Removing noise and spikes with the Profile Editor (G09)

Top

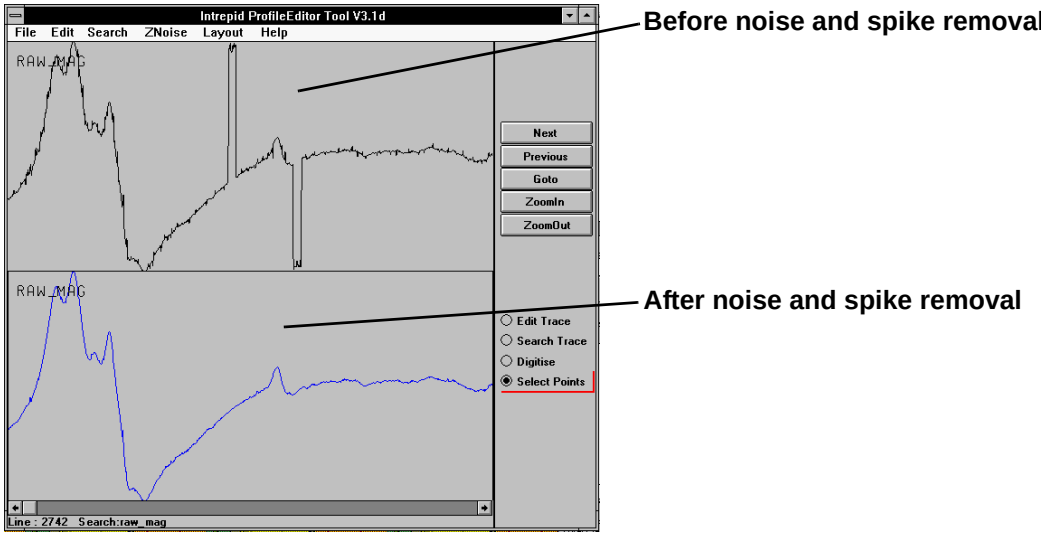
New survey data often contains errors that need to be removed, for example:

- Noise– small high frequency fluctuations in measurements due to extraneous factors or small shallow irrelevant data sources.
- Spikes– a single point of noise.

In order to correct these errors and also for general viewing of line data, it is helpful to be able to view a profile of the data collected along each line. The Profile Editor enables you to do this.

In this guided tour you will examine the profiles of lines of a dataset. You will then remove the noise and spikes using a variety of methods. You can examine the results in a new grid.

This illustration shows a 'raw' data line and the same line with noise and spikes removed.



Overview

The Profile Editor is one of the INTREPID editors (Spreadsheet, Flight Path, auto clip line, split cruise and Profile).

- It provides a time and line-based view of the data, showing the profiles of individual lines one at a time.
- It can calculate filters (such as Naudy and 4th difference) and display the results.
- You can use this tool to quickly and effectively identify and edit noise.
- It supports vector, tensor and quaternion signal fields as well as the traditional scalars
- It is geared to work on a time series, perhaps before the geolocation of your signal has been carried out.
- It supports current, next and previous overlays of profiles.
- Profile Editor enables you to:
  - Select and change the values of data points using the mouse,

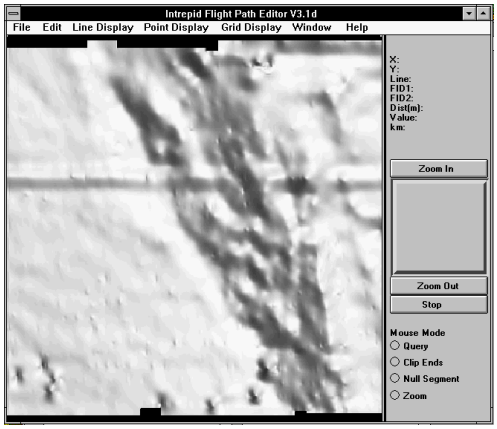
- Automatically filter an entire dataset,
- Compare different fields from the same line of the same dataset,
- Perform extensive range checks on the data,
- Look at profiles of full tensor data and search for noise spikes,
- Superimpose profiles of data components before and after noise filtering.

Profile Editing process

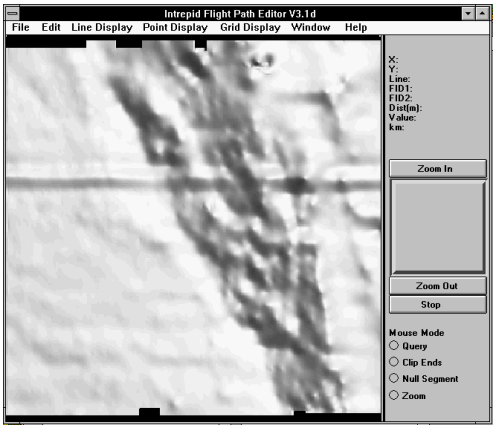
This illustration on the first page of this guided tour shows a line profile of magnetic data before and after noise and spike removal. The upper profile shows noise at regular intervals along the line and two spikes. The lower profile shows the same line data with the noise and spikes removed.

Grids produced from data before and after use of Profile Editor

This illustration shows grids produced from magnetic data before and after noise and spike removal. The left grid produced from data still containing noise and spikes shows many small 'pin prick' anomalies due to noise, and several larger steep anomalies near the bottom due to spikes. The right hand grid produced from data that has had noise and spikes removed does not have these anomalies.



Before noise and spike removal



After noise and spike removal

Context of this guided tour

In the context of your data processing cycle, this tour represents an important first or second step in processing a set of newly imported data. You should perform this process in conjunction with editing out unwanted sections of flight paths using the Flight Path Editor.Location of sample data for Guided Tours

We provide two complete sets of sample datasets, one in INTREPID format and one in *Geosoft* format. INTREPID works equally well with both formats. When you want to open a dataset, navigate to the directory containing the required data format.

Where ***install_path*** is the path of your INTREPID installation, the project directories for the *Guided Tours* sample data are ***install_path*\sample_data\guided_tours\intrepid_datasets** and ***install_path*\sample_data\guided_tours\geosoft_datasets**.

For example, if INTREPID is installed in
C:\Program Files\Intrepid\Intrepid4.5.nnn,
then you can find the INTREPID format sample data at
C:\Program Files\Intrepid\Intrepid4.5.nnn\sample_data\guided_tours\intrepid_datasets

This is the default location for the sample data. If you have installed INTREPID normally, the data resides there. If you have installed INTREPID elsewhere, the exercises will work just as well. Just use the appropriate pathnames.

For more information about installing the sample data, see "Sample datasets—installing, locating, naming" in INTREPID Guided Tours Introduction (G01)

For a more detailed description of INTREPID datasets, see Introduction to the INTREPID database (G20). For even more detail, see INTREPID database, file and data structures (R05).

Location of sample data for CookBooks

Right next to the Guided tours data, is a rich set of more exotic geophysics datasets and grids, already prepared for the cookbook training sessions. A casual user might also gain some trial and error insights into the capbilities of the software, just by testing the Project Manger's ability to preview and describe the attributes of each of the cookbook datasets.

Should you complete this guided tour?

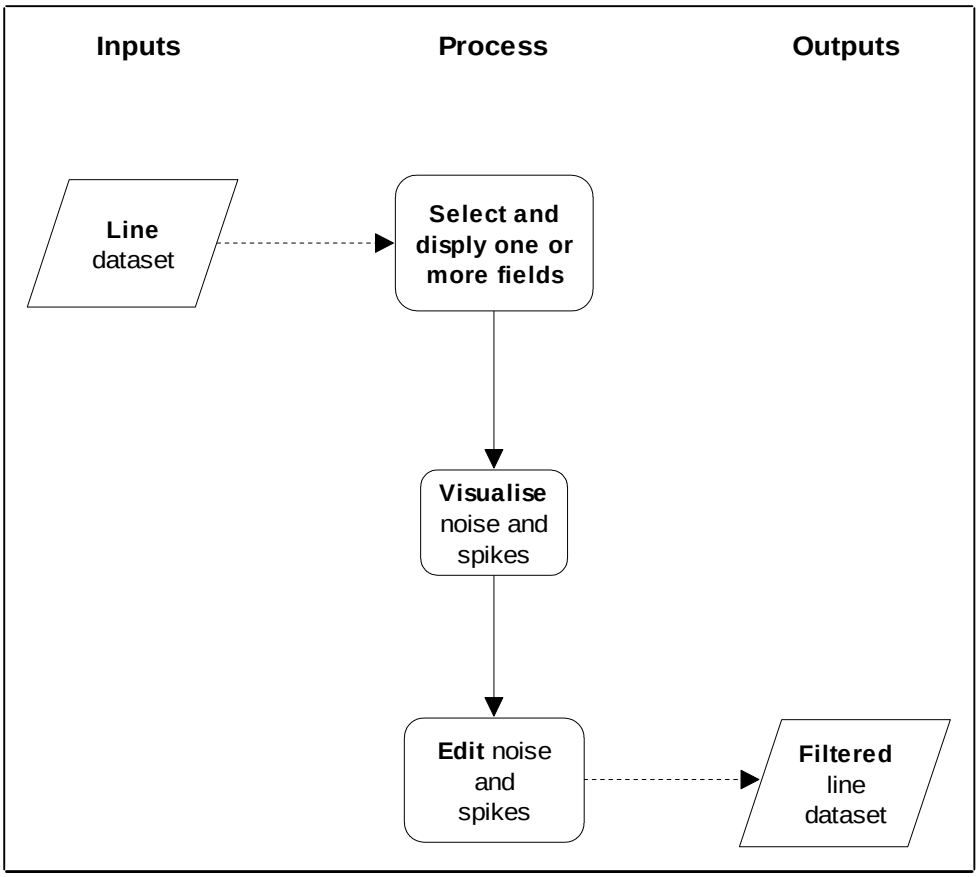
This guided tour is intended for intermediate level users. Its process is more complex than that of an introductory level tour and its instructions are less detailed. If you are a beginner or wish only to have a brief overview of INTREPID's capabilities, you can omit this guided tour. Omitting this guided tour will not affect your understanding of later tours. Examining time series profiles of your signal is often very helpful, especially when you also do before and after comparisons. Similarly, noise and spike removal is an important step in processing geophysical data.

Gradiometry

With the advent of support for FTG or full tensor gradiometry data, an intersting application is the ability to inspect for correlations of the components with the terrain correction signal, and then deciding what terrain denisty to use to minimize the correlations. The tool has options for Falcon, FTG, Vector field data and a Quaternion or 3D rotations signal. The linear vetorization of a 3D rotation matrix is becoming a lot more popular as a result of better instrumentaion systems being deployed upon aircraft. Some of the geophysical signal can be ascribed to the wrong field gradient components when there are errors in measuring the Roll,Pitch and Yaw of the aircraft. The traditional "compensation" process to unscramble the signal using figures of merit and a 16 to 18 term polynomial, embedded in a black box, has done great service over the past 20 years, but the time has come to face up to the requirement for new and more rigourous treatments of the rotational attitude of the aircraft during acquisition, and the deconvolution to tensor/vector fields. The tensor training course is the best place for detailed material on gradiometry. The enhanced cookbook datasets and examples that are next to the guided tours, includes some samples for you.

What you will do

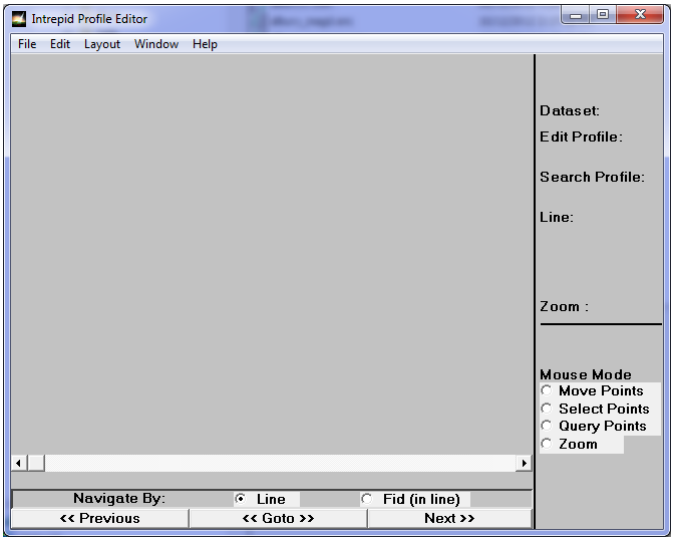
Flowchart Summary



Steps to follow

Launch the Profile Editor

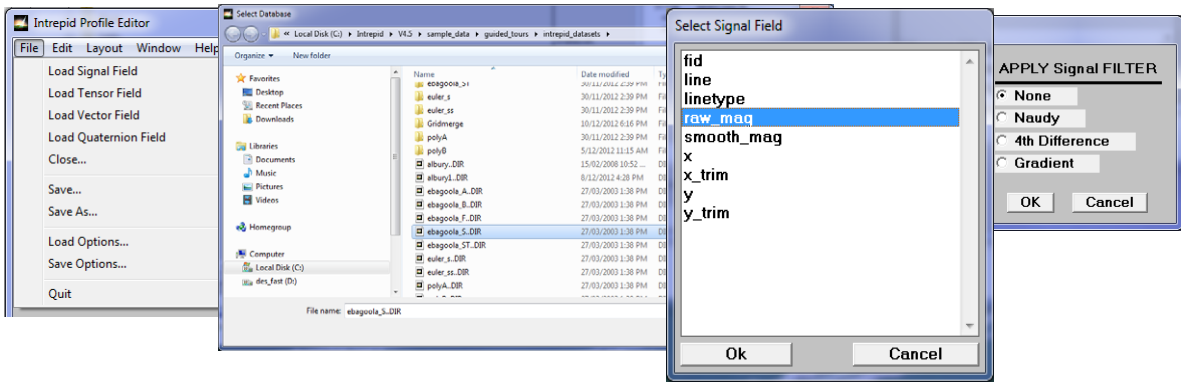
1 *Start the Project Manager. Navigate to the directory* ***`install_path`*****`\sample_data\guided_tours\intrepid_datasets`**. *Start the Profile Editor.* Choose **Profile_Editor** from the **Editors** menu, INTREPID displays the Profile Editor tool.



Display a profile

2 *Open a dataset and display the* **`raw_mag`** *field.*

From the **File** menu choose **Load Signal Field**. INTREPID displays the **Select Signal Dataset** dialog box. Open the **`ebagoola_S`** dataset directory ***`install_path`*****`\sample_data\guided_tours\intrepid_datasets\ebagoola_S`**. Select **`raw_mag`**. Choose **OK**. INTREPID displays the **Apply Signal Filter** dialog box. Select **None** then choose **OK**.



Examine profiles of other lines

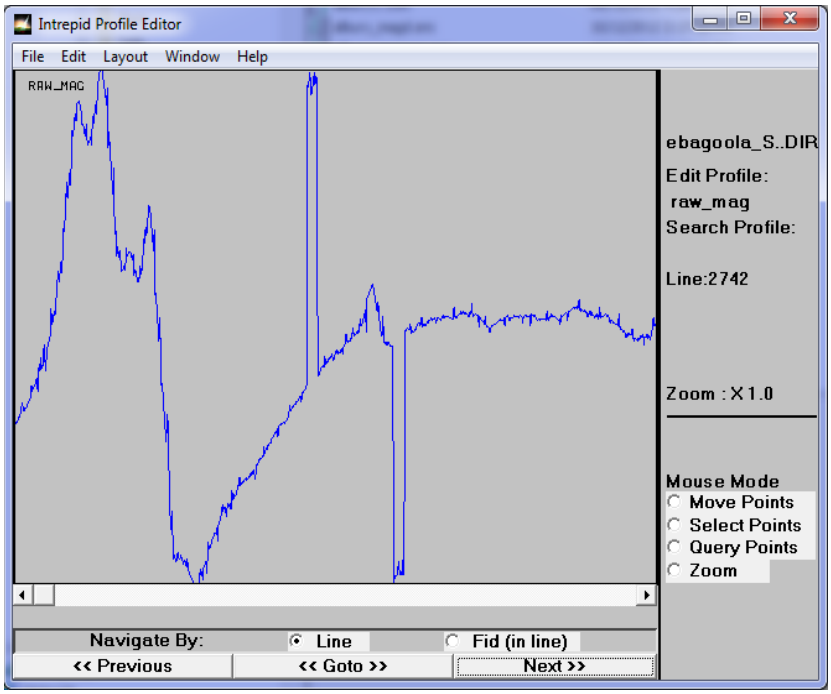
3 *Examine the profiles of several lines*

Choose **Next** and **Previous** to examine the next or previous line. Note the noise patterns throughout all profiles and the larger spikes in lines 2742, 2751, 2761 and 2771 (INTREPID displays the line number at the right of the screen).

Select line 2742

4 *Display the profile of line 2742.*

Use the **Next**, **Previous** or **Goto** buttons to display line 2742 if it is not already showing.



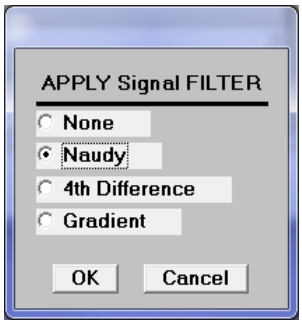
Display a copy of the profile with Naudy filter

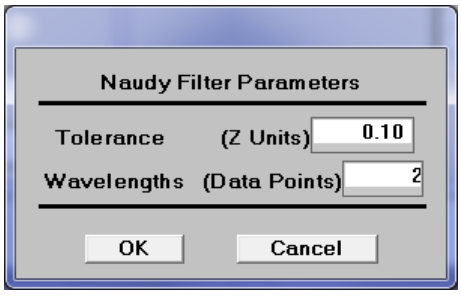
5 *Open a second copy of the* **raw_mag** *field with a Naudy noise filter applied.*

From the **File** menu choose **Load Signal Field**. INTREPID displays the **Select Signal Dataset** dialog box. Select **raw_mag**. Choose **OK**.

INTREPID displays the **Apply Signal Filter** dialog box. Select **Naudy** then choose **OK**.

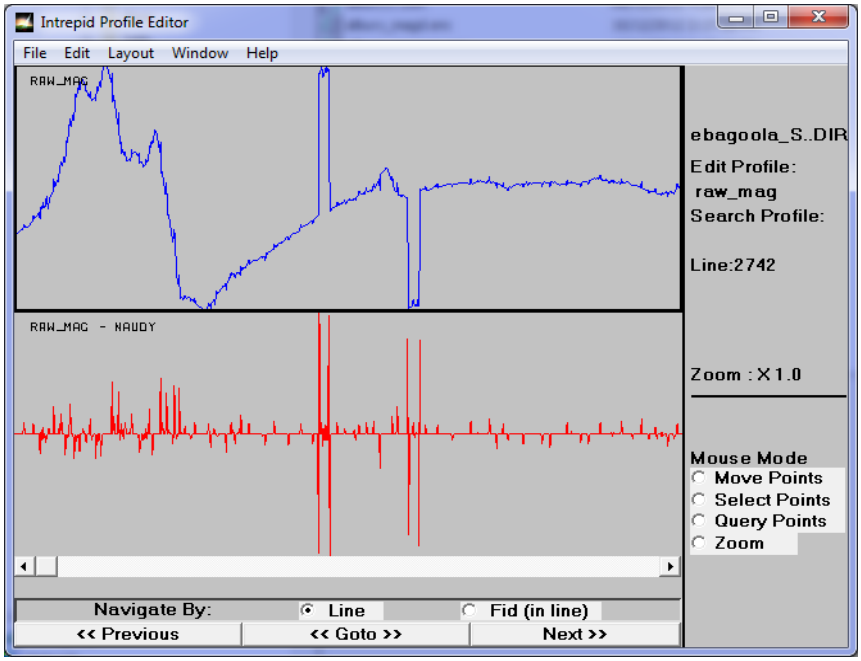
INTREPID displays the **Naudy Filter Parameters** dialog box. Set **Tolerance** to **0.1** and **Wavelength** to **5**. The units here are 0.1 nT as the spike finder threshold, and filter length of 5 data points in a moving window.





Choose **OK**.

INTREPID displays the profile showing Naudy noise levels.

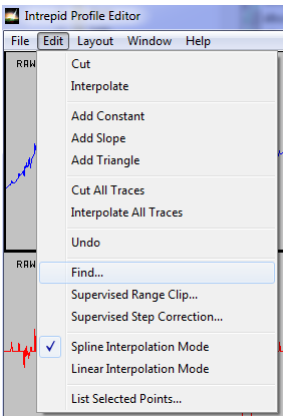


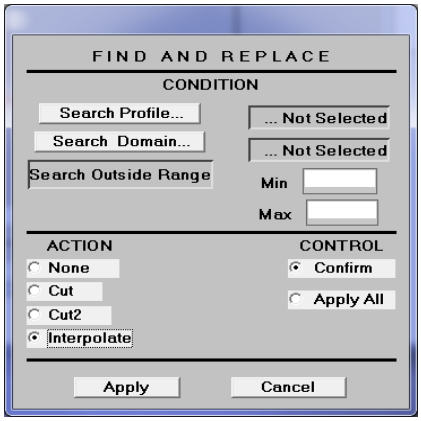
Automatic noise removal

Configure search options

6 *Set the **Find** options to interpolate edited points.*

From the **Edit** menu choose **Find**. INTREPID displays the **Condition** dialog box. Select **Interpolate** from the **Action** options.

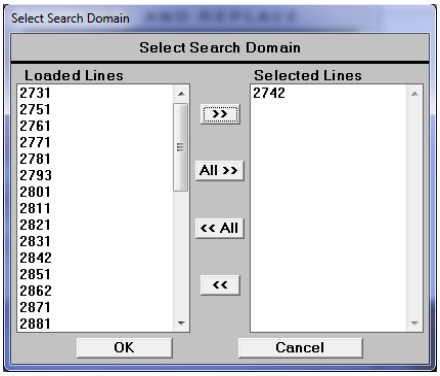


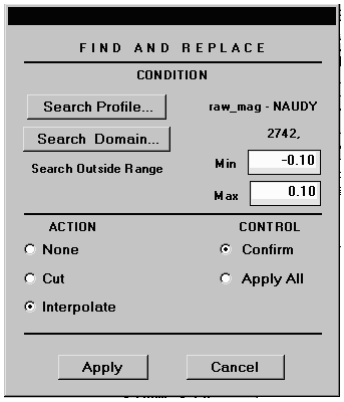


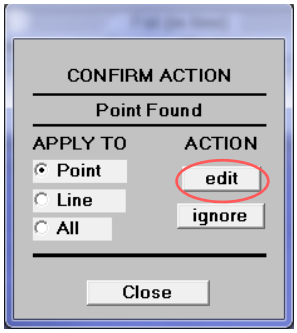
There are two traces in the Profile Editor window. Select raw_mag – Naudy for automatic editing. This means that you will be searching the **raw_mag** field for noise as detected by the Naudy filter. Choose **Search Profile**. INTREPID displays the **Select Search Profile** dialog box with a list of profiles that are currently displayed. Select (click) **raw_mag – Naudy**.

Choose **OK**. INTREPID displays the name of the profile against the **Search Profile** button and place a red frame around the profile in the display.

Specify the domain (set of lines) for automatic editing to include line 2742 only: Choose **Select Domain** in the **Condition** dialog box. INTREPID displays the **Select Search Domain** dialog box containing the list of loaded lines. Select (click) line 2742. Choose **>>** to include line 2742 in the domain. INTREPID will show it in the **Selected lines** list. Choose **OK** in the **Select Search Domain** dialog box. INTREPID will report the selected domain against the **Search Domain** button in the **Condition** dialog box. Choose **Apply** in the **Condition** dialog box. INTREPID displays the **Confirm Action** dialog box for every spike found. You have to choose to either edit or ignore each spike. In the top window, the current spike has a red box drawn to mark its position in the profile.



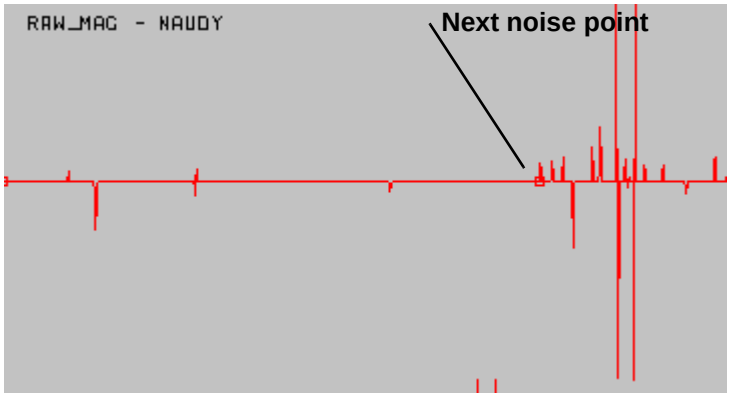




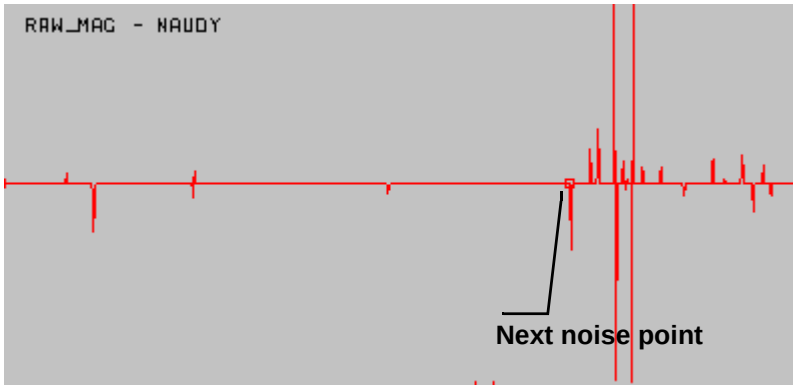
Apply automatic editing

7 *Apply the automatic editing you have specified one by one to the first few instances of noise detected by the Naudy filter, then automatically to the rest of the line.*

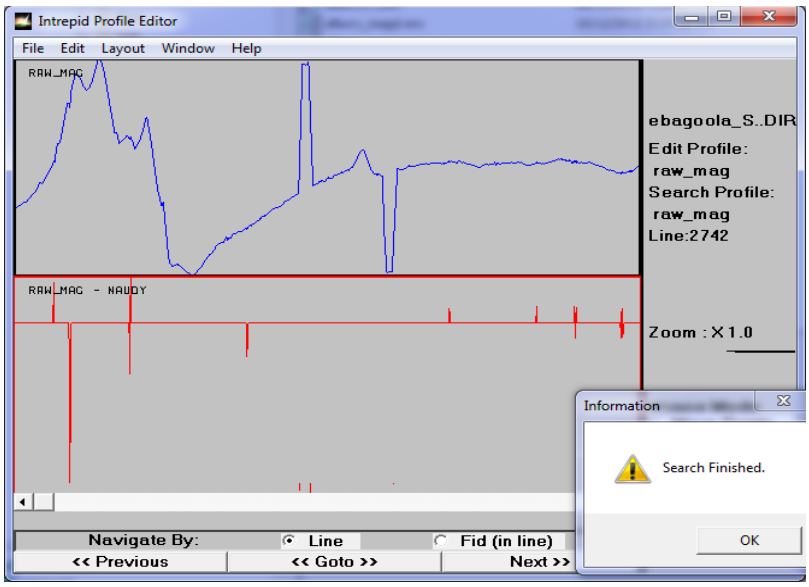
Ensure that **Point** is selected from the **Apply To** options in the **Confirm Action** dialog box. Choose **Edit**. INTREPID will find and correct the first noise point in the line, indicating the next instance of noise with a small red square.



Choose **Edit** a few times. Each time you choose **Edit** INTREPID will edit the next instance of noise.



Once you have observed the process working, apply the automatic editing to the rest of the line. Select **Line** from the **Apply To** options. Choose **Edit**. INTREPID will remove noise from the rest of the line. Observe the effects of the noise removal in the top trace, which shows the **raw_mag** data without noise filter. Observe also that the automatic noise removal removed the low-amplitude noise from the data but not the larger spikes.



Manual spike removal by interpolating between points on either side

The spikes have yet to be removed from this data. You can remove them manually by:

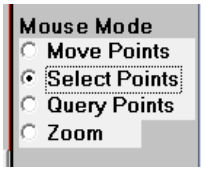
- Moving individual data points to correct the spike or
- Cutting out the spike and interpolating across the gap.

In this guided tour we will use the second option– interpolate across the section of a line that contains a spike.

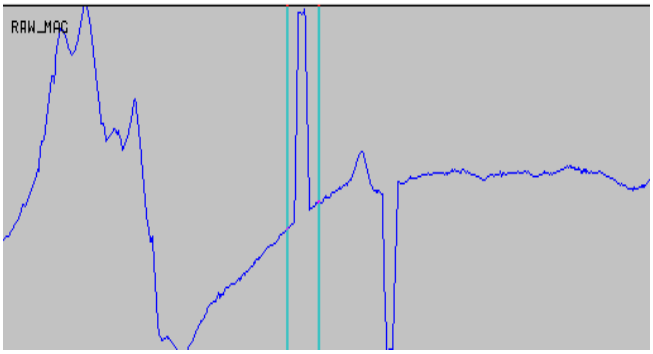
Select line section containing a spike then remove the spike

8 *Define a section of the profile enclosing a spike ready for interpolation.*

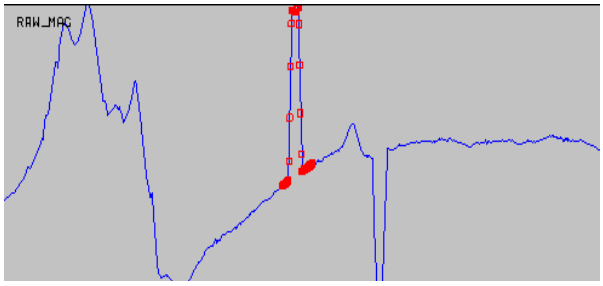
Select **Select Points** mouse mode.



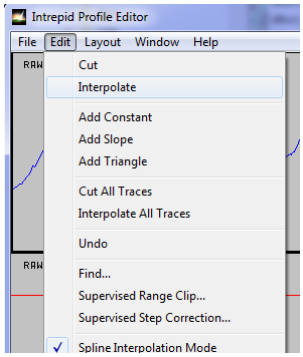
Move the mouse pointer to a point on the profile just to the left of the spike. Hold down the mouse button and drag to a point just to the right of the spike. A pair of blue lines will appear marking the region as you select it.

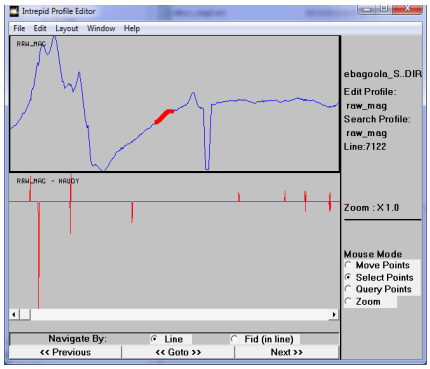


When you release the mouse button INTREPID displays red markers on the points selected.



To remove the spike, choose **Interpolate** from the **Edit** menu.





Further practice and saving your results

Repeat the process

9 *If you require further practice, repeat the process with the other spikes in line 2742 and with the noise and spikes in lines 2751, 2761 and/or 2771.*

Saving occurs at this point

10 *Normally you would save your edited Signal field at this stage.*

This has been a brief demonstration of Profile Editing. After completing the process you would normally save the edited Signal data. Since you have only processed a small portion of the data, we recommend that you do not save your work.

Tip: *We have provided a solution field,* **`smooth_mag`**, *which contains data with noise and spikes removed. The following guided tours, which demonstrate the next steps in the survey data refinement process, will use this field rather than* **`raw_mag`**.

Examining a section where two lines overlap

This section is **optional**. Go to Examining the results in a grid if you do not wish to complete it.

The ends of lines 3012 and 3013 overlap. It is good practice to remove the end of one of the lines as part of dataset processing. You can use the Profile Editor to examine the profiles of the lines in the overlap area and determine which line to trim.

The overlap area is between fiducial counts 528068 and 528192 in line 3012, and between 536052 and 536178 in line 3013.

Examine a line overlap region containing spikes

11 *(Optional:) Open the* **`smooth_mag`** *field with no filter. Turn on horizontal axis display. View the profiles on lines 3012 and 3013 in the regions described above.*

Open **`smooth_mag`** as described in Step 2 above, but with no filter.

Choose **HAxis** from the **Layout** menu. This will show the fiducial count as the horizontal axis scale.

Examine lines 3012 and 3013 in the fiducial ranges set out above (Use the **Goto** button). You will notice that there are spikes in this region of line 3013. See "Deciding which line to clip in an overlap area" in Editing with the Flight Path Editor (G10) for an illustration and further discussion of this problem.

Examining the results in a grid

This section is optional. If you do not wish to create or examine a grid from the results of the profile editing process, go to Step 12.

You will create a grid using a Signal field from which noise and spikes have been removed and compare it with a grid that contains noise and spikes.

You can specify the input, output and parameters for creating the grid in this stage of the guided tour using the job file **`ch10_1.job`**. *If you wish, start the Gridding tool and load the job file as described in "Task specification (job) file short cuts" in INTREPID Guided Tours Introduction (G01). Choose* ***Apply***. *The Gridding tool will create the desired grid.*

Grid the filtered field and examine the grid

12 *(Optional:) Create a grid dataset called* **`smooth_grid1`** *from the* **`smooth_mag`** *field of the* **`ebagoola_S`** *dataset.*

Recall the instructions in Creating grids (G07) for creating grid datasets. (Optional:) Use the Windows Visualisation Tool to compare the grid created from a noise-containing Signal field (**`raw_grid`**) with a grid created from a Signal field from which noise has been removed (**`smooth_grid`**) (identical to **`smooth_grid1`** you created).

Recall the instructions in Visualisation tools(G05) for viewing these datasets.

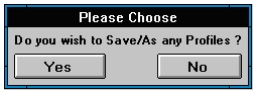
Tip: *You can launch two copies of the tool, load a different grid into each one and place them side by side on the screen for best comparison.*

See the first page of this chapter for an illustration of grids produced before and after a profile editing session.

Exit

13 *Exit from the Profile Editor without saving any of your editing.*

From the **File** menu choose **Quit**. INTREPID displays the **Save Before Exit** dialog box.



Choose **No**. The Profile Editor will exit.

Key points for this guided tour

In this guided tour you have used the Profile Editor to:

- Apply filters and perform range checks on the data;
- Demonstrate automatic filtering that could be performed on an entire dataset;
- Remove a spike by interpolating between points on either side of the spike.

Using the Profile Editor you can also:

- Select and change values of data points by moving them with the mouse;

Frequently Asked Questions

Q : Can I superimpose profiles?

A : Yes, but in separate synchronised windows. You can load as many different fields of the dataset as you wish. The Profile Editor enables you to load and display as many field profiles as you wish. Each profile displays in a separate window. The Profile Editor synchronises all windows so that it always displays the same part of the same line in each window.

Q : Can I also examine gradient, rotational and tensor data

A : Yes. INTREPID uses a colour code system to allow you to show before and after traces in the same plot using the common scale option.

Q : Can I compare fields with and without noise filters?

A : Yes. You can load several copies of a field and display each copy differently, including versions of the data before and after processing.

Q : What filter technology is used?

A : All the filters are 1D convolution operators in this tool.