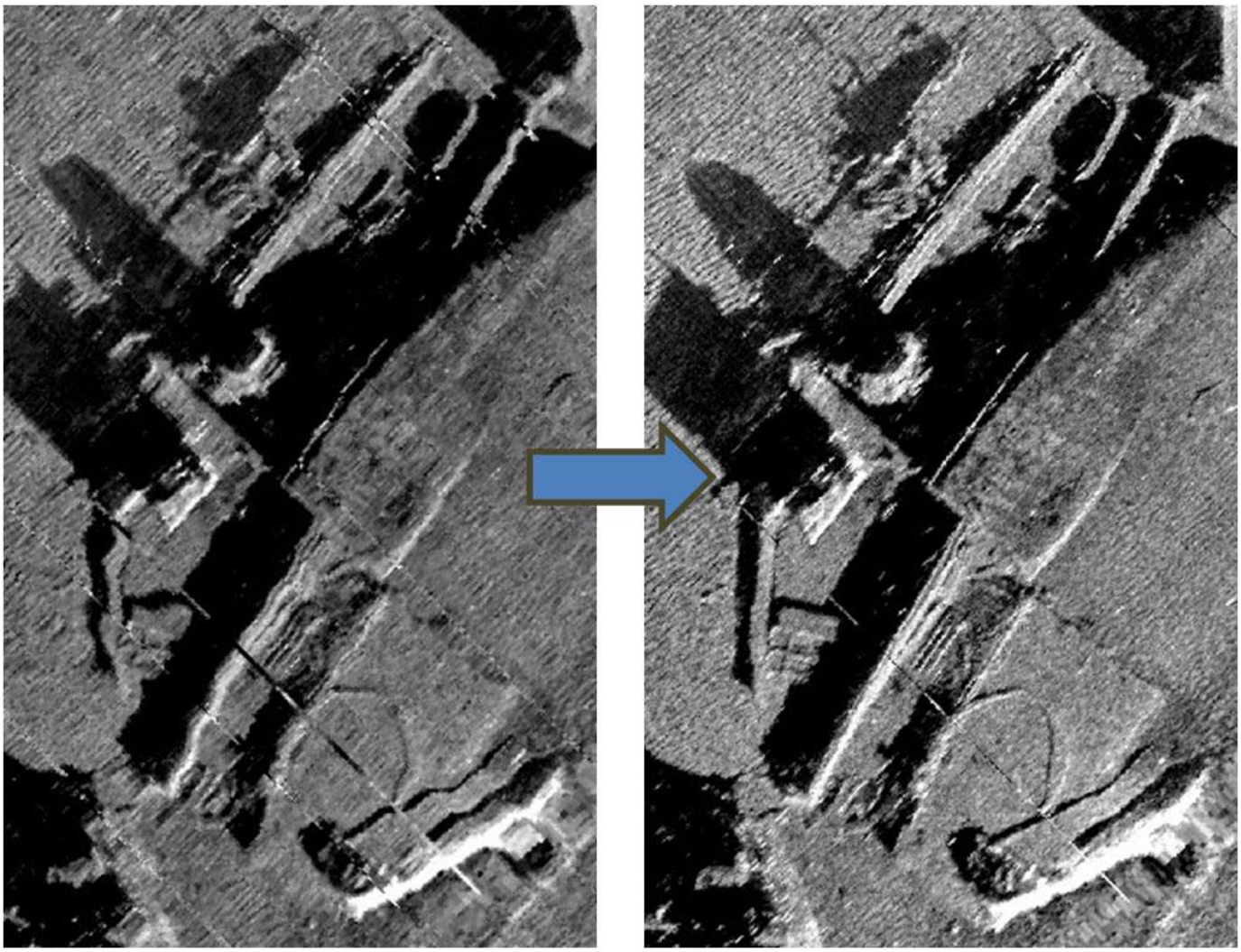
Perspective

-- Navigation Processing Guide --



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This user guide is provided as a means to become familiar with TRITON's software through an explanation of the options available for processing sidescan data. The user interface presented in this guide is subject to change to accommodate software upgrades and revisions. While every precaution has been taken to eliminate errors in this guide, TRITON assumes no responsibility for errors in this document.

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Navigation Processing

Processing navigation is an important step to obtaining clean results and some thought should go into what parameters to use and what level of processing is necessary for the collected data. Discussed in the following sections are how Perspective sorts and displays the navigation data from imported raw data files, reasons to process navigation prior to creating mosaics or DTMs, available options for navigation processing, and possible workflows. There are also a couple examples of processing files with bad navigation at the end of this document

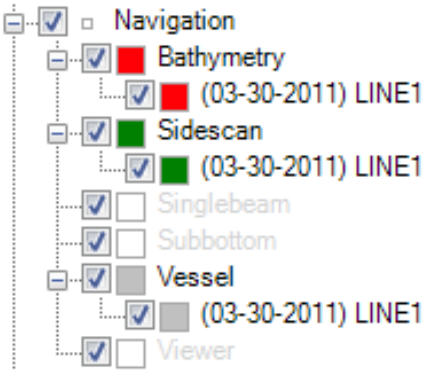
1.0 Navigation Types

In Perspective, when raw data files are imported the navigation data is automatically extracted, displayed in the map view, and placed in the file tree navigation layers. The navigation file tree is sorted into 5 main categories:

- *Sidescan* - navigation for sidescan data extracted from raw data file
- *Bathymetry* - navigation for bathymetry data extracted from raw data file
- *Singlebeam* - navigation for singlebeam data extracted from raw data file
- *Subbottom* - navigation for subbottom data extracted from raw data file
- *Vessel* - vessel navigation extracted from raw data file

If multiple data types are available in one raw data file, importing that one data file can populate multiple navigation data fields. This is important as it allows the

For example, if the data file comes from a Reson 7125 survey and includes both multibeam bathymetry and sidescan data, the importing of only one raw data file will populate the *Sidescan* navigation node, the *Bathymetry* navigation node and the *Vessel* navigation node as shown right.



This is very important as it allows the user to perform minimal processing on the bathymetry navigation just to remove spikes in the data while heavily processing the sidescan navigation to get parallel uniformly spaced beam lines for clean mosaics.

2.0 Navigation Processing

2.1 When to process…

When importing raw data files into Perspective, the import/processing wizard automatically launches. While the wizard does give the option to process the navigation for the data type being imported, multiple stages of navigation processing cannot be accomplished before the wizard completes the mosaic or DTM creation. If there is reason to believe that the navigation data needs additional cleanup, then it is best to skip the creation of the mosaics or DTMs at this stage and process the navigation completely first.

By selecting *Process Navigation* from the File Tree before creating mosaics or DTMs, repeat processing can be performed on the data to fix really bad navigation from overhead obstructions and data with timing updates coming in slower than the sonar ping rate. Also, processing singlebeam, subbottom or vessel navigation requires the navigation to be processed from the File Tree since there are no processing wizards for these data types.

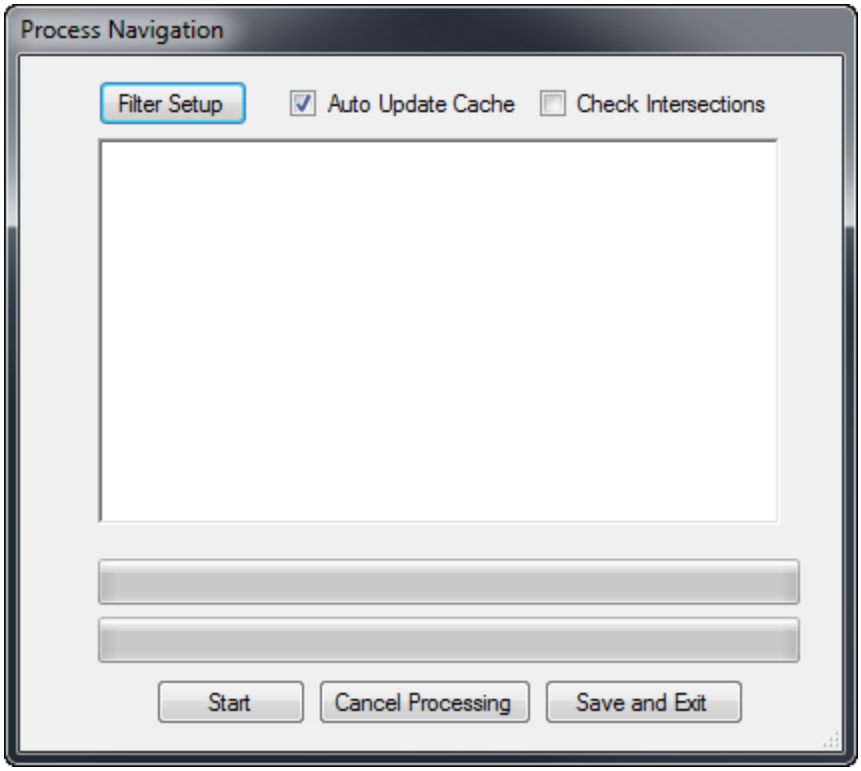
Below is a table that summarizes the above discussion:

Data Type	Processing Wizard (one pass only)	File Tree (multiple passes)
Sidescan	use for high speed nav data collected in good weather	usually best choice for sidescan to get parallel beams with uniform spacing
Bathymetry	usually best choice for bathymetry to preserve the true vessel orientation at the time of each ping while still removing bad spikes	use for data with very bad navigation due to overhead obstructions or poor GPS signal quality
Singlebeam, Subbottom & Vessel	usually best choice, only needed to remove spikes in data	use for data with very bad navigation due to overhead obstructions or poor GPS signal quality

2.2 Processing from File Tree

For processing navigation from the File Tree, select the *Process Navigation* option available by right-clicking on any tree level in the *Navigation* layer. Selecting this will launch the *Process Navigation* dialog shown below:

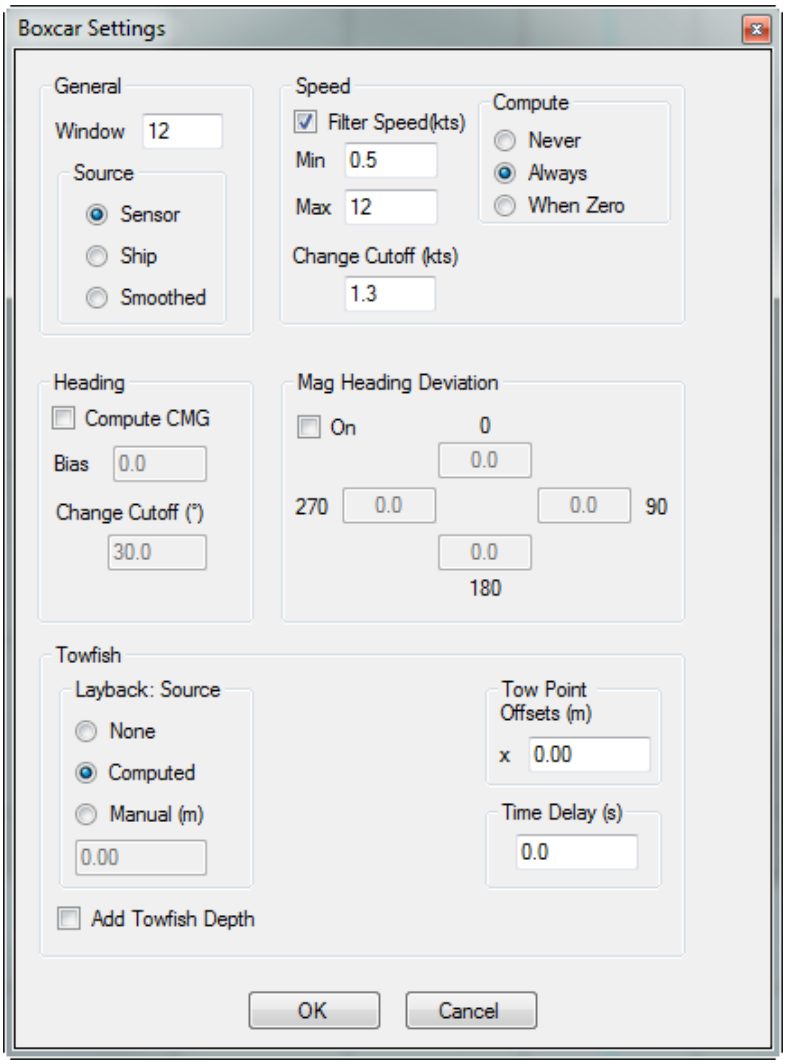
Detailed descriptions of the options available in the *Process Navigation* dialog for setting navigation processing parameters are presented below.



- *Filter Setup* – Opens Boxcar Setting dialog (see next section for details).
- *Auto Update Cache* - Writes the processed navigation into the cache file, important for repeat processing.
- *Check Intersections* - Checks for navigation line intersections. This is very important for subbottom navigation processing in order to see cross lines on the profiles and take advantage of the Folded Profile tool.
- *Start* - Click after Boxcar Settings have been made to initiate processing. This can be clicked as many times as the user wants to repeat the navigation processing. Please note that to process the results from the previous navigation processing step, the navigation source must be changed to *Smoothed*. This will use the processed navigation in the cache file as the source allowing for multiple steps of processing.
- *Cancel Processing* - Cancels current processing step, does not remove saved processed navigation from cache file.
- *Save and Exit* - Saves processing to cache file if not already done with the auto update option, exits processing wizard.

2.3 Boxcar Filter Settings

Both processing methods presented (file tree and wizard) use the boxcar filter setting dialog shown to the right.



In this dialog it is possible to set the size of the boxcar filter, the source of the navigation data, plus speed filter, heading and layback options.

Detailed descriptions of the options available in the *Boxcar Settings* dialog for setting navigation processing parameters are presented below.

General

Window - sets boxcar window size

Source - sets source navigation

- Sensor - uses the position found in the XTF sensor navigation
- Ship - uses the position found in the XTF ship navigation
- Smoothed - uses the smoothed position already in the cache file, (uses the previously smoothed navigation from the last processing)

Heading

Compute CMG - check box to compute a heading from the Course Made Good (navigation), very important for sonars with no heading sensor, should not be using on lines with turns!

Bias - apply a single bias to the computed CMG heading

Change Cutoff - cutoff value for CMG calculation (in degrees)

Towfish

Layback Source - three options for setting towfish layback

- None - do not apply a layback
- Computed - computes a layback using the values found in the XTF file for Cable Out, Towfish Depth, Towpoint Height, and Towpoint offset from the navigation antenna
- Manual - Enter a fixed layback value (in meters)

Tow Point Offsets - applies user-defined value in crossbeam direction: +X equals Starboard, -X equals Port

Time Delay - static time delay (in seconds)

Speed

Filter Speed - turns the option on

- Min - enter the minimum expected speed
- Max - enter the maximum expected speed
- Change Cutoff - cutoff value for speed filter (in knots)

Compute

- Never - use the speed from the XTF file
- Always - ignore existing speed and re-compute
- When Zero - only computes speed if the value in the file is zero

Mag Heading Deviation

On Check Box - turns the option on

0, 90, 180, 270 - Enter the corrected heading for each of cardinal compass points. The mosaic engine

Important Note: Navigation source is not always as obvious as it sounds. Of the three options available, only SHIP and SENSOR can be used the first run through. These are the two possible navigation types in the XTF file and before running the processing once, the SMOOTHED navigation which is written into the cache file does not yet exist.

Generally SHIP navigation is used for hull or pole mounted sonars and SENSOR is used for towed sonars. However what is actually stored in these two locations in the XTF file is determined by the surveyor during acquisition setup and what software is used to acquire the data.

For repeat processing of the navigation data, the user must select the SMOOTHED option in the *Boxcar Settings* after the first run. If this is not selected, every time the *Start* button is clicked in the *Process Navigation* dialog it will keep looking to the raw data file and not the already smoothed data to use as the source.

It is a good idea to monitor the Beamlines while processing the navigation to verify the processing setting are correct and are working as expected.

3.0 Navigation Processing Workflows (Sidescan & Bathymetry)

3.1 Process on Import

Upon importing raw survey data files, the processing wizards each have a button for setting the navigation processing settings. These settings are made and then applied when the data is being processed for creating mosaics or DTMs.

Processing Steps:

1. Import Raw Data
2. Use Wizard to process imported data
3. Check the Navigation Processing checkbox
   - found on the *Raw Processing* page of the BathyOne wizard
   - found on the *Choose Line Settings* page of the MosaicOne wizard
4. Click on the Settings button, make changes to the Boxcar Settings and click OK
5. Complete data processing wizard and click Finish, this will first process the navigation data using the specified parameters and then will process the data using the processed navigation

3.2 Process from File Tree

Upon import of the raw survey data, the processing wizards are skipped and only the navigation lines are imported. Then the navigation can be processed using the Process Navigation dialog available from the File Tree.

Processing Steps:

1. Import Raw Data
2. Skip the processing of the imported data
3. Select *Show Beamlines* for at least one of the data files to be processed. This option is only found by right-clicking on an individual file under the Sidescan navigation file tree node
4. Use the Zoom toolbar button  to zoom into the Beamlines enough to monitor the processing results
5. Right-click on a navigation layer to process the navigation data
   - on the root Sidescan or Bathymetry nodes in the Navigation tree for processing all files in that node at one time, recommended unless from different sonars
   - on individual lines within the root Sidescan or Bathymetry nodes in the Navigation tree for processing navigation for only that file
6. Click on the *Filter Setup* button to open the *Boxcar Settings* dialog, make changes to the settings, be sure to select either SHIP or SENSOR for the source, then click *OK*
7. Click Start to initiate the first run through the navigation processing
8. Click on the *Filter Setup* button again and change the source to SMOOTHED, then click *OK*
9. Click Start to run through the navigation processing again.
10. Repeat until the results are good
11. In the data processing wizards, make sure the *Navigation Processing* checkbox is NOT checked!

4.0 Bad Navigation Example (Sidescan)

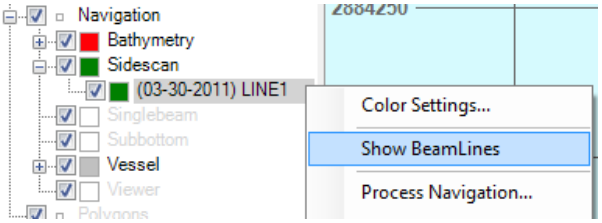
4.1 Overview

The following example illustrates the need for multiple passes of filtering for sidescan data file. This is an uncommon problem but works well for showing why it is sometimes necessary for repeat processing of the navigation.

This data comes from a Klein 5000 sonar which for this survey had a ping rate set faster than the incoming navigation data. It is common for GPS receivers to only receive an update every 1 second while sonar ping rates are much faster. During acquisition as each new ping is received it is assigned the last known navigation position resulting in multiple pings with the same time and position. It is possible to get what we call "high speed" GPS data from more expensive equipment which provides a time and position for each ping.

4.2 Show Beamlines

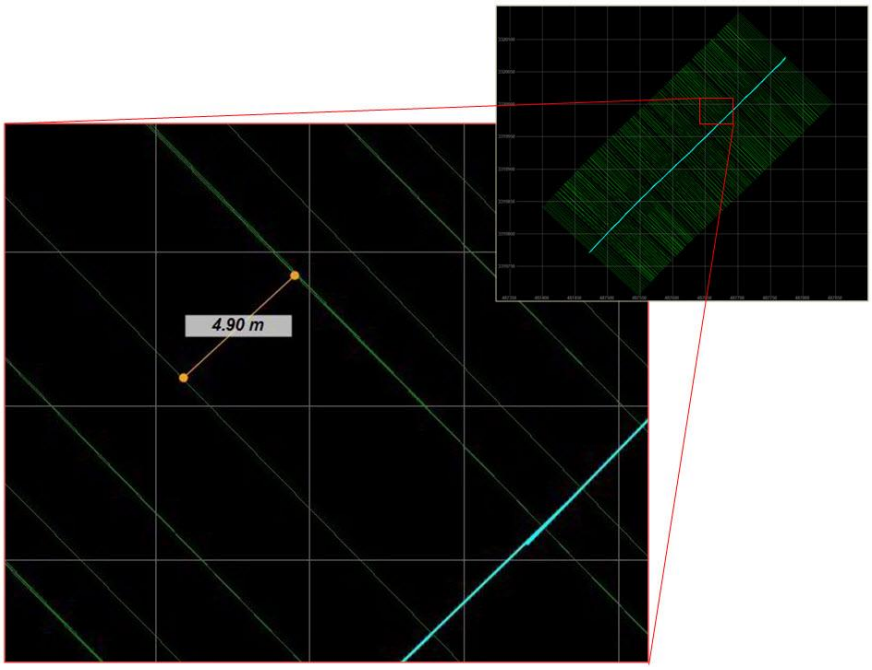
Using *Show Beamlines*, it is possible to see the beam lines for each ping by right-clicking on the file name in the sidescan mosaic layer in the file tree as shown in the image to the right.



4.3 No Navigation Processing

For this example you can see in the images below the beam lines for this Klein 5000 survey.

Note the beam line spacing is up to 4.9 meters apart! This is the distance the sonar travelled between navigation updates so all the beams that should fall in this gap are overlapped at each ping that receives the new navigation fix from the GPS receiver.



Based on the ping rate and the vessel speed we expect the beam spacing to be 0.2 meters, not 4.9 meters. By processing the navigation we can smooth the positions of the pings so that the beam lines are parallel and evenly spaced. This is important for getting clean sidescan mosaics without navigation errors impacting the ability to interpret the data.

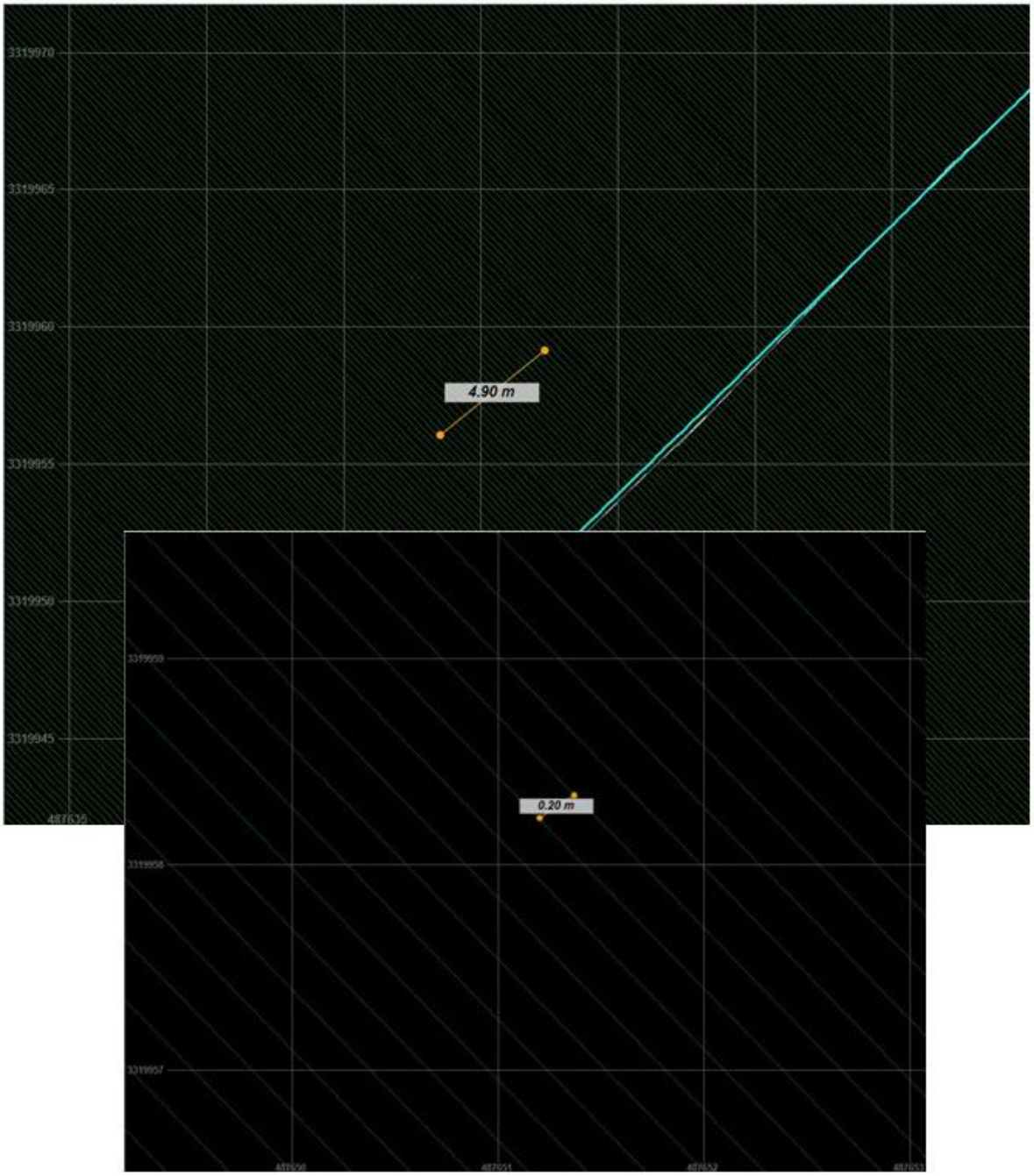
4.4 Step 1 of Navigation Processing

For processing this data I selected SENSOR as the navigation source since it is mounted to the vessel and left everything else unchecked. After only one step of processing the image below shows the overlapping beam lines to be spread out but they are still not uniformly spaced and need additional processing.

Creating a sidescan mosaic using the navigation after only one step of navigation filtering shows an obvious striping caused by the unevenly spaced beam lines. This is what processing navigation only within the MosaicOne wizard would have produced for this data file. Files such as this one can clearly benefit from additional navigation processing.

4.5 Step 2 of Navigation Processing

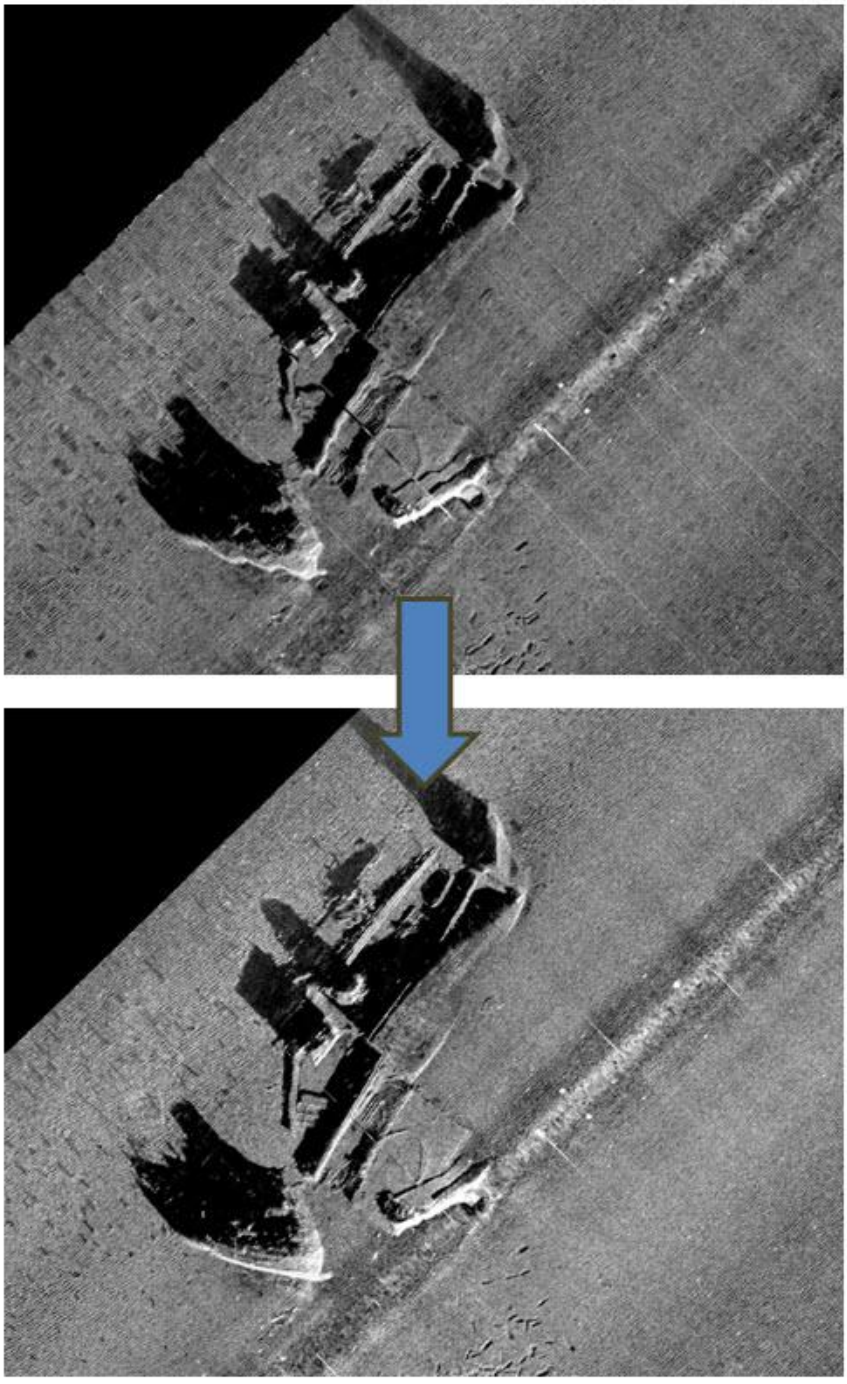
After two processing steps, the images below now show the overlapping beam lines to be spread evenly. The lower image shows the 0.2 meter beam spacing expected.



This was after only 2 steps of processing but additional steps may be needed for some data files. Having *Beamlines* displayed allows the user to immediately see the results of each processing step.

4.6 Compare Results

Shown below is the difference inadequate navigation processing can cause in sidescan processing results:

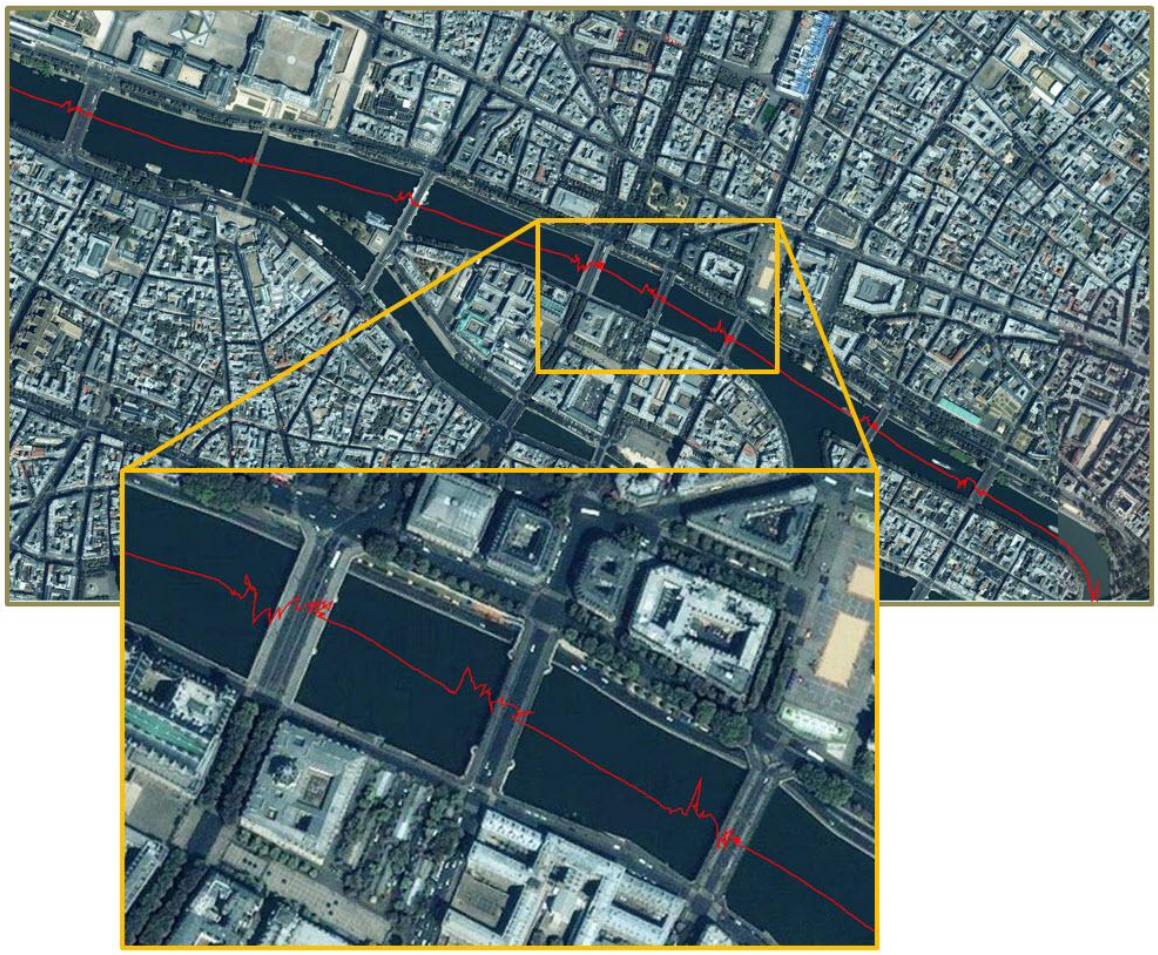


5.0 Bad Navigation Example (Bathymetry)

5.1 Overview

The following example illustrates the need for multiple passes of filtering for a bathymetry data file. The bad navigation present in this file is due to overhead obstructions and is a common problem when working in harbors and river channels.

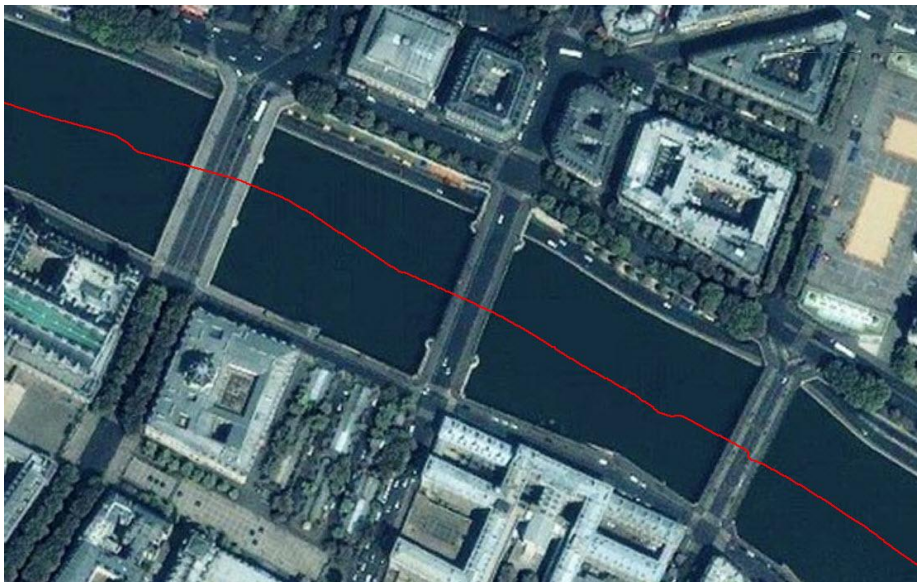
This data comes from a GeoAcoustics GeoSwath Plus interferrometric sonar and was collected along the Seine River during a demonstration performed by the ECA group of their Inspector USV (unmanned surface vessel). As seen in the image below, the Seine River has many bridge crossings some of which are very wide and represent a significant amount of time without receiving a GPS signal.



Looking at the navigation line in the lower image, the as the vessel passes under each bridge the GPS signal is lost and the vessel trackline becomes erratic and the recorded positions are not correct until the GPS signal is re-acquired.

5.2 Step 1 of Navigation Processing

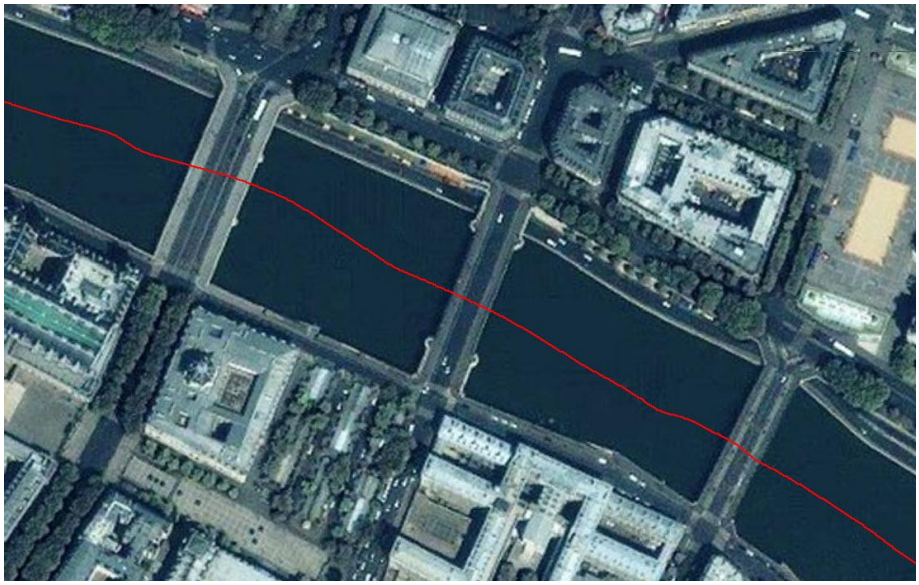
For processing this data I selected ship as the navigation source since it is mounted to the vessel and used a speed filter between 0.5 and 7 knots. After only one step of processing the image below shows a relatively smooth line.



While this might be adequate for getting good bathymetry processing results, processing the navigation a second time can help remove the remaining sharp bends from the navigation track.

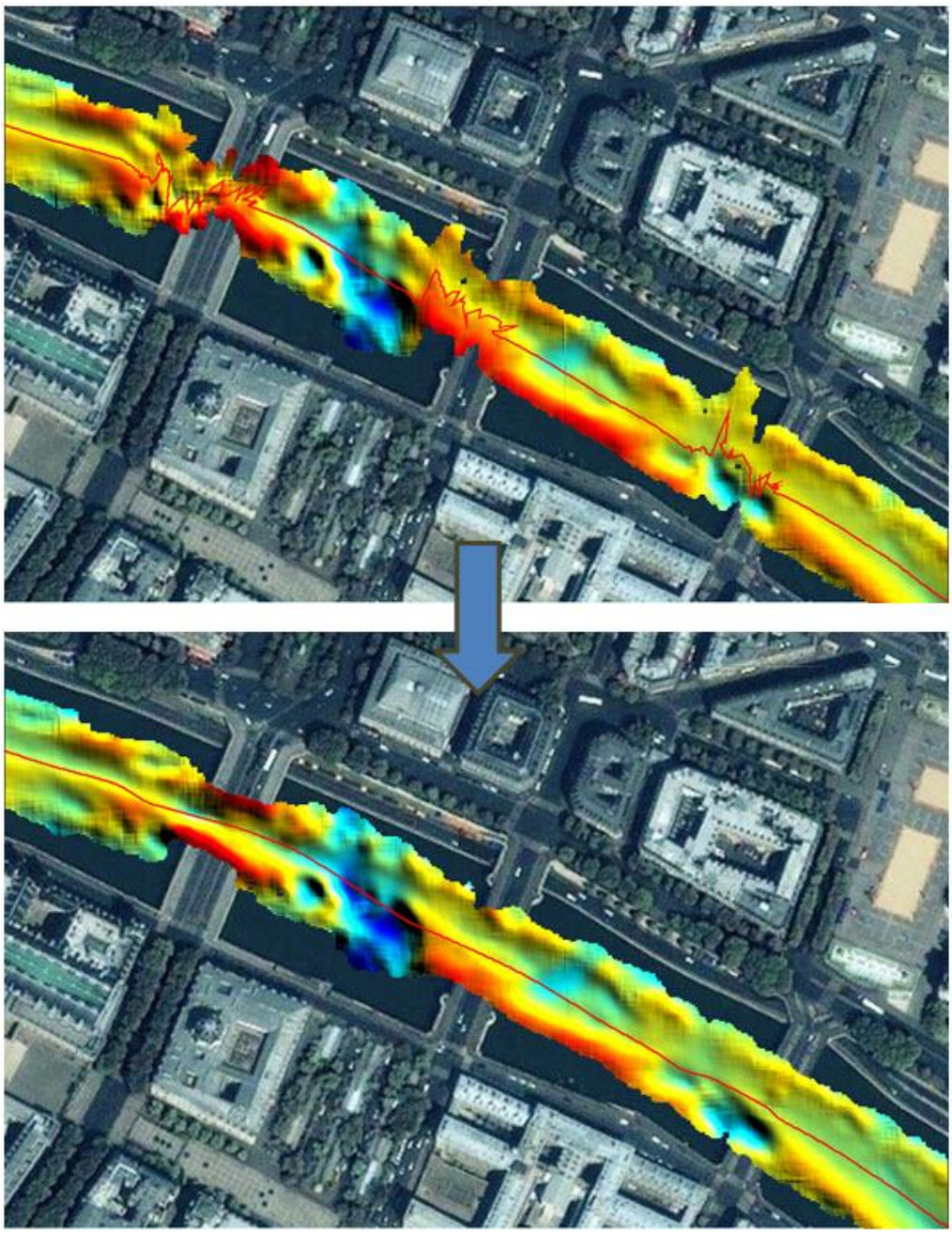
5.3 Step 2 of Navigation Processing

After the second step of processing the image below shows a relatively smooth trackline.



5.4 Compare Results

This data example started with very erratic navigation beneath the bridges spanning the river. With repeat navigation processing it was possible to smooth the bad navigation to approximate the true vessel position as it passed under the bridges.



It is important to note that even with navigation as bad as this file started with, one pass through the navigation filter was basically enough to get good bathymetry processing results, especially if the boxcar filter window size is increased to a larger number than the default value of 12.