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Software User Manual – MFILERUNNER

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Sheet **2 of 70**

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Abstract

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1 Introduction

1.1 Purpose of this document

This document is intended to serve as a handbook for the users of the PEGASUS modules MFILE and MFILERUNNER. As the purpose of the PEGASUS is mainly based on the processing of data collected in-flight and on-ground with satellite navigation systems, especially the EGNOS Satellite Test bed (ESTB), a background in the fields of satellite navigation and air traffic management is also necessary for every user working with the PEGASUS software programs. The tools developed allow experimental use of satellite navigation and augmentation systems, notably the European Satellite Test bed, ranging and (wide-area)-differential ranging processing of GPS and ESTB and combinations.

The purpose of the document is to describe the use of the software program MFILE and MFILERUNNER used either as module in the PEGASUS Project or as a standalone program.

In order to use the prototypes correctly, it is recommended that the user should read the Interface Control Document ICD [1] (which describes an important part of the data formats used) and the Technical Notes TN [4] (which describes the algorithmic implementation). It will be helpful to read the ESTB User Interface documentation [10], although this document describes the ESTB Signal-In-Space V1.0, which is based in the specification contained in [6]. It is important to acknowledge that the current ESTB SIS V1.2 conforms to a mix between the specifications [7] and [8].

1.2 Definitions, Acronyms and Abbreviations

AAIM	Aircraft Autonomous Integrity Monitoring
ASCII	American Standard Code for Information Interchange
Doc. No.	Document Number
DD	Design Document
EEC	EUROCONTROL Experimental Centre
EGNOS	European Geostationary Navigation Overlay System
ESTB	EGNOS Satellite Test Bed
ICD	Interface Control Document
GBAS	Ground Based Augmentation System
GLONASS	Global Navigation Satellite System by Russia
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
MT	Message Type
PEG	PEGASUS
PEGASUS	Prototype EGNOS GBAS Analysis System Using SAPPHIRE

PRN	Pseudo-Random Noise – Satellite Identifier
RAIM	Receiver Autonomous Integrity Monitoring
RINEX	Receiver Independent Navigation Exchange
RTCA	Radio Technical Commission for Aeronautics
SAPPHIRE	Satellite and Aircraft Database Project for System Integrity Research
SARPS	Standards and Recommended Practices
SBAS	Satellite Based Augmentation Systems
SIS	Signal In Space
SUM	Software User Manual
TBD	to be determined / defined
TN	Technical Notes
URD	User Requirements Document
UTC	Universal Time Co-ordinated
WAAS	Wide Area Augmentation System
WGS84	World Geodetic System 1984

1.3 References

- [1] PEGASUS Interface Control Document, Doc. No. PEG-ICD-01
- [2] PEGASUS User Requirement Document, Doc. No. PEG-URD-01
- [3] PEGASUS*Plus User Requirement Document¹, Doc. No. PEG+-URD-01
- [4] PEGASUS Technical Notes, Doc. No. PEG-TN-SBAS
- [5] PEGASUS Software User Manual Frame, Doc. No. PEG-SUM-01
- [6] RTCA: Minimal Operational Performance Standards for GPS/WAAS Airborne Equipment. Doc. No. Do 229, June 1996, Including Change 1, July 1997
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¹ The PEGASUS*Plus project established an extension to the original PEGASUS project that decode, process and evaluate the GNSS / SBAS data. Recent developments have integrated all these modules into a PEGASUS frame and the necessary documentation has been modified accordingly – except for the URD where it has been decided not to generate a new issue.

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- [19] SAPPHIRE II Integrity Monitoring, Technical Note, 1998
- [20] SAPPHIRE DUAU User Manual, Doc. No. DUAU-TN-2472-002, Issue J, May 1999
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1.4 Overview

The PEGASUS frame and modules are based on several main software programs allowing the user to decode GNSS data that are then used to perform a GNSS navigation solution. The user is then able to perform further calculation described in the complete set of PEGASUS Software User Manuals (which are contained in the Software User Manual for the PEGASUS FRAME program [5]).

This document contains the Software User Manual for the PEGASUS modules MFILE and MFILERUNNER. This section contains a short introduction to the PEGASUS approach of GPS/SBAS data processing.

In chapter 2 of this document, a short description for the installation and de-installation of the modules MFILE and MFILERUNNER is given when they are used as stand alone programs. Chapter 3 will describe the use of the MFILE module and chapter 4 illustrates the use of the MFILERUNNER module. The Appendix A provides a list of possible error warnings and the associated recovery procedures for the modules MFILE and MFILERUNNER and the Appendix B contains a description of the initialisation file which is associated with the modules MFILE and MFILERUNNER.

2 Installation and System Requirements

2.1 Installation

The installation and de-installation of the program is done via the installation routines of the PEGASUS software. For more information, please refer to the chapter Installation from the PEGASUS Frame User manual [5]. Separate installation is discouraged due to DLL dependencies.

2.2 System Requirements

The MFILERUNNER has been successfully tested on WinNT™ 4.0 SP 5/6, Win95™ and on Win2000™. It is expected to run, as well, using Win98™ and WinXP™. The minimum system requirements are 16 MB RAM and a processor with a performance similar to Pentium I with 133 MHz. A graphical display of 800x600 pixel will be sufficient to use the program. However, since other modules will need to have a 1024X768 pixel display, it is recommended to use the 1024X768 pixel resolution for the MFILERUNNER program as well.

The MFILES have been successfully tested with MATLAB™ versions 4.2, 5.0, 5.3 and 6.1. Most of the functionality of these m-files can be accessed by using the standard set of MATLAB™ functions, however, a few calls to functions of the statistics toolbox are made. If this toolbox is not available, the calls to these functions can be easily commented out.

3 General Graphical Routines

The following chapters give an overview of how to use the “Graphical Routines” for each supported module.

3.1 Introduction

The purpose of the m-files that are delivered as a support for PEGASUS is to obtain an automated method to evaluate the current performance of the GPS/SBAS/GBAS data in a standardised way. The m-files will enable a user to produce graphs and displays of the current data.

3.2 Getting started

The following section provides an overview of each of the Graphical Routines module. The following sub-sections detail what kind of plot(s) the user can get for each supported module with the corresponding executable. It also details what GUI are launched for each of the executables.

The “Graphical routines” for a given supported module can be started in command line mode by typing:

<Module Code Name>_visu.exe xxx

The <Module Code Name> prefix will be one of the following:

- ‘medll’ for MEDLL module
- ‘prediction’ for Prediction Tool module
- ‘carrierphase’ for Carrier Phase module
- ‘dynamics’ for the Aircraft Dynamics module
- ‘procedure’ for the Procedure module

the ‘xxx’ input argument contains the path and file name of ‘ini’ file used by the module without its extension. For example, in order to visualize the output of the Prediction module, the user shall type in the command prompt:

‘prediction_visu.exe C:\data\prediction’

Where “C:\data\prediction.ini” is the ‘ini’ file used by the prediction module to generate its output(s).

3.3 Detailed Description of the Graphical Routines

3.3.1 SBAS Messages visualisation

The SBAS Visualisation module generates graphs for SBAS Messages analysis containing Slow, Fast and Iono corrections together with SIS statistics.

The interface is separated in four main parts:

- SBAS Fast Corrections analysis (includes time and statistics series cf. 4.1 and 4.4) – analyses the PRN mask and evaluates the fast correction data. It will produce time and statistics interactive plots for the PRC and the UDREI for the satellites that are currently contained in the PRN-mask.
- SBAS Slow Correction analysis (includes time and statistics series cf. 4.1 and 4.4) – analyses the PRN mask and evaluates the slow correction data. It will produce time and statistics interactive plots for the slow corrections (for both velocity codes) for the satellites that are currently contained in the PRN-mask.
- SBAS Iono Corrections - analyses the IGP mask and evaluates the vertical delays and the GIVEI for the transmitted bands and block. It will produce time interactive plots of the vertical delays and GIVEI per point (see chapter 4.9) and an area plot for the whole geographic area (see chapter 4.7). Additionally, it will produce a graph of the area with the currently supported/unsupported IGPs.
- SBAS Message Distribution - analyses the quantity distribution, the time distribution and the broadcast frequency of the messages. It will generate a table with the number of broadcast messages and will display the message type distribution and time difference plots(see chapter 4.10).

3.3.2 WinGPSAll visualisation

The WinGPSAll Visualisation module generates graphs for position solution, protection levels, integrity and availability using data computed by the WinGPSAll module.

The interface is separated in five main parts:

- Interactive Plots – including time series (cf. §4.1) visualising WinGPSAll module output
- Stanford Plots – analyses the horizontal and vertical situation for integrity and availability purposes. It will produce a graphic identical to the one which can be achieved by the Stanford University approach
- North-East error – analyses the horizontal position error on North-east basis
- Time Series for Position error and Protection levels – analyses the position error and protection level data on time basis. It will produce graphics of the horizontal and vertical position error and of the horizontal and vertical protection levels.
- Statistics series - analyses the position error and protection level data and produces histograms of the relevant data.

3.3.3 MEDLL visualisation

The MEDLL module generates per PRN timed data such as the Pseudorange error for example. By launching the 'medll_visu' executable with the proper input argument, the user will have multiple way to visualise and analyse the output data of the module:

- Per PRN Time series (cf. §4.2): To visualise the MEDLL module output data temporally.
- Per PRN Statistics series (cf. §4.4) : To visualise the statistics (histograms, PDF and CDF) of MEDLL module output data.
- Color Sky Plots (cf. §4.5): To visualise the MEDLL module output data grouped in Elevation/Azimuth bins.
- Per PRN Sky Plots (cf. §4.6): To visualise the course of the satellites with regard to the receiver (Elevation/Azimuth positions).

3.3.4 Prediction Tool visualisation

The Prediction Tool module generates multiple output data files. By launching the 'prediction_visu' executable with the proper input argument, the user will have multiple way to visualise and analyse the output data of the module. The launched GUIs will vary depending on the processing configuration (The output files will vary in number and in format depending on the configuration contained in the ini file). Please refer to Prediction Tool module Software User Manual for a description of the 3 three possible computing modes: 'Point' mode, 'Tracked' mode, 'Grid' mode.

3.3.4.1 Point mode and Track mode

Please find below a list of launched GUI for this mode:

- Time series (cf. §4.1): To visualise receiver position used by the "Prediction Tool" module.
- Per PRN Time series (cf. §4.2): To visualise "Prediction Tool" predicted value for satellite information (position, velocity, etc).
- Time series (cf. §4.1): To visualise "Prediction Tool" predicted value for DOP, Protection levels, NSE, etc...
- Statistics series (cf. §4.3) : To visualise the statistics (histograms, PDF and CDF) of "Prediction Tool" predicted value (DOP, Protection levels, NSE, etc)
- Per PRN Sky Plots (cf. §4.6): To visualise the course of the satellites with regard to the receiver (Elevation/Azimuth positions).

3.3.4.2 Grid mode

Please find below a list of launched GUI for this mode:

- Instantaneous Grid Plot Series (cf. §4.7): To visualise the instantaneous “Grid Plot” of “Prediction Tool” predicted value (DOP, Protection levels, NSE, etc)
- Statistics Grid Plot Series (cf. §4.8): To visualise the “Grid Plot” of statistics for “Prediction Tool” predicted value (DOP, Protection levels, NSE, etc)

3.3.5 Carrier Phase visualisation

The Carrier Phase module generates timed data such as the receiver antenna position for example. By launching the ‘carrierphase_visu’ executable with the proper input argument, the user will be able to visualise and analyse the output data of the module with the “Time series” GUI (cf. §4.1).

3.3.6 Dynamics visualisation

The Dynamics module generates timed data such as the Navigation system error for example. By launching the ‘dynamics_visu’ executable with the proper input argument, the user will have multiple way to visualise and analyse the output data of the module:

- Time series (cf. §4.1): To visualise the Dynamics module output data temporally.
- Statistics series (cf. §4.3) : To visualise the statistics (histograms, PDF and CDF) of the Dynamics module output data.

One to five additional figures might be generated depending on the configuration used for the Dynamics module processing (defined in the ‘ini’ file):

- three-dimensional plots of NSFP, AFP and DFP.
- Procedure display with corresponding NSFP and AFP
- Pressure versus height display
- Temperature versus height display
- Aircraft Dynamics display (Acceleration, Ground Speed and Attitude)

3.3.7 Procedure visualisation

Depending on the configuration contained in the ‘ini’ file one to three figures are generated:

- Procedure display: always generated
- Message type 2 display: generated if message available
- Message type 4 display: generated if message available

All three figures does not require any interaction with the user.

3.4 Operating Modes

All five module visualisation executables can be operated in two modes:

1. Embedded Mode:

The executables are run inside the PEGASUS frame via the M-file runner module. This mode of operation is described in **Error! Reference source not found.**

2. Command-line Mode:

The Graphical routines for a given supported module can be started in command line mode by typing:

<Module Name>_visu.exe xxx

the 'xxx' input argument contains the path and file name of 'ini' file used by the module without its extension. For example, in order to visualize the output of the Prediction module, the user shall type in the command prompt:

' prediction_visu.exe C:\data\prediction '

Where "C:\data\prediction.ini" is the 'ini' file used by the prediction module to generate its output(s).

4 Services

4.1 “Time series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Time series” GUI.

4.1.1 Main GUI

The “Time series” GUI is presented in Figure 4.1-1.

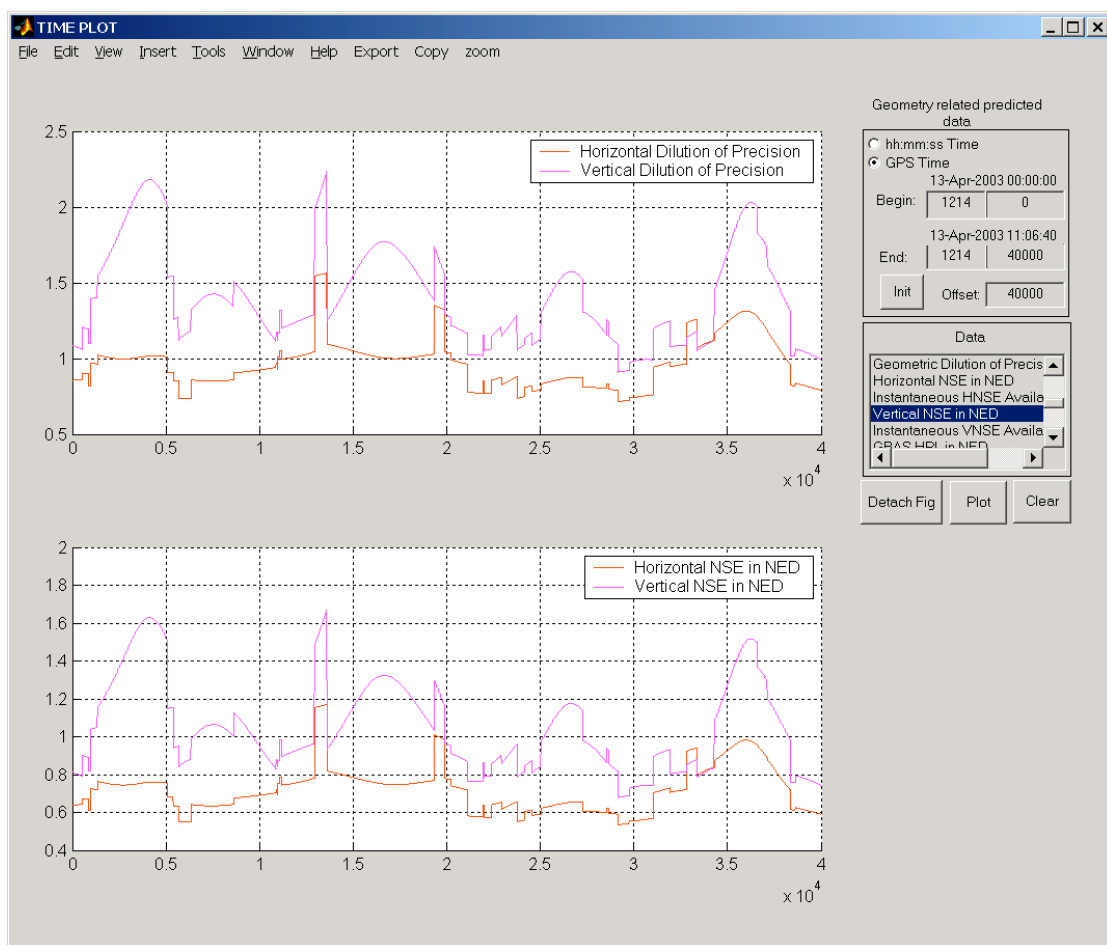


Figure 4.1-1: “Time series” main window

From the main window 4 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will be displayed
2. “Time Frame”: Selection/Display of time begin, end, and offset
3. “Data List”: List of available data for plotting
4. “Action buttons”: “Detach Fig”, “Clear”, “Plot”

4.1.2 Step-by-step Overview

In the following sections the main steps ‘how-to-use’ the “Time Plot” GUI are described.

Step1: Select Data to plot

Single plot: select a data by clicking on its description in the “Data list” list box

Multiple subplots: hold the control key [Ctrl] and click on one or more data that you want to plot in the “Data list” list box.

Step 2: Click On “Clear” button

A click on this button will delete all graphics in current GUI if any. This button will have no effect if nothing is plotted yet.

Step 3: Click On “Plot” button

When you click on this button, the data you have selected in the first step will be plotted as a function of time. See section 4.1.3.3 for more explanations on this feature.

Step 4: Click On “Detach Fig” button

Click on this button to “detach” the current plots from the GUI by creating a new figure. See section 4.1.3.5 for more explanations on this feature.

Step 5: Save the figure

Click on the export menu to save the current figure in one of the proposed format. See section 4.1.3.5 for more explanations on this feature.

4.1.3 Detailed Description of the GUI

4.1.3.1 The “Time frame”

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).
- End of GPS time (Week and Second edit boxes): The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box): The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.1.3.2 The “Data list frame”

This list box display a list of data available for plotting. The user can select more than one data by pressing the [Ctrl] key before left-clicking with the mouse.

4.1.3.3 The “Plot” button

This button allows to plot the data selected in the “Data List” against the time window displayed in the “Time Frame”.

Important Note:

- The number of subplots will be equal to the number of data selected.

Each time the user click on the plot button, the software will first check the current state of the graphics sub-window:

If empty, the software will create one or more subplot depending on the selected data. If not empty and if the current number of subplot is different from the number of data selected, the software will erase the current subplot(s) before plotting the new one(s). If not empty and if the current number of subplot is equal to the number of data selected, the software will plot the new data onto current subplot(s) while conserving current graphics.

4.1.3.4 The “Clear” button

This button deletes all the graphics of current GUI.

4.1.3.5 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,

- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.2 “Per PRN Time series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Per PRN Time series” GUI. This GUI differs from the “Time series” one in that the user can select the data he wants to plot on a per PRN basis. This implies that multiple data cannot be plotted in the same subplot.

4.2.1 Main GUI

The “Per PRN Time series” GUI is presented in Figure 4.2-1.

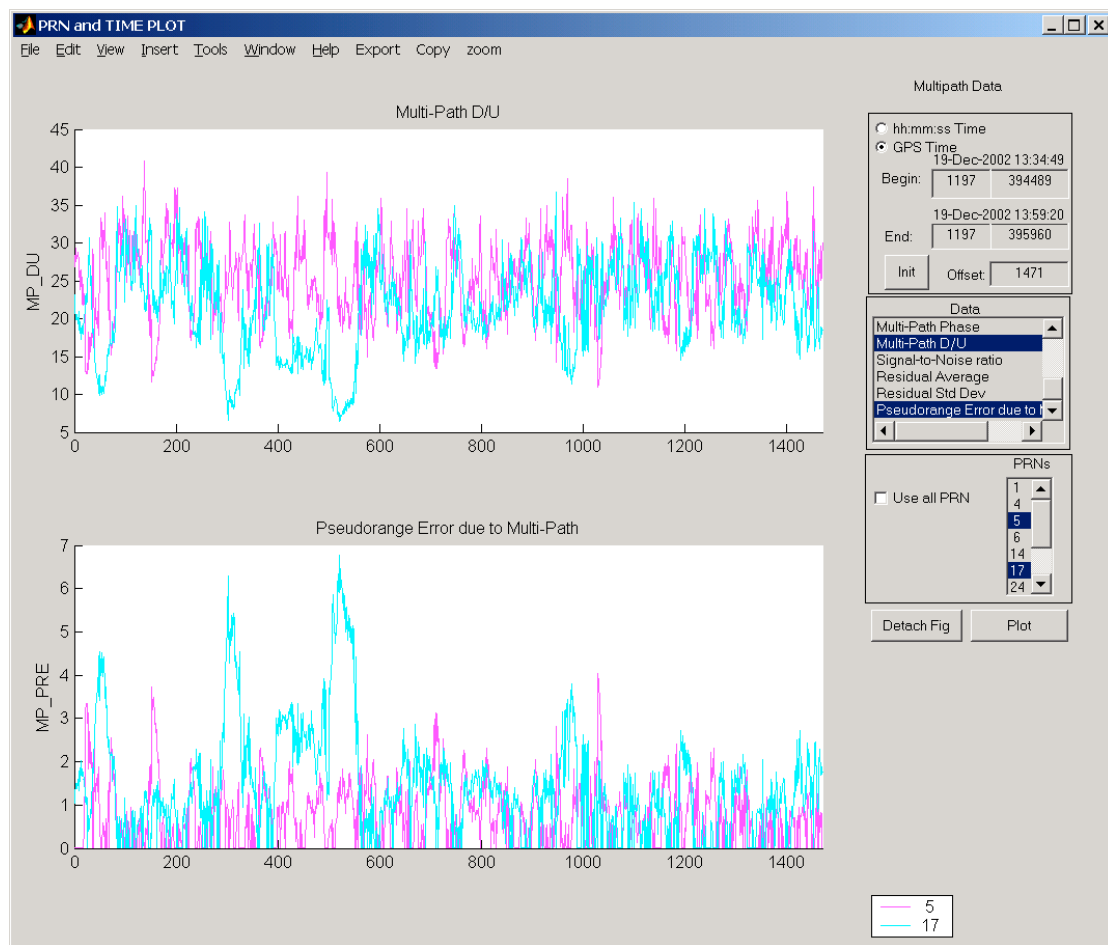


Figure 4.2-1: “Per PRN Time series” main window

From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Time Frame”: Selection/Display of time begin, end, and offset
3. “Data List Frame”: List of available data for plotting
4. “PRN List Frame”: List of available PRN for plotting
5. Action buttons: “Detach Fig”, “Plot”

4.2.2 Step-by-step Overview

In the following sections the main steps ‘how-to-use’ the “Per PRN Time Plot” GUI are described:

- Step 1: Select Data to plot
 - Single plot: select a data by clicking on its description in the “Data list” list box
 - Multiple subplots: hold the control key [Ctrl] and click one or more time on the data you want to plot in the “Data list” list box.
- Step 2: Select PRN(s) to plot
 - Single PRN: select a PRN by clicking on it in the “PRN list” list box
 - Multiple PRN: hold the control key [Ctrl] and click one or more time on the PRN(s) you want to plot in the “PRN list” list box.
 - All PRN: click on the “All PRN” check box.
- Step 3: Click On “Plot” button
When you click on this button, the data you have selected in the first step will be plotted as a function of time for all selected PRN (in step 2).
- Step 4: Click On “Detach Fig” button
Click on this button to “detach” the current plots from the GUI by creating a new figure.
- Step 5: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.2.3 Detailed Description of the GUI

4.2.3.1 The “Time frame”

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).
- End of GPS time (Week and Second edit boxes) : The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box) : The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.2.3.2 The “Data list frame”

This list box display a list of data available for plotting. The user can select more than one data by pressing the [Ctrl] key before left-clicking with the mouse.

4.2.3.3 The “PRN list frame”

The user can choose here the PRN for which he wants to analyse the Data selected in the “Data list frame”.

The check-box “Use All PRN” allows to select all the PRN displayed in the list box in one go.

4.2.3.4 The “Plot” button

This button allows to plot the data selected in the “Data List” for the PRN selected in the “PRN list frame” against the time window displayed in the “Time Frame”.

Important Notes:

- The number of subplots will be equal to the number of data selected. All previous graphics will be deleted.
- The number of curves will be equal to the number of PRN selected in the “PRN list frame”.

4.2.3.5 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

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- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.3 “Statistics series” Graphical Interface

This section provides an overview of the graphical user interface of the “Statistics series” GUI. This GUI differs from the “Time series” in that the data is not simply displayed as a function of time. Instead, the statistical properties of the data are analysed and three types of plot are offered to the user: histograms, PDF and CDF. The following section will help the user understanding the workings of this GUI.

4.3.1 Main GUI

The “Statistics series” GUI is presented in Figure 4.3-1.

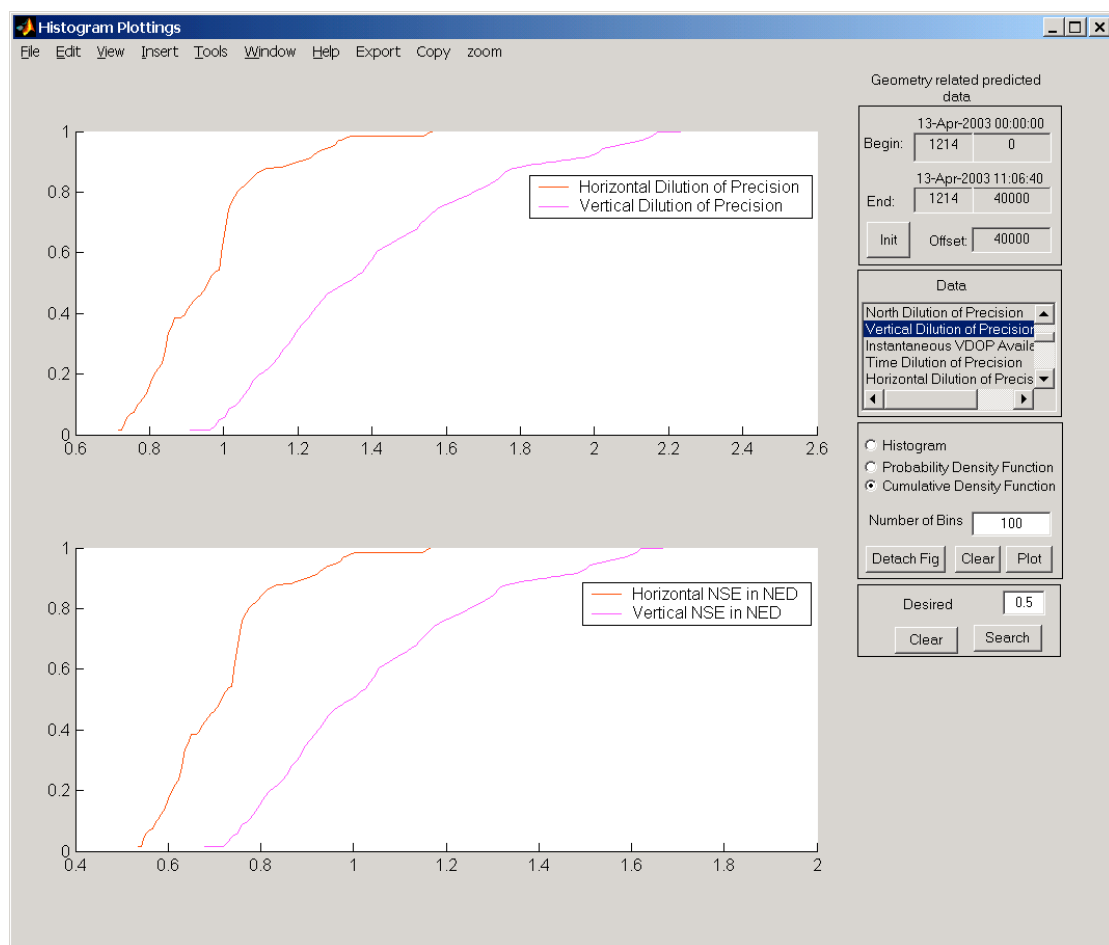


Figure 4.3-1: “Statistics series” main window

From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Time Frame”: Selection/Display of time begin, end, and offset
3. “Data List”: List of available data for processing and display
4. “Action Frame”: Selection of Statistics Type and Action buttons (“Detach Fig”, “Clear”, “Plot”)
5. “Desired Probability Frame”: Set and search desired Probability, this frame is not always visible (c.f. §4.3.3.8).

4.3.2 Step-by-step Overview

In the following sections the main steps 'how-to-use' the "Statistics series" GUI are described:

- Step 1: Select Data to analyse for statistics plot.
 - Single plot: select a data by clicking on its description in the "Data list" list box.
 - Multiple subplots: hold the control key [Ctrl] and click one or more time on the data you want to plot in the "Data list" list box.
- Step 2: Click On "Clear" button
A click on this button will delete all graphics in current GUI if any. This button will have no effect if there is nothing plotted yet.
- Step 3: Select type of statistics
 - Histogram: right-click on "Histogram" radio-button
 - PDF: right-click on "Probability Density Function" radio-button
 - CDF: right-click on "Cumulative Density Function" radio-button
- Step 4: Click On "Plot" button
When you click on this button, depending on what type of statistics you selected in the previous step, histogram(s), PDF(s) or CDF(s) of the data selected in the first step will be plotted.
- Step 5: Click On "Detach Fig" button
Click on this button to "detach" the current plots from the GUI by creating a new figure.
- Step 6: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.3.3 Detailed Description of the GUI

4.3.3.1 The "Time frame"

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).
- End of GPS time (Week and Second edit boxes): The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box) : The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.3.3.2 The “Data list frame”

This list box display a list of data available for plotting. The user can select more than one data by pressing the [Ctrl] key before left-clicking with the mouse.

4.3.3.3 The “Statistics Type” radio-buttons

Right-click on the radio-button of your choice to select histograms, PDF (Probability Density Function) or CDF (Cumulative Density Function).

4.3.3.4 The “Number of bins” edit box

This edit box allows the user to change the number of bins used for statistics calculation. To change this value, right-click on it and type in the value you want. To validate this new number of bins, right-click on the “Plot” button or type [Enter] key of your keyboard.

4.3.3.5 The “Plot” button

This button allows to plot statistics for the data selected in the “Data List”. **The number of subplots will be equal to the number of data selected. All previous graphics will be deleted.**

The statistics are calculated with the displayed “number of bins” just before being plotted. Only the subset of data corresponding to the time window displayed in the “Time Frame” will be used for the calculation.

Each time the user click on the plot button, the software will first check the current state of the graphics sub-window:

If empty, the software will create one or more subplot depending on the selected data.

If not empty and if the current number of subplot is different from the number of data selected, the software will erase the current subplot(s) before plotting the new one(s)

If not empty and if the current number of subplot is equal to the number of data selected, the software will plot the new data onto current subplot(s) while conserving current graphics.

4.3.3.6 The “Clear” button

This button deletes all the graphics of current GUI.

4.3.3.7 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile ('emf' extension)
- 256 colours Windows Bitmap ('bmp' extension)
- JPEG image ('jpg' extension)
- PNG image ('png' extension)
- PDF format ('pdf' extension)
- Encapsulated Postscript ('eps' extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.3.3.8 The “Desired Probability” frame

This frame allows the user to search for a desired probability for all the curves plotted in the “Graphics” sub-window. **This frame is only visible in the “Statistics Type” is set to “Cumulative Density Function” (c.f. §4.3.3.3).** The frame is composed of :

- an edit box to input the desired probability
Any value between 0 and 1 is allowed.
- a search button to search for the desired probability
A right-click on this button will search for the value displayed in the edit box above in all the curves plotted in the “Graphics” sub-window. It will also draw some line and circles to show found values (see Figure 4.1-1).
- a clear button to clear all the texts and lines drawn by the search button.

4.4 “Per PRN Statistics series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Per PRN Statistics series” GUI. This GUI differs from the “per PRN Time series” in that the data is not simply displayed as a function of time. Instead, the statistical properties of the data is analysed and three type of plot are offered to the user: histograms, PDF and CDF. This GUI differs from the “Statistics series” one in that the user can select the data he wants to analyse statistics for on a per PRN basis. This implies that multiple data cannot be plotted in the same subplot.

4.4.1 Main GUI

The “Statistics series” GUI is presented in Figure 4.4-1.

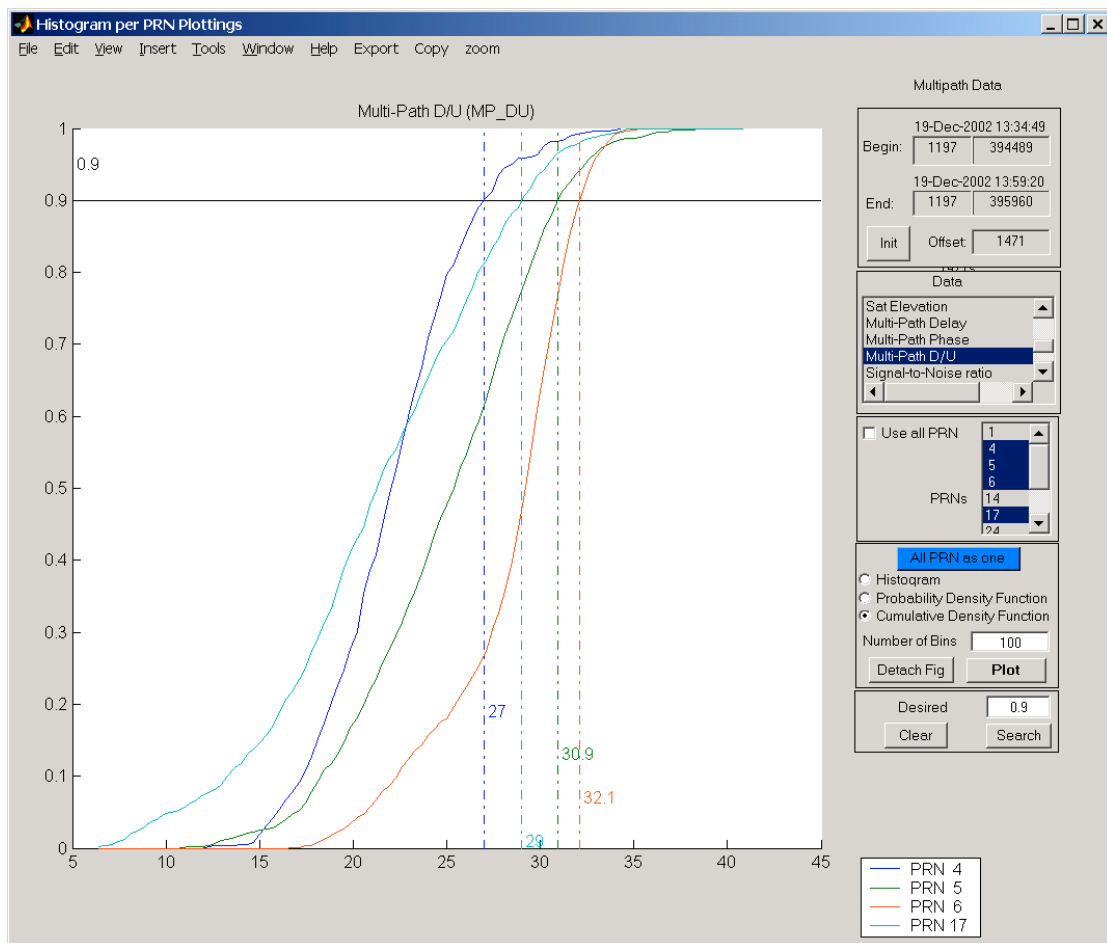


Figure 4.4-1: “Per PRN Statistics series” main window

From the main window the 5 different parts can be seen:

“Graphics sub-window”: where all the graphics will go

“Time Frame”: Selection/Display of time begin, end, and offset

“Data List”: List of available data for processing and display

“Action Frame”: Selection of Statistics Type and Action buttons (“Detach Fig”, “Clear”, “Plot”)

“Desired Probability Frame”: Set and search desired Probability, this frame is not always visible (c.f. §4.4.3.9).

4.4.2 Step-by-step Overview

In the following sections the main steps ‘how-to-use’ the “Statistics series” GUI are described:

- Step 1: Select Data to analyse for statistics plot.
 - Single plot: select a data by clicking on its description in the “Data list” list box.
 - Multiple subplots: hold the control key [Ctrl] and click one or more time on the data you want to plot in the “Data list” list box.
- Step 2: Select PRN(s) to plot
 - Single PRN: select a PRN by clicking on it in the “PRN list” list box
 - Multiple PRN: hold the control key [Ctrl] and click one or more time on the PRN(s) you want to plot in the “PRN list” list box.
 - All PRN: click on the “All PRN” check box.
- Step 3: Select type of statistics
 - Histogram: right-click on “Histogram” radio-button
 - PDF: right-click on “Probability Density Function” radio-button
 - CDF: right-click on “Cumulative Density Function” radio-button
- Step 4: Click On “Plot” button
When you right-click on this button, depending on what type of statistics you selected in the previous step, histogram(s), PDF(s) or CDF(s) of the data selected in the first step will be plotted.
- Step 5: Click On “Detach Fig” button
Right-Click on this button to “detach” the current plots from the GUI by creating a new figure.
- Step 6: Save the figure
Right-Click on the export menu to save the current figure in one of the proposed format.

4.4.3 Detailed Description of the GUI

4.4.3.1 The “Time frame”

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).

- End of GPS time (Week and Second edit boxes) : The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box) : The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.4.3.2 The “Data list frame”

This list box display a list of data available for plotting. The user can select more than one data by pressing the [Ctrl] key before left-clicking with the mouse.

4.4.3.3 The “PRN list frame”

The user can choose here the PRN for which he wants to analyse the Data selected in the “Data list frame”.

The check-box “Use All PRN” allows to select all the PRN displayed in the list box in one go.

4.4.3.4 The “All PRN as one” toggle button

When this toggle button is set (by right-clicking on it), the PRN selected in the “PRN list frame” will be grouped for each data selected in the “Data list frame”. Then the new “All PRN as one” data will be used for the calculation.

4.4.3.5 The “Statistics Type” radio-buttons

A right-click on one of the three radio-buttons allows the user to select histograms, PDF (Probability Density Function) or CDF (Cumulative Density Function).

4.4.3.6 The “Number of bins” edit box

This edit box allows the user to change the number of bins used for statistics calculation. To change this value, right-click on it and type in the value you want. To validate this new number of bins, right-click on the “Plot” button or type [Enter] key of your keyboard.

4.4.3.7 The “Plot” button

This button allows to plot statistics for the data selected in the “Data List” and the PRN selected in the “PRN list frame”.

Important Notes:

- The number of subplots will be equal to the number of data selected. All previous graphics will be deleted.
- If “All PRN as One” toggle button is set, the number of curves will be equal to the number of PRN selected in the “PRN list frame”, else there will be only one curve.

The statistics are calculated with the displayed “number of bins” just before being plotted. Only the subset of data corresponding to the time window displayed in the “Time Frame” and the PRN selected in the “PRN list frame” will be used for the calculation.

4.4.3.8 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.4.3.9 The “Desired Probability” frame

This frame allows the user to search for a desired probability for all the curves plotted in the “Graphics” sub-window. **This frame is only visible in the “Statistics Type” is set to “Cumulative Density Function” (c.f. §4.4.3.4).** The frame is composed of :

- an edit box to input the desired probability
Any value between 0 and 1 is allowed.
- a search button to search for the desired probability
A right-click on this button will search for the value displayed in the edit box above in all the curves plotted in the “Graphics” sub-window. It will also draw some line and circles to show found values (see Figure 4.1-1).
- a clear button to clear all the texts and lines drawn by the search button.

4.5 “Color Sky Plot Series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Color Sky Plot Series” GUI. This GUI differs from the “Time series” in that the data is not simply displayed as a function of time. Instead, the data are first sorted on a Elevation/Azimuth basis and three types of “Color Sky Plot” are offered to the user: minimum Value, maximum Value and mean Value.

4.5.1 Main GUI

The “Color Sky Plot Series” GUI is presented in Figure 4.5-1.

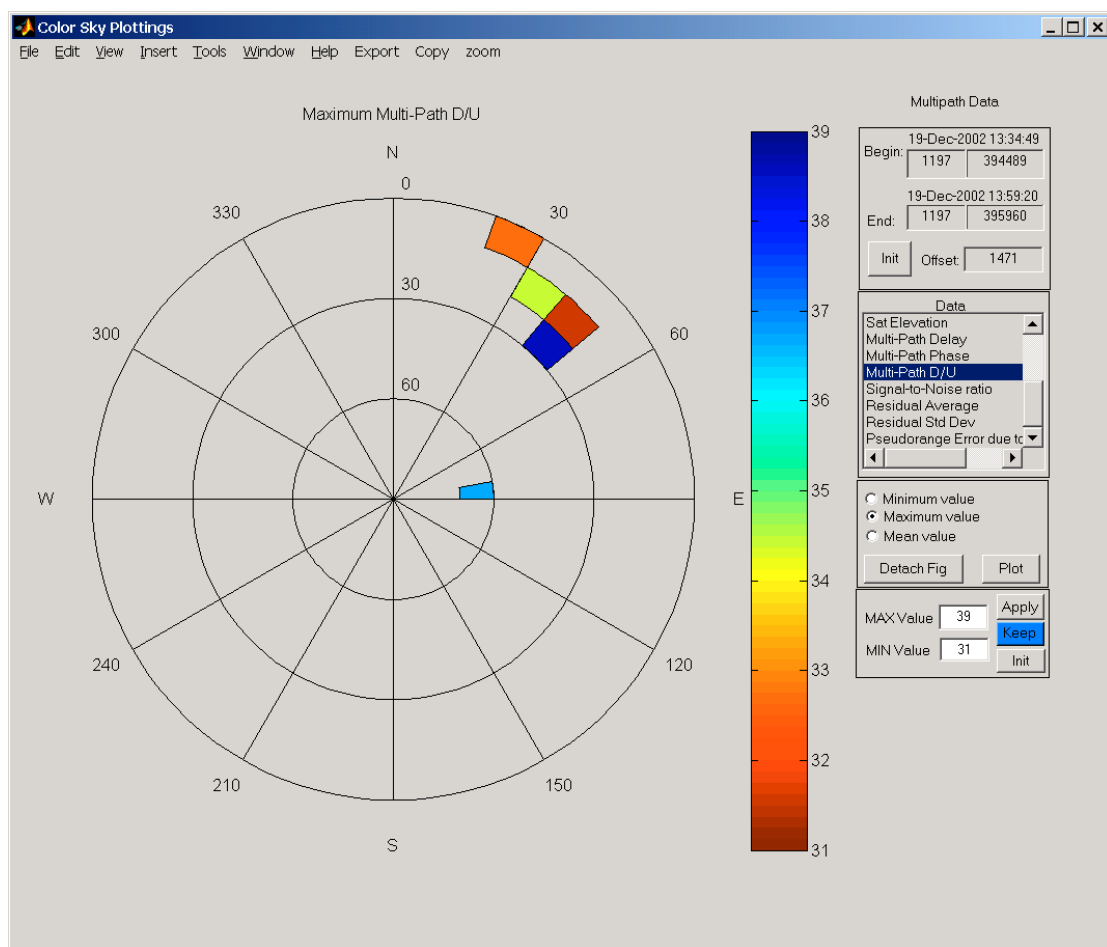


Figure 4.5-1: “Color Sky Plot series” main window

From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Time Frame”: Selection/Display of time begin, end, and offset
3. “Data List”: List of available data for processing and display
4. “Action Frame”: Selection of Plot Type and Action buttons (“Detach Fig”, “Plot”)
5. “Range Frame”: Set or Initialise minimum and maximum values for current plots.

4.5.2 Step-by-step Overview

In the following sections the main steps 'how-to-use' the "Color Sky Plot Series" GUI are described:

- Step 1: Select Data to analyse for statistics plot.
 - Single plot: select a data by clicking on its description in the "Data list" list box.
 - Multiple subplots: hold the control key [Ctrl] and click one or more time on the data you want to plot in the "Data list" list box.
- Step 2: Click On "Clear" button
A click on this button will delete all graphics in current GUI if any. This button will have no effect if there is nothing plotted yet.
- Step 3: Select type of "Color Sky Plot"
 - Minimum value: minimum value of the data will be plotted
 - Maximum value: maximum value of the data will be plotted
 - Mean value: mean value of the data will be plotted
- Step 4: Click On "Plot" button
When you click on this button, depending on what type of statistics you selected in the previous step, minimum "Color Sky plot(s)", "maximum Color Sky plot(s)" or "mean Color Sky plot(s)" of the data selected in the first step will be plotted.
- Step 5: Click On "Detach Fig" button
Click on this button to "detach" the current plots from the GUI by creating a new figure.
- Step 6: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.5.3 Detailed Description of the GUI

4.5.3.1 The “Time frame”

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).
- End of GPS time (Week and Second edit boxes) : The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box) : The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.5.3.2 The “Data list frame”

This list box display a list of data available for plotting. The user can select more than one data by pressing the [Ctrl] key before left-clicking with the mouse.

4.5.3.3 The “Plot Type” radio-buttons

Right-click on the radio-button of your choice to select minimum Color Sky plot, maximum Color Sky plot or mean Color Sky plot.

4.5.3.4 The “Plot” button

This button allows to Color Sky Plot(s) for the data selected in the “Data List”.

Important Notes:

- The number of subplots will be equal to the number of data selected. All previous graphics will be deleted.
- Only the subset of data corresponding to the time window displayed in the “Time Frame” will be used for the calculation.

4.5.3.5 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.5.3.6 The “Range frame”

This frame allows the user to fix minimum and maximum values for the Sky Plots currently under display.

The frame is composed of :

- a “MIN” edit box to input the minimum desired value.
- a “MAX” edit box to input the maximum desired value.
- an “Apply” button to apply minimum and/or maximum value currently displayed in the “MIN” and “MAX” edit boxes.
- a “Keep” toggle button to force any new plot to use current range values.
- an “Init” button to initialise “MIN” and “MAX” edit boxes to the true minimum and maximum values of the currently selected data.

4.6 “Per PRN Sky Plot Series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Per PRN Sky Plot Series” GUI. This GUI allows the user to plot satellite position (i.e. Elevation/Azimuth) with regard to the receiver for a certain time windows.

4.6.1 Main GUI

The “Per PRN Sky Plot Series” GUI is presented in Figure 4.6-1.

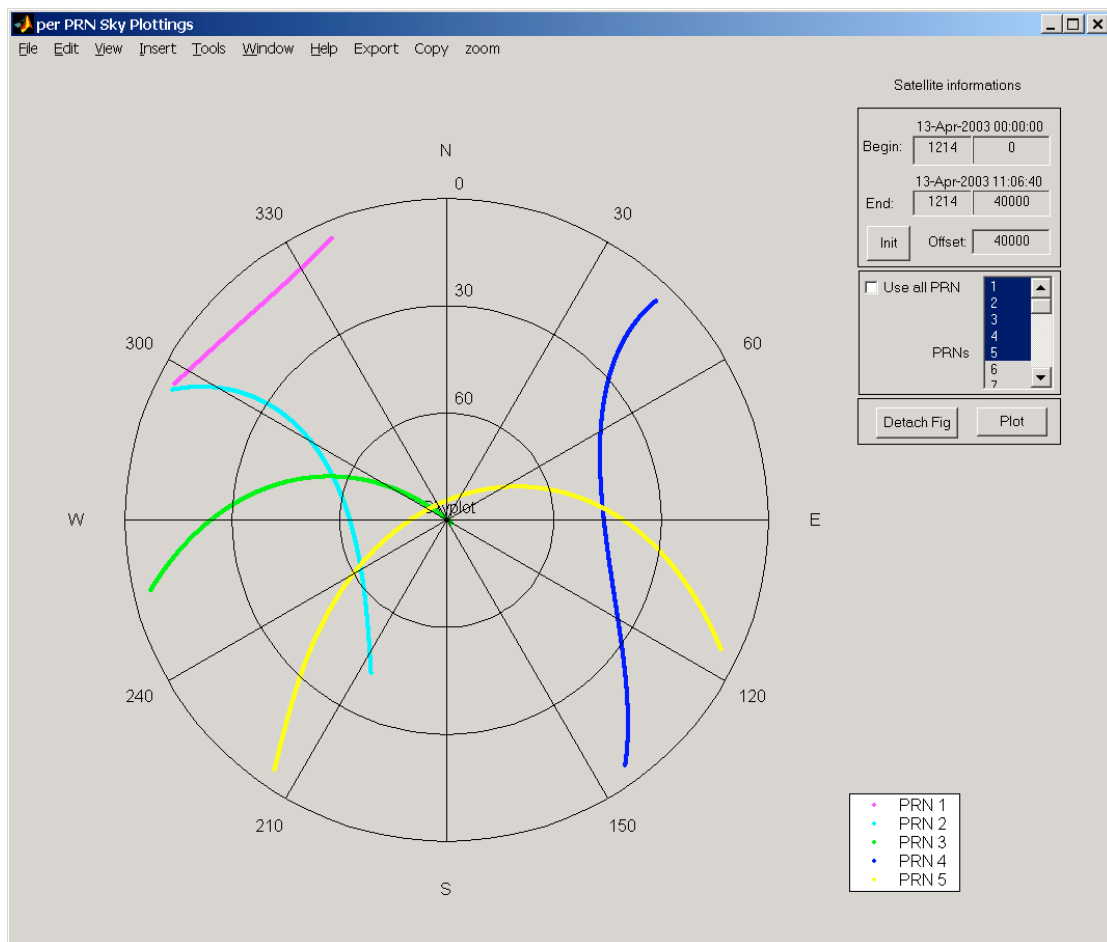


Figure 4.6-1: “Per PRN Sky Plot series” main window

From the main window the 4 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Time Frame”: Selection/Display of time begin, end, and offset
3. “PRN List”: List of available data for processing and display
4. “Action Frame”: “Detach Fig” and “Plot” buttons

4.6.2 Step-by-step Overview

In the following sections the main steps ‘how-to-use’ the “Per PRN Sky Plottings” GUI are described:

- Step 1: Select PRN for “Sky plots”.
- Step 2: Click On “Plot” button
“Sky Plot” of each selected PRN will be plotted.
- Step 3: Click On “Detach Fig” button
Click on this button to “detach” the current plots from the GUI by creating a new figure.
- Step 4: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.6.3 Detailed Description of the GUI

4.6.3.1 The “Time frame”

This group of edit boxes and button allows to control the time windows that applies to current plots. When edited, the user can change any of the following information:

- Beginning of GPS time (Week and Second edit boxes): The displayed time refers to the time begin of the plot(s).
- End of GPS time (Week and Second edit boxes): The displayed time refers to the time end of the plot(s).
- Offset time (Second only edit box): The displayed time refers to the time window length in seconds. It is always equal to elapsed time between time begin and time end.

To change any of these times, edit one of the five edit boxes and click on the “Plot” button or type [Enter] key of your keyboard.

Remark 1: The Gregorian date/time above these edit boxes will automatically reflect the time change.

Remark 2: The time displayed in the edit boxes are automatically updated to reflect any change done manually by the user in one of the edit boxes.

The “Init” button permits to initialise the time window to the time begin and time end of the original data.

4.6.3.2 The “PRN list frame”

The user can choose here the PRN for which he wants to analyse the Data selected in the “Data list frame”.

The check-box “Use All PRN” allows to select all the PRN displayed in the list box in one go.

4.6.3.3 The “Plot” button

This button allows to plot “Sky Plot(s)” for each selected PRN.

Important Note:

- Only the subset of data corresponding to the time window displayed in the “Time Frame” will be used for the calculation.

4.6.3.4 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.7 “Instantaneous Grid Plot Series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Instantaneous Grid Plot Series” GUI. This GUI differs from the “Time series” in that the data is not simply plotted as a function of time. Instead, the data are plotted as a function of the receiver horizontal position (Latitude/Longitude) for a given time.

4.7.1 Main GUI

The “Instantaneous Grid Plot Series” GUI is presented in Figure 4.7-1.

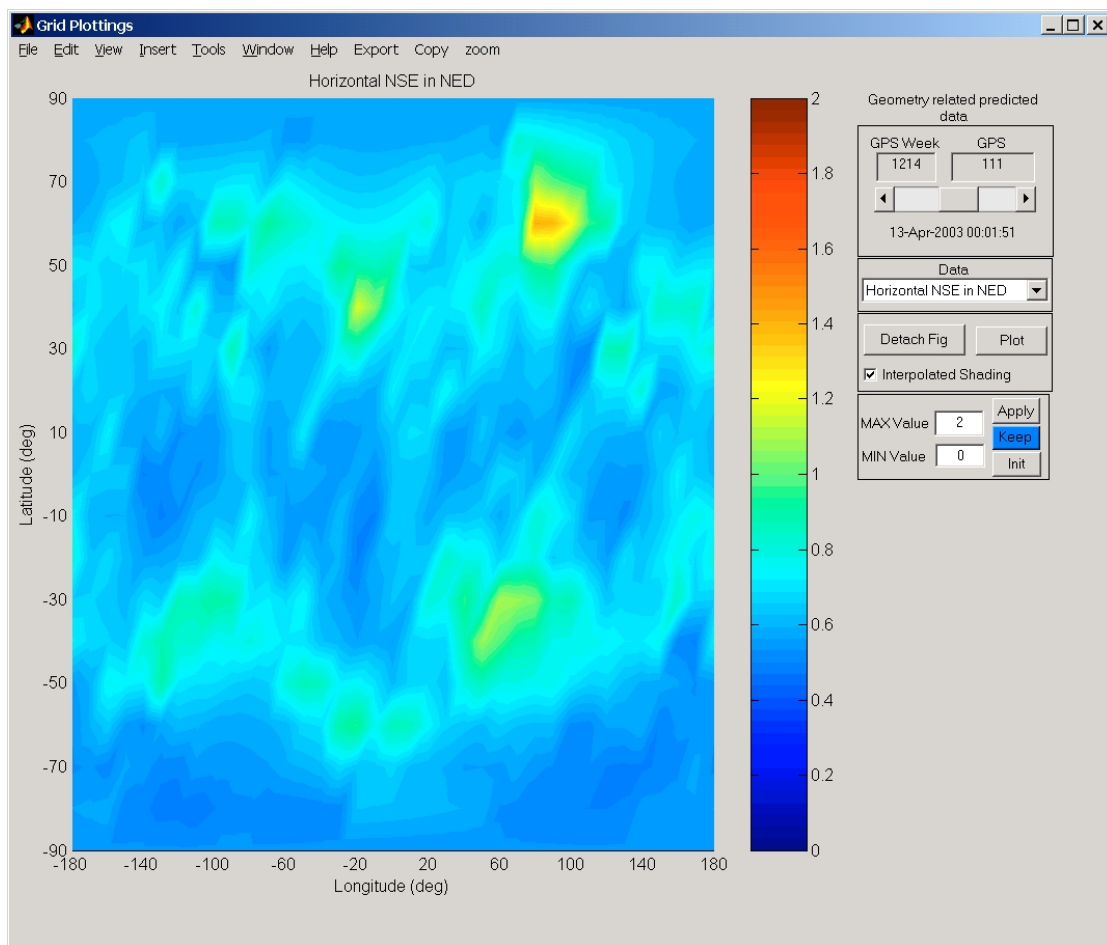


Figure 4.7-1: “Instantaneous Grid Plot Series” GUI main window

From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Time Frame”: Selection of time of application
3. “Data List”: List of available data for processing and display
4. “Action Frame”: Action buttons (“Detach Fig”, “Plot”) and Selection of Plot Type
5. “Range Frame”: Set or Initialise minimum and maximum values for current plots.

4.7.2 Step-by-step Overview

In the following sections the main steps 'how-to-use' the "Instantaneous Grid Plot Series" GUI are described:

- Step 1: Select Data to analyse for statistics plot.
- Step 2: Click on "Plot" button
When you right-click on this button the "Instantaneous Grid Plot" of the data selected in the first step will be plotted. The time of application is displayed in the "Time frame".
- Step 3: Click on the "Interpolated shading" check box
This will change the grid plot aspect to an interpolated shading.
- Step 4: Change the time of application
Right-click on the right or left arrow of the "Time frame slider" to navigate the "Grid Plot" chronologically.
- Step 5: Click on "Detach Fig" button
Click on this button to "detach" the current plots from the GUI by creating a new figure.
- Step 6: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.7.3 Detailed Description of the GUI

4.7.3.1 The "Time frame"

The "Time frame" allows the user to change the time of application of the "Instantaneous Grid Plot" currently under display.

This frame is composed of:

- two edit boxes to let the user input GPS time (Week and Sec) manually,
- a "time slider" to move the time chronologically,
- a "date/time text" to display the current Gregorian data/time.

All components are all linked to provide consistent display for each user operation on the UI controls.

4.7.3.2 The "Data list frame"

This is a pop-up menu allowing the user to select one data for "Instantaneous Grid Plotting".

4.7.3.3 The “Plot” button

This button allows to “Instantaneous Grid Plot” for the data selected in the “Data List frame” and the time of application displayed in the “Time frame”.

4.7.3.4 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.7.3.5 The “Range frame”

This frame allows the user to fix minimum and maximum values for the Sky Plots currently under display.

The frame is composed of :

- a “MIN Value” edit box to input the minimum desired value.
- a “MAX Value” edit box to input the maximum desired value.
- an “Apply” button to apply minimum and/or maximum value currently displayed in the “MIN” and “MAX” edit boxes.
- a “Keep” toggle button to force any new plot to use current range values.
- an “Init” button to initialise “MIN” and “MAX” edit boxes to the true minimum and maximum values of the currently selected data.

4.8 “Statistics Grid Plot Series” Graphical Interface

The following section provides an overview of the graphical user interface of the “Statistics Grid Plot Series” GUI. This GUI differs from the “Instantaneous Grid Plot series” in that it is independent of time. This GUI has been designed to visualise the **“GBAS-MARS 2 Prediction Tool”** module statistics output.

4.8.1 Main GUI

The “Statistics Grid Plot Series” GUI is presented in Figure 4.8-1.

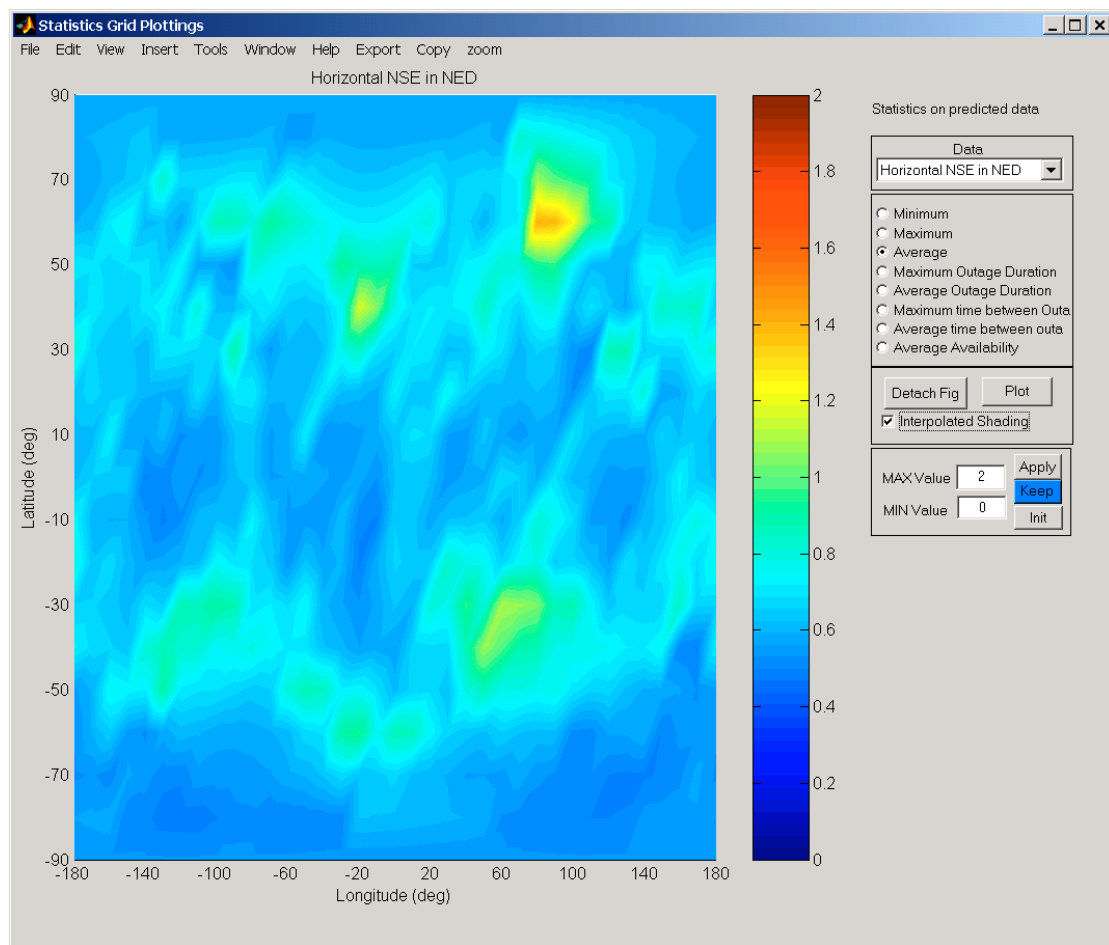


Figure 4.8-1: “Statistics Grid Plot Series” GUI main window

From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go
2. “Data List”: List of available data for processing and display
3. “Statistics Type frame”: List of available statistics for grid plotting.
4. “Action Frame”: Action buttons (“Detach Fig”, “Plot”) and Selection of Plot Type
5. “Range Frame”: Set or Initialise minimum and maximum values for current plots.

4.8.2 Step-by-step Overview

In the following sections the main steps 'how-to-use' the "Instantaneous Grid Plot Series" GUI are described:

- Step 1: Select Data to analyse for statistics plot.
- Step 2: Select type of "Statistics Grid Plot"
- Step 3: Click On "Plot" button
When you right-click on this button the "Instantaneous Grid Plot" of the data selected in the first step will be plotted. The time of application is displayed in the "Time frame".
- Step 4: Click on the "Interpolated shading" check box
This will change the grid plot aspect to an interpolated shading.
- Step 5: Click On "Detach Fig" button
Click on this button to "detach" the current plots from the GUI by creating a new figure.
- Step 6: Save the figure
Click on the export menu to save the current figure in one of the proposed format.

4.8.3 Detailed Description of the GUI

4.8.3.1 The "Data list"

This is a pop-up menu allowing the user to select one data for "Statistics Grid Plotting".

4.8.3.2 "Statistics Type" radio-buttons

Height radio-buttons are available for the user to select the statistics of his choice:

- Minimum: minimum value of the data will be plotted
- Maximum: maximum value of the data will be plotted
- Average : average value of the data will be plotted
- Maximum outage duration
- Average outage duration
- Maximum time between outages
- Average time between outages
- Average availability

4.8.3.3 The "Plot" button

This button allows to "Grid Plot" selected statistics for the data selected in the "Data List".

Important Notes:

- If the Grid Plot displayed has a constant value of **-1** means that this type of statistics is not applicable for currently selected data (egg. there is no outage).
- If the Grid Plot displayed has a constant value of **-2** means that this type of statistics is not calculated in current version of the **“GBAS-MARS 2 Prediction Tool”** module.

4.8.3.4 The “Detach Fig” button

This button allows all the graphics of current GUI to be copied onto a new figure. This button should be used whenever the user is happy with the data displayed and wants to save the results.

This new figure does not contain any user interface control but permits to manipulate the graphics by means of the figure toolbar.

In addition the new figure contains some useful information about the displayed data in an info box at the right of the graphics sub-window.

By clicking the export menu, the user can save the current figure in one of the proposed format (a popup window allows to name the graphics file):

- Enhanced Windows Metafile (‘emf’ extension)
- 256 colours Windows Bitmap (‘bmp’ extension)
- JPEG image (‘jpg’ extension)
- PNG image (‘png’ extension)
- PDF format (‘pdf’ extension)
- Encapsulated Postscript (‘eps’ extension)

By clicking the copy menu, the user can copy the current figure:

- to Clipboard in Metafile format,
- to Clipboard in Bitmap format,
- to Current Printer in color,
- to Current Printer in monochrome,
- to Selected Printer.

4.8.3.5 The “Range frame”

This frame allows the user to fix minimum and maximum values for the Sky Plots currently under display.

The frame is composed of :

- a “MIN Value” edit box to input the minimum desired value.
- a “MAX Value” edit box to input the maximum desired value.
- an “Apply” button to apply minimum and/or maximum value currently displayed in the “MIN” and “MAX” edit boxes.
- a “Keep” toggle button to force any new plot to use current range values.

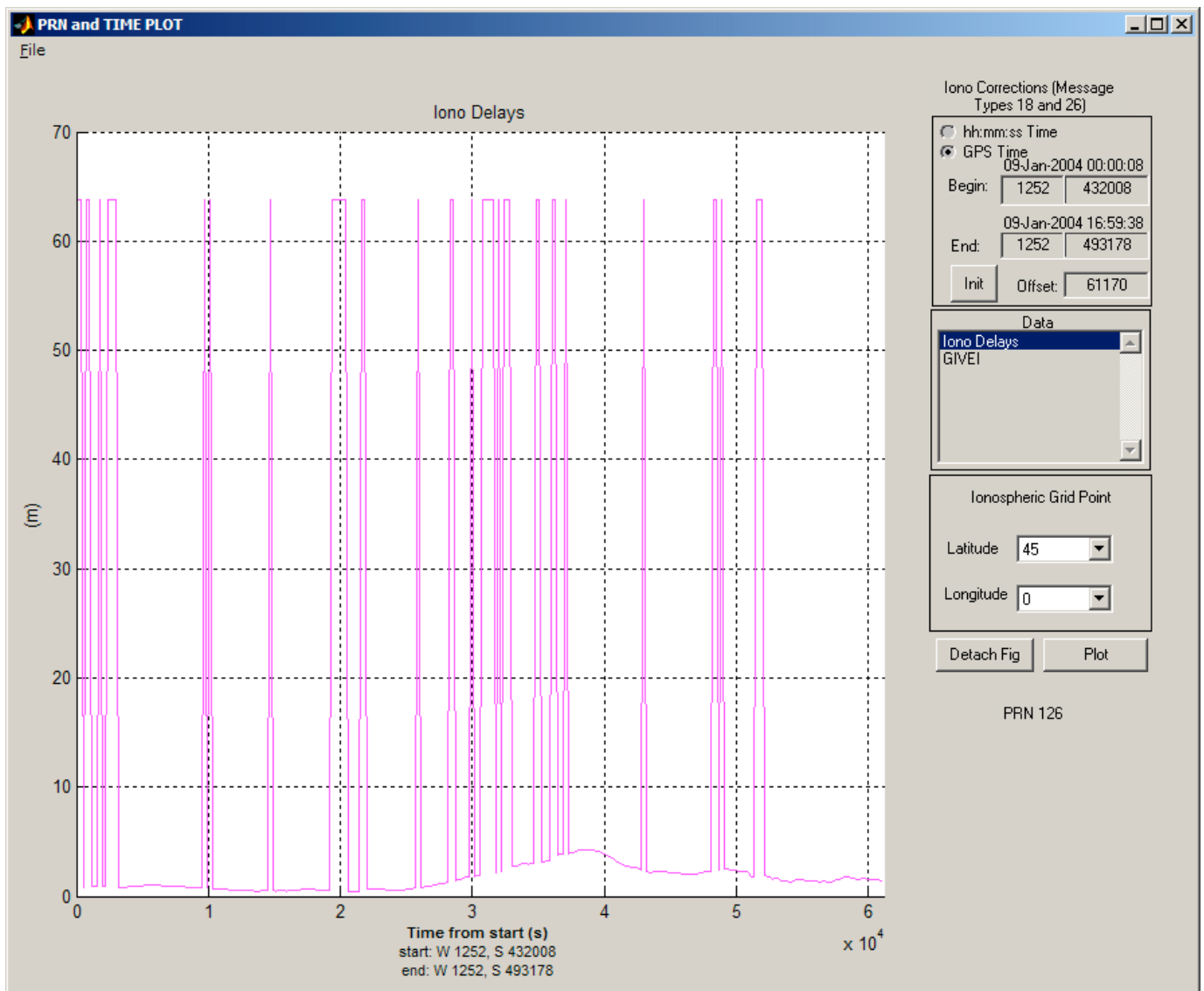
- an “Init” button to initialise “MIN” and “MAX” edit boxes to the true minimum and maximum values of the currently selected data.

4.9 SBAS Iono Corrections time plot

This time plot allows the plotting of the Iono delays and GIVEI on time bases. This GUI is very similar to the “Time series” but it differs in that the user can select the data he wants to plot on a per Grid point basis.

4.9.1 Main GUI

The GUI is very similar to the “Time series” interface including a possibility to select the grid point to be used for plotting



From the main window the 5 different parts can be seen:

1. “Graphics sub-window”: where all the graphics will go

2. "Time Frame": Selection/Display of time begin, end, and offset
3. "Data List Frame: List of available data for plotting
4. "Ionospheric Grid points": List of grid points to plot
5. Action buttons: "Detach Fig", "Plot"

4.9.2 Step-by-step Overview

In the following sections the main steps 'how-to-use' the "Iono Correction Time Plot" GUI are described:

- Step 1: Select Data to plot
- Step 2: Select Grid Point to plot – the user can select latitude and longitude for all existing points in the Ionospheric Mask Bands. If a point that is not supported by the Service provider plots empty graph.
- Step 3: Click On "Plot" button

For more detailed description see the "Time series" plots (chapter 4.1)

4.9.3 Detailed Description of the GUI

4.9.3.1 The "Ionospheric grid Point" frame

4.9.3.2 Other frames

See the "Time series" plots (chapter 4.1)

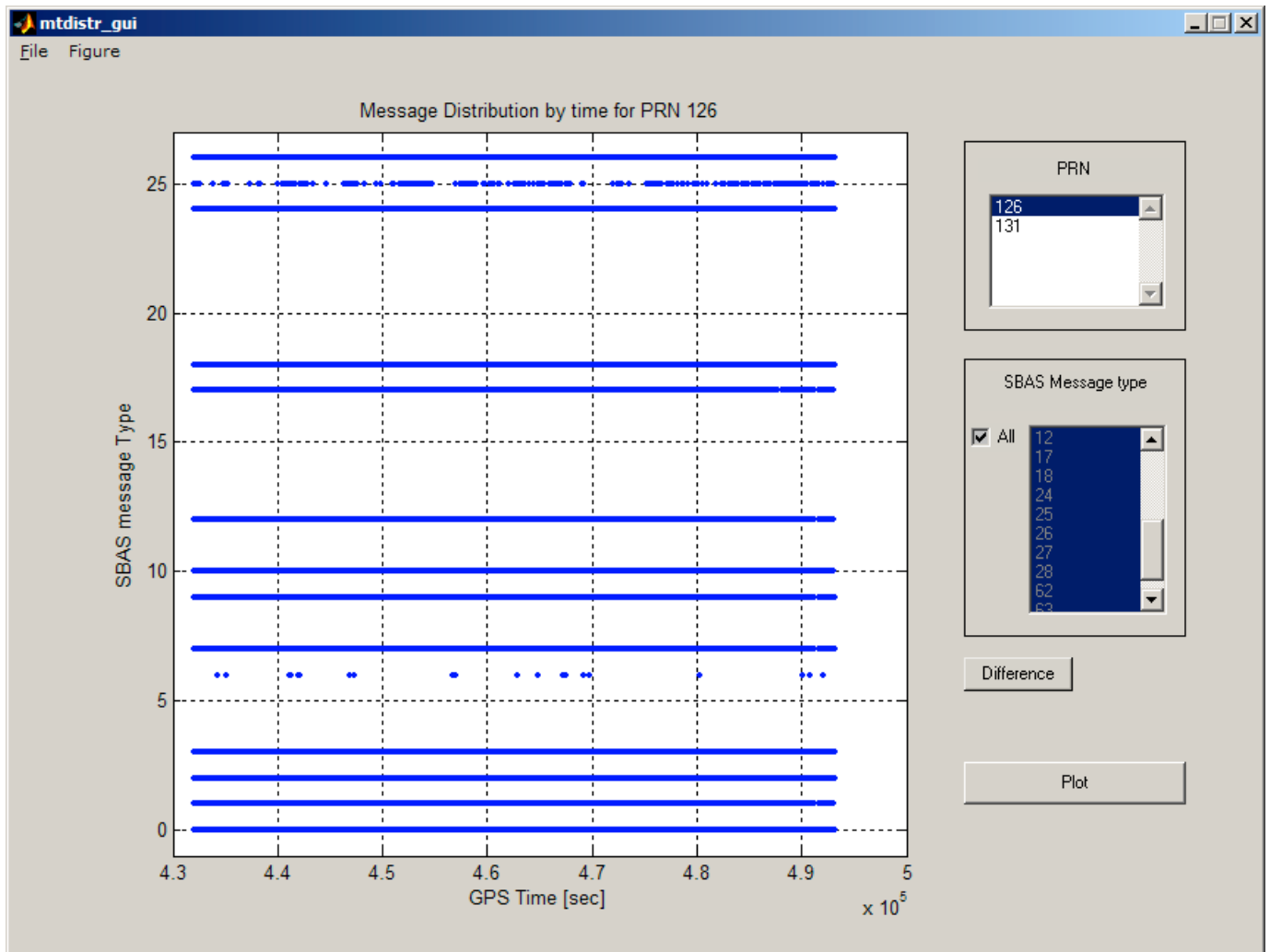
4.10 SBAS Message distribution and time difference

This time plot allows the plotting of the SBAS Message distribution and the update interval on time bases

4.10.1 Main GUI

From the main window the 5 different parts can be seen:

1. "Graphics sub-window": where all the graphics will go
 2. "PRN frame": Selection of the broadcasting SBAS satellite
 3. "Message type Frame: List of all SBAS message types for plotting
- Action buttons: "Difference", "Plot"



4.10.2 Step-by-step Overview

- Step 1: PRN of the broadcasting GEO satellite to be analysed.
- Step 2: Select Message type to be plot
- Step 3: Click On “Plot” button in order to plot the time of message reception
- Step 4: Click on the “Difference” button in order to plot the message update interval

4.10.3 Detailed Description of the GUI

4.10.3.1 The “PRN list”

This menu allows to select the PRN of the Broadcasting Geo satellite that dould be analysed

4.10.3.2 SBAS Message type frame

This part allows to select the message type to be analysed. Multiple selection is possible.

The Check box All allows to select all the messages at the same time.

4.10.3.3 The Difference button

When pressed this button allows to plot the difference in the reception time for two instances of the selected message type (update interval).

4.10.3.4 The “Plot” button

This button, when is pressed, plots time distribution for the selected messages and PRN number. When the Difference button is pressed the update interval is plotted.

5 M-FILE-RUNNER

5.1 Introduction

The software M-File Runner is developed as a part of the PEGASUS software and is used for visualisation of the graphical results, presented as MATLAB functions and detailed in the preceding section.

5.2 Operating Modes and Use of the Software

There are two main running modes of M-File runner and respectively three different types of interface for each mode.

- **Normal mode:** This mode is used when the M-File runner is run as a stand-alone program independently from Pegasus. In this mode all the functionality of the software are present.
- **Image extraction mode:** This mode is used when the program is started from the PEGASUS interface to create the standard report. In this mode no interface is available.

5.2.1 Detailed Interface descriptions

As described before the three running modes has different interfaces. The image extraction mode has no user interface and is running as a background process. The interfaces of the normal and the reduced mode are similar. In this chapter description of the normal and reduced mode user interface is done.

5.2.1.1 Normal mode interface

The following image shows the General interface of the M-File Runner program. The normal mode user interface is composed of two parts.

- General part:
- Figures part

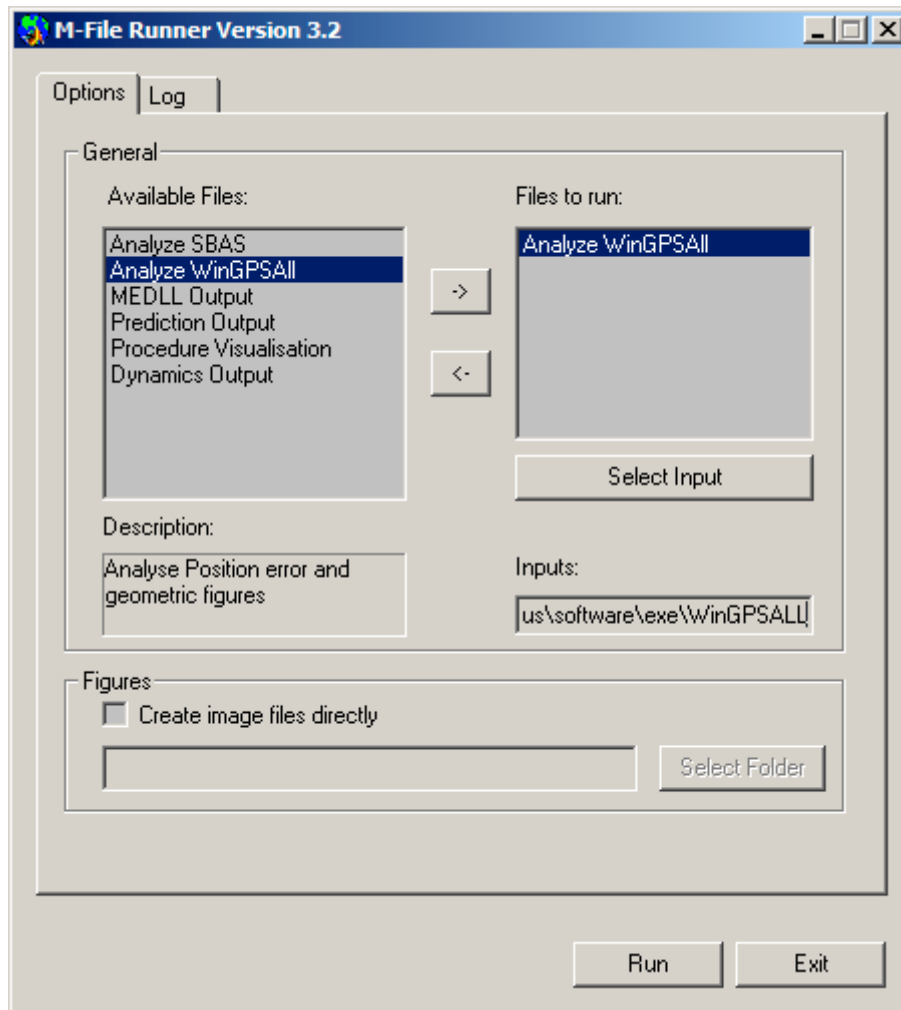


Figure 1: M-file runner interface – general view

1) General Part of the Interface

The available files contains all the available scripts for the visualisation of the results. Some description for each script is available in the Description box. All the items in the list are executable files, which are described in the description file of the software (mrunner.dsc) and can be executed independently. This file contains also some description for each script. In the current version of M-File runner the following files are available:

- Analyse SBAS Messages
- Analyse WinGPSAll
- MEDLL Output
- Prediction Output
- Procedure Visualisation
- Dynamics Output

The files to run presents the user selected files to be executed. The Select Input button and the edit box Inputs give the possibility to the user to select and visualise the inputs for each script to be executed.

2) Figures Part of the Interface:

The “Create image files directly” check box is used when the user need to extract the graphical results of the selected script directly to image files. In this case the graphics are not displayed on the screen, but are redirected to image files, which are created in the extended meta file format (emf). .

The Select Folder button gives the possibility to the user to select the folder where the created files will be stored.

3) Summary of the Interface

A more detailed description of each element of the software is done below, using the numbering of the items in the following figure. .

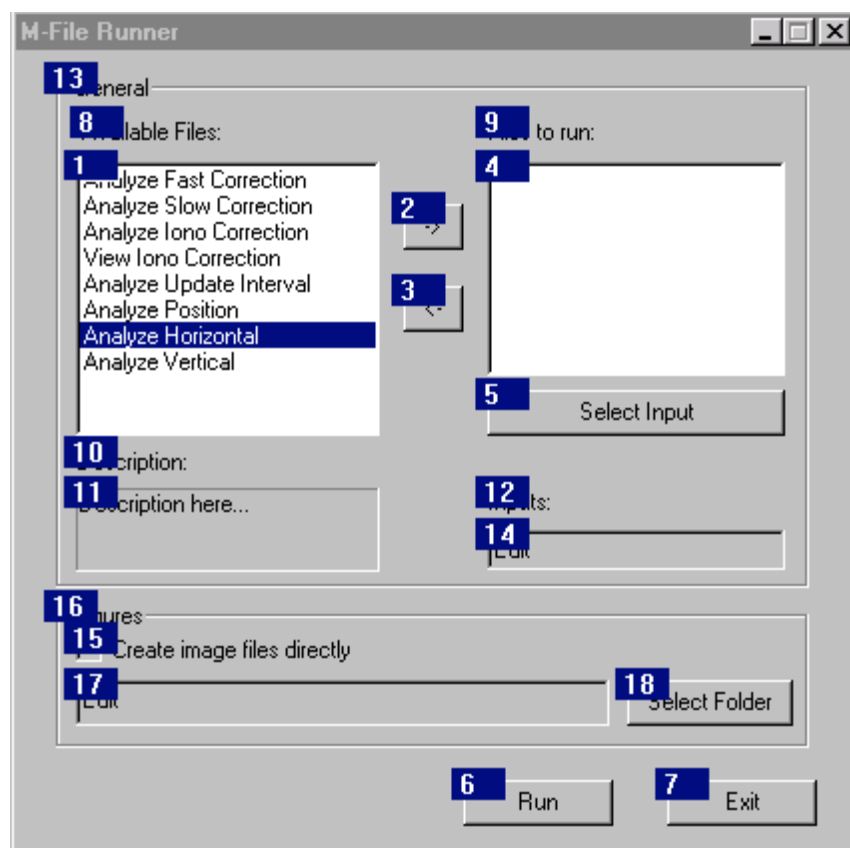


Figure 2: M-file runner interface - description

- Item 1: List of available scripts.
- Item 2: Move right button. Used to select a script to be added to the list of files to be executed. This button adds the selected script from the left list to the right list.

- Item 3: Move left. Used to remove a script from the list of files to be executed. This button remove the selected script from the right list.
- Item 4: List of scripts to be executed.
- Item 5: Button to select an input file for a script. This button open a file dialog box to select the input file for the selected script in the list. The same result is produced on double click on a script.
- Item 6: Run button. Run all the scripts in the list for execution. For each item in the list a console window is open before the visualisation of the graphics if the direct creation of images is not chosen, otherwise the graphics windows are shown and closed immediately.
- Item 7: Exit button. Exit from the program.
- Item 11: Description of the selected script.
- Item 14: Input for the selected script.
- Item 16: Check box for extraction of the results to image files.
- Item 17: Edit box for visualisation of the folder the images to be extracted.
- Item 18: Select folder for extraction button.

5.2.1.2 Image extraction mode interface

The program is running in this mode when the report button in the PEGASUS interface is pressed.

For this mode no interface is available. The program is running as a background process. Figures are displayed on the screen and closed immediately at the end of the processing.

5.2.2 Starting the MFILERUNNER

The M-File Runner can be started in several ways:

- From icon on the desktop
- From an executable file
- From a command line in Command Prompt

Using a command prompt, there is the possibility to provide command line arguments and thus to start the program in different modes.

5.2.2.1 Starting in Normal mode

To start the program in normal mode a simple click on the M-File Runner icon on the PEGASUS desktop is sufficient if the icon is present. Another way to start the program is to run the executable file from a command line or from the Windows Explorer.

5.2.2.2 Starting in background

To start the program in background it must be started by a command prompt using the argument `-b`.

Ex: In the Command Prompt the following line starts the MFILERUNNER in background mode

```
mfilerunner.exe -b
```

5.2.2.3 Starting with initialisation file (ini file)

To start the program with ini file it must be started using the command prompt with the argument `-ini` followed by the name and location of the ini file.

Ex: In the Command Prompt the following line starts the MFILERUNNER runner using a particular initialisation file:

```
mfilerunner.exe -ini d:\mfilerunner\ini\mfile.ini
```

5.2.2.4 Starting with non default description file

If the name of the description file is not defined the program starts with default description file that is located in the folder of the executable file and its name is `mranner.dsc`. To start the program with different description file it must be started using the command prompt with the argument `-d` followed by the name of the description file.

Ex: In the Command Prompt the following line starts the MFILERUNNER with a particular description file:

```
mfilerunner.exe -d d:\mfilerunner\dsc\personal.dsc
```

5.2.3 Starting a sequence

The sequence of producing a set of graphics using the normal interface is described below. For the reduced interface a similar procedure applies.

- Start `Mfilerunner.exe`.
- Select the desired files to run and transfer them to the right window using the “->” button.

- Select the desired namebase and location for the input file(s) with the “Select Input” button.
- The extension for the files needed by the M-files will be automatically chosen. Should a required file not be present, an error message is displayed.
- If saving of the created figures on disk is desired, the “Figures” checkbox should be marked and an output location selected.
- “Run” starts the graphics generation.

The INI-file created during an interactive sequence may subsequently be used to start the same sequence in background mode, noting that the figures must imperatively be stored on disk for the program to operate properly in this mode.

5.3 Data Input

Required input data are determined by the individual M-file sequence to be executed. Please refer to the descriptions in Section 3.

5.4 Data Output

Output of the operation of the module will be graphic displays and figures stored on disk depending on the graphics files selected. In addition an INI-file and an error log file are created either in the installation directory of the executable (stand-alone operation) or in the directory of the source data (operation within PEGASUS)

6 MATLAB Routines

6.1 High-Level M-Files

6.1.1 M-Function AnalyzeFastCor

The m-function file AnalyzeFastCorr loads the following message types into the MATLAB workspace

- message type MT 01 file
- message type MT 02-05 file
- message type MT 07 file

and analyses the PRN mask and evaluates the fast correction data. It will produce graphics of the PRC and the UDREI for the satellites that are currently contained in the PRN-mask. Additionally, it will produce a graphic of the currently existing fast correction degradation factors AI.

Syntax: AnalyzeFastCor()

Input : file name basis for the ESTB data, i.e. the file name without the extensions

Output: none

Note: the input file name basis should be enclosed with single quotes ('estb120')

6.1.2 M-Function AnalyzeSlowCor

The m-function file AnalyzeSlowCorr loads the following message types into the MATLAB workspace

- message type MT 01 file
- message type MT 25 file

and analyses the PRN mask and evaluates the slow correction data. It will produce graphics of the slow corrections (for both velocity codes) for the satellites that are currently contained in the PRN-mask.

Syntax: AnalyzeSlowCor()

Input: file name basis for the ESTB data, i.e. the file name without the extensions

Output: none

Note: the input file name basis should be enclosed with single quotes ('estb120').

6.1.3 M-Function AnalyzelonoCorr

The m-function file AnalyzelonoCorr loads the following message types into the MATLAB workspace

- message type MT 18 file
- message type MT 26 file

and analyses the IGP mask and evaluates the vertical delays and the GIVEI for the transmitted bands and block. It will produce graphics of the vertical delays and GIVEI. Additionally, it will produce a graph of the ECAC area with the currently supported/unsupported IGP.

6.1.4 M-Function AnalyzeMessageDistr

The m-function file AnalyzeMessageDistr loads all the SBAS message types into the MATLAB workspace and analyses the quantity distribution, the time distribution and the broadcast frequency of the messages. It will generate a pie-chart, a table with the number of broadcast messages and will display the message type distribution and time difference plots.

For the time distribution and the time difference plots an interactive interface is presented in order to select the PRN number, the SBAS message and the type of the plot.

On the time plot interface there are two types of plot for each message type and PRN. The user can plot the time distribution for one or more SBAS messages or the broadcast intervals for a selected message type.

Syntax: AnalyzeMessageDistr()

Input file name basis for the ESTB data, i.e. the file name without the extensions

Output: none

Note: the input file name basis should be enclosed with single quotes ('estb120').

6.1.5 M-Function AnalyzeHorizontal and AnalyzeVertical

The m-function file AnalyzeHorizontal and AnalyzeVertical loads the PEGASUS related output file of WinGPSALL into the MATLAB workspace and analyses the horizontal situation for integrity and availability purposes. It will produce a graphic identical to the one which can be achieved by the Stanford University approach.

Syntax: AnalyzeHorizontal()

Syntax: AnalyzeVertical()

Input file name of the output data

Output none

Note: the input file name should be enclosed with single quotes ('estb120.csv').

6.1.6 M-Function AnalyzePos

The m-function file AnalyzePos loads the PEGASUS related output file of WinGPSALL into the MATLAB workspace and analyses the position error and protection level data. It will produce graphics of the horizontal and vertical position error and of the horizontal and vertical protection level. Additionally, histograms of the relevant data will be produced.

Syntax: AnalyzePos()

Input file name of the output data

Output none

Note: the input file name should be enclosed with single quotes ('estb120.csv').

6.2 Low-Level M-Files

6.2.1 M-Function readmt00

The low-level m-function file readmt00 can be used to load the SBAS message type data for MT 00 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt00()

Input: file name of the MT 00 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m00').

6.2.2 M-Function readmt01

The low-level m-function file readmt01 can be used to load the SBAS message type data for MT 01 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt01()

Input: file name of the MT 01 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m01').

6.2.3 M-Function readmtfc

The low-level m-function file readmtfc can be used to load the SBAS message type data for MT 02-05 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmtfc()

Input: file name of the MT FC data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.mfc').

6.2.4 M-Function readmt07

The low-level m-function file readmt07 can be used to load the SBAS message type data for MT 07 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt07()

Input: file name of the MT 07 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m07').

6.2.5 M-Function readmt12

The low-level m-function file readmt12 can be used to load the SBAS message type data for MT 12 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt12()

Input: file name of the MT 12 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m12').

6.2.6 M-Function readmt18

The low-level m-function file readmt18 can be used to load the SBAS message type data for MT 18 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt18()

Input: file name of the MT 18 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m18').

6.2.7 M-Function readmt25

The low-level m-function file readmt25 can be used to load the SBAS message type data for MT 25 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt25()

Input: file name of the MT 25 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m25').

6.2.8 M-Function readmt26

The low-level m-function file readmt26 can be used to load the SBAS message type data for MT 26 into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readmt26()

Input: file name of the MT 26 data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.m26').

6.2.9 M_Function readmtx

The low-level m-function file readmtx can be used to load the SBAS message types broadcast information into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

This function uses the function readcsv.m in order to read the mtx file.

Syntax: readmtmtx()

Input: file name of the MTX data

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.mtx').

6.2.10 M-Function readpos

The low-level m-function file readpos can be used to load the PEGASUS output file into the MATLAB workspace. There, the user can access the relevant information and perform own evaluations.

Syntax: readpos()

Input: file name of the output file

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.csv').

6.2.11 M-Function AnalyzeAPV_I

The low-level m-function file AnalyzeAPV_I loads the PEGASUS related output file of WinGPSALL module into the MATLAB workspace and analyses the vertical error situation for integrity and availability purposes. It will produce a graph of the vertical protection level over the vertical position error for APV I

Syntax: AnalyzeAPV_I ()

Input: file name of the output file, integer for automatic creation of images, path to the folder with the images

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.csv').

This file is used by AnalyzeVertical described in chapter 3.2.8

6.2.12 M-Function AnalyzeAPV_II

The low-level m-function file AnalyzeAPV_II loads the PEGASUS related output file of WinGPSALL module into the MATLAB workspace and analyses the vertical error situation for integrity and availability purposes. It will produce a graph of the vertical protection level over the vertical position error for APV II

Syntax: AnalyzeAPV_II ()

Input: file name of the output file, integer for automatic creation of images, path to the folder with the images

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.csv').

This file is used by AnalyzeVertical described in chapter 3.2.8

6.2.13 M-Function AnalyzeCAT_I

The low-level m-function file AnalyzeAPV_I loads the PEGASUS related output file of WinGPSALL module into the MATLAB workspace and analyses the vertical error situation for integrity and availability purposes. It will produce a graph of the vertical protection level over the vertical position error for CAT I

Syntax: AnalyzeCAT_I ()

Input: file name of the output file, integer for automatic creation of images, path to the folder with the images

Output: see MATLAB help functionality

Note: the input file name should be enclosed with single quotes ('estb120.csv').

This file is used by AnalyzeVertical described in chapter 3.2.8

6.2.14 Other Files

There are other m-files that can be found in the PEGASUS tools. These are m-files that are needed for the compilation of the m-file sources to obtain executable programs for the PEGASUS tools.

- addikmenu.m : m-file to add a menu on the graphical displays
- bmpdlg.m: m-file to save a graphic in BMP-format
- emfdlg.m: m-file to save a graphic in EMF-format
- jpgdlg.m: m-file to save a graphic in JPEG-format
- coasts.mat: matlab binary file containing the world coastlines
- worldmap.m: m-file to display the world coastlines in a graphic
- compileall.bat: batch file to compile all m-files with a MATLAB™ compiler function
- PlotDistrTable.m: m-file to plot the Message Distribution table
- PlotDistrpie.m: m-file to plot the Message Distribution pie
- Plottimedistr.m; m-file to plot the time distribution for the SBAS messages
- Plottimediff.m; m-file to plot the broadcast time interval for the SBAS messages
- Mtdistr_gui.m and Mtdistr_gui.fig: interface for the Message Distribution Time Plots

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Appendix A: Errors, Warnings and Recovery Procedures

This appendix contains a list of errors and warning that are generated by the programs of the PEGASUS module MFILE and MFILERUNNER. Additionally, for each error message and warning, a possible cause is given and an appropriate recovery procedure is proposed.

In this context, errors are considered to be fault conditions that do not allow the associated program to run and to produce an output file. Warnings are considered to be fault conditions that allow an associated program to run, however, due to the fault condition, the result output file may be incomplete or less useful.

In contrast to that, user notifications are considered to be conditions where the user has selected an option which may seem to be inappropriate for the associated program. The user is presented at the time of the execution with a notification of the condition and the program proposes a suitable procedure to change the selected option. These user notifications are not included in this appendix.

A.1 MFILES

Error Message: invalid file identifier

Cause: The user has specified a file, which could not be found. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the path- and file-name for the file. It should be noted that for the analysis of the ESTB SIS, the file-name must be specified without the extensions, whereas for the analysis of the ESTB positioning and integrity, the file-name must be specified using the extension.

Error Message: too many output arguments

Cause: The user has specified too many output arguments. This error message will appear only, if the low level M-File functions have been called by the user itself. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the number of output arguments to be used with the particular function. The MATLAB™ help feature will display the relevant information.

Error Message: undefined function or variable

Cause: The user has forgotten to enclose the second input argument of the function call with a ' character. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the second input argument for a ' character at the start of the argument.

Error Message: missing ' at the end of a string or misplaced transpose character

Cause: The user has forgotten to enclose the second input argument of the function call with a ' character. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the second input argument for a ' character at the end of the argument.

Error Message: improper function reference

Cause: The user has forgotten to enclose the first input argument of the function call with a ' character. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the first input argument for a ' character at the end of the argument.

Error Message: missing variable at function

Cause: The user has forgotten to enclose the first input argument of the function call with a ' character. MATLAB™ stops the execution of the m-file.

Recovery: The user should check the first input argument for a ' character at the start of the argument.

Warning Message: Axes XTickLabels has been renamed XTickLabel for consistency with all other mode/value property pairs, whose root names are singular, not plural.

Cause: This warning message is generated, because an older version of the m-file function 'worldmap' is used. This message is displayed after the execution of the m-file.

Recovery: This warning message can be ignored. No impact on other functionalities and features have been noticed.

A.2 MFILERUNNER

The errors of the MFILERUNNER are output in a log file called mrunner.log.

Appendix B: Format and Description of INI-File and description file

The user options and settings for the MFILERUNNER program will be kept in corresponding initialisation files. They will be saved on program exit so that they will be available on the next start. The files may, however, also be edited manually or generated externally, e.g. by the PEGASUS frame (for more information, the interested reader is referred to [3]). Therefore, the following sections describe the initialisation file contents and shows a sample file.

The user options are kept in a INI-file and describe the possible settings for the M-files. The MFILERUNNER INI-file is named "MRUNNER.INI" and located in the MFILERUNNER working directory. The program options are kept in a corresponding description file and describe the possible scripts to be run using the program. The MFILERUNNER description file is named "MRUNNER.DSC" and located in the MFILERUNNER working directory.

B.1 File Contents

The description of the complete format for the MFile Runner initialisation file can be found in the following table. Any parameter that is not specified takes its default value, as is the case when no initialisation file can be found at all.

Key name	Description	Type	Limits & Specifications	Default
[System] section				
Items	Number of the files to be run	Int	Items > 0	0
Images	Automatic creation of the images	Int	0 = no, 1 = yes	0
ImgFolder	Path to the folder where the created images should be stored	String	max. 255 characters	(empty)
[Item] section				
Name	Name of the script to be run	string	max. 255 characters	-
Argument	Argument for the script	string	max. 255 characters	-

The description of the complete format for the MFile Runner Description file can be found in the following table.

Key name	Description	Type	Limits & Specifications	Default
[System] section				
Itemsize	Number of the scripts	Int	Items > 0	0
[Item] section				
Name	Name of the script to be run	string	max. 255 characters	-
Description	Short description of the script functionality	string	max. 255 characters	-
Executable	Executable file related to the script. To be run when the script is run	string	max. 255 characters	-

Key name	Description	Type	Limits & Specifications	Default
Extension	Shows if the argument is a file with or without extension	Int	>0	-
Filetype	Describes the files to be used as input	string	max. 255 characters	-
Filefilter	Displays the extensions of the files that can be used as input for the executable	string	max. 255 characters	-

B.2 Sample File

B.2.1 INI-file

```
[System]
Items=2
ImgFolder=D:\Programs\pplus\Data\Jobs\test\img
Images=0
[Item 0]
Name=Analyze Fast Correction
Argument=D:\Programs\pplus\Data\Jobs\test\01_Convertor\01_Convertor
[Item 1]
Name=Analyze Position
Argument=D:\Programs\pplus\Data\Jobs\test\02_WinGPSAll\02_WinGPSAll.csv
```

B.2.2 Description file

```
[System]
Itemsize=3
[Item 0]
Name=Analyze Fast Correction
Description=Analyse PRN mask and evaluates fast correction data
Executable=..\MFiles\exe\AnalyzeFastCor.exe
Extension=0
[Item 1]
Name= Analyze Position
Description= Analyse the position error and protection level data
Executable= ..\MFiles\exe\AnalyzePos.exe
Extension=1
[Item 2]
Name=Display Data File
Description=Displays a specific data file
Executable=..\MFiles\exe\display.exe
Extension=0
Filetype=Data files (*.dat, *.data)
Filefilter=*.dat|*.data
```

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