BKG Earth Rotation Simulation Tool

User Manual

Version V3.0.1

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Document

BKG Earth Rotation Simulation Tool - User Manual

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The document is subject to change without prior announcement.

Table of Contents

1 About this Document

This chapter provides an overview of this document and information on its use.

1.1 Purpose of this Document

This manual contains information about the structure, function and operation of the program. It is intended to enable and to facilitate your work and the usage of the program.

Read and use the manual if you work with the program and operate the software.

1.2 Using this Document

This manual consists of:

- an overview of program
- an overview of the process of analyzing signals with the system
- detailed operating instructions how to use the system

This manual does not contain information about the data or data formats, and not about procedures applied for analysis. This type of knowledge is assumed to be present to the users of program and must be achieved from other sources.

1.3 Special Representations

Cross references Cross references are displayed as *shown here*.

Controls The steps in the chapters containing step wise instructions partially refer to on-screen controls. These are, e. g.:

- buttons to be clicked with the mouse
- lists from which elements are to be selected (drop down list fields etc.)
- fields into which text is to be entered (text fields)

All these carry labels which are represented **as shown here**.

Keys If keys or combinations of keys are required for operation, then this is represented as follows:

- [Ctrl + a] means that the "Ctrl" key and the "a" key (lower case) must be pushed simultaneously
- [Return] means that the "Return" key must be pushed.
- [Shift] means that the "Shift" key must be pushed

The steps of the instructions are numbered and should be carried out in the given order if nothing else is denoted.

2 Introduction

The program allows for interactive analysis of geodetic time series data.

2.1 Overview

Users can apply standard methods of time series analysis on geodetic data sets. The data sets can be selected by means of a graphical user interface and be loaded into an analysis application. Predefined data sets of different origin are available as well as the functionality to use own data sets.

The time series can be combined and the procedures intended to be applied on the data sets can be selected and be parameterized.

Result data can be presented as numeric data or visualized graphically, whereby users can widely control the graphical output.

The software is divided into three operational sections separated by tabs. The sections are:

- **Data** – select data file and a period of time of which data sets are to be analyzed
- **Pre-Processing** – select a pre-processing procedure (method) to be used for analysis and set its parameters
- **Combination** – accumulate and compare model time series to compute correlations and differences
- **Output** – set the output parameters and view the numerical and/or graphic results

Another section **About** presents information about the program operator, disclaimer and imprint.

The following chapters show how to operate the program. The different procedures and their outputs are described in separate documents.

2.2 System Requirements

The program can be run platform independently in a browser. Sufficient computing power is required on the client computer or on the server.

The program needs Java Runtime environment Version 1.5 on the client computer.

3 Working with the Program

Follow the instructions of this chapter to operate the program.

3.1 Requirements of the Data Material

Data of different origin and use are available by the software, however, you can also use own data.

The program can handle data in CSV and XML table formats.

The first column of the table is always used as x-axis parameters.

Handling of irregular data

During the load process, each data series is checked for regular time intervals. Some procedures presume regularity of the time intervals, so a **warning** is printed if **irregular time intervals** are detected.

Special resampling procedures exist to fill gaps in data series or to create regular data from irregular data. **Spline-based interpolation** or **Chebychev-Polynom interpolation** resamples those data series.

The target interval can be selected from a list, where the minimum interval is half of the current interval and the maximum is calculated so that at least 10 sample points are in the result series, or one year, whichever is less.

The procedures check the input data for interval sizes and propose the most probable target interval. If the intervals exceed a certain value, the procedure will print an error message. The exact size of the valuedepneds on the procedure used.

3.2 Starting the Program

The program runs in a web browser.

Note(s):

Response time of the program strongly depends on the quality of the internet connection.

To start the program:

1. Start a web browser and enter the URL (internet address) of the program as you received by your software operator.

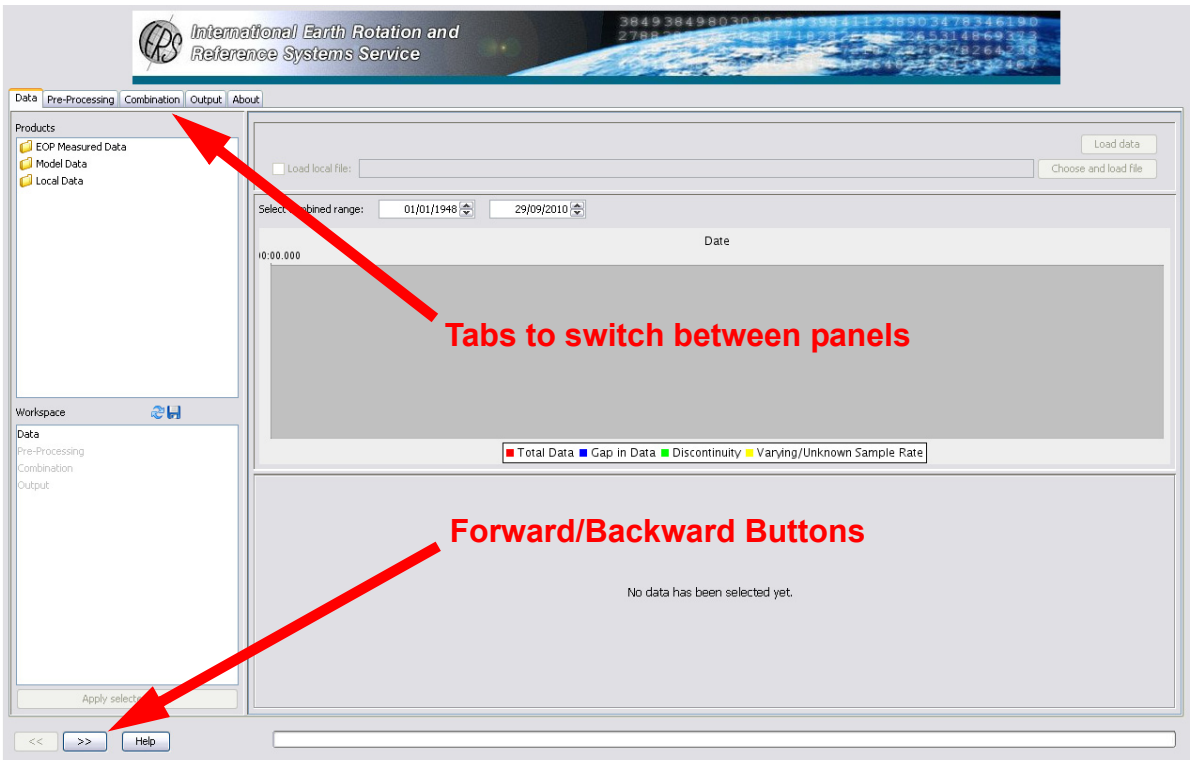
3.3 Overview of the Process

This section briefly explains how to turn numerical geodetic time series data into expressive overview graphics.

3.3.1. Structure of the Program

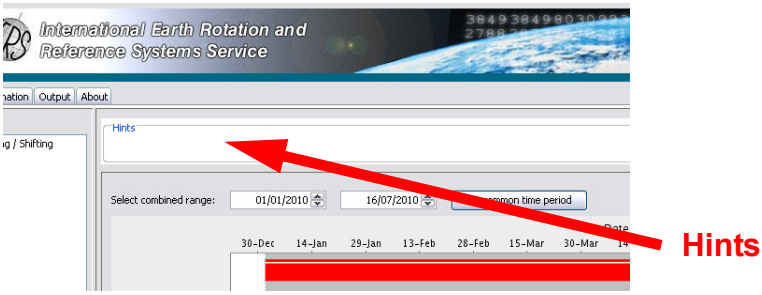
The program is subdivided into panels, which can be invoked by the tabs at the upper edge of the program window.

They are intended to be used one after the other from the left to the right, therefore, alternatively they can also be invoked by forward/ backward buttons switching between subsequent panels.



Hints

In certain situations hints are indicated explaining briefly what is best to do next.



Functions in panels

The functions provided by the panels are available only if the previous steps are completed successfully. The panels provide :

- **Data** – select data file and a period of time of which data sets are to be analysed
- **Pre-processing** – select a procedure (method) to be used for analysis and set its parameters (loaded data required)
- **Combination** – accumulate and compare model time series to compute correlations and differences
- **Output** – set the output parameters and view the numerical and/or graphic results (results from completed procedure required)

Another panel **About** contains information about the program and the operator of the service. It is not needed to operate the program, however, it may contain information of your interest.

Panel areas

The panels provide white areas in the left, with which you control the program as follows:

- Select between the items offered depending on the current program status in the upper white field. For example: when the **Procedure** panel is active, select the procedure to be used.
- See, select, and delete data objects loaded for analysis, depending on the program status (workspace) in the lower white field. For example, when the **Procedure** panel is active, select data for graphical output.

In the larger right area of the program window, enter data or view outputs, depending on the situation. Follow the detailed steps described in the sections below:

- *Loading and Selecting Data* on page 14
- *Pre-Processing Data* on page 29
- *Combining Model Time Series* on page 33
- *Generating Graphical Output* on page 35

3.3.2. Interrupting and Continuing Work

You can interrupt your work at any time and continue later. If you want to do so, save the current program status to a local file and reload the file when you want to continue.

Saving the program status

To save the current program status:

1. Click on **Save** .
2. Find a location for the file, enter a file name and click on **Save**.

Loading a program status

The file is saved to the given location. It contains all current program information.

If you want to load a status file, be aware that the current program settings will be replaced by those of the file and will be lost. If you want to preserve your current settings, first save them to another file as described above.

To reload the status file:

1. Click on **Load** .
2. Find and select the file and click on **Open**.

The program is set to the status as stored in the file.

3.3.3. Using Online Help

The program provides online help for each panel.

1. Click on the **Help** button to call for help about the currently active panel.

Help is displayed in a standard web browser or in a specific help viewer, depending on the type of installation.

3.4 Loading and Selecting Data

You can decide to use predefined data from the data base, or own structured data or own data without structure.

Note(s):

The meaning, the comparability, and the combinability of input data is not subject of this documentation. This document deals with the program operation only, on which data have no effect.

In doubt, test different data combinations or ask the operator of the software.

See

- *Using Data from the Data Base* on page 15
- *Importing Structured Data* on page 19
- *Importing Data Without Structure* on page 22

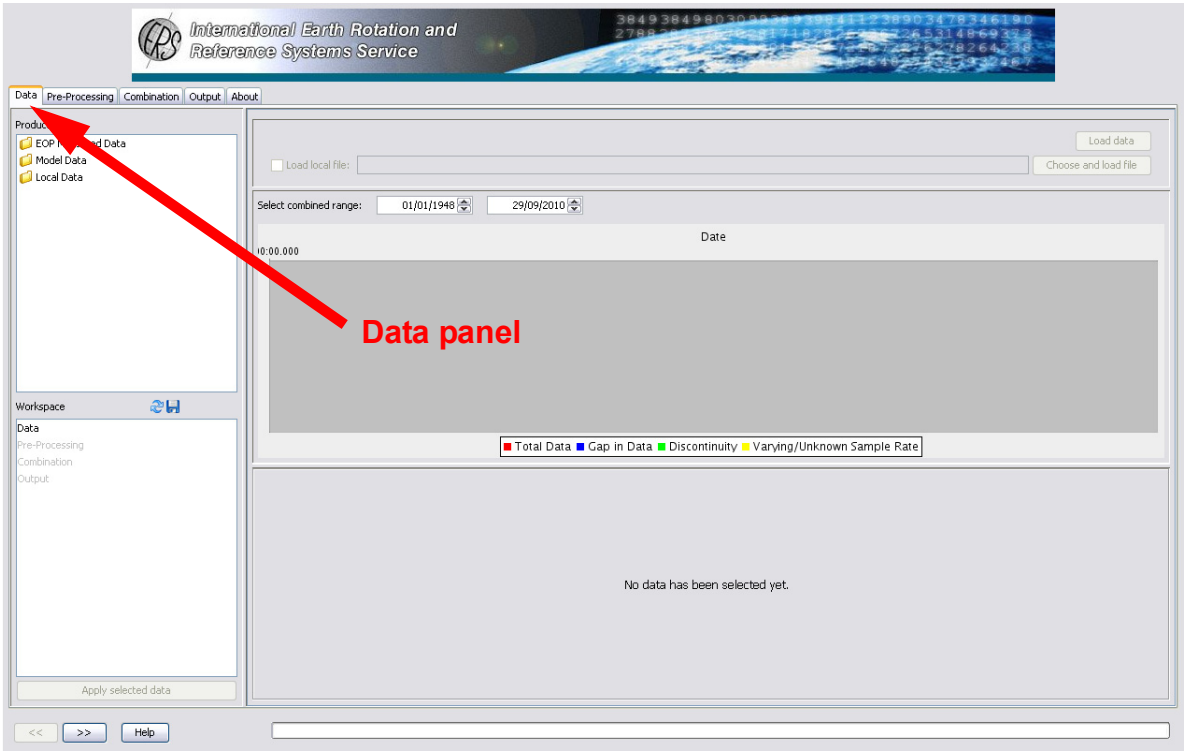
3.4.1. Using Data from the Data Base

In the *Data* panel you select the data to be analysed. They are arranged in tables presented in form of a so-called “tree”, that is: the data are grouped in different levels:

- product groups (Basic procedures, Correlation, Approximation etc.) in the root of the tree
- products, which can be in turn subdivided into groups (depending on the selected product group: Basic statistics, Autocorrelation, etc.) in the branches of the tree
- data vectors (name of a table column, depending on the selected product) in subbranches

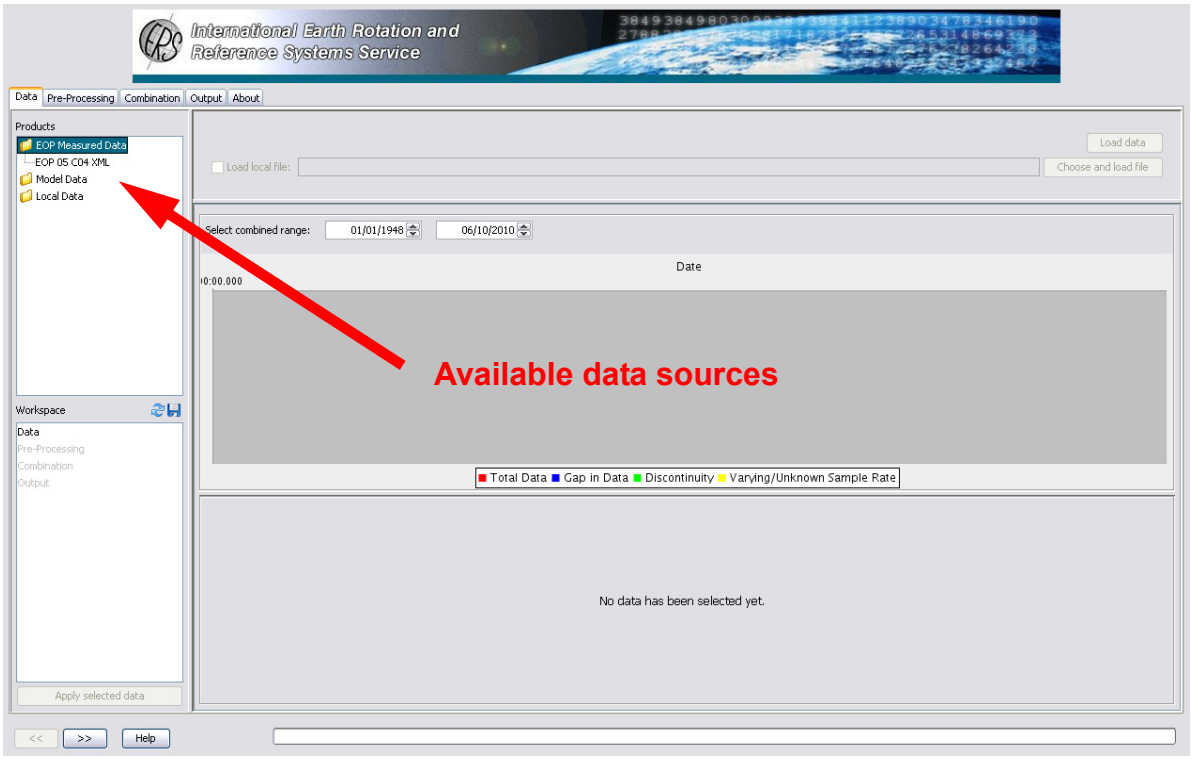
To load predefined data from the data base, proceed as follows:

1. Activate the **Data** panel.



2. Click on an input data source in the upper left field **Products**.

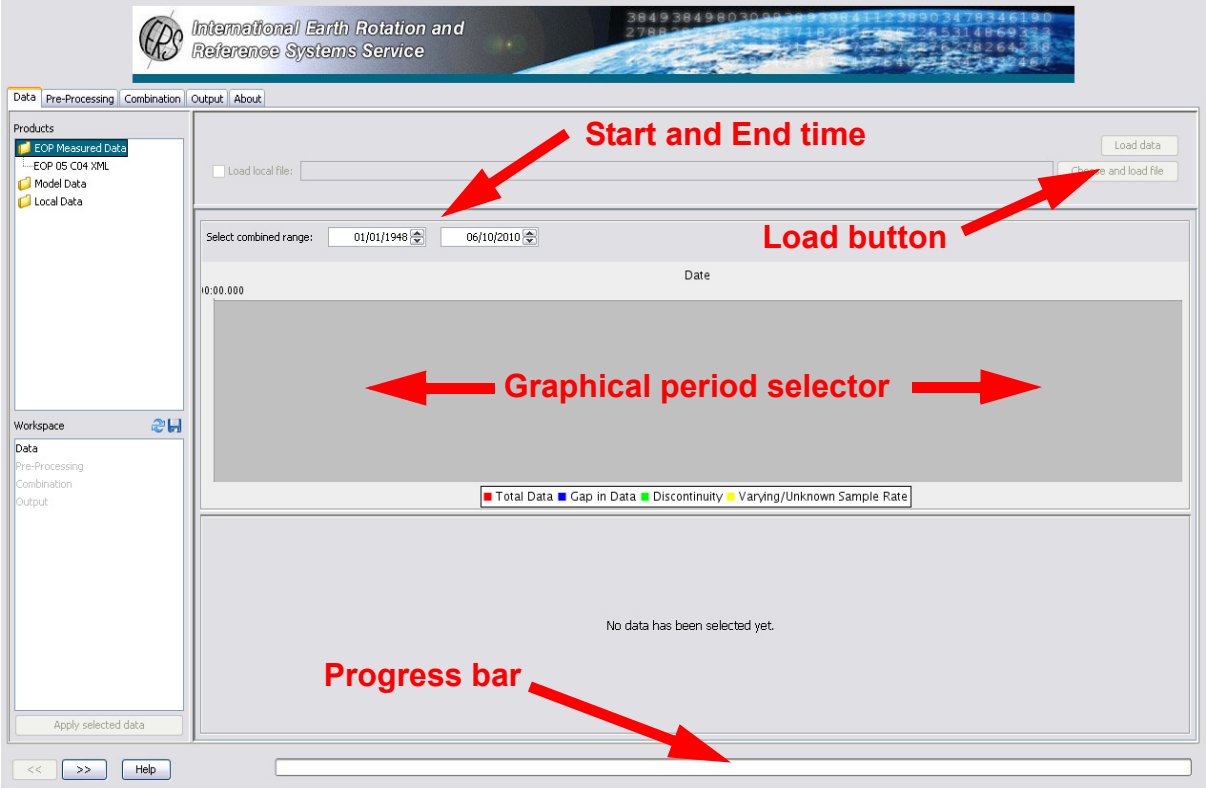
   Depending on the data type, branches may open, in which you may select data sources:



3. Click to select the data source or sources for the analysis.

   To add more sources to the selection: keep pressed the [Ctrl] key while clicking on other entries. If you click again, the entry will be unselected.

To add a complete branch, just click it. All elements of the branch will be selected.



4. Click the **Load** button to load them into the program.

   A progress bar indicates the loading status and shows when the load process is complete.

   The data are listed in a table for selection.

5. You can select a period of time within which data are to be considered and adjust a sample rate. See *Selecting Period of Time of Data and Sample Rate* on page 27.

6. Select the data to analyse in the **Product** field. They refer to the columns of the table.

   To add more columns to the selection: keep pressed the [Ctrl] key while clicking on other entries. If you click again, the entry will be unselected.

7. Enter start time and end time of the period to analyse in the date fields or use the graphical selector.

8. Click on **Apply selected data**.

   The data are displayed in the lower white field (workspace) when loading is finished.

   You can repeat the steps until all required data are in the workspace.

When all the correct data are in the workspace, you proceed with setting up the analysis procedure, see *Pre-Processing Data* on page 29.

Correcting wrong entries

If you notice that you want to delete loaded data, proceed as follows:

1. Select the data entry to delete in the workspace and right click the data entry.

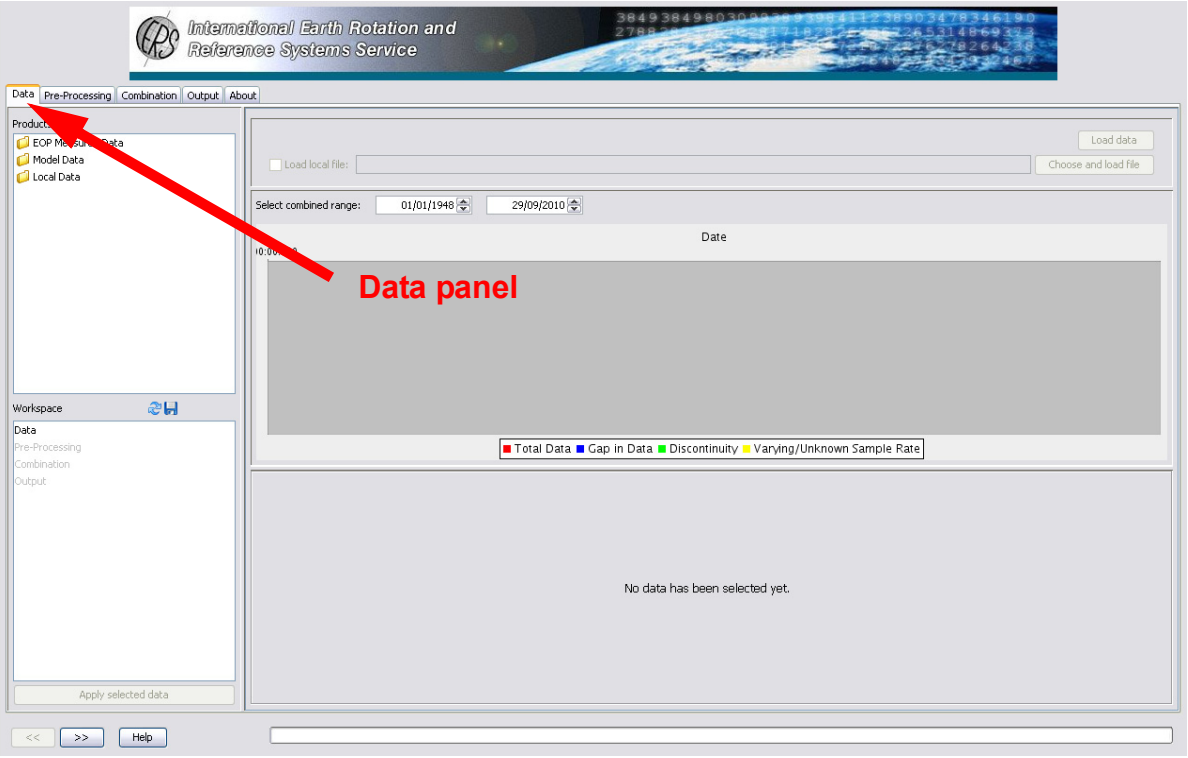
2. Select **Delete** from the context menu showing up.

   The entry will be deleted.

3.4.2. Importing Structured Data

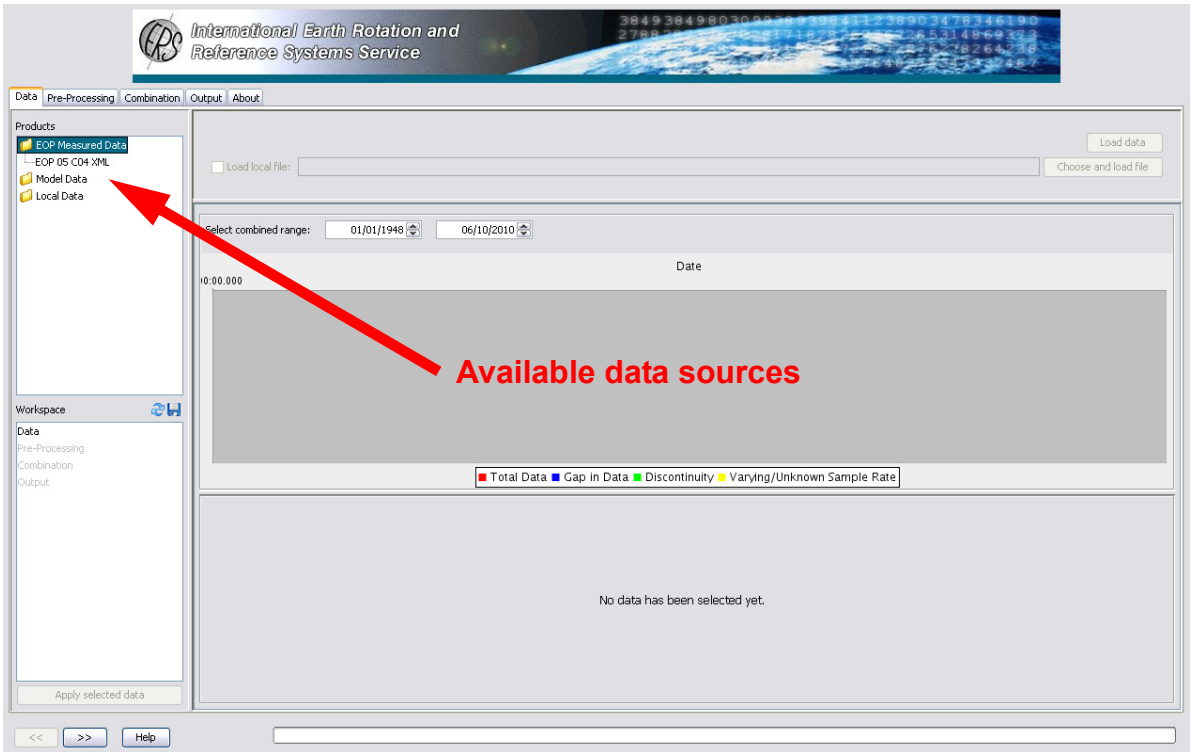
You can load structured own data if their structure corresponds to that of the sources in the data base.

1. Activate the **Data** panel.



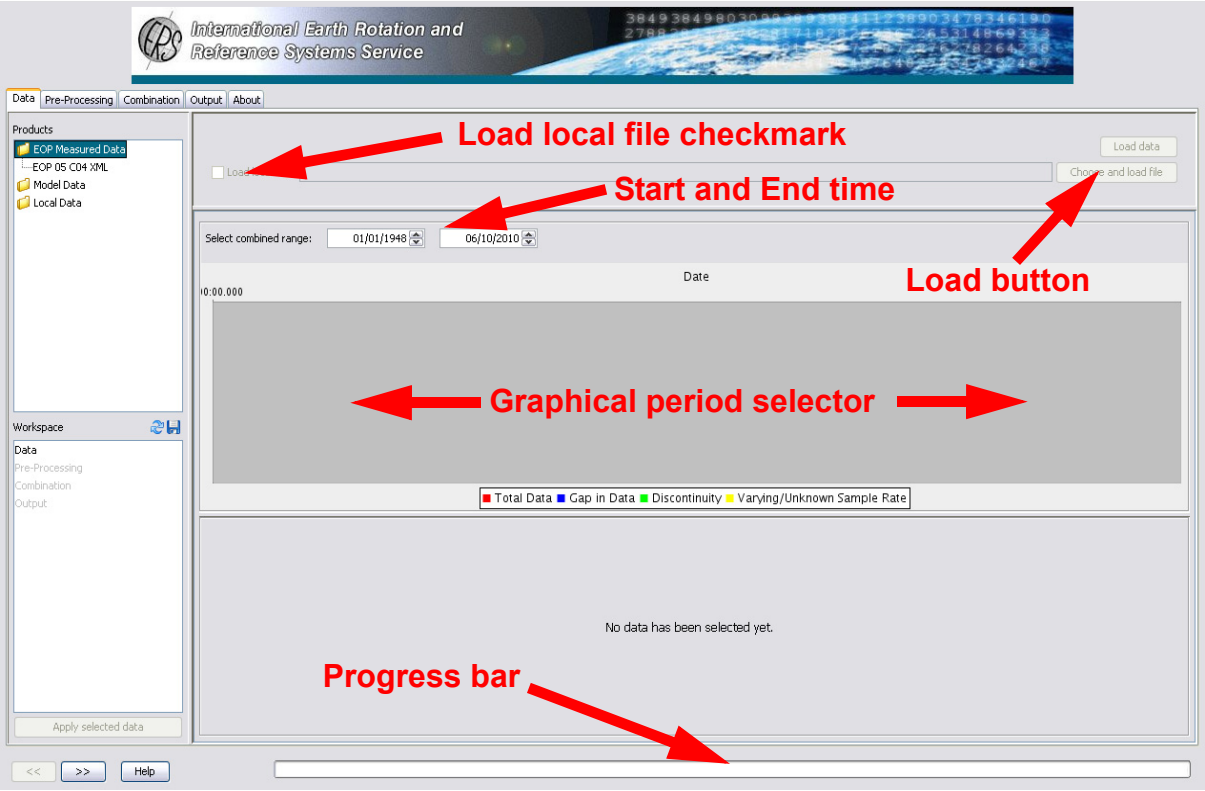
2. Click the input data source corresponding to the data to import in the upper left field **Products**.

Depending on the data type, branches may open, in which you may select data sources:



3. Click to select the data source for the analysis.

4. You can select a period of time within which data are to be considered and adjust a sample rate. See *Selecting Period of Time of Data and Sample Rate* on page 27.



5. Checkmark **Load local file** to activate loading of a local file.

6. Click on **Choose and load file**. Select the file to load and click on **OK**.

   The file is loaded. The period of time, over which data sets are contained in the file, is indicated in the graphical period selector.

7. In the **Products** field, the columns are added as branches of the loaded file. Select the branches/columns to be used for the analysis.

   To add more columns to the selection: keep pressed the [Ctrl] key while clicking on other entries. If you click again, the entry will be unselected.

8. When finished, click on **Apply selected data** under the **Selected Data** field left.

The data are gathered from the file and added to the white **Selected data** field left. Now they can be used for analysis.

Correcting wrong entries

If you notice that you want to delete loaded data, proceed as follows:

1. Select the data entry to delete in the workspace and right click the data entry.
2. Select **Delete** from the context menu showing up.

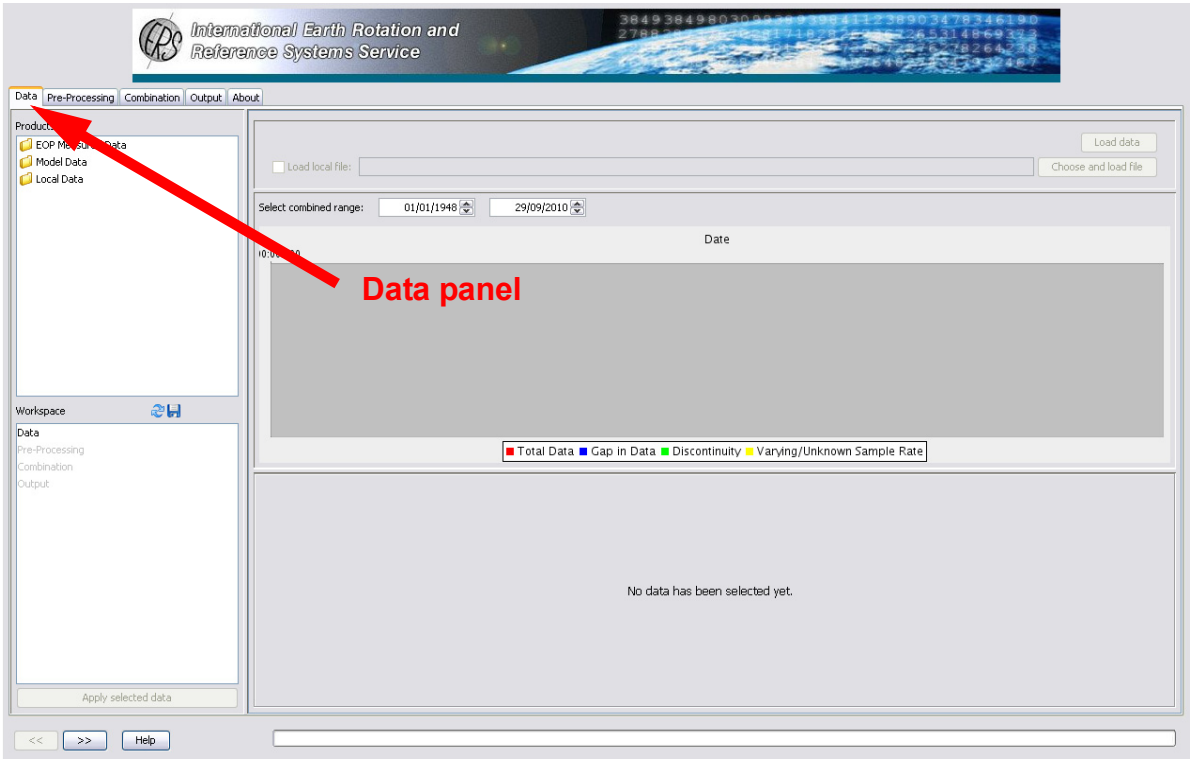
   The entry will be deleted.

3.4.3. Importing Data Without Structure

You can load data without structure, that means: the data are arranged in a table. In this case, load the data and add structure information as table column separators and names.

To use own data without structure:

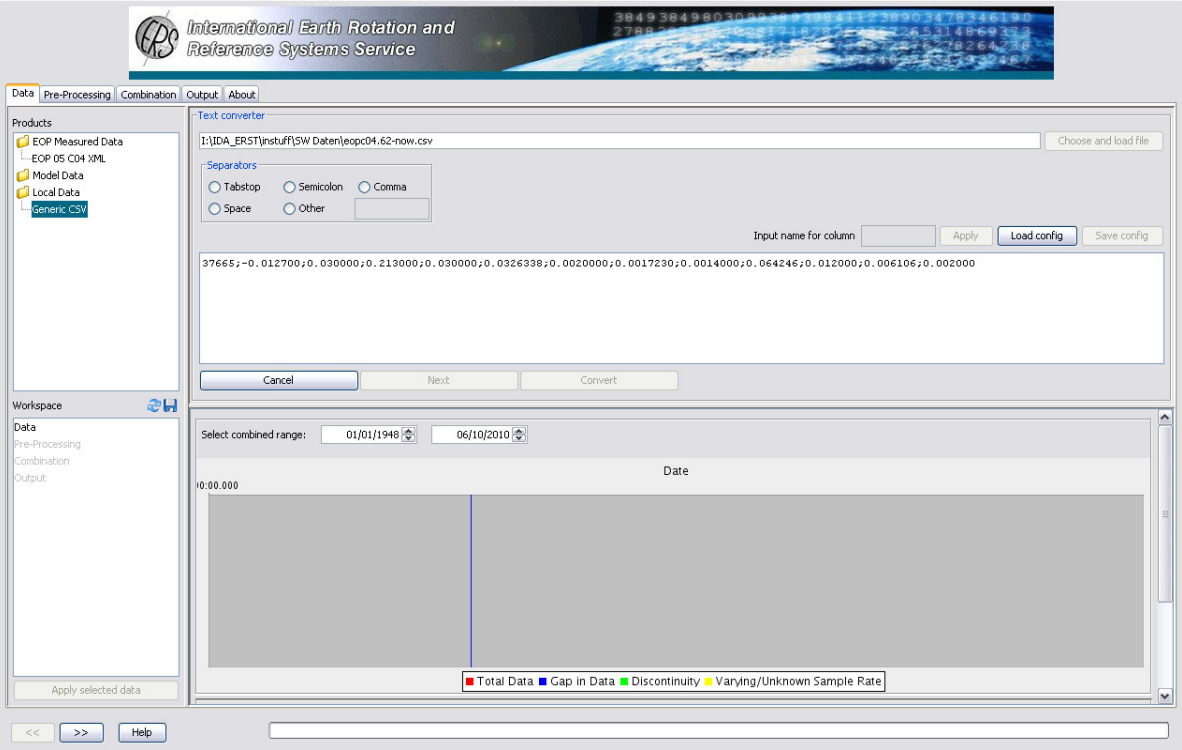
1. Activate the **Data** panel.



2. In the **Products** field, select **Local Data | Generic CSV**.

The **CSV Import** panel shows up in the right, allowing for selection of a data file and specifying parameters.

3. Click on **Choose and load file**. Select the file to load and click on **OK**.



The first line of the data table is shown in the text field. This maybe the line with the table header information (names of the columns) or it also maybe the first data line.

Table structure configuration

You can either use a predefined configuration or enter a configuration. The configuration specifies the column separator and the names of the columns. You can skip these steps if the first line of the table contains the column names anyway.

To use a predefined configuration, load it from file:

1. Click on **Load config**.

2. Find the desired file and click on **OK**. The file is loaded.

3. Click on **Apply**. The configuration is applied to the loaded data.

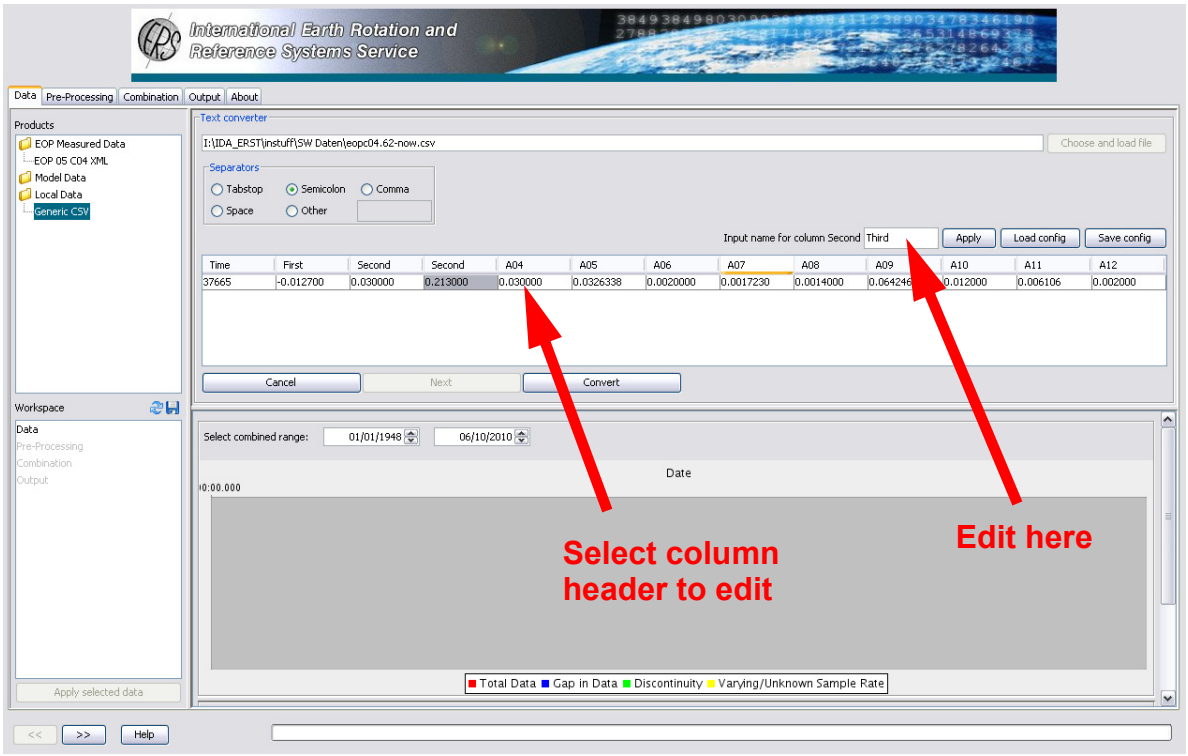
Alternatively specify the configuration:

1. Adjust the proper column separator and click the **Next** button.

2. Click in the first table cell **under the table header** and enter a column name.

   Click on **Apply** or use the **[Enter]** key when you finished with a name.

   Repeat this for each column.



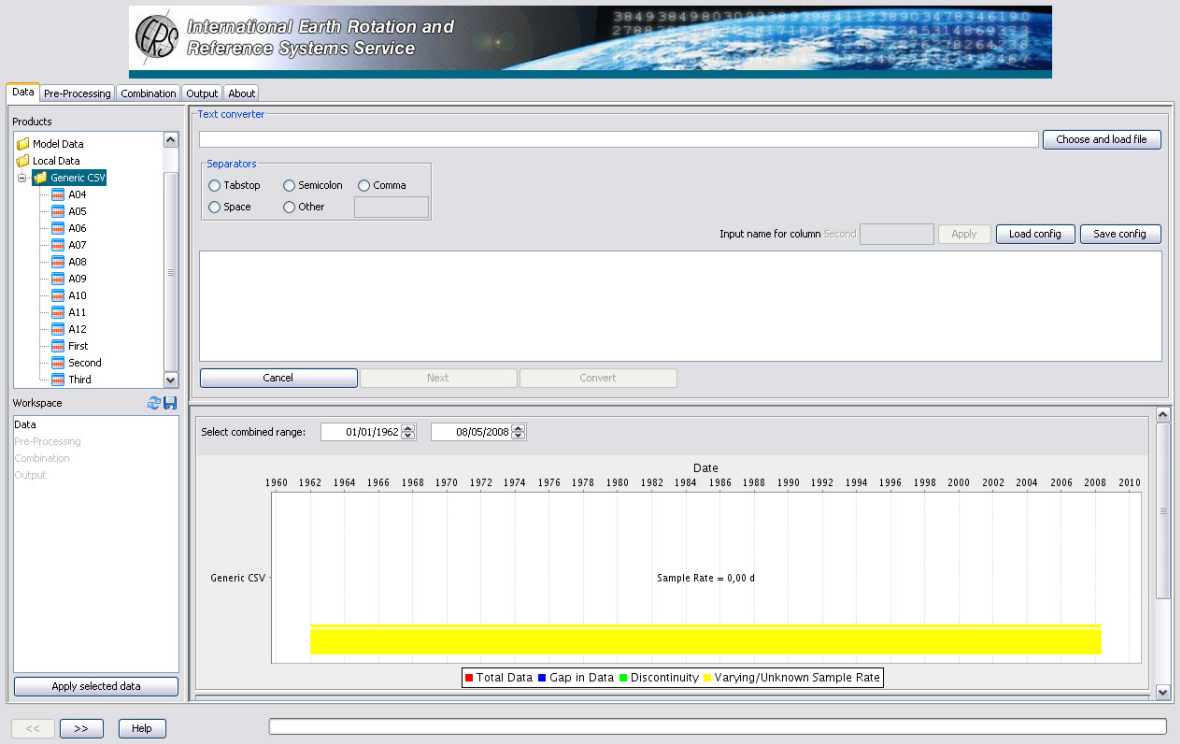
3. If you want to re-use this configuration later, save it to file. To do so, click on **Save config**, find a directory, enter a file name, and click on **Save**.

Converting and loading the file

When configuration is finished, continue with converting the and loading the file:

1. Click on **Convert**.

   A progress bar indicates the loading status and shows when the load process is complete.



2. In the **Products** field, the columns are added in alphabetical order as branches of the loaded file. Select the branches/columns to be used for the analysis.

   To add more columns to the selection: keep pressed the [Ctrl] key while clicking on other entries. If you click again, the entry will be unselected.

3. You can select a period of time within which data are to be considered and adjust a sample rate. See *Selecting Period of Time of Data and Sample Rate* on page 27.

4. When finished, click on **Apply selected data** under the **Selected Data** field left.

The data are gathered from the file and added to the white **Selected data** field left. Now they can be used for analysis.

Correcting wrong entries

If you notice that you want to delete loaded data, proceed as follows:

1. Select the data entry to delete in the workspace and right click the data entry.
2. Select **Delete** from the context menu showing up.

   The entry will be deleted.

3.5 Selecting Period of Time of Data and Sample Rate

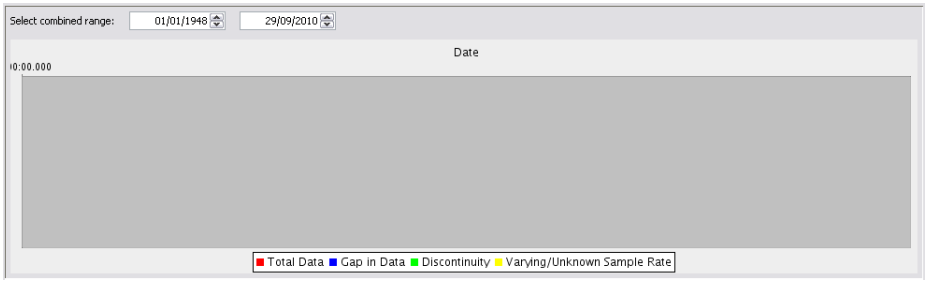
To compare model data time series, it is required that they:

- refer to the same period of time

  – and –

- provide the same sample rate

You will note that you can select a period of time of the data at each stage of the program.



The reason is that different time data can be required in the different stages, but need to be loaded only once.

The graphical time display shows the periods of time of all loaded data one below the other. You can easily recognise signal, gaps, discontinuities and varying sample rates.

Once the data are loaded, reduce their period of time for processing according to your needs:

1. Enter start time and end time of the period to analyse.

- Enter them into the date fields. If you click the **Set Common Time Period** button, the fields are set to start and end date of the period of time shared by all loaded data.

- Use the graphical selector. Left click into the graphic at the start time, draw right to the end time and release the mouse button.

Over the processing period of time, the are no gaps, discontinuities and varying sample rates allowed. If so, use pre-processing functions to remove them. Pre-processing data is one of the subsequent steps and is explained in *Pre-Processing Data* on page 29.

Example:

Assume you want to analyse

- *EOP/Pole/x* from 1970 to 1980
- *EOP/Pole/y* from 1975 to 1985

In this case, you first load the complete *EOP/Pole* data over the complete period of time from 1970 to 1985. Then you apply analyse procedures on them or restrict the period of time, depending on the type of data or procedure.

When plotting the data, you may restrict the time period again for the graphics displaying results according your requirements.

3.6 Pre-Processing Data

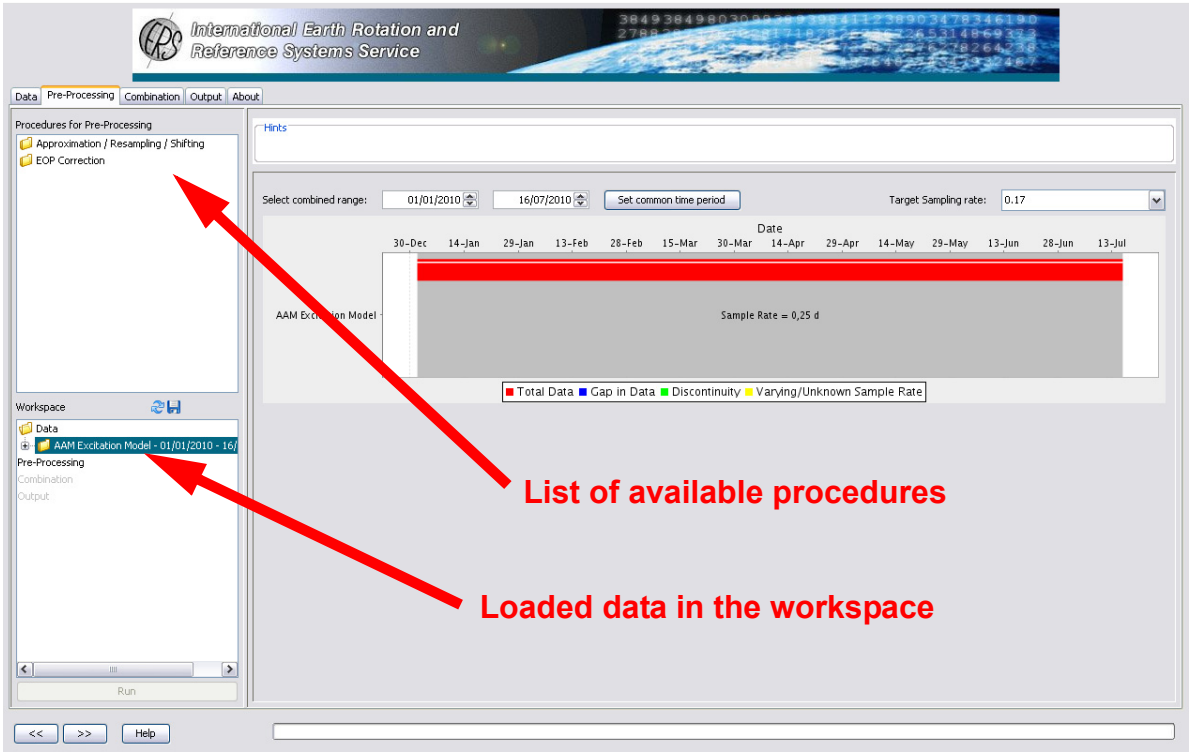
You can process data only if you have loaded data into the workspace previously. If you did not yet, return to *Loading and Selecting Data* on page 14.

Similar to the products in the data panel, the procedures for data pre-processing are arranged in groups. Only those can be selected which correspond to the loaded data type and for which a sufficient amount of data is loaded to the workspace. They are described in *Procedures* auf Seite 39.

To set up and apply the procedure:

1. Change to the **Pre-Processing** panel, either by clicking its tab or click on the forward button [>>] in the **Data** panel.

   The **Pre-Processing** panel becomes active. The available analysis methods are listed in the left upper white field. The other white field below still shows the data in the workspace:



Note(s):

The meaning, effect, parameters, and the output of the procedures are subject of the descriptions shipped with these procedures. This document deals with the program operation only, on which the procedures do not have effect.

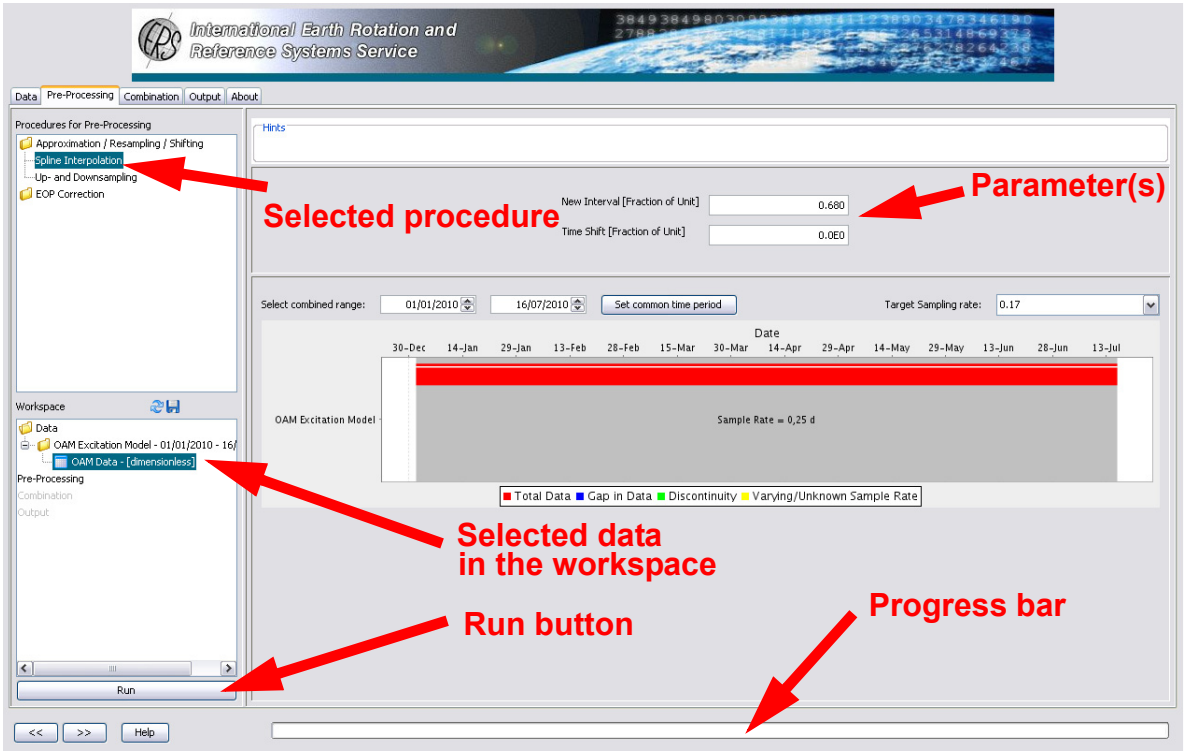
2. Select the data in the workspace, on which you intend to apply the procedure.

3. Select the procedure or procedure group in the upper left field Procedures for **Pre-Processing** by a click.

   Branches with procedures may open for selection. If so, select the appropriate type of procedure. If not, return to selecting appropriate data.

   Only procedures are selectable which are suitable to the loaded data in the workspace. If you have selected the procedure prior to the data, inappropriate data become not selectable anymore (are greyed out) in the workspace.

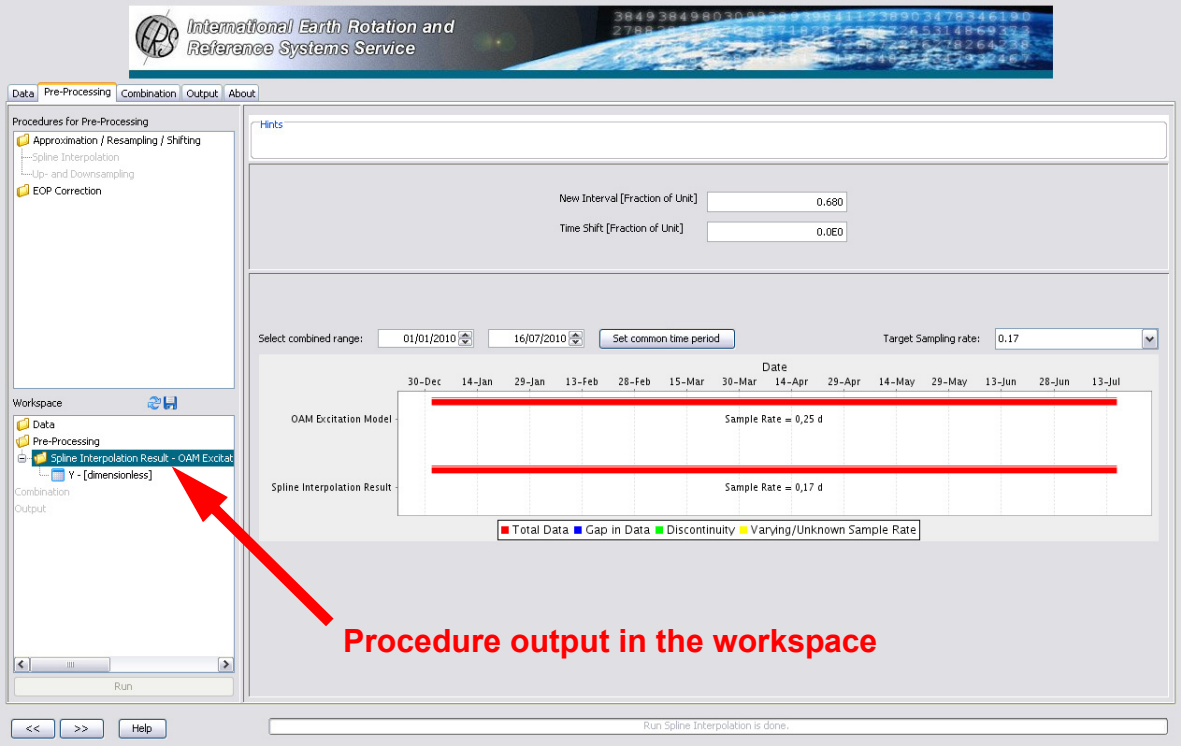
4. The procedures may provide input parameters. Enter proper values for the intended analysis:



5. When finished, click the **Run** button. Analysis starts.

   A progress bar indicates the status and shows when the process is complete.

   Then result is output in the graphical display and added to the workspace:



If it is required to improve the results, return to altering the parameters or to load other data. This is described in the previous sections.

You can repeat the previous steps, to collect various data in the workspace.

If the results are complete and meet the expectations, you can

- use them as an input for other procedures
- use them for combination and comparation, as described in *Combining Model Time Series* on page 33
- continue with turning them into graphical output, as described in *Generating Graphical Output* on page 35.

  Otherwise repeat the previous steps.

Correcting wrong entries

If you notice that you want to delete data from the workspace, proceed as follows:

1. Select the data entry to delete in the workspace and right click the data entry.
2. Select **Delete** from the context menu showing up.

   The entry will be deleted.

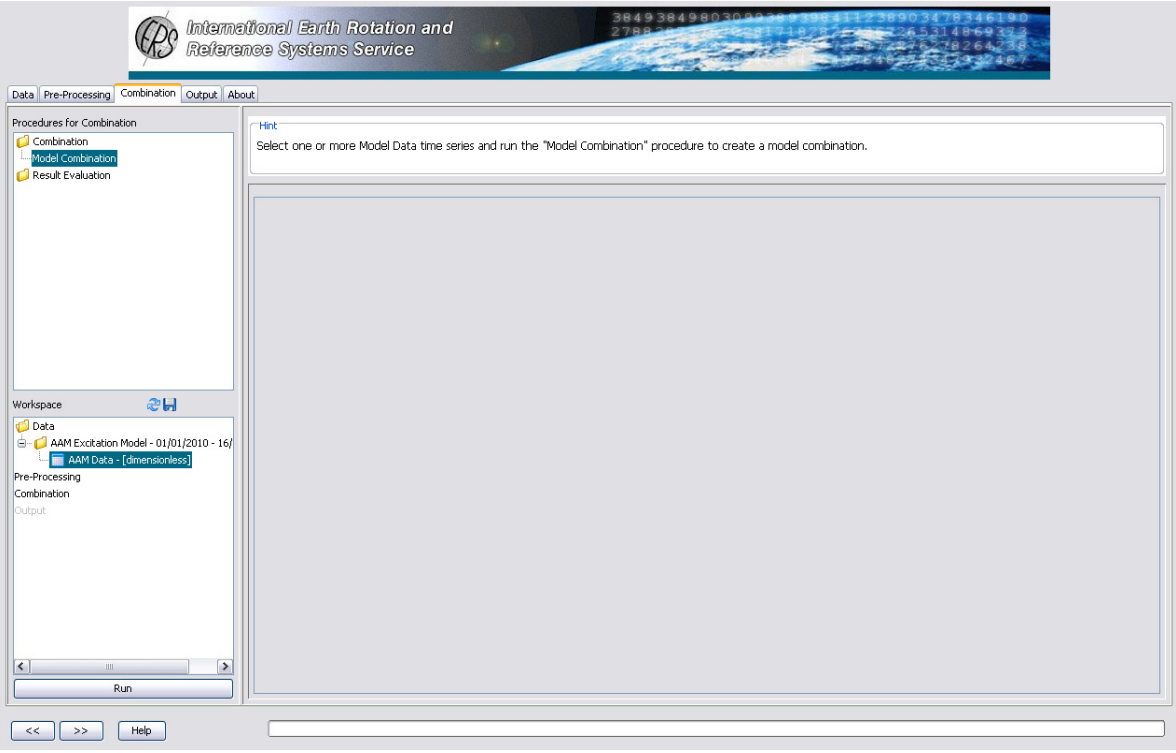
3.7 Combining Model Time Series

This function allows to combine and compare different types of model time series data.

As a first step, create combinations of model time series by simple accumulation. Then compare the model combinations and EOP data sets. Relations between the model combinations and/or the EOP time series and differences between the compared parameters of the model combination can be computed and displayed. The methods are described in *Procedures* auf Seite 39.

1. Change to the **Combination** panel, either by clicking its tab or click on the forward button [>>] in the **Pre-Processing** panel

2. The **Combination** panel becomes active. The available combination methods are listed in the left upper white field. The other white field below still shows the data in the workspace:



3. Select the data in the workspace, on which you intend to apply the combination method.

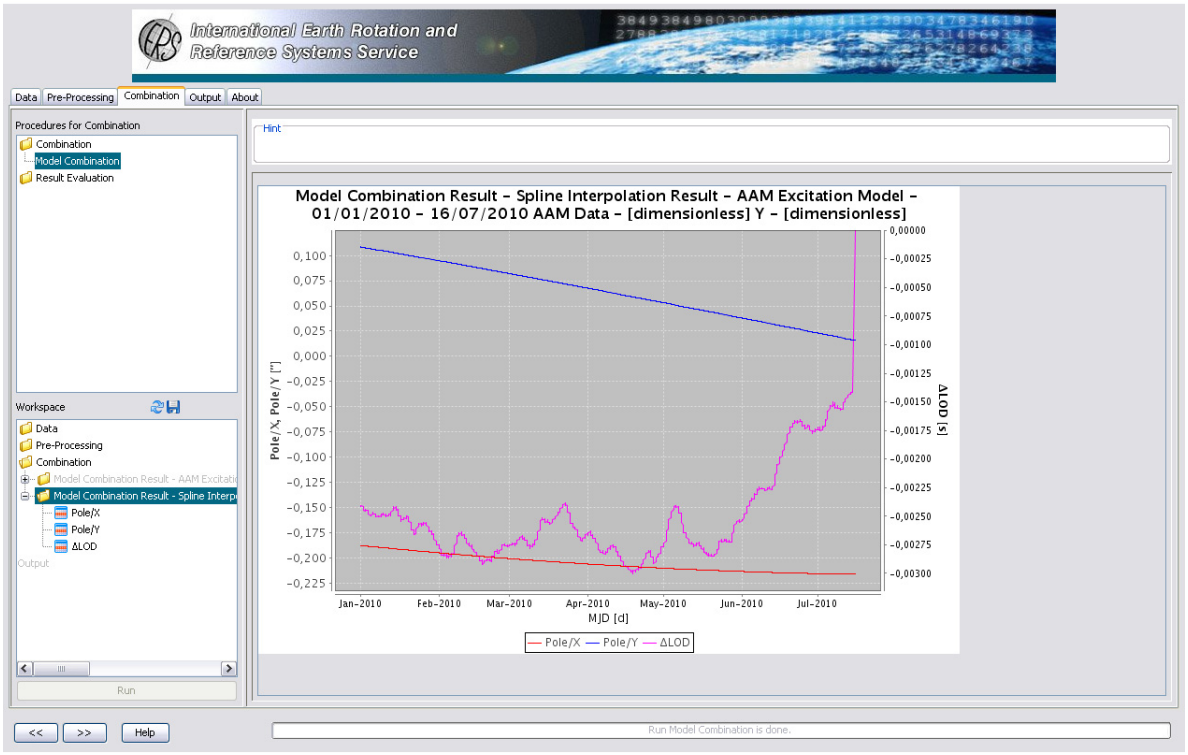
4. Select the method or methods group in the upper left field **Procedures for Combination** by a click.

   Branches with methods may open for selection. If so, select the appropriate type of method. If not, return to selecting appropriate data.

   Only methods are selectable which are suitable to the loaded data in the workspace. If you have selected the methods prior to the data, inappropriate data become not selectable anymore (are greyed out) in the workspace.

5. When finished, click the **Run** button. Analysis starts.

   A progress bar indicates the status and shows when the process is complete.



3.8 Generating Graphical Output

To generate graphical output (= plotting), data and/or procedure and/or combinations output needs to be in the workspace. Two different methods for plotting are available.

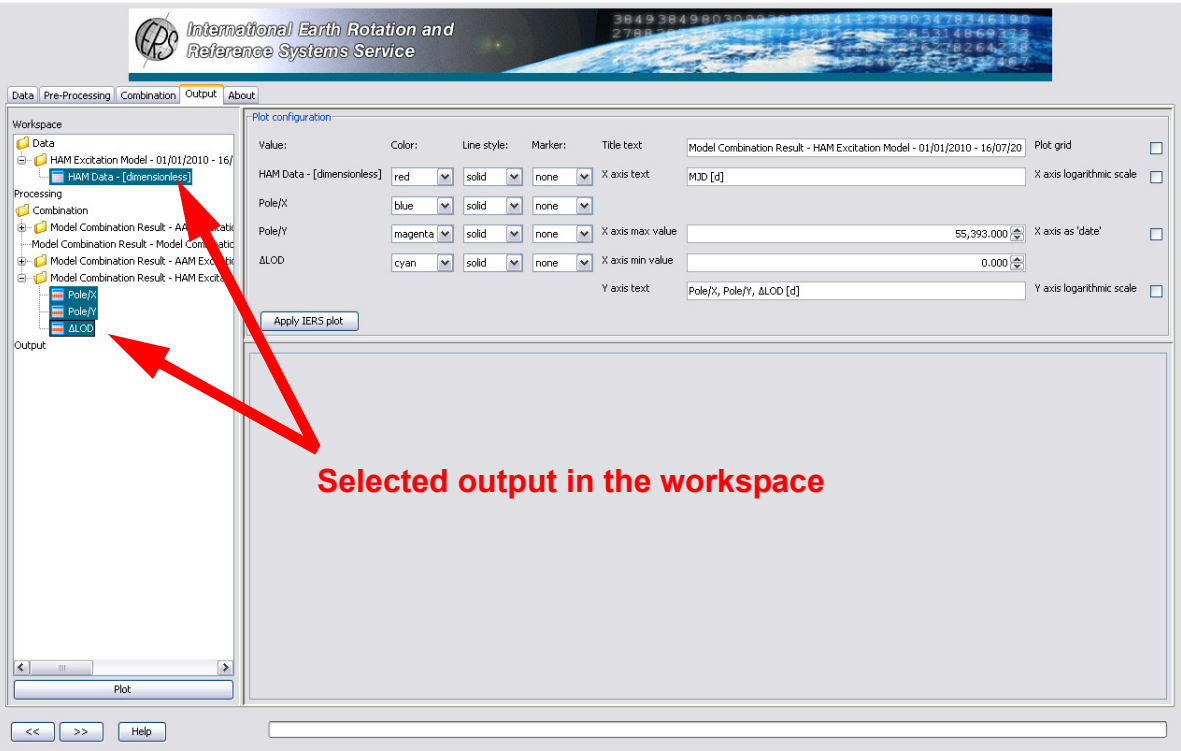
If this is not yet fulfilled, return to

- *Loading and Selecting Data* on page 14 or
- *Pre-Processing Data* on page 29 or
- *Combining Model Time Series* on page 33

To generate graphic output:

Note that the upper white control field disappeared, only the workspace remained.

1. Change to the **Output** panel, either by clicking its tab or click on the forward button [>>] in the *Procedure* panel.
2. Select the data to display graphically in the workspace:

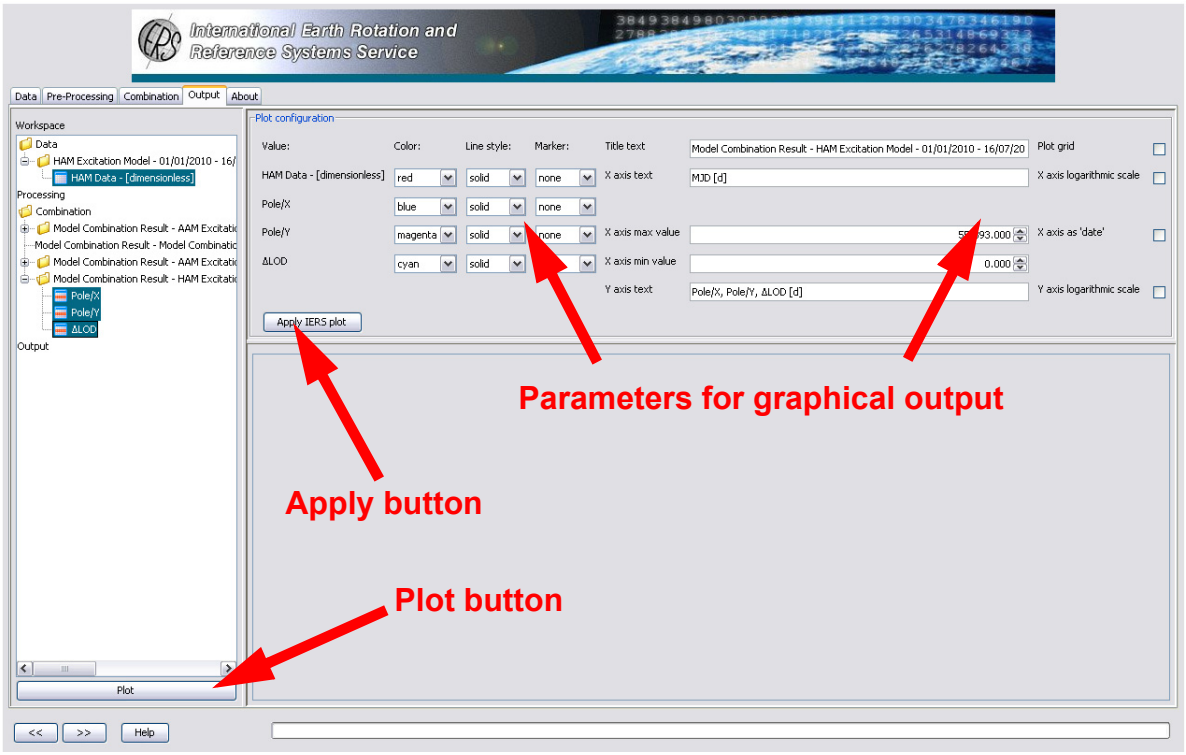


3. To add more data to the selection: keep pressed the [Ctrl] key while clicking on other data entries. Click again, the entry will be unselected.

You can repeat the steps until all required data to be plotted are selected.

All the selected data will be displayed in the graphic.

4. Click on **Plot**.



5. Enter the parameters for the graphical output:

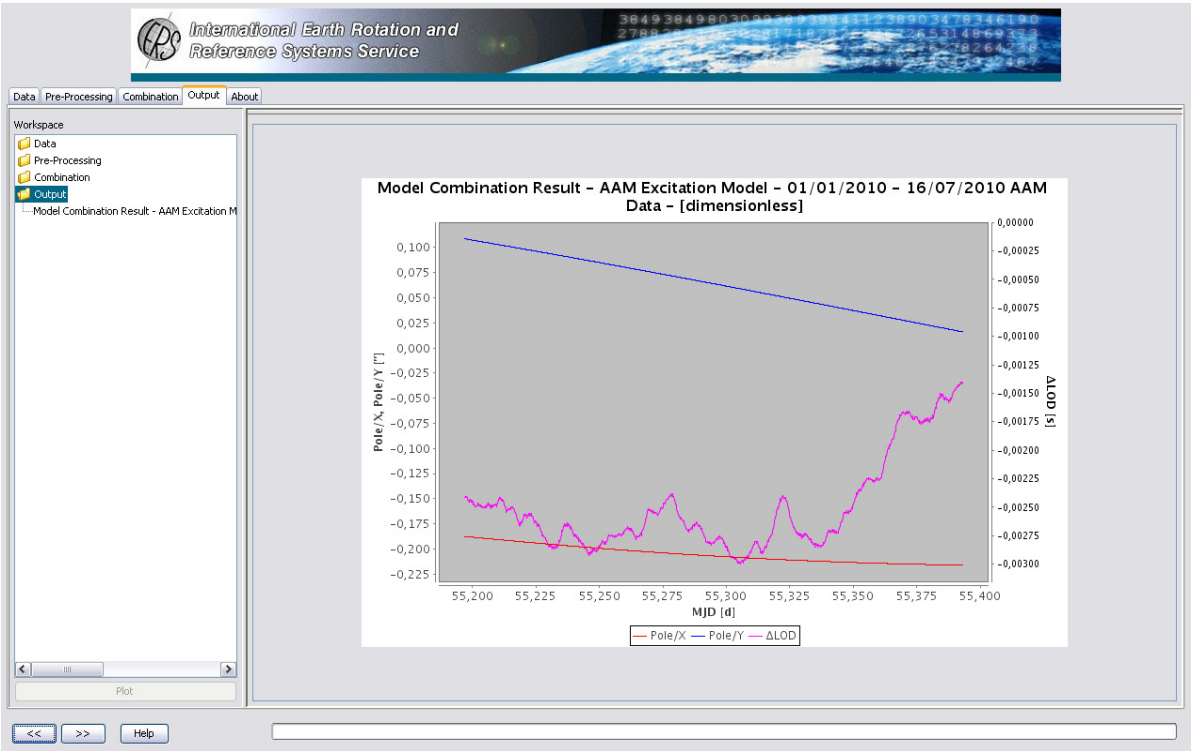
Value	Shows the data selected item.
Color	Adjust the color of the plotted graphic line.
Line Style	Adjust the line style of the plotted graphic line (solid, dotted, etc.)
Marker	Defines symbols displayed at data points on the curve.
Title Text	Enter a text that is displayed over the graphic.
Plot grid	Switch on or off whether a grid is desired in the graphic.
X axis text	Enter the label texts for the x-axis.
X axis logarithmic scale	Switch on or off logarithmic scale for x-axis.

x axis max value	Select the period of time to be displayed, here the lower start value. Data loaded and processed remain unchanged, this setting refers to the display graphic only.
x axis as 'date'	Enable to display the x axis in date format (MM/DD/YYYY). If disabled, the x axis is displayed in MJD format (Modified Julian Date, double integer value).
x axis min value	Select the period of time to be displayed, here the upper end value. Data loaded and processed remain unchanged, this setting refers to the display graphic only.
Y axis text	Enter the label texts for the y-axis.
Y axis logarithmic scale	Switch on or off logarithmic scale for y-axis.
Generate default X-Y-Plot	If two data series are selected as input, activate this to plot the series against each other instead of plotting them both over time. This requires two data series over the same period of time. If other than two data series are selected as input, this function is not available.

Note that not all parameters apply for each type of input data.

6. Click on the **Apply** buttons to generate the graphic(s).

The graphic(s) shows up:



If you are satisfied with the result, you are finished.

Improving and Adding new Graphics

Otherwise you may alter the output parameters by returning to entering the parameters:

1. If desired, select other output data.
2. Click on **Plot** and change the desired parameters.
3. Click on **Apply**. A new graphic will be generated and added to the previous graphics.

Note(s):

Note you can return to any previous panel to alter selections in the data/procedure/output control field or in the workspace to improve your results.

3.9 Printing Graphics

Graphics can be printed. To print graphics:

1. Right click the data in the workspace in the *Output* branch.
2. Select **Print**. The printer control panel opens.
3. Set up the printer and click on **OK**. The graphics are printed.

3.10 Exporting Graphics

Graphics can be exported as PNG or JPEG file. To export graphics data:

1. Right click the data in the workspace in the *Output* branch.
2. Select **Export JPG** or **Export PNG**.
3. Find a directory and enter a name for the file.
4. Click on **Save**.

4 Procedures

In this chapter, the methods are listed and described in alphabetical order.

4.1 Comparison

This method allows for visual comparison of two signals without further modification.

It expects two time series as input, which are directed to output without modification, so that they can be viewed in the same plot, whereby, however, one of the time series can be time shifted as specified by parameter.

See *Up-/Downsampling and Time Shift* on page 44.

Input parameters are:

Time Shift	Specifies a time shift value.

Output parameters are:

Difference	Contains the difference between the two signals.
Time shifted	Contains the time shift.

4.2 Correlation

This method computes the (normalized) correlation coefficient of two signals. Autocorrelation is a special case of correlation.

If the correlation is plotted over time, the length of the window used for the correlation must be specified (similar to short term correlation), and the number of points at which a correlation shall be computed. The default values depend on the signal length. Another parameter specifies a time shift of the signals against each other.

If the correlation is plotted over the signal shift, another output is, at which time shift the correlation is maximized and minimized, and the peak values of both.

Output parameters are:

Correlation	Contains the correlated signal.
Maximum	Contains the maximum correlation value.
Minimum	Contains the minimum correlation value.
Timepoint Maximum	Contains the time of the maximum correlation value.
Timepoint Minimum	Contains the time of the minimum correlation value.

4.3 Fast Fourier Transformation and Short Term FFT

This method applies an FFT on the time series input.

Input parameters are:

FFT Length	Select an FFT length from 2 to 65536 in steps of powers of two. The signal is filled up with zeroes up to the specified length.
Window Type	Select a Window type: • None • Square • Hamming • Hanning

Output parameters are:

Amplitude	Contains the amplitude series values (FFT magnitude).
Frequency	Contains the frequency series values.
Imaginary Part	Contains the imaginary part series values.
Phase	Contains the phase series values (FFT phase, prograde and retrograde).
Real Part	Contains the real part series values.

4.4 Filters

These methods allow for filtering the input time series by different FIR filters (finite impulse response filters).

The filters are:

- band pass
- differentiation
- generic
- high pass
- low pass
- moving average

The **band pass filter**, the **high pass filter**, and the low **pass filter** have a linear phase least-square filter design. Certain, fix cut-off-frequencies are given for these filterings (see table below).

Select between high pass or low pass filters. They are available with the following sample rates:

- hourly
- four times a day
- daily

The method checks whether one of these sample rates is used and automatically selects the correct filter. If a different sample rate had been used, it issues an error message.

The **differentiation filter** is an FIR filter. The filter length can be specified by parameter, i.e. the number of samples used.

The **moving average filter** is an FIR filter with a rectangular impulse response. The pulse period (in days) can be specified by parameter. The default value depends on the selected type of filter, the user setting is checked for validity.

A **generic filter** using individual filter coefficients is available to advanced users. All coefficients and the filter degree can be specified by parameters.

Input parameters are:

Band Pass Filter **Center Frequency**	Specifies the center frequency of the band pass. Select between: • Monthly (30 days) • Semi Annual (182 days) • Annual (365 days) • Chandler Wobble (435 days)
Differentiation Filter **Filter Length**	Specifies the filter length of the differentiation filter.
Generic Filter **Filter Coefficients**	Specifies filter coefficients for the generic filter. Separate the values by ";".
High Pass Filter *Low Pass Filter* **Cut-Off-Frequency**	Specifies the cut-off-frequency of the filters. Select between: • Monthly (30 days) • Semi Annual (182 days) • Annual (365 days) • Chandler Wobble (435 days)
Moving Average **Averaging Time**	Specifies the averaging time (pulse period) for the filter. Select between 6, 14, 30, 60 and 90 days.

Output parameters are:

Filtered Values	Contains the series of filtered values.

4.5 Power Spectrum

This method estimates a power density spectrum using averaged periodograms.

The parameters should be set to useful values according to the data set (signal length).

Result is a frequency series.

Input parameters are:

Number of Periodogram	Specifies the number of periodograms.
Overlap of Periodogram	Specifies the overlap of the periodograms in percent.
Window Type	Select a Window type: • None • Square • Hamming • Hanning

Output parameters are:

Amplitude	Contains the amplitude series values (FFT magnitude).
Frequency	Contains the frequency series values.
Imaginary Part	Contains the imaginary part series values.
Phase	Contains the phase series values (FFT phase, prograde and retrograde).
Real Part	Contains the real part series values.

4.6 Short Term FFT

See *Fast Fourier Transformation and Short Term FFT* on page 40.

4.7 Spline Interpolation

This method conducts a spline approximation or interpolation.

This is a resampling or interpolation method, i.e. the number of available samples can be increased via the spline approximation, and the time series can be complemented by additional values between the real sample values. As an adjustable parameter for the spline approximation, the new sample interval is specified, which can be set freely. A time shift in the subsample domain can be specified additionally.

The method checks whether the new sample interval is shorter than the original interval of the input time series. Only in this case, the method can be applied usefully.

A residual signal cannot be determined by this method!

Input parameters are:

New Interval	Specifies the new sample interval.
Time Shift	Specifies a value for the time shift.

Output parameters are:

Y	Contains the result values of the polynome interpolation.

4.8 Time Shift

See *Up-/Downsampling and Time Shift* on page 44.

4.9 Up-/Downsampling and Time Shift

This method conducts up- and downsampling on the input signal, and allows for time shifting.

It enables for changing the sample rate of the input signal in powers of two, i.e. dividing or multiplying by 2, 4, etc. Upsampling and downsampling are offered as two different methods with a parameter to specify the resampling factor.

The modification of the sample rate follows the Theory of sampling band limited signals for the special case of low pass limited signals, i.e. upsampling uses an interpolation of higher degree. This means that the signal is filled up with zeroes and then be low pass filtered. The low pass usually provides a cut-off-frequency of half the sampling rate of the original signal.

When downsampling, the sample rate changes so that the rules for the low pass limit are tightened. This is ensured by previous low pass filtering.

Furthermore, time shifting is provided. The signal remains unchanged, only the time axis information is changed.

Input parameters are:

Sample Factor	Specifies the sample factor for the signal.

Output parameters are:

Resampled Value	Contains the resampled signal.

4.10 Wavelet Transformation

This method conducts a high resolution time-frequency analysis by means of a wavelet analysis.

Output of the method is a time-frequency series.

Mother wavelet is the Morlet wavelet (see *Oliver Faber: "Effiziente Wavelet Filterung mit hoher Zeit-Frequenz-Auflösung", Theoretische Geodäsie, Heft Nr. 119, http://dgk.badw.de/index.php?id=11*).

A parameter is the parameter Sigma in the publication named above. Another parameter specifies whether prograde or retrograde portions are plotted (scaling parameter a > 0 or scaling parameter a < 0).

Input parameters are:

Scaling	Specifies whether scaling prograde or retrograde.
Sigma	Specifies the Sigma value as explained in the named documents.

Output parameters are:

Time	Contains the time value series.
Real Amplitude	Contains the real amplitude value series.

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