

Documentation ScanNav Routing and Polar Module

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Introduction

The Routing and Polar functions come as an optional module of ScanNav. It lets you calculate the best route according to your boat’s performance for the given winds and currents forecasts. It uses the isochrones approach for the calculation. This documentation is up to date with release 22.0 (December 2021)

The routing takes the following points in account:

- Choice of the Polar file
- Choice of multiple Grib files for the Wind and Swell
- Tidal currents: can use either the Shom currents model files, or currents grib files
- Possibility to apply a percentage ratio to your Polar, and the Wind, Waves and Currents forecasts
- Different routing modes: Sail Only, Mixed Sail and Engine, or Engine only
- Tack and/or Jibe penalties
- Possibility to define fixed wind and/or currents
- Use of Shoreline shape files and/or User defined danger area to avoid grounding
- Avoid areas according to a maximum user defined Wind strength or Waves height
- Possibility to define upwind and downwind limit angles, to avoid uncomfortable points of sail
- Multi-point routing, passage and turning points
- Best Start
- Ability to interact with the routing graph to find alternatives
- Export of the final routes, and route plans

In complement, a Polar Display lets you follow the real time performances of your boat compared to its theoretical Polar

User Interface

To enter the Routing module, you may use 2 methods:

- Use menu « Option » → « Route calculation »
- or right click on an existing route, and choose “Calculate Route” or “Calculate inverse route”

The following screen will let you define the routing parameters

If you close this window, the parameters will be restored on the next opening.

The dialog box is structured by categories.

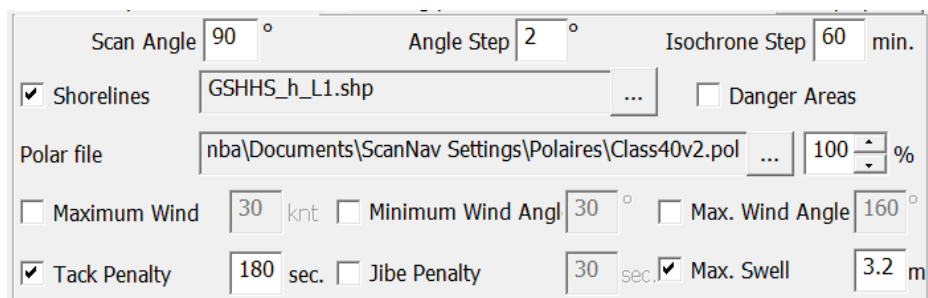
The first row lets you control the window display so as to limit its size accordingly, and define elements displayed on the chart.

“General parameters” and “Routing parameters” lets you optimize display to gain space on screen: show/hide the corresponding group of parameters by checking/unchecking the checkbox.

Display button: Opens a new window to tune display settings.

You can define here limit angles for the different points of sail according to your boat and habits, colors to display them in the graph and final route, and also choose the different elements to display with their graphics attributes, so as to optimize the chart display.

General Parameters:



You need to define your basic settings here.

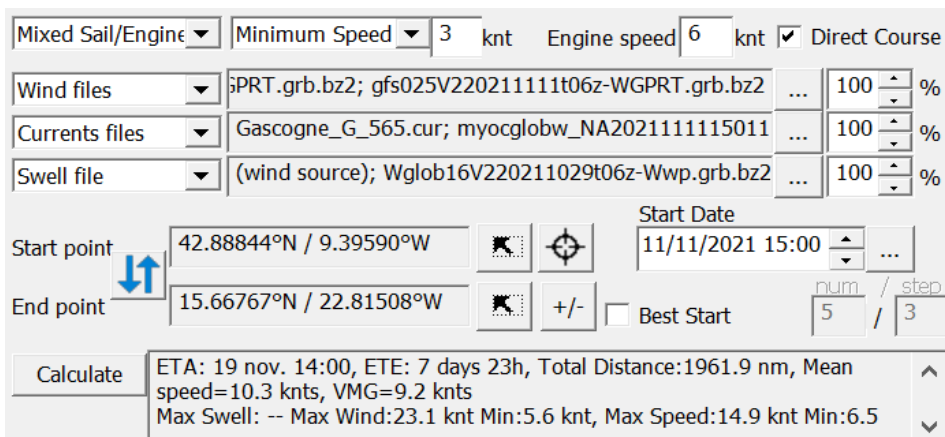
- **Scan Angle** : Controls the maximum angle the algorithm will scan from left and right of the direct route. Giving a value of 90° will scan 180° : 90° on each sides. You may need to go above 90° when the routing needs to go around obstacles, for example to go out of a bay.
- **Angle step**: This is the increment applied between each angle when scanning. 2° with a scan angle of 90° will therefore scan 90 directions every 2° between -90° and +90°.
- **Isochrone step** : Give the duration of each Isochrone in minutes.
- **Shorelines**: Lets you activate or deactivate shoreline detection to avoid landing. Click on the edit field to open a chooser to select or download contour shape file(s). (Refer to chapter “Avoiding ground: Shorelines and Danger Areas” later in this document)
- **Danger Areas**: When checked, the routing will also avoid user defined danger areas that are in active state.
- **Polar File** Click on button « ... » to choose your Polar file. Although the location of the file is free, it is highly recommended to use the default folder ‘Polaires’ located under “ScanNav Settings”. You may also give a percentage ratio to reflect the impact of different factors on performances (Condition of sails, swell, cleanliness of the hull, skipper’s shape, etc...)
- In addition to the Polar file information, you can also add security or comfort constraints:
 - **Maximum Wind** : Avoid areas with winds above the given value.
 - **Max. Swell** : Avoid areas with waves above the given value.
 - **Minimum Wind Angle** : Avoid upwind points of sail above the given angle.
 - **Maximum Wind Angle** : To avoid downwind too close to running.
 - You can also define **penalties for Tack or Jibe** (defined in seconds). These later can limit the number of tacks or jibes when sailing directly upwind or downwind.
- You can assign specific parameters to individual segments of a multi-point routing calculation

Routing parameters:

You can choose the type of routing between Sail Only, Mixed Sail/Engine, or Engine Only.

For a **Mixed routing**, you must indicate the conditions that will trigger the switch to Engine between the following:

- **Minimum Wind** : The routing will switch to Engine if the wind is below the given value
- **Minimum Speed** : The routing will switch to Engine if the boat speed cannot go above the given value in any direction at this point.
- **Minimum VMG**: The routing will switch to Engine if the **VMG** cannot go above the given value at this point.
- **Direct Course** : If checked, the routing will only propose Engine for the direct course to the final point, all other directions staying with the sails. If unchecked, it will switch to Engine in all directions, which can help



to “go find the wind”.




For an “**Engine Only**” routing, you only need to supply the Engine speed, and for a “**Sail Only**” routing, no extra parameters are needed.

Choice of Wind, Swell, and Currents sources:

You can specify multiple sources, with file names separated by semicolons. To modify or check details, click on the field to display the window opposite. The principle is the same for wind files and current files.

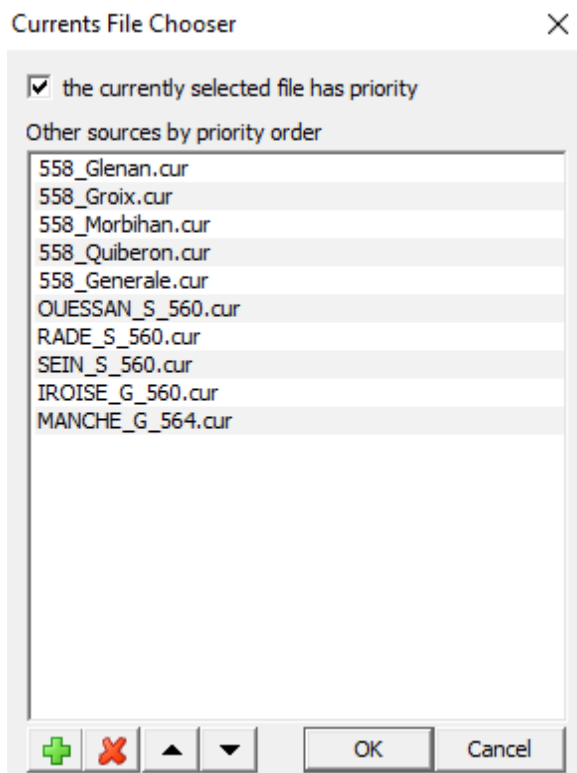
To add sources, click on the button . A menu will allow you to select grib or currents files.

For currents, you can also include all Shom files in one operation (it will only select those for which you have the license). You may then delete selected areas you do not need. It is indeed better to limit to the coverage needed for the routing in order to avoid slowing down the startup process.

ScanNav takes in account the files at the top of the list in priority. The menu allows you to sort the entries in decreasing scale order so as to take the most detailed sources in priority. You can also force the order with buttons  , and use button  to delete entries.

The **file currently selected in the Currents or Grib module** will also be taken into account, even if it is not in the list. It will be taken in priority or as a last resort depending on whether the option at the top of the window is checked or not.

For the Swell, you can either use the same files as the wind source, or other independent files, or both at the same time, thanks to the option "**Include source of the wind files**" which replaces the previous option at the top of the selector.



Note: The swell has several components. ScanNav takes the Total Swell into account as a priority, unless it is not present in the source. The order of priority is as follows: 1: Total Swell, 2: Primary Swell, 3: Secondary Swell, 4: Wind waves, 5: Total Sea. It is possible in advanced use to change this order, contact us if you wish to take another type of swell into account as a priority.

You may apply a **percentage ratio** to raise or moderate the forecasts strengths. You may also define fixed values for wind and currents, although this later possibility is more oriented on training rather than a realistic routing.

Defining the route and start date:

On the very first launch of the routing interface, Start and End positions will be empty, unless you used the right click on an existing route to open the dialog.

To define the Start and End points use the corresponding  button, and click on the chart to position it.

Button  lets you position the Start point to the current GPS location.

Multi-Point Routing:

The intermediate points are displayed on the chart, but don't appear in the main dialog interface.

If you launch the routing dialog from an existing route, intermediate points will already be taken in account.

The **+/-** button lets you create intermediate points, or move/delete existing points, using the following ergonomics. You need to distinguish the Press, drag, and Release of the mouse left button as follow:

- Press gives the position of the source
- Release gives the position of the destination

You must therefore press the button, drag the mouse without releasing it, and then release the button.

- Pressing on an existing point, you move that point to the release position

- Pressing on an existing segment, you add a point to this segment at the release position
- If a routing graph already exists, you can also directly click on a node to add a point at the corresponding segment.
- If pressing outside segments and/or existing points, a new point will be added at the end of the initial route.
- The new point is created (or moved) at the position where the mouse button is released.
- To remove an existing point, press the <Shift> key while clicking on the point.

Note: In this version, there is no direct feed-back to show interactions directly, as in creation/modification of standard routes in ScanNav.

Settings specific to each route segment:

As of version 20.0, it is possible to specify a different parameter setting for each route segment, which makes it possible for example to refine coastal passages, while keeping wider parameters for the high seas areas. Passage points are also less strict, with a configurable Arrival distance (or tolerance circle) where the routing will consider that it can pass to the next point.

The setting is done using the window below which opens when you click on the button +/-

Intermediate waypoints x

Name	Position	Distance	Isochrones	Scan a...	Angle Step	Type
pt1	47°40,886'N / 003°22,458'W	<i>ns</i>	120 mn	60°	-	passage
pt2	47°26,945'N / 003°11,753'W	4 nm	15 mn	90°	-	<input type="checkbox"/> passage
pt3	47°32,640'N / 002°55,623'W	0.1 nm	<i>ns</i>	<i>ns</i>	<i>ns</i>	passage

+ x Close


You can configure for each segment the following information:


- The waypoint arrival distance for each point
- The Isochrone duration of the segment starting from each point
- The scanning angle of the segment
- The angle increment
- and the type of point “Passage”, or “Turning” . See the following chapter for an explanation of this advanced function.

Parameters specific to a segment (Isochrone, Scan angle range and step) are defined in the starting point. When a value is empty, it is represented by "-", and takes the value defined in the main window.

To modify the values, double-click in the box to make it editable, and fill in the new value. To return to the value defined in the main box, simply empty the field.

Values whose parameterisation is meaningless are indicated "ns", and it is not possible to edit them. For example, it does not make sense to assign an arrival distance to the starting point ...

 When this button is pressed, you can move or add intermediate points using the mouse on the map. (see previous chapter)

 This button allows you to easily remove the selected (highlighted in blue) waypoints.

Arrival distance:

- When you calculate a route from an existing route, the arrival distance parameter is initialized to the value of the same name "Arrival Distance" parameter set in the waypoint properties (see general documentation).
- When you create a route by just defining a start and end point, the arrival distance parameter is initialized to the last defined value.
- And if you add a point, it is set to the value of the previous existing point.

The arrival distance is materialized for each point by a red circle around the point. You can therefore easily detect eventual anomalies and correct them.

This concept of arrival distance is very useful for defining intermediate points of passage, without creating additional strong constraints. For example, you can create an intermediate point with a very wide circle, including an area where you will have to pass, which will help passing caps with a sharp change of direction, and/or let you set different

conditions for the next segment. For example on a landing buoy, to refine the routing parameters in the following coastal area.

Unlike previous versions where the waypoints created a strong constraint, related to the fact that the routing had to pass exactly on the point, the constraint is here much lighter. Routing should only pass through the area defined by the proximity circle, and all branches passing through the area will be retained to calculate the rest of the routing. The constraint being proportional to the radius of the proximity circle.

Passage Points vs Turning Points (Advanced users)

The turning points go a little further in eliminating the constraints. This is an advanced use that we advise you to address once the other rudiments of routing mastered.


A turning point is simply an **indication of direction** for the segment preceding the point, without any obligation to pass through the point or its tolerance zone.

It will serve as a starting direction axis, towards which the routing will go, until one of the branches of the routing graph passes in its tolerance zone. The routing will then move to the next point, with a new direction axis, this from all routing branches, including those that do not pass through the tolerance circle.

And just like the classical passage points, you can change the parameter settings after passing this point, this without any constraint of actual passage through the point.

The main difference with a conventional passage point, being that with turning points, the routing will not have to go through the tolerance zone, if it finds a more suitable path not passing through.


Setting the start date:

The initial date is remembered between different launch of the routing. You can modify it directly in the specific field, or use the  button that opens a calendar, including a “now” button to set to the current date/time. In the case of a Best Start calculation, this date corresponds to the first start.

Best Start :

This option allows you to calculate multiple routing at different start dates. The parameter "**nb**" indicates the number of routings to be calculated, and the parameter "**step**" the time between each start, indicated in number of isochrones. For example, for a value of 2, and an "Isochrone step" of 60 minutes, the different routings will be calculated with a departure every 2 hours.

Launch of the routing calculation:

Click on the “**Calculate**” button to start the routing calculation. Progress will be visualized in a progress bar and on the chart as the calculation progresses, and the button will be renamed “**Cancel**” to let you cancel it at any time. All other buttons will be grayed out until the calculation ends, except “Display”, “Close” and 

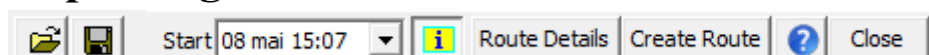
The calculation runs in background, and you are not blocked during this time. It is possible to close the dialog while calculating, it will be displayed again when finished, or if you reopen it explicitly. If you close the dialog with the “Close” button or the Windows “x” cross, the graph will not be displayed anymore until the dialog is reopened; If you iconify the dialog with the windows “-” button, the graph will stay visible.

A summary displaying the routing parameters appears in an independent text window, and will be completed after the routing is completed with the results summary.

Note on parameters displayed in the dialog box:


These parameters correspond to the ones that will be used for the next calculation. If a routing has already been calculated and you change parameters, refer to the Route Plan described in next chapters to check for original parameters.

Exploiting the Results:



Once the calculation completed, the best calculated route is displayed on the map, with wind feathers and currents

arrows according to display settings. In case of a “Best start” calculation, once all starts are calculated, the first start is displayed, and you may select the different start dates using the choice list. When calculating, the run under calculation is displayed so as to see it’s progress, but you may select any other already calculated run to analyze without waiting for the full completion of the different runs.

You can query the routing graph using button . When clicking on a graph node, information corresponding to the node is displayed in a popup window, and a new alternate route to this point is displayed. This route is named “Selected route” later in this document.

Use the “**Create Route**” button to create the ScanNav route corresponding to the **calculated** or **selected** route. It can then be managed as any other ScanNav route. Information regarding wind, currents, date, speed are embedded in the comments of each individual waypoint, which therefore lets you display them in the popup info when passing the mouse cursor over waypoints.

Starting with version 22.0, you can also Create "**all routes**" of a "best start" result in one click, without having to select each start individually. Confirmation is requested for each route, allowing to skip some routes.

The routes attributes are precomputed and can be modified before validation. In particular, the default name is the start date according to the format “Start dd/mm/yy hh:mm”, and the class name is the active class followed by the suffix “(Routing)”, the other attributes being initialized to the last used values.

Best Start, and Route Plan tables:

The “**Route Details**” button opens a menu giving you the choice to open the following tables in a separate window:

- “**Best Start**”: displays a recap table including the results of all different starts, letting you compare using your preferred criteria.
- “**Route Details**”: displays a table detailing the different legs of the currently **calculated** or **selected** route for the selected start.
- The “**Copy...**” entries let you copy the Best Start, or Calculated/Selected Route details to the Windows clipboard, so you can paste directly in Excel or any other equivalent spreadsheet software.
- From version 22.0, you can also copy the details of **all calculated routes** of a ”best start results” in one click.

The top part of the 2 tables include a summary of the routing, and eventual warning or error messages. It may be necessary to scroll down to view the entire text. Note that this text is also present in the independent messages window.

You may choose what and how columns are displayed using the “Columns” button in each table window.

The “**Best Start**” table includes one line per start, and one column per result type, letting you compare according to your own criteria to choose the best start date.

When calculating, lines are added to the table as the calculation progresses. It is therefore possible to analyze results for calculated starts, without waiting for the completion of all starts.


The table background reflects the state of the route, and draws your attention for specific conditions. It is:

- Red if the routing could not be calculated for this start, or is still in progress
- Orange, if the routing extends before or after the wind valid dates defined in the grib file.
- Yellow, if the routing extends before or after the Currents valid dates defined in the currents grib file, except if already Orange.

When calculating a Best Start Route, the last line will always be red, as still in progress.

When **Double-Clicking** on a line, the routing corresponding to the start is selected, both in the main chart window, and the Route details table if opened. It is the same as selecting a start date in the combo of the routing window.

The “**Route Plan**” table includes one line per leg (isochrone step), including all information, speed, wind, currents, etc... The background color inherits of the same color codes as the Best Start table, letting you view from which date you are out of the grib dates boundaries.

The table shows the route plan of the “**calculated** route” or “**selected** route”, according to the selected route state (see usage of the  button in the preceding chapters)

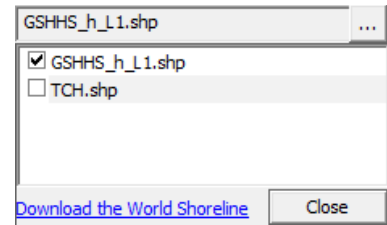
Avoiding ground: Shorelines and Danger Areas

Shorelines :

To go around shores, ScanNav takes in account shoreline files in Shapefile format provided by the NOAA and the SHOM. Shorelines are quite voluminous data. For this reason, they are not included in the ScanNav installation package, otherwise it would make it double or triple size, if not more.

You therefore need to download the NOAA Shorelines database. Click on the edit field which will open a chooser. This chooser will be empty on first usage. Click on the "Download the World Shoreline" link to start the download. When completed, the new entry "GSHHS_h_L1.shp" will appear.

The choice list lets you activate/deactivate contour files individually. Make sure not to activate too many contour files at the same time, which could have an impact on performance.



In practice, the NOAA global coastline is sufficient, but you can also install other contours manually. Shoreline files must imperatively be installed in the dedicated folder « **ScanNav Settings\Contour** » located under your standard Windows « Documents » folder.

Shapefiles are composed of several files with different extensions. To date, only the « .shp » (geometry file), and « .prj » (Projection definition file) are used by ScanNav. Once the NOAA contour file downloaded, you will see the 2 files GSHHS_h_L1.shp and GSHHS_h_L1.prj in the Contour folder.

The NOAA shoreline also exists at a higher definition, but this doesn't bring significant improvements, and considerably increases the usage of memory and processor. The full data source of the NOAA Shoreline including all resolutions is available here: <https://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html>

For French coasts, it is also possible to use the high resolution Shoreline from the SHOM/IGN. Although its precision is much more accurate than the NOAA shoreline, the fact that it is based on the high water mark limits the interest of such a higher resolution. Please refer to this link: <https://www.data.gouv.fr/fr/datasets/trait-de-cote-histolitt/>

The Shapefile format has a lot of variants. To date, only Shapefiles provided by the NOAA and SHOM have been tested, and it is not guaranteed that other sources will work. In case you have a source that you wish to integrate, please contact us, we will check what can be done.

It must be borne in mind that whatever their origin, these coastlines are approximate, represent the high seas, and do not take into account isolated shoals. Although they make it possible to circumvent most obstacles, it is therefore necessary to verify the results and add danger areas when appropriate.

Danger Areas:

Taking into account the Danger Areas makes it possible to overcome this problem by manually creating areas to be avoided. The conventional use is to initiate a first routing, and if it passes on zones at risk, add one or more danger areas and then restart the routing.

Avoiding ground also has a cost in terms of performances. It may therefore be interesting to deactivate the option for transoceanic routings, even if it is necessary to rectify with some crude danger zones to pass the capes.



To be taken into account by routing, areas must have the "Active Area" attribute checked. In this version, circular danger zones can not be used as a routing avoidance.

Display of Shorelines:

The display of shorelines lets you visualize it to check its accuracy, as well as the danger areas taken into account. They are only displayed on option and when the routing dialog is opened.

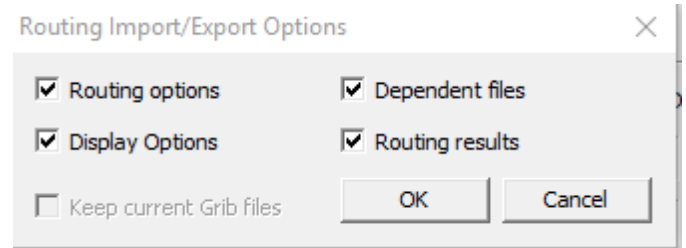
It can nevertheless be expensive in terms of performance especially when zooming out, since it comprises several tens of thousands of contours and has not been optimized for display. It is therefore advisable to disable its display during routing calculations in order not to penalize performance (see display parameters earlier in this document).

File Save / Load:

You can Save and Load routing sessions using buttons  and . This enables you to calculate several alternatives and reload them fast and/or to communicate to third parties.

You can select items to export or import to/from the file, among the proposed items in the dialog that opens after selecting the file.

- Display Options: All displays settings
- Routing options: Includes all options selected in the routing dialog box. If this option is unchecked, the following options are inaccessible.
- Routing results: Includes all results of the calculated routes (complete graph, and resulting routes for the different starts)
- Dependent files: Includes Wind, Waves and Currents Grib files, and the Polar file. Lets you communicate all parameters to reproduce the routing on another station. When importing, files are restored respectively in folders "Grib" and "Polaires" located under the "ScanNav Settings" folder, whatever their location was initially. If the files already exist, you will be prompted to override or not.
- Keep current Grib files : This option is only present when importing. If checked, Wind and Currents presently opened in ScanNav will be preserved. If unchecked, ScanNav will load the Wind and Currents files defined by the routing file. This option is inaccessible (forced to unchecked) if the "Routing results" option is checked, so as to preserve consistency between the displayed results and loaded Wind/Currents files.
- "Export V1": This option is only present for export (it takes the place of "Keep current Grib files" of the import). It allows the routing to be exported in legacy mode so as to be compatible with earlier versions of ScanNav (before 22.0), the Swell information having required a modification of the format.



Notes on the file format :

Danger areas defined by the user are not included in the file. To take them in account for a new calculation on a different station, you need to communicate them separately.

Although the files can be saved anywhere on disk, we recommend that you use the default folder « **ScanNav Settings\Routages** » located under your standard Windows « Documents » folder.

The file format has been reviewed completely between versions 17.0 and 17.1, so as to bring new features and improve performances. The used extension is '.snrout' starting from version 17.1, but it is also possible to select .xml extension to import routing files saved with the 17.0 version.

Routing completion problems

There are several reasons why a routing may not be successful. The most common are:

- The starting or ending point of your route is inside land area or a danger zone.
 - ➔ Display the coastline, and zoom in on the start and end points to verify that they are not inland.
- Your wind or currents files do not cover the complete geographic area or time schedule of the routing.
 - ➔ Check that the Grib files cover the entire geographical area (with a little margin),
 - ➔ Check that the departure date matches the Grib file(s),
- Your constraints are too strong (maximum wind or swell, maximum upwind angle, etc.)
 - ➔ Check if the routing succeeds by removing the constraints, and adapt them accordingly... or stay at the port! :-)
- The Scan angle might be too small (circumventing capes, obstacles, etc... combined with the dead upwind angle).
 - ➔ Increase the Scan Angle
 - ➔ Or possibly add a turning point to pass a cape or other obstacle.
- The specified isochronous is too large for the navigation area. The routing indeed abandons the tracks which come up against an obstacle.
 - ➔ Decrease the duration of the isochrones to adapt them to your type of navigation
 - ➔ In case of mixed navigation offshore / coastal / close to pebbles, create segments with different parameters. To avoid creating forced waypoint constraints, consider using turning points, or very large arrival distances for these points. (see above under "Settings specific to each route segment").

Generally speaking, checking the display of the routing graph will allow you to visualize where the routing stops, which will be a great help so as to determine the probable cause.

If the problem persists, send us an export of your routing, taking care to check the attachments, so that we have all the elements to reproduce the problem. Check the size of the export file beforehand to avoid sending too large attachments by email. If so, please use transfer services like wetransfer (<https://wetransfer.com/>) or any other, to send attachments.

Polar management

Polar Files:

Polar files represent the performance characteristics of your boat at different wind speeds and point of sail, which are needed to calculate routing. Theoretical polars are provided by constructors in the format ".pol", which is in fact a tabulated text format, editable by Excel, or any other spreadsheet. They have the following form:

TWA/TWS	0	4	6	8	...
20	0	0	0	0	0
35	0	2.1	3.1	3.9	...
40	0	2.4	3.6	4.3	...
45	0	...	...	...	...
...	0	...	...	...	...
180	0	...	...	...	...

The data array should start at the first top-left cell, without any blank lines or columns.

- The first line indicates the True Wind Speeds (TWS).
- The first column indicate the True Wind Angles (TWA).
- Then come values specific to your boat performances (target speed) for each point of sail. In the above example, with a wind speed of 8 knots, the theoretical speed of the boat should be 4.3 knots when going upwind at 40° of the true wind.

Target speed for intermediate wind angle and speed are calculated by the software. It is strongly advised to create a first line with a minimum wind angle and all speed values at 0knts, and a first column with the minimum wind speed under which the boat will have a 0knt speed. This avoids interpolating under a defined angle or wind speed.

The angle and speed steps are free, and do not need to be constant. You can for example add a column at 7knts or other...

Boat constructors generally propose theoretical polars for recent boats, and / or they can be found on the Internet. Keep in mind that these are theoretical polars in ideal sea conditions, a new set of sail, a polished hull, and a crew boosted with RedBull :-). Thus the importance of applying a percentage to it, and ideally modify it to reflect your real boat performances and sailing conditions and habits.

To edit your own polar file (it is recommended to start from an existing polar to avoid syntax errors), open the file in Excel (or any other spreadsheet) and edit according to the format described above, then export it in tabulated text format with "tab" or ";" as a separator. You may use ScanNav's Track Analysis tool to determine target speeds based on wind speeds and forces. Other tools will undoubtedly be made available in later versions.

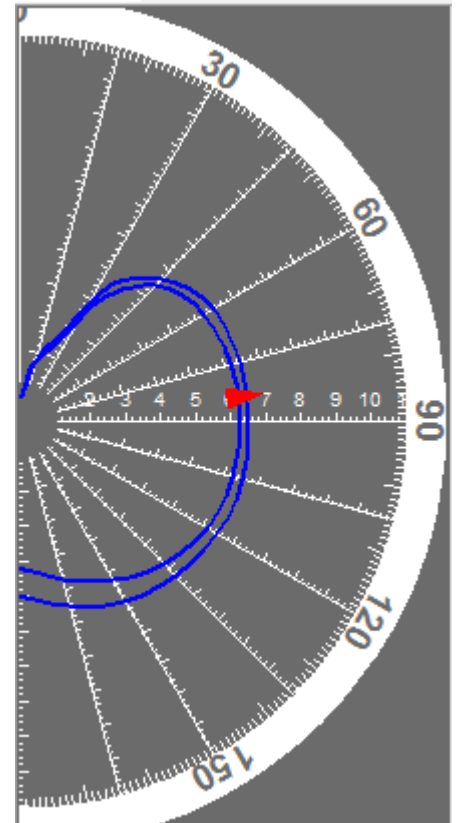
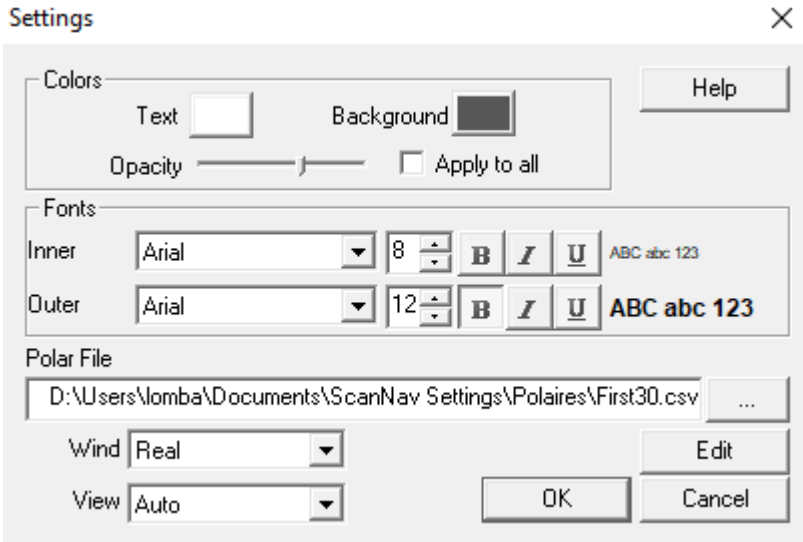
Although polar files can be stored anywhere on your disk, we recommend that you save them to the default "ScanNav Settings \ Polaires" directory under your "Documents" folder. This location might be imposed in later versions.

Polar Display:

The Polar Display is accessible as for other displays using menu «Display» → «Polar»
It lets you visualize a graphic representation of the target speeds reaching percentage.

- The polar curves corresponding to the wind immediately above and below the current wind are displayed in blue.
- The small red triangle represents the current speed and point of sail of the boat.

Tuning settings is done in the same manner as for the other repeaters: by right-clicking on the repeater, then "Properties"



- You must select the appropriate polar file for your boat. The polar file used by the polar display is not necessarily the same as that defined for routing. This makes it possible to differentiate the two aspects, with a performance polar for displayed target speeds, while using a more reasonable routing polar.
- The "View" field allows you to view all the curves of the polar, or only those that surround the real-time wind. (Wind immediately below and above the current wind, as in the example above)
- The "Wind" field allows to choose which wind is taken into account among the Real wind, Surface, or Apparent.
- It is possible to customize the background colors and text, and define the fonts used for internal and external graduations.