnetic variation information. In case GPS does deliver this value, it will always be taken from the GPS sensor!

Calibration Process



The process for correcting the deviation is called compass swing calibration. This is a process, where the compass sensor adjusts its internal sensors. Therefore, the compass swing procedure is different between sensor manufacturers. You need to read the compass sensor manufacturer manual to see how to perform compass swing calibration. Usually, this is done by sailing constant circles with a given speed and duration immediately after powering the compass sensor.

Compass swing is an important process and must not be skipped. No safe navigation is possible without it. Perform Compass Swing calibration before adjusting the heading offset

After performing the compass swing calibration, the sensor has to be adjusted for mounting offset.

Choose two points with a known leading line and sail straight (under power) heading exactly on the bearing line. As an alternative, choose an area with no tidal currents, go under engine with high speed and adjust the heading to be the same as the COG value, which is displayed in the calibration window.

Adjust the “Heading offset” field in a way the displayed “Heading – True” value matches the bearing (from the sea chart)

Make sure you have a GPS sensor selected or the correct manual variation set. True Heading uses magnetic variation information which is delivered by the GPS sensor.

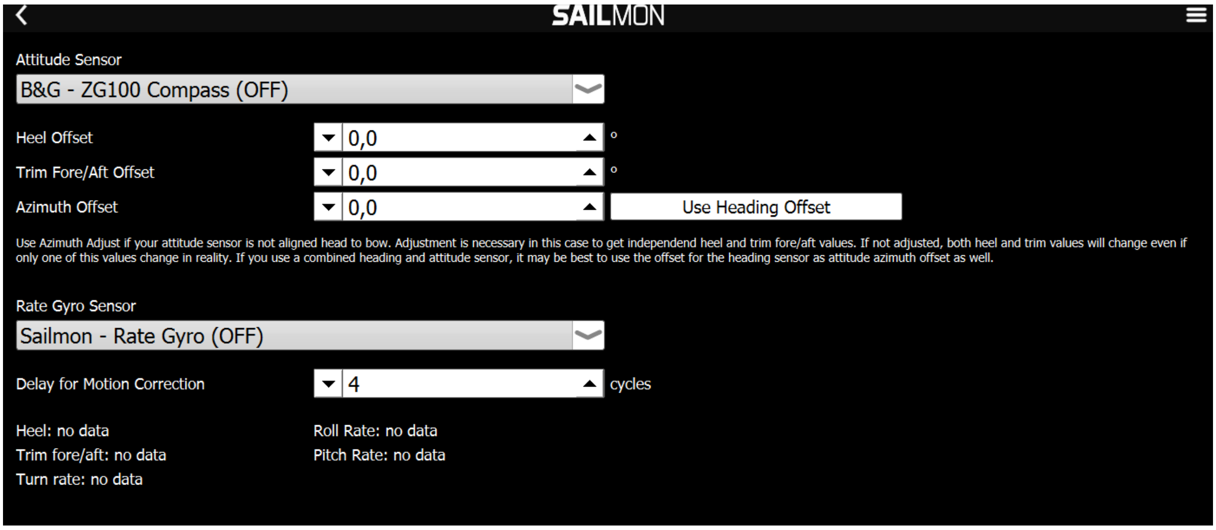
4.4 Attitude sensor calibration

Calibration Goal

Correct the heel, trim fore/after values for sensor mounting offset and the turnrate for sensor drift. Go to the Others.. > Attitude tab

If your sensor is not aligned head to bow, you need to correct for azimuth angles to get independent heel and trim.

Calibration Process



In your yacht berth, with minimum ship movement due to waves or wind, make sure the boat is balanced and loaded as usual (No excessive, unusual loads on any location, normal water and diesel levels)

Adjust the “Heel Offset” and “Trim Fore/Aft Offset” value in a way both “Heel” and “Trim fore / after” show 0.0°

Rate Gyro Sensor

If you have a Sailmon Rate gyro fitted, select it here and set the Delay of cycles here.(4 for a 25Hz windsensor and 10 for a 10Hz windsensor).

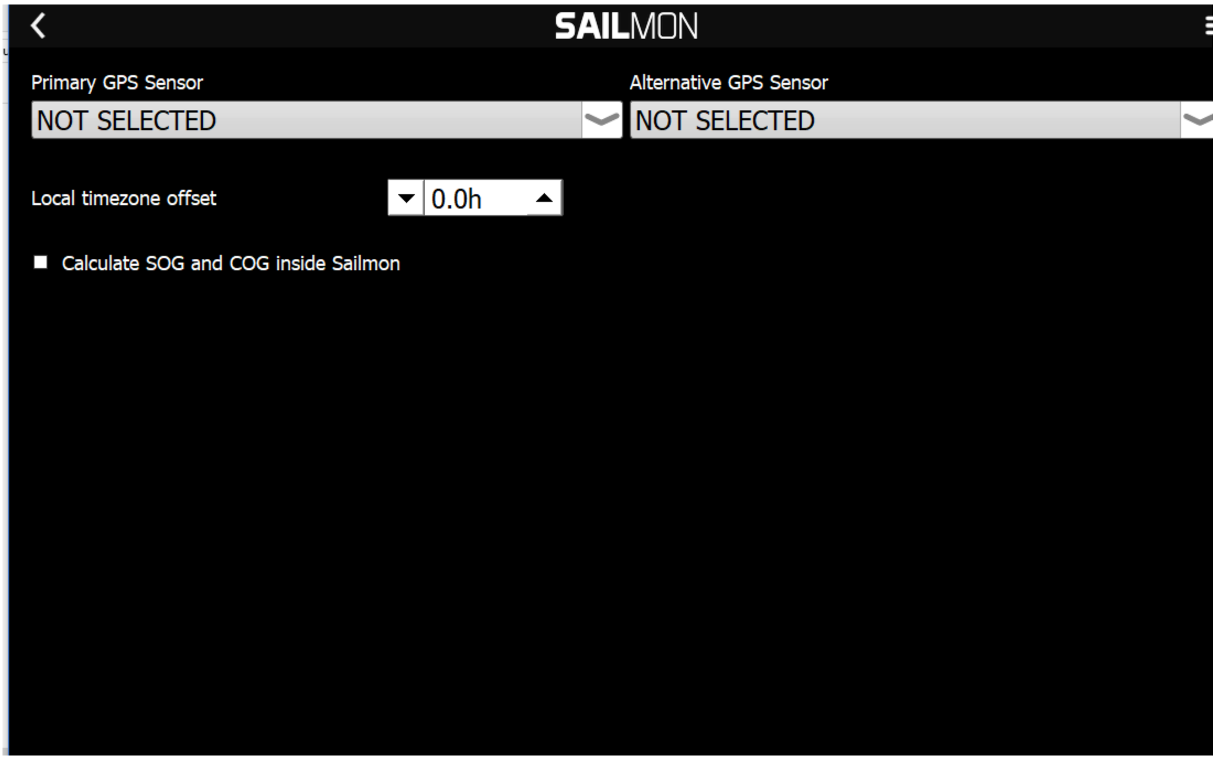
Further adjust the turn rate offset in a way the “Turn Rate” value shows a value approx. 0.0°/s. Note that cheaper sensors will introduce some drift, a stable value won’t be achieved then. Try to minimize the turnrate value.

Make sure the turnrate sensor is powered some time before calibration, since turn rate sensors are likely to no be accurate immediately after power up. Read the sensor manufacturers manual. It is safe to wait 10 minutes after power up for almost all sensors.

A special case occurs if your attitude sensor is not aligned head to bow. In this case the heel and trim values have to be corrected for azimuth angle. If you have a combined heading and attitude sensor, you might want to use the heading offset you adjusted during heading calibration to be the same for the attitude. Click on “Use Heading Offset” in this case or adjust manually otherwise. Failing to correct for azimuth will lead to the effect that the trim value will change if only heading is changed in reality, and vice versa.

4.5 GPS Calibration

GPS does not need calibration in the usual matter. You will only have to choose the sensors you want the system to use and calculate with.

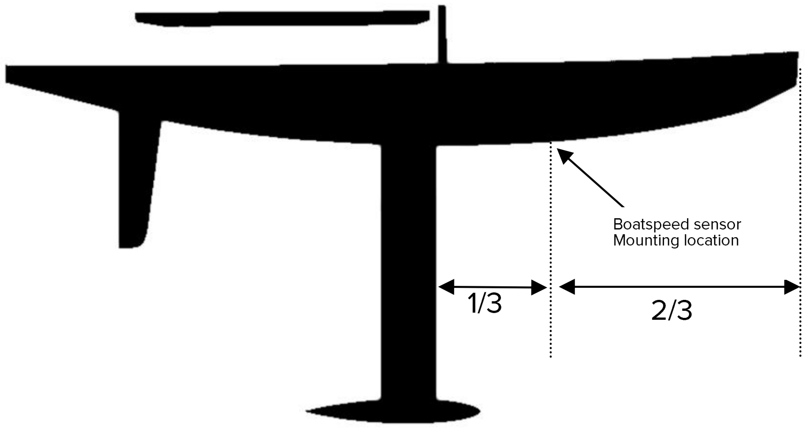


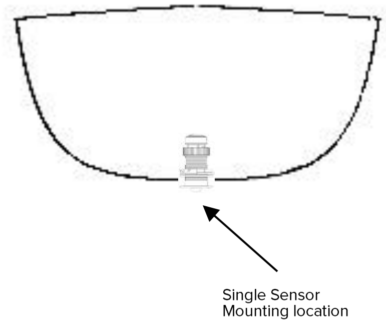
The primary GPS Sensor is the Sensor which is used for all calculations inside the Sailmon system. In case of primary sensor failure, the system automatically switches over to the alternative sensor. Choosing an alternative sensor is optional.

Since GPS is the source for a number of important values, it is obligatory for reliable system operation to have a working GPS sensor.

Position data is needed by your tactic software. Sailmon provides a 10Hz position output over the wireless Expedition interface. This allows getting rapid update of your ships position in critical situations, like prestart. Obviously, even if the position output is 10Hz, the data will only change with the update rate of the GPS Sensor. See the Sailmon Installation and User Guide for details about the high speed output.

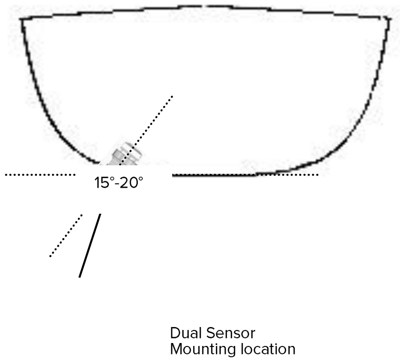
4.6 Boatspeed

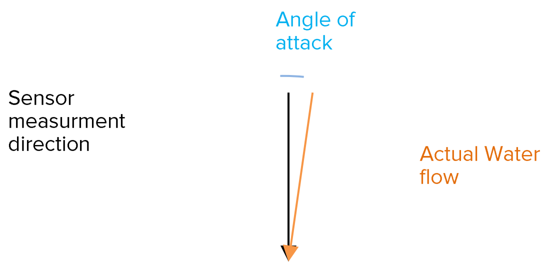




Dual sensor installation

A dual sensor installation can be more accurate than a single sensor installation. This is because in usual conditions the boat is heeled, so the current flow along an inclined sensor is straighter than if this sensor is mounted in the center of the hull. Sometimes a dual sensor installation is needed due to the hull shape and structural components. Sailmon provides automatic heel switchover for dual sensor installation.





Boatspeed and Heel

Since the angle of attack of the water to the sensor is different for different ship attitudes, either paddle wheel or ultrasonic sensors need to be corrected for this effect. In addition, the angle of attack changes depending on your boatspeed, making an advanced calibration necessary.

Both Paddle Wheel and ultrasonic sensors only measure the amount of water speed with runs straight over the sensor.

Obviously, the vector length of the sensor measurement is shorter as the actual water speed, resulting in an under reading. The formula will be:

$$Sensor\ measurement[kn] = Actual\ Water\ flow[kn] * \cos(Angle\ of\ attack)$$

Since water flow is complex and along the hull, angle of attack is difficult to define, it is not possible to mathematically calculate it so we need calibration. Not that the angle of attack might be 0° on 10-20° heel if your respective sensor is mounted inclined. This would basically lead to an under reading when the boat has little heel. As you perform your calibration run with little heel, the boatspeed factor is calculated for little heel as well. This finally leads to an over reading when the boat if heeled.

Boatspeed - Heel – Tack Correction

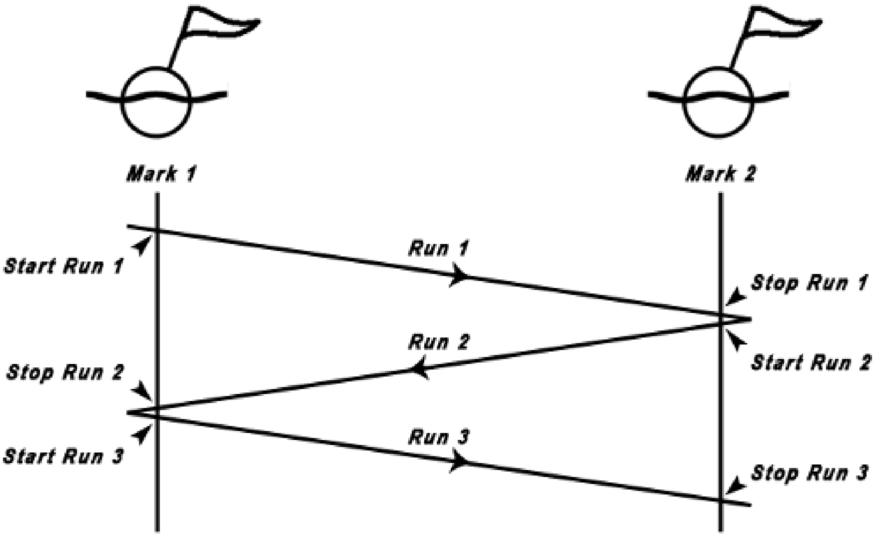
This is a 3 dimensional calibration method where both heel and flow nonlinearity (in case of a paddle wheel sensor) is compensated. Tack correction means that there can be different offsets for port and starboard tack. The Boatspeed – Heel – Tack correction can be disabled by disabling the “Enable Heel – Tack correction” field. Only the Boatspeed factor is used in calculation then.

Boatspeed Sensor Factor

The boatspeed factor is a multiplication factor for the sensor raw value. This factor is applied before any further calibration. The factor can be obtained by SOG run calibration or Distance run calibration.

Distance Run calibration

This is the most accurate method for obtaining a boatspeed factor. The concept is to sail under power along a known distance for 3 times:



You could compare your distance log with the real distance between the marks and set the boatspeed sensor factor to compensate for any difference. However, the result won’t be accurate if there are any tidal currents at the time you are calibrating. Since tidal currents will exist almost all time, we need to perform another calibration run from Mark 2 to Mark 1 and compare the distances again.

This will allow compensation of the error due to the tidal current if and only if the current is steady. Since calibration runs are usually a process which take approx 20 to 40 minutes, current is likely to change during the calibration runs. If you perform another calibration run from Mark 1 to Mark 2 again we can compensate for current change as well.

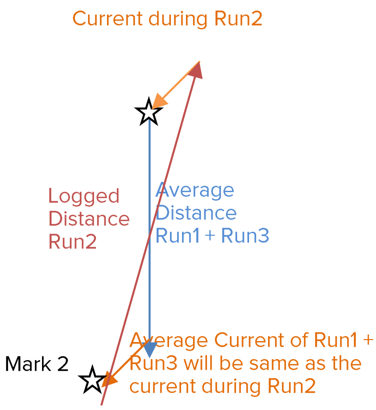
A very important requirement is that you do not calibrate in conditions where the current changes are extraordinary or tidal currents change direction during calibration runs.

The calculation principle is as follows:

We average the distance from the Run1 and Run3:

$$AVG1[nm] = \frac{Run1[nm] + Run3[nm]}{2}$$

This gives the average distance travelled on Run1 and Run3, both Runs are from Mark 1 to Mark2. So, if the current speed changed in the time between Run1 and Run3, we see the distance vector with an average current which likely was flowing in between Run1 and Run3. This was the time where Run2 took place, but the direction or Run2 was from Mark 2 to Mark1, in the opposite direction of Run1 and Run3. So, if we again average the result from the last formula with the distance log of Run2, we get the distance log without current influence. It is essential that all 3 Runs are sailed immediately after each other; you won't get the average current otherwise.



The illustration shows the vectors for the calibration runs. The current vector adds to both calibration run vectors. On Run1 and Run3, the current flows in vessel direction, in Run2 it flows against the vessel direction. Since the average current of Run1 and Run3 is equal the current during Run2 if the current is steady, the distance sensed by the boatspeed sensor must be equal the distance between Mark1 and Mark2. If not, we can compare and calculate the new boatspeed factor to achieve equality.

Then we average the distance from the formula above with the distance measured in Run2

$$AVG2[nm] = \frac{AVG1[nm] + Run2[nm]}{2}$$

This is the distance sensed by the boatspeed sensor, with the complete current removed. So we just need to compare the measured distance AVG2 with the actual distance between Mark1 and Mark2 (from the sea chart).

The new boatspeed factor calculated to:

$$BSFactor = \frac{Distance\ between\ Mark1\ and\ Mark2\ [nm]}{AVG2}$$

Consider the following example.

Mark 1 to Mark2 distance from sea chart: 0.5nm, boatspeed during calibration run approx. 5kn.

Run1: from 10:00UTC until 10:06UTC; logged distance from sensor: 0,46nm; current 0.3kn to 210°

Run2: from 10:08UTC until 10:14UTC; logged distance from sensor: 0.50nm; current 0.2kn to 210°

Run3: from 10:16UTC until 10:22UTC; logged distance from sensor: 0.48nm; current 0.1kn to 210°

Note that the current direction does not change, which is important for this calibration method. Fortunately, the relative angle between the current and the mark position does not affect the calibration.

$$AVG1[nm] = \frac{0.46nm + 0.48nm}{2} = 0.47nm$$

$$AVG2[nm] = \frac{0.47nm + 0.50nm}{2} = 0.485nm$$

$$BSFactor = \frac{0.5nm}{0.485nm} = 1.03$$

So, if the Boatspeed sensor factor is set to 1.03 in this case, the sensor is calibrated. Note that since you should perform the calibration runs with approx. 5kn of boatspeed, the calibration is only valid for the range around 5kn, due to nonlinear sensor characteristics. Therefore we need 3D nonlinearity correction if you boatspeed can be significantly greater than 5kn (>10kn). See the Boatspeed - Heel – Tack Correction for details.

4.6.1 Boatspeed Calibration

Calibration Goal

Since the paddle wheel transducer can be mounted on different locations of the hull, where different water flow can be observed, the transducer will sense water speeds which do not mach with the actual boatspeed. For a most yachts it is sufficient to set a multiplication factor, which the sensor value will be multiplied with. The easiest and most convenient way to calibrate is to compare the measured sensor value with GPS speed over ground (SOG). The only restriction is that tidal currents should be at a minimum during calibration run.

Provided the boatspeed sensor was calibrated correctly, also the distance log will show correct values.

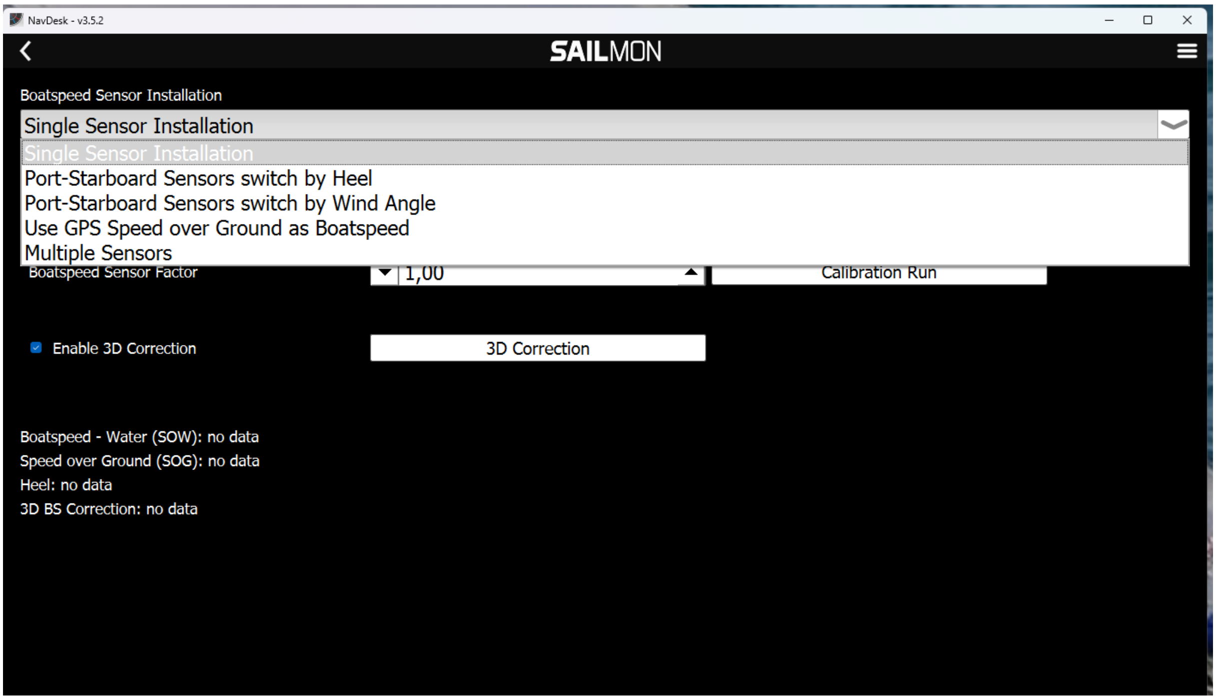
Check your boatspeed sensor for algae or other disturbance in advance.

Simple Calibration

If you have a port and Starboard speedsensor set boatspeed as single sensor and select one of the 2. This means you have to perform the calibration sequence twice!

Enter the Sailmon Tool Calibration window and choose “Boatspeed”. Depending on your installation, you might have one or two boatspeed sensors. Make sure you select “Single Sensor Installation” or “Port – Starboard Sensor Installation” before you continue.

Do not check “Enable Heel – Tack Correction” since this is not used in recreational calibration.

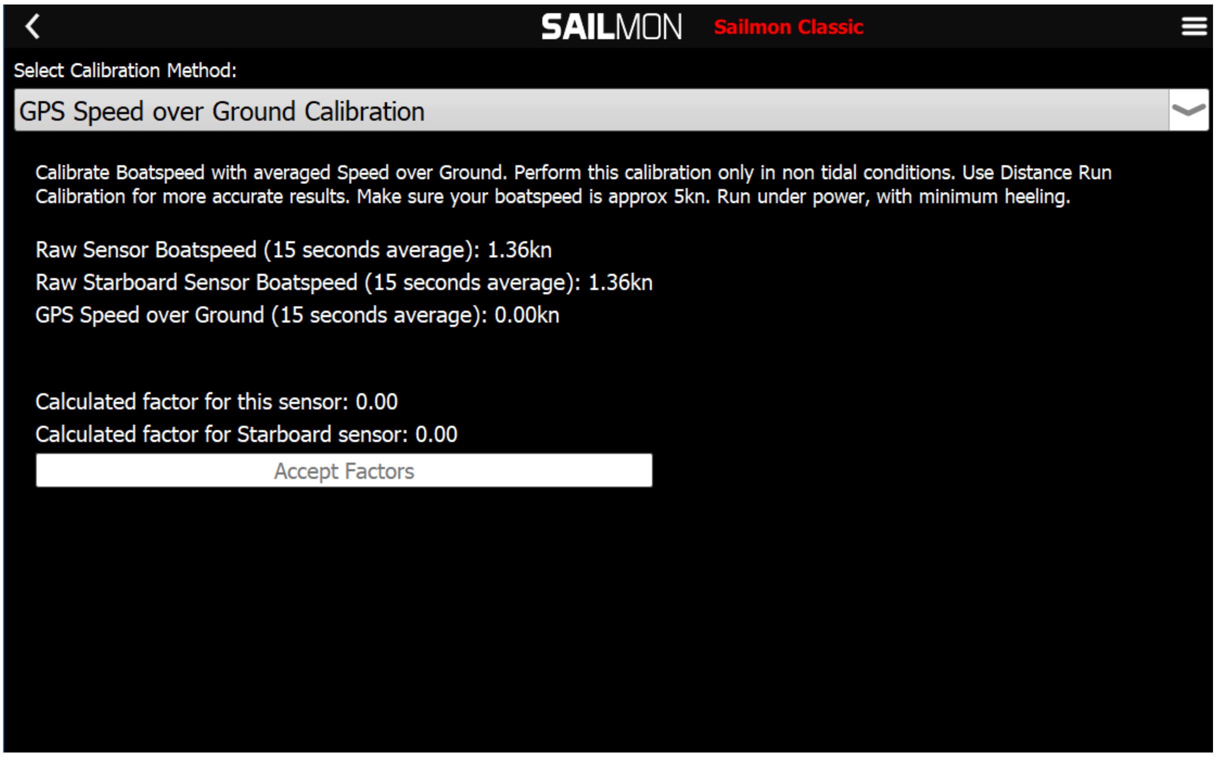


Port – Starboard Sensor Installation window:

The sensor factor for each sensor has to be adjusted.

A factor of 1.0 means the sensor value will be displayed as it is measured from the sensor.

You can adjust the factor manually or press “Calibration Run“ where the system helps in getting the correct factor and select “GPS Speed over ground calibration”..



GPS Boatspeed calibration is the easiest method for boatspeed calibration, but it is only accurate if you perform it in non tidal conditions since currents will directly add to the calibration result. GPS calibration is sufficient for most recreational sailors, if you wish to get more accurate results or you sail in a area with currents, you might consider choosing “Distance run calibration”, which is described in the race calibration section.

The screen will show the actual boatspeed from all sensors and the GPS over ground. It will compare both values (15s average) and suggest a calibration factor.

During calibration maintain a boatspeed which is greater than 5kn, and press “Accept Factors” as soon as the “Calculated Factor for Sensor” values are stable.

Press “Close” to return to the main calibration window.

If you select Port – Starboard sensor installation, you have to select a sensor for both tacks. Do not leave one sensor „Not selected“ since you won’t have a boatspeed value on the respective tack then.

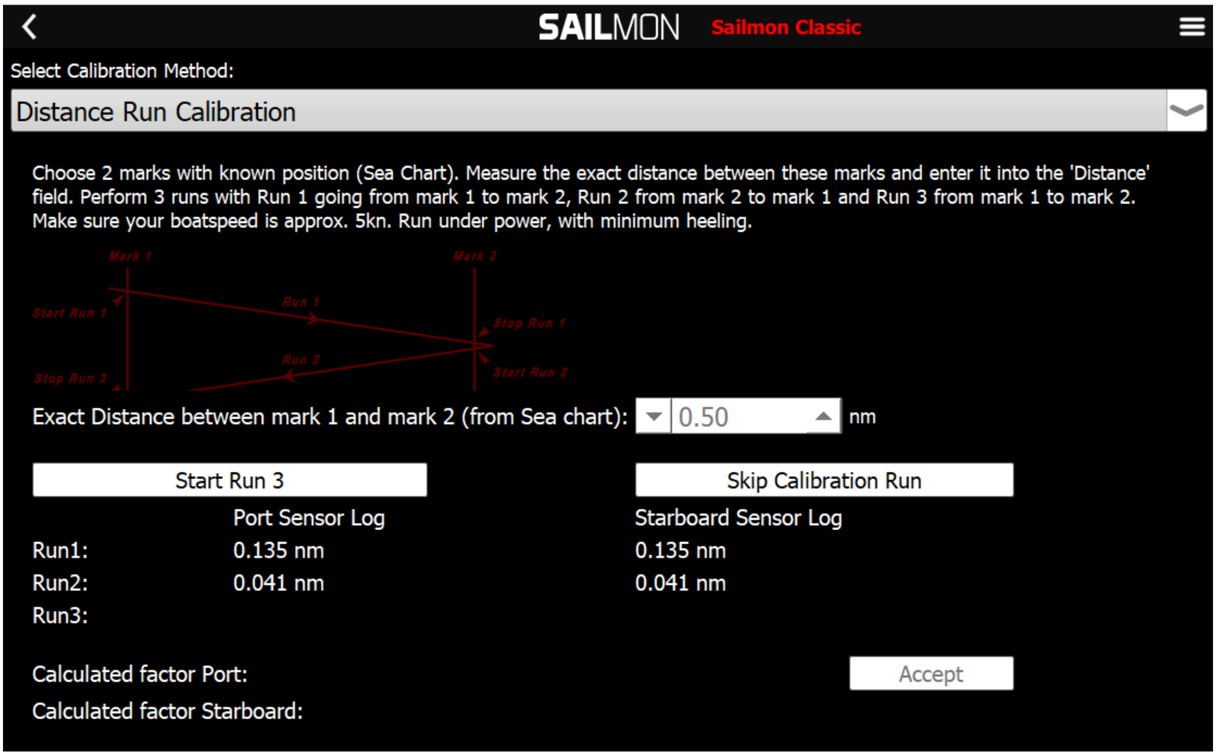
Sailmon uses the true wind angle or Heelangle for selecting the right tack, if the true wind angle is positive, meaning the true wind comes from port, the starboard sensor is selected. On the other hand, if the true wind angle is negative, the port sensor is selected.

To enhance calibration it is advisable to do 3 runs for each sensor. Therefore set the system to single sensor and change between between sensors after the initial 3 runs and do 3 more runs with the oposite sensor.

Advanced Calibration

You have to perform calibration runs to obtain the boatspeed factor **before** doing the 3D calibration. Select “Auto factor” and select “Distance run calibration”. Take your time and perform a distance run calibration, don’t use SOG calibration for a race boat.

Sailmon helps you with this calibration method by doing all the calculation work:



Set up for sailing under power with a boatspeed as you would sail upwind at with 10-12kts of wind and with minimum heel. Choose two marks and enter their exact distance in the respective field.

Sail as close as possible to Mark1, heading already exactly to Mark2. As soon your mast is at the mark, press “Start Run1”. Head to Mark2 all the time during calibration run. As your mast reaches mark 2, press “End Run1”.

Perform a 180° turn as fast as possible and sail to Mark2, already heading to Mark1. As you mast reaches Mark2, press “Start Run2”. Head to Mark1 all the time, and as your mast reaches Mark1 press “End Run2”.

Again, immediately make a 180° turn, sail to Mark1 and press “Start Run3” as your mast is at the mark. Finally, press “End Run3” as your mast is at Mark2 again.

Sailmon will do all the calculations explained above and suggest boatspeed sensor factors for each sensor. Press “Accept Factors” to save and store the factors in the calibration database.

“Close” will return to the main window.

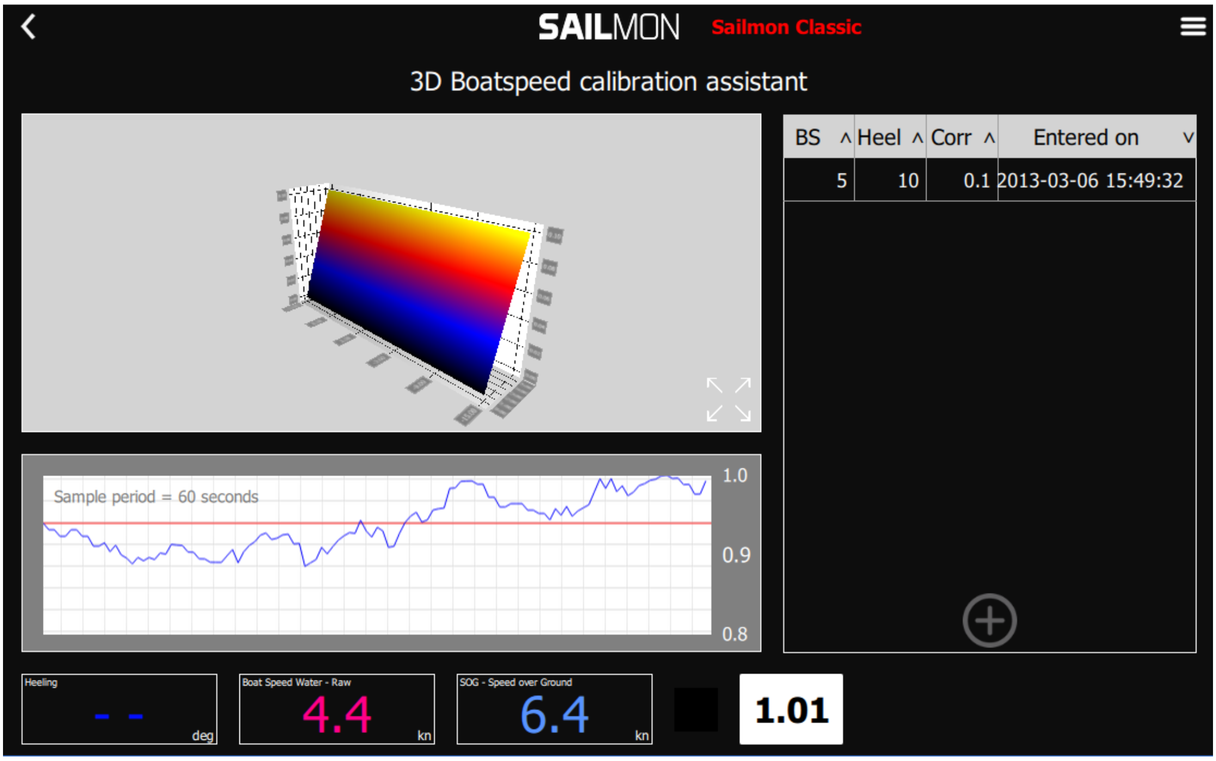
Boatspeed – Heel – Tack calibration

The Boatspeed –Heel – Tack calibration is for correcting the effects of heel and, in case of paddle wheel sensors, sensor nonlinearity. Imagine a sensor which is mounted in the hull. Depending on the heel, the flow will either run in the line of the paddle wheel or has an angle of attack to the paddle wheel. This leads to misreading of the boatspeed, as only the part of the flow vector which is in the line of the paddle wheel is measured. Even worse, the flow characteristics will change with boatspeed, so the heel correction must take place for every boatspeed.

For paddle wheel sensors another effect related to water hydrodynamic is the boundary layer effect on the boats hull as boatspeed increases. This boundary layer originated due to surface friction on the hull. The water molecules will be slowed in the vicinity of the hull, resulting in difficulties reading flow speed.

Sailmon's concept of boatspeed calibration:

Sailmon uses a high performance 3D model for interpolation of the values in the table. Therefore it is definitely allowed to leave cells blank. Press "Boatspeed – Heel – Tack Correction":



We strongly recommend to only populating cells where you know the value, do not estimate and enter any value manually, since this will likely decrease model performance. **If you enter any correction value, always enter at least one offset values for the other tack too, the system will not be able to determine offset otherwise.**

The 3D Calibration needs at least 6 entries in the table to be enabled.

The table values are offsets to the corrected sensors speed (corrected by the boatspeed factor). This mean, if you enter a value of -2.1 in any field, the displayed boatspeed will be 2.1kn less than the sensor reading.

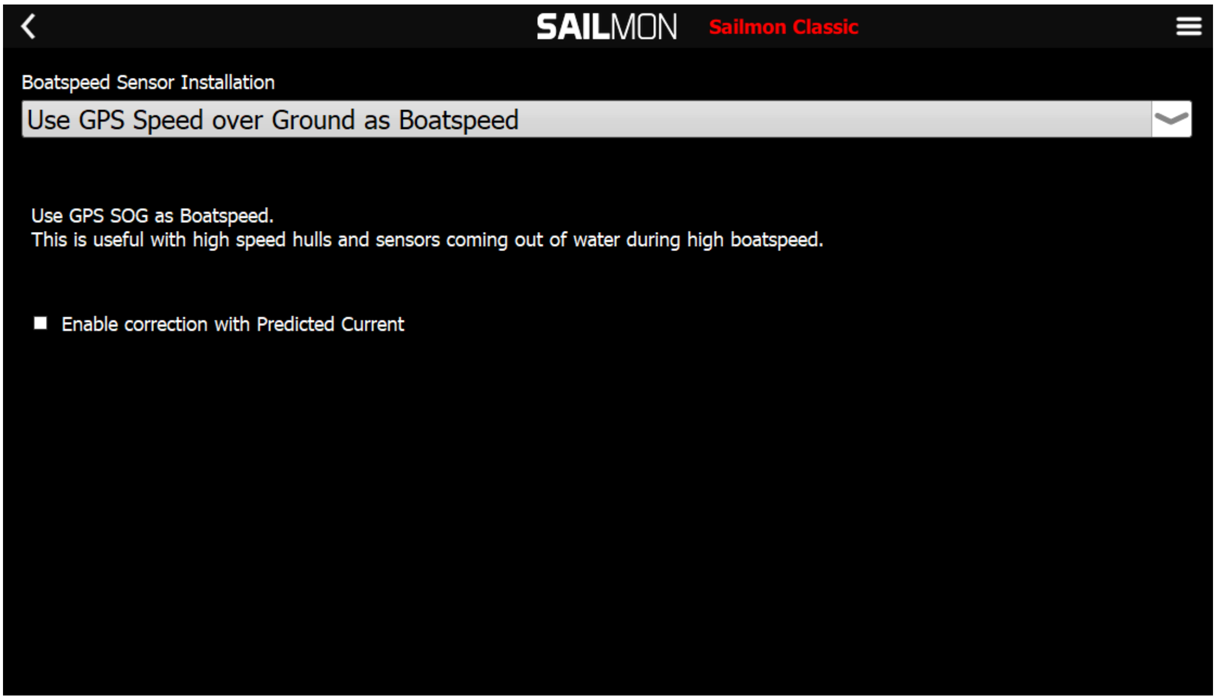
Since sensor measurement might be different from one side to the other, especially if you have an unsymmetrical sensor mounting position, it is possible to correct for both tacks. As defined, a negative heel is a heel to the port side, a positive heel to the starboard side.

It is a tricky task to perform heel calibration, since you cannot perform a distance run calibration with a constant heel over the (long) period of a this calibration method.

The only reliable way to obtain correction offsets is to get the heel correction from your boat designer, out of the simulation model. We recommend to not using 3D boatspeed calibration unless you have reliable data, you won't make results better by guessing.

The 3D view on the bottom of the calibration table allows an immediate view of the values, which are calculated by the Sailmon functions out of your table values. For validity check, make sure the surface is smooth. With boatspeed – heel calibration, the 3D graph must have the shape of a trough.

GPS Boatspeed Mode



You can select “Use GPS Speed over Ground as Boatspeed” to substitute the values from the boatspeed sensor with the data from the GPS.
Use this option if it is not possible to sense the boatspeed for any reason, for instance ultra high speed hulls.

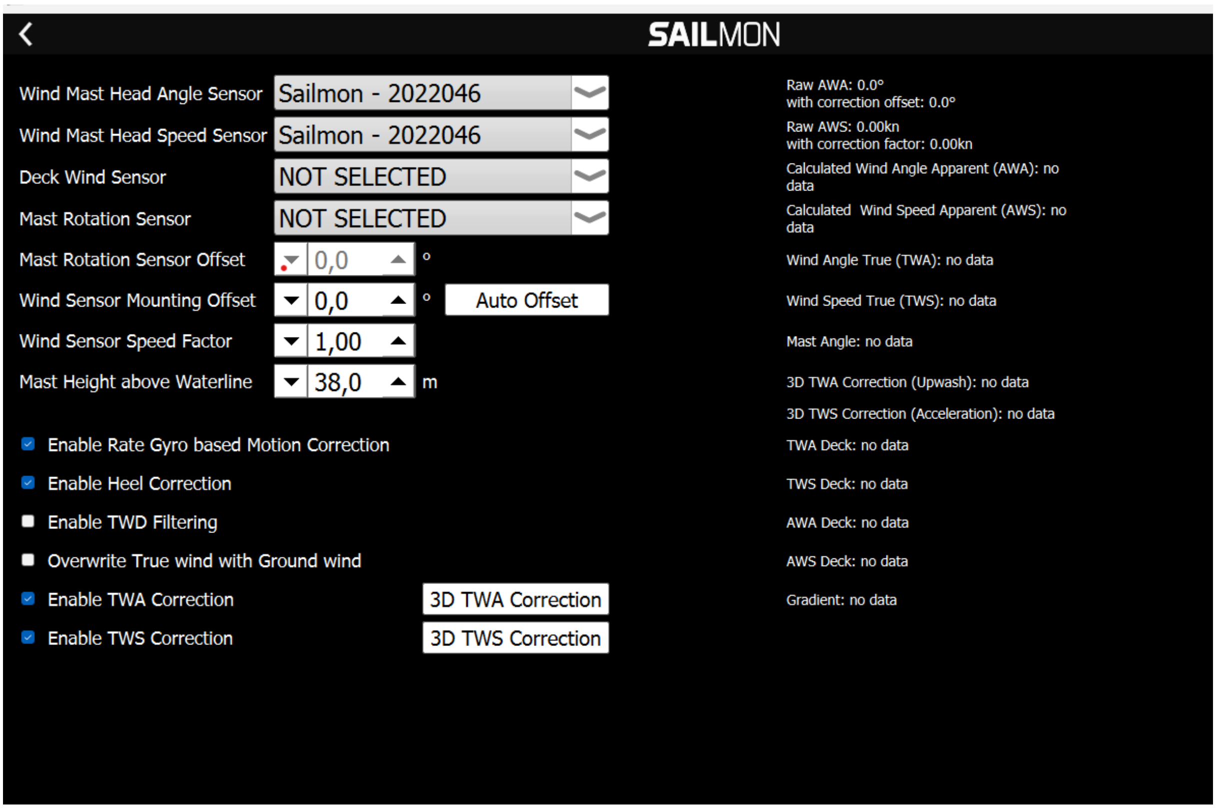
This setting also might be useful if your boatspeed sensor fails.

Note that a lot of calculation is made inaccurate by choosing this option. You will not able to get the tidal currents as well, true wind will include tidal currents, and much more.

4.7 Wind Calibration

Calibration Goal

Wind calibration is essential for reliable data during sailing. For the recreational sailor, the most important need is to adjust for the mast head sensor misalignment and choose a mast rotation sensor if you have a rotation mast.



- **Deck Wind sensor:** If a deck wind sensor is installed, this can be selected here.
- **Mast Rotation sensor**: If you have a rotation mast, choose a mast rotation sensor to correct the wind angle value from the mast head wind sensor for mast rotation.
- **Mast Rotation sensor offset**: If a rotation mast is used, the sensor for the mast angle must show 0.0° if the mast is straight. Use the offset value to correct for mast rotation sensor misalignment.
- **Wind Sensor mounting offset**: Since the mast head wind sensor can be misaligned during installation, an offset can be applied to correct. Failing to do will show different wind angles on different tacks.
- **Wind sensor speed factor:** This factor is multiplied with the actual mast head sensor wind speed. Leave this value to 1.0 since almost all sensors are factory calibrated for wind speed.
- **Mast Height**
  Put in Mastheight here if you have a Sailmon Rate Gyro fitted.
- **Enable Rate Gyro based Motion Correction**
  If you have a Sailmon Rate Gyro select it here and in the Attitude calibration section select the amount of cycles to wait (4 for a 25Hz windsensor 10 for a 10Hz sensor.)
- **Enable Heel Correction:** Enabling this value will introduce the heel angle in the TWA calibration and will significantly increase the stability of the displayed TWA. If you have a heel sensor enable this option.
- **Enable TWD Filtering.** This ads a damping value of 10 seconds to the TWD value.
- **Overwrire true wind with ground wind.** Only for use in coachboats with a Sailmon coachpole system!
- **Enable TWA Correction:** Enables 3D True Wind Angle Correction. This feature is used to correct a number of aero dynamical effects.

- **Enable TWS Correction:** Enables 3D True Wind Speed Correction. This feature is used to correct a number of aero dynamical effects.
- **True Wind Angle Correction Table:** Set up the TWA Correction.
- **True Wind Speed Correction Table:** Set up the TWS Correction.

Calibration Process

Select the correct mast head sensor before you change any settings. Choose your mast rotation sensor if you have a rotation mast installed. Choose “Not selected” if you do not have a rotating mast.

Select the mast rotation offset. This means the mast rotation value must show 0.0° if your mast is in center position.

If the mast head unit sensor is not installed exactly in the centerline of the boat, you will need to adjust for this misalignment. The misalignment is usually a few degrees in port or starboard direction.

For a recreational sailor, the calibration process in simple. Sail under power with maximum possible speed, straight against the wind. If the “Raw AWA” value on the bottom of the screen shows a number not equal to 0.0, adjust the “Wind sensor mounting offset” field in a way that the “Raw AWA” reads 0.0.

Choose a day with low wind speeds and no waves. Maximum true wind speed should not exceed 10kn. Use the calibration method from the advanced calibration chapter if wind is too strong.

Leave the “Wind Sensor Speed Factor” to 1.0 (no speed correction is necessary for almost all sensors), and do not select “Enable TWA Correction” and “Enable TWS Correction”.

No TWA or TWS Correction is needed for recreational sailing.

Race Calibration

True wind is considered to be the most important value on a race boat. As soon as you start sailing with polars, you will definitely need to have an exact wind reading to make target wind angles and target boatspeeds usable.

The goal is to

- Compensate for masthead unit misalignment
- Compensate for mast rotation
- Compensate for upwash, mast twist, gradient and shear
- Compensate for downwind acceleration
- Compensate for mast height
- Compensate for leeway

Another nice effect when calibrated correctly is that the true wind direction will read the same for both tacks (no true wind tacking). This will help a lot in your tactical decisions.

Calibration Process Step 1: Compenate for Mast rotation

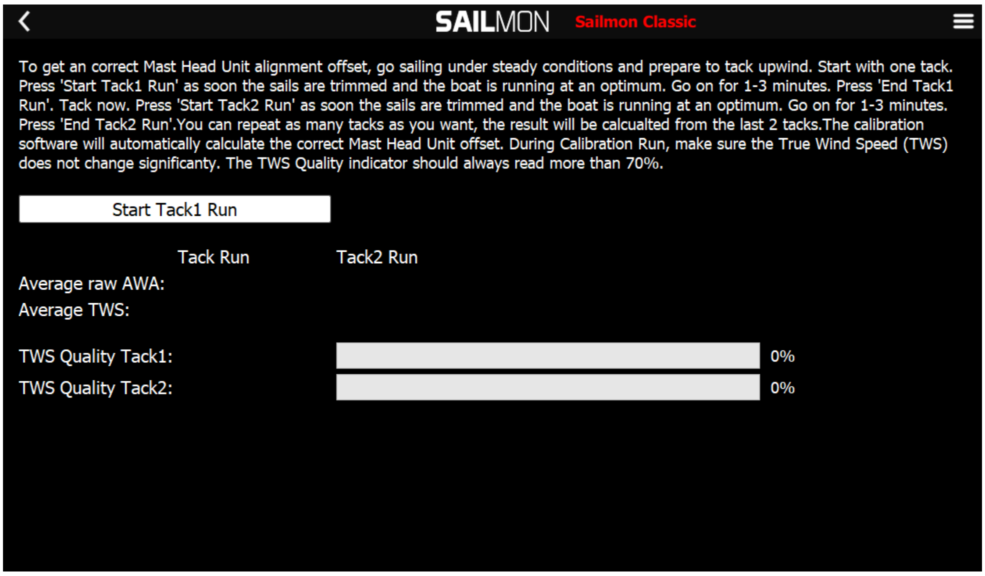
If you have a rotation mast you need to have a mast rotation sensor equipped. Sailmon recognizes all sensors which deliver the “rudder angle” value as mast rotation sensors, meaning you can select the sensor in the calibration window if such a sensor type is connected.

Mast rotation compensation is simple, just turn your mast to the center position and modify the offset value until the “Mast Angle” value on the bottom displays 0.0°

Calibration Process Step 2: Compensate for Masthead unit misalignment

During installation it is possible that the mast head unit is mounted with a small offset of a few degrees. This will lead to misreading of the apparent wind angle. The simple method described in the recreational section will not allow sufficient accuracy of the masthead alignment. The method of choice is to set up for upwind tacks and compare the apparent wind angles for both tacks. Sailmon guides you through this process.

Select “Auto Offset” in the wind calibration window.



Perform the steps below:

Sail upwind on any tack, with standard sail configuration. Maintain the optimum flow in your sails by watching the telltales. As your boat runs steady, press “Start Tack1 Run”. This will average the raw apparent wind angle until you press “End Tack1 Run”. Tack and set up to upwind again and press “Start Tack2 Run” as soon as everything is steady. This will again average the raw apparent wind angle until you press “End Tack2 Run. Sail on either tack about 2 to 3 minutes.

During the runs, TWS quality will be displayed in the bars. Since you wind speed needs to be constant during the calibration run, make sure that both TWS Qualities will be better than 70°, accuracy will be insufficient otherwise.

After you end the 2nd tack run, the system suggests a correction offset for the sensor.

Press “Accept Offset” to write the offset to the calibration database, or start a new tack if you are not satisfied with the results. You can tack between both tacks as often as you need to; the offset value is always calculated from the 2 last runs.

“Close” returns to the main window.

Calibration Process Step 3: Adjust the wind sensor speed factor

Unless you really know what you are doing, leave this value to 1.0. The wind sensor factor is the multiplication factor the raw wind speed is corrected with. Almost all sensors are factory calibrated for wind speed, so only change this value if you obviously need to adjust apparent wind speed.

Calibration Process Step 4: Heel Correction

If your boat heels, the mast head wind sensor will likely measure misaligned wind angle values. Common misalignment will be in the range of 1-5° Therefore you can enable the heel correction function, which compensates for this effect. Note that an attitude sensor has to be connected to have the heel value available.

Calibration Process Step 5: True Wind Angle Correction

Do not underestimate the importance of this step; it is essential for a reliable true wind reading. As described before, we need to compensate for upwash, gradient and shear. Polar diagram’s true wind is referenced to the water surface wind speed and direction, so this is what we want to measure too. Read the “Definitions” chapter on the beginning of the advanced calibration chapter to understand the principles.

As described in the “Definitions” the principle of true wind angle calibration is that upwash, gradient and shear is corrected if you do not experience true wind tacking.

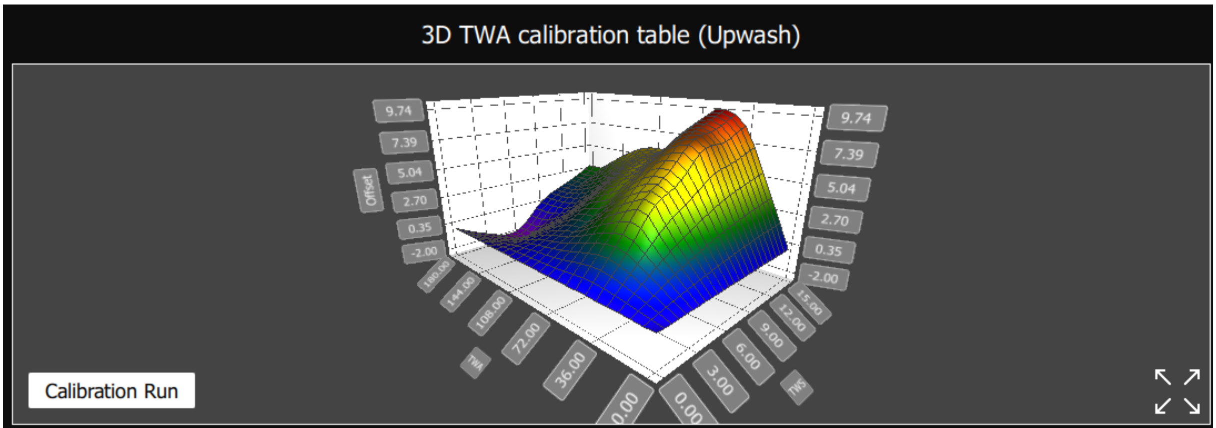
So, during calibration, you have to sail a number of true wind angles at different wind speeds. The system calculates true wind **direction** (magnetic wind direction over water) for all situations, and corrects the true wind angle if any true wind tacking occurs.

Basically, you have to sail a run with port and starboard tack for:

- Upwind
- Reach (approx. 90° TWA)
- Downwind

Since upwash heavily depends on your sails set, always set the correct sails for the calibration run, including spinnaker, Gennaker… for DOWNWIND, right jib size and reef for high wind speeds.

The True Wind angle correction table:



	5kn	10kn	15kn	20kn	25kn	30kn	35kn
Upwind 40°	5	8	9				
Reacher 90°	2	5	6				
Down. Asym. 135°							
Down. Sym. 165°	-2	1	3				

Sailmon uses a high performance 3D model for the interpolation values in between the cell points. Therefore you can leave cells blank if you do not have the possibility for a calibration run.

The values in the cells are offsets which are added to the current true wind angle. This means if the raw value of true wind angle is 45° and the calculated offset is -3.2° the displays will show 41.8° for the TWA.

For downwind calibration use the table Down Sym 165 when you have a non planing boat. Use the Down Asym 135 for Catamarans, foiling,planing boats which do not sail lower than 135-150 TWA

The values on the x-axis of the table correspond to the true wind speed. The 3D view on the bottom of the table shows the output of the Sailmon interpolator function. For validity check of your table entries, make sure the surface is smooth.

When to calibrate:

It is important that you perform a TWA calibration run before every race, especially with low wind speeds (< 6kn TWS). Since gradient and shear can change rapidly, you will not have a valid calibration for TWA if you rely on your existing calibration.

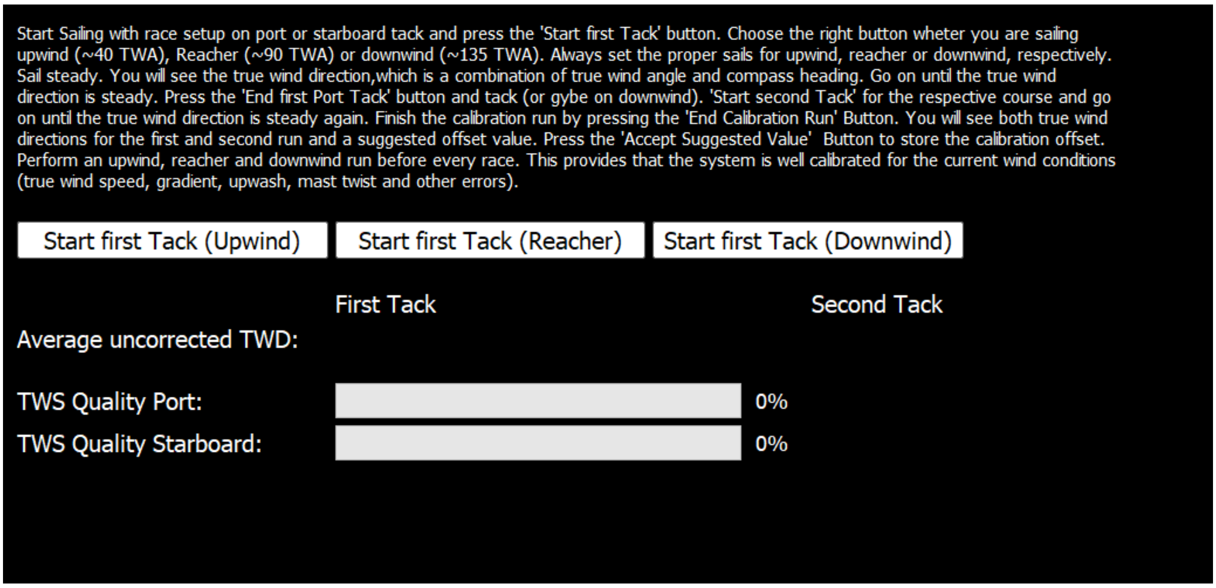
Imagine the following situation: You are prior to a race and the winds are light. The chance you have excessive gradient and shear is high. If you skip calibration, you will not have a valid TWA available, so your polars are useless. Make sure you understand that the pre-race calibration does only change the offsets for the existing TWS. So, if during race the wind starts to increase, you will still have valid calibration in the calibration table.

You could skip calibration prior racing if the TWS is more than 10kn. Gradient and shear are likely to be in a certain range at higher TWS. However it will always be more accurate if you take the time to calibrate.

Make sure "Enable TWA Calibration" in the main window is checked to enable TWA calibration.

Obtaining Correction offsets:

This is a straightforward process for the TWA. Click on the "True Wind Angle Correction Table" Button and press "Calibration Run". The system will assist you in the following process.



Follow the steps below:

Set up for upwind tacking, with the sails set you will use during the race. Sail on port tack and try to maintain steady conditions. Press "Start Port Tack (Upwind)" and go for 1 minute. The system will calculate an average true wind direction for this run Press "End Port Tack Run" to end the port tack. Tack to starboard and repeat the step above. The system will again average the TWD. After you press "End Starboard Tack Run" the system will suggest an offset value for the current TWS. The TWS will be rounded to the next 5kn value and is automatically entered into the Correction Table if you press "Accept Offset"

You can now set your reacher sails and repeat the same steps for a TWA of approx 90°. Make sure you press "Start Port Tack (Reacher)" in this case.

For Downwind set your downwind sails and press "Start Port Tack (Downwind)".

Since values are 3D interpolated, make sure you perform upwind, reacher and downwind calibration for any true wind speed.

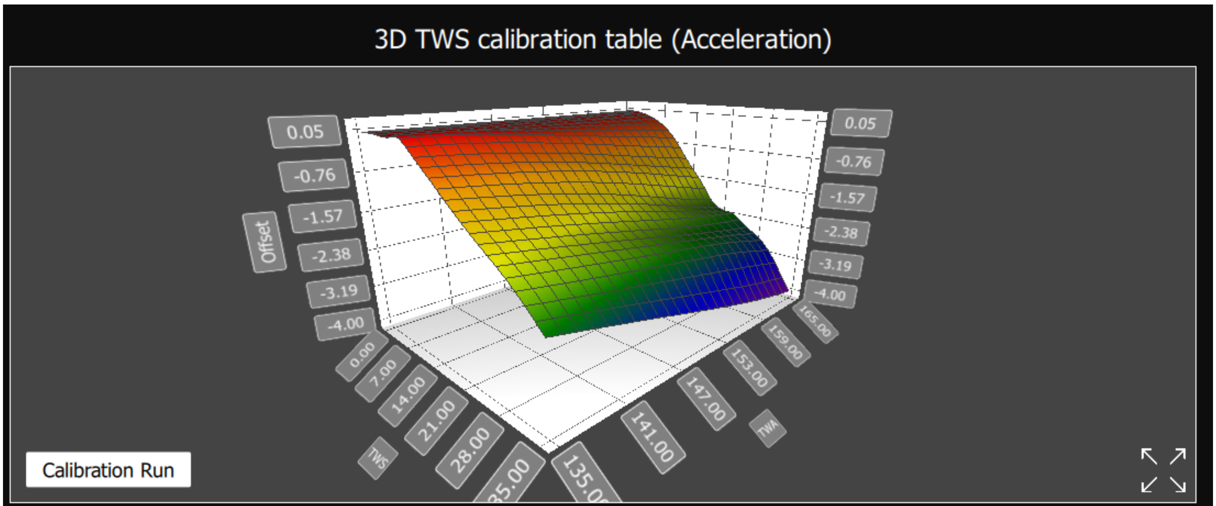
During Calibration Runs, a TWS Quality indicator shows the steadiness of the wind speed. Make sure the TWS Quality is above 70%, do not calibrate in unsteady winds.

We have successfully calibrated the correction offsets for the **current TWS.** After a new instrument installation you need to perform this calibration in different wind speed conditions to obtain a reliable system.

It is definitely allowed to leave unknown table entries blank. Over time the table will be filled up.

Calibration Process Step 6: True wind Speed Calibration

As described above, air is accelerated over the mast top on downwind courses. Therefore the TWS will over read if uncorrected. Use the 3D TWS calibration to correct for this effect:



	5kn	10kn	15kn	20kn	25kn	30kn	35kn
Corr. Offset [kn]	0	-0.5	-1	-2	-2.5	-3	-4
Corr. Angle [°]	135	140	155	160	165	165	165

Sailmon uses a high performance 3D model for the interpolation values in between the cell points. Therefore you can leave cells blank if you do not have the possibility for a calibration run.

The values in the cells are offsets which are added to the current true wind speed, if the true wind angle is above 90°. The value you have to enter is valid for a specific angle, which in most cases will be the optimum true wind angle (downwind). The offset is then interpolated down to 90° TWA where it is 0kn. **Offset values can only be negative.**

The correction offset for the specific angle is a value in knots, which is added to the current TWS. So, if the current TWS is 21kn and the downwind interpolator calculates an offset of -5.6kn, you will read 15.4kn on your display.

Read through the Definitions chapter to understand the principles of TWS calibration.

Obtaining the TWS Calibration values

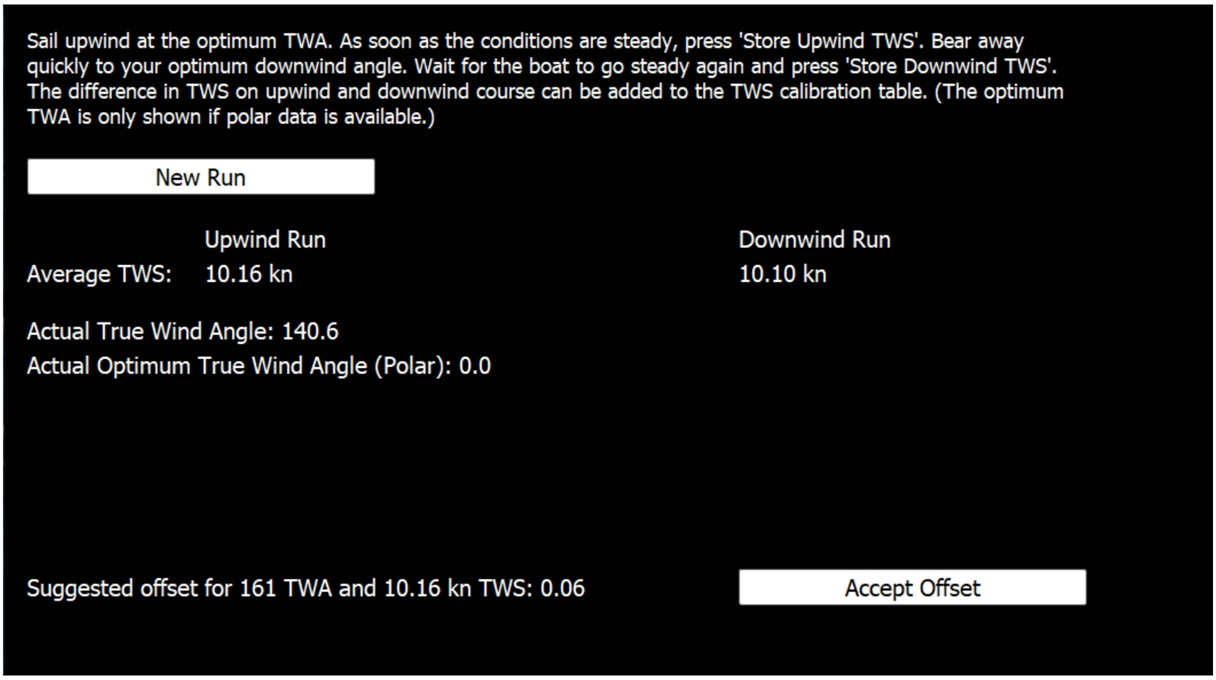
There is a simple way on how to obtain the value for a specific wind speed. Sail with your main and jib set on an upwind tack. Note your TWS. Quickly bear off to your optimum downwind course and note the TWS again. Assuming the real wind speed has not changed during the maneuver, you will experience a higher TWS on the downwind course as on the upwind course. The difference is the over reading, which is to be corrected.

Note that the TWS Downwind acceleration, which is the actual offset out of the calibration model, can directly be displayed on your Sailmon monitor. Select Wind->TWS – Downwind Acceleration. This value is the amount of TWS which is subtracted from your actual TWS.

Example

The calculated TWS without 3D TWS Calibration enabled is 20kn. The calibration model gives an offset (= TWS - Downwind acceleration) of -3kn. Therefore, your display will show 17kn for TWS.

Sailmon will help you obtaining the correction values. Click on "Calibration Run":



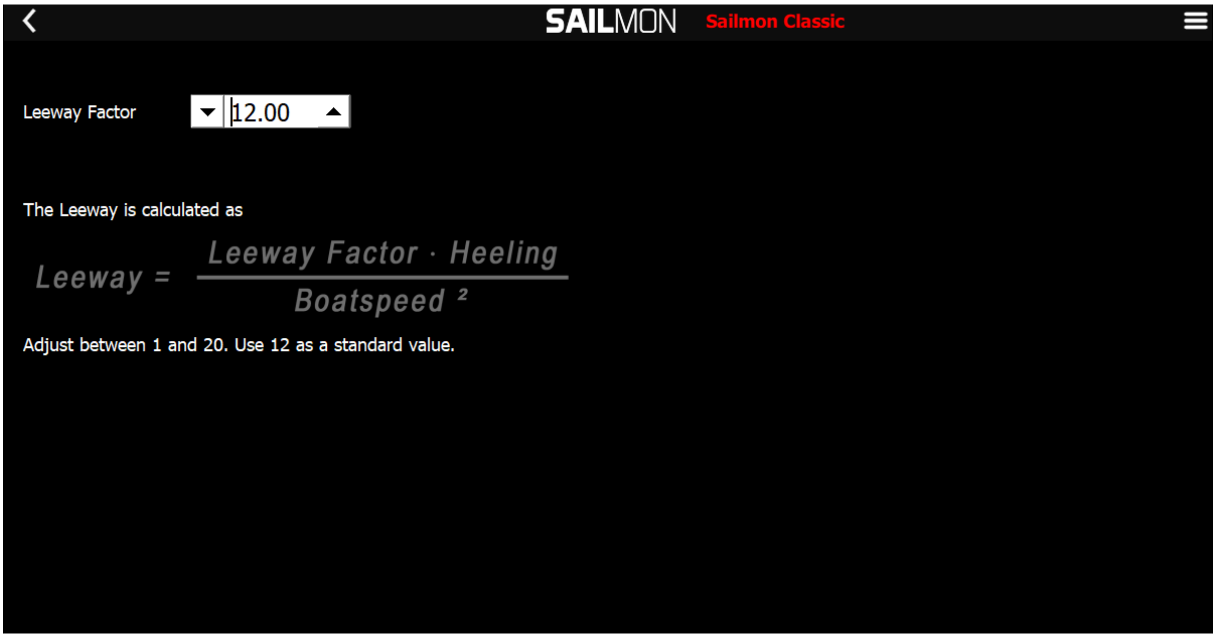
As you sail upwind, go steady and press "Store Upwind TWS". Quickly bear off to optimum downwind. It is not necessary to set your spinnaker, since the main sail has the most influence on air acceleration. As soon as you reach your downwind course, press "Store downwind TWS". The system will suggest an offset value which you can automatically insert to the database if you press "Accept Offset".

The system will round to the nearest 5kn of TWS.

Make sure the "Enable TWS Correction" is checked in the main window to enable TWS Calibration.

4.8 Leeway Calibration

Leeway is the angle between the heading and the course over water. This means leeway gives the amount of side drift during sailing. Leeway is included in wind calculation, a correct value is essential if you use velocity prediction and polar data. The factor heavily depends on your boat design. As better the yacht as lower the leeway factor.



Ask your boat designer to get a correct leeway factor. Since leeway affects your true wind angle, a correct value will lead to a better TWA and back calculated AWA.

As a course rule, set it to 10.0 for a standard racer if you can't get simulation data. This calculates a leeway of 2.3° at 15° of heel and 8kn of boatspeed.

Note the strong influence of boatspeed^2 on leeway! This means leeway will be much lower as soon your boatspeed rises.

Set the value to 12.0 for a standard cruiser with moderate draft.