TSAP-Win™

Time Series Analysis and Presentation for
Dendrochronology and Related Applications

Version 4.64 for Microsoft Windows

User Reference

Please read carefully before
installation and usage of the software

RINNTECH®

11/01/2011

The software described in this reference may be subject to changes.
Updates are available via the Internet: www.rinntech.com

CONTENTS

INTRODUCTION

TSAP was first presented in 1991, and meanwhile it has become one of the standard programs for time series analysis and presentation in dendrochronology and related applications.

Now, ten years later, TSAP has been completely revised and adapted to a Windows environment. Thus, handling becomes more convenient for all those users already familiar with Windows software. The new version would not be available without the input of a number of valued TSAP-users. We greatly appreciate their ideas, criticism and advice. In the future we are still open for your feedback.

Like the previous version, TSAP remains a platform for most tasks in dendrochronology: measurement, data editing, cross-dating, chronology building, mathematical analysis and graphical presentation of time series.

We wish you lots of success with your copy of TSAP-Win!

The RINNTECH Team

GETTING STARTED

SYSTEM REQUIREMENTS

TSAP-Win can be used on personal computers with one of the following operating systems:

- Microsoft Windows 7, Vista, XP, 2000, NT
- Microsoft Windows ME, 98 or 95

Your PC should be equipped with a Pentium processor and at least 32 MB memory.

For tree-ring measurements via LINTAB (or any other device), a serial port or USB port is required.

VERSIONS

The following versions and modules are available within the TSAP-family:

- TSAP-Basic: Measurement and editing of tree-ring data (only in connection with LINTAB).
- TSAP-Professional: Basic + cross-dating, chronology building, simple graphs
  - Math library: easy operations, arithmetic, square, derivation, transformation, indexation, internal statistics, correlation, trend/regression, average/mean, user plugins.
  - Graph library: line graphs (single and multiple), all in one, grid beams, core beams, standard series plot
  - Format library: supports exchange of other data formats like CATRAS, Hemmenhofen, Birmensdorf, Matrix, Göttingen, V-Format, Hohenheim, Stanley, Belfast, Sheffield, INRA.
  - Table module: supports other measurement tables like Velmex, Aniol, Kutschenreuther, Heidenhain, NE 202.
- TSAP-Win Scientific: Professional + all libraries and modules

UPDATES

TSAP-Win will be revised and improved on a regular basis. Updates can be downloaded from our website: http://www.rinntech.com

If you encounter problems downloading, please contact us. We will send you the requested download.

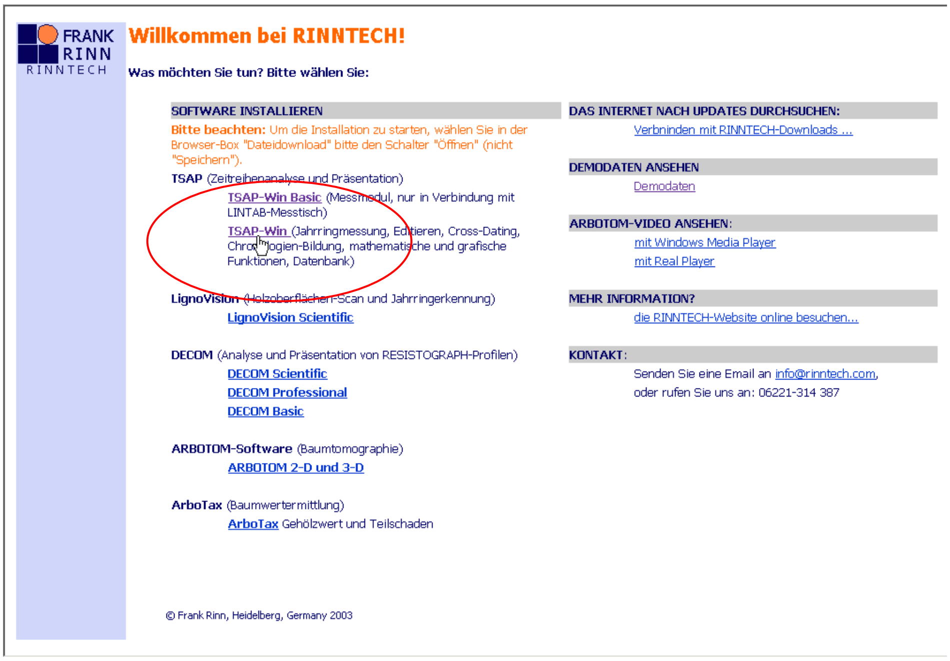
INSTALLATION OF TSAP-WIN

TSAP-Win can be easily installed on your PC:

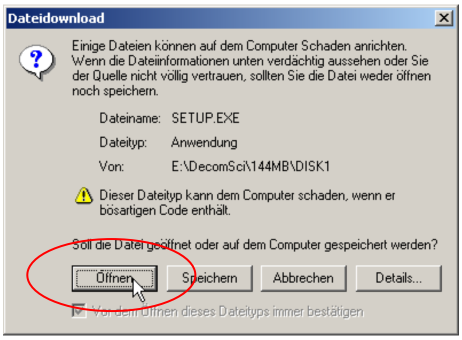
1. Insert the RINNTECH Software CD into the CD-ROM drive and close it.

2. After a while the CD starts automatically. Choose your language. In case the CD does not start, please use the Windows Explorer or any other Windows file manager to open index.html from the CD manually.

3. Select TSAP-Win from the software list.



4. Open the installation file. (Note: Do not save it)



5. The Setup-Program will be started. Please follow the instructions.

6. After successful installation the software must be unlocked by RINNTECH (see next chapter). TSAP-Win will only offer full performance when unlocked.

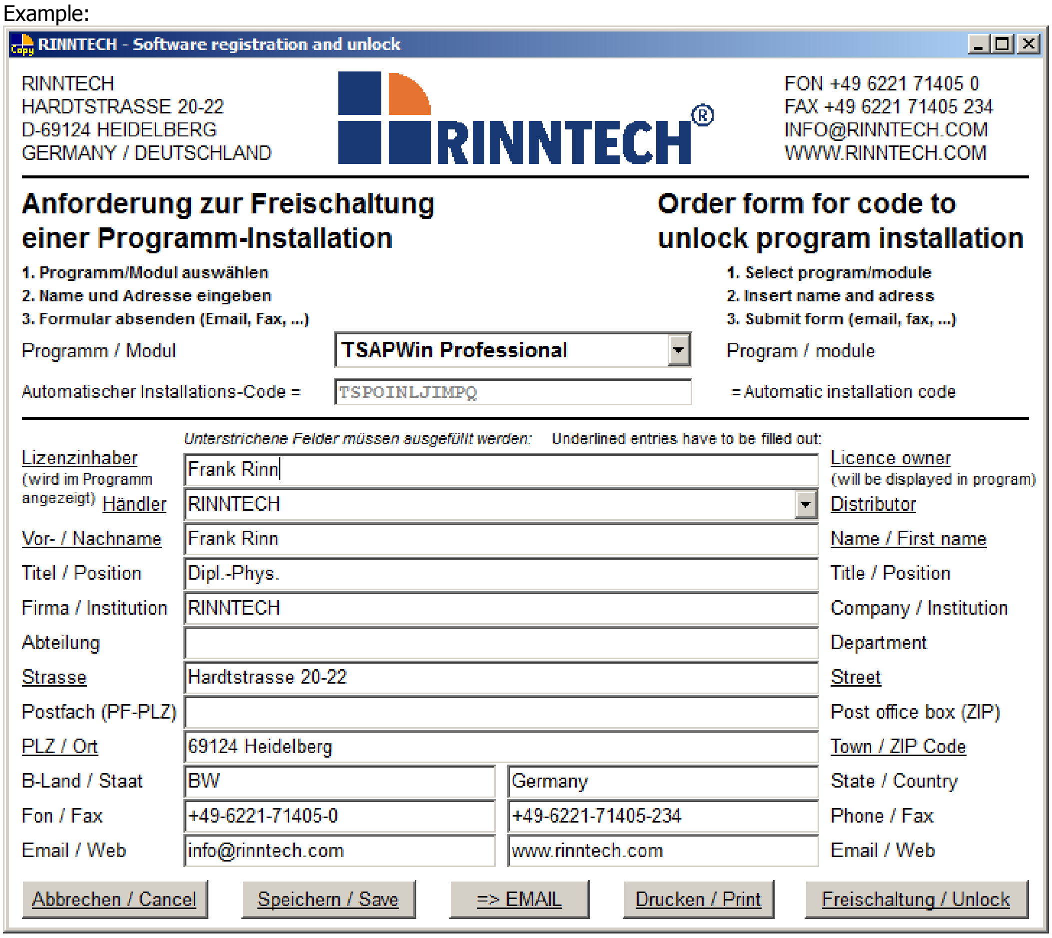
UNLOCK TSAP-WIN

The unlock code is only valid for the PC where the system code has been generated. For installation on another PC you will need another unlock code.

To unlock, please do the following:

1. Click on Start, select "Programs", "RINNTECH", "TSAP-Win" and the "**Registration Form**".
2. **Choose the TSAP-Win version** you purchased (Professional or Scientific). In case you purchased TSAP-Win Professional with additional modules please do also select these modules.
3. **Please fill in the registration form completely.** This helps us to provide the optimal support possible. The fields *Name Street*, *Zip* code and *Town* are compulsory.
4. **Print the form** (click the button "Print" and send the form by fax or mail. It is also possible to send the form by email (click the button "email").
5. **You will receive the unlock code in return.** To insert the code, please re-open the registration form again (see 1.) and click on "Unlock" (button at bottom right). Type in the code provided by RINNTECH and confirm by pressing enter. TSAP-Win is now unlocked.

Example:



Please note the license agreement.

Working with TSAP-Win

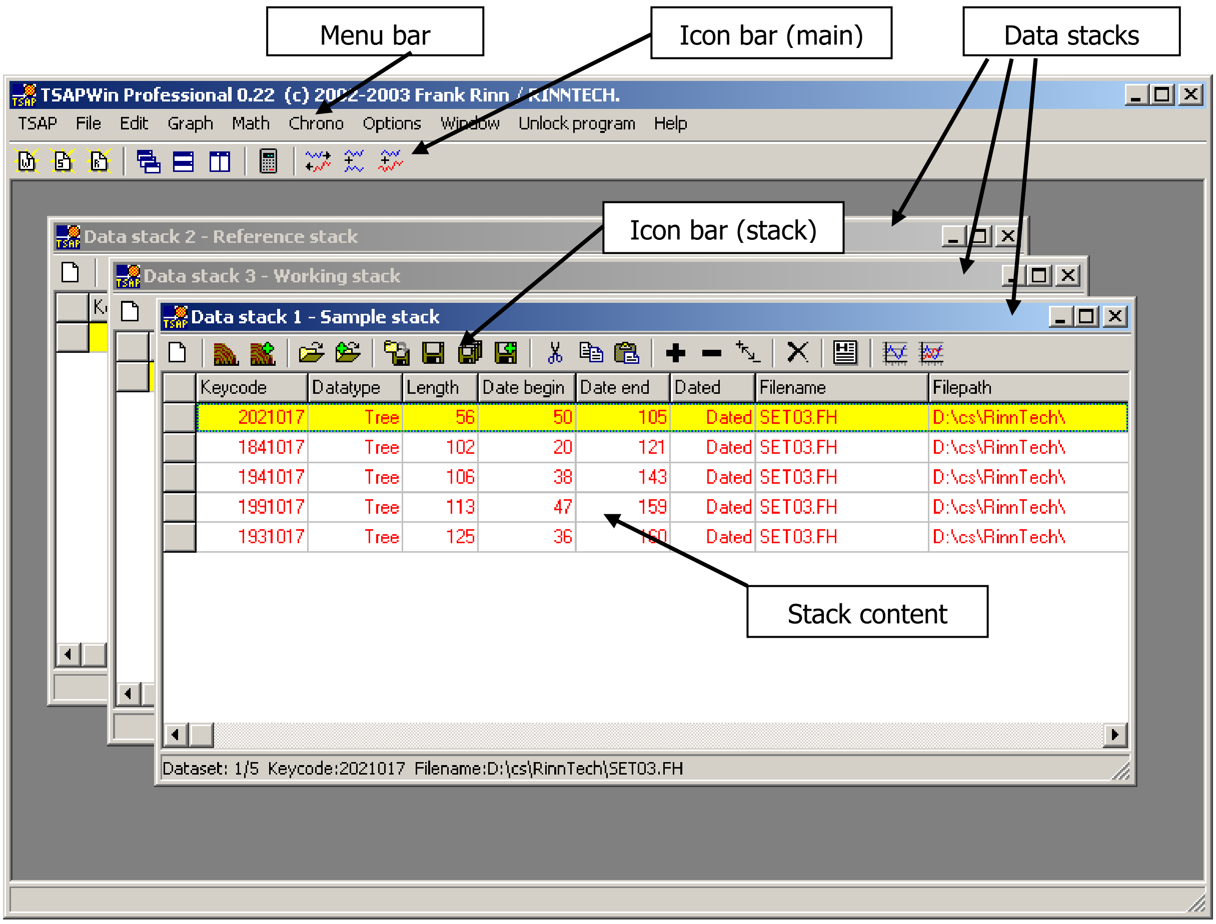
Starting the program

You can start TSAP-Win via the Windows-Taskbar. Subsequently click on Start / Programs / RINNTECH / TSAP-Win Professional.

You also can create a program link on your desktop: Open the start menu, hold the Ctrl-key and drag the program link to your desktop using the mouse. Attention: If you do not hold the Ctrl-key, the program link will be removed from the start menu.

The program window

The program window of TSAP-Win contains the graph window, the profile list, the icon bar, the menu bar and the status bar.



BASIC STRUCTURES AND FEATURES OF TSAP

FOLDERS (DIRECTORIES)

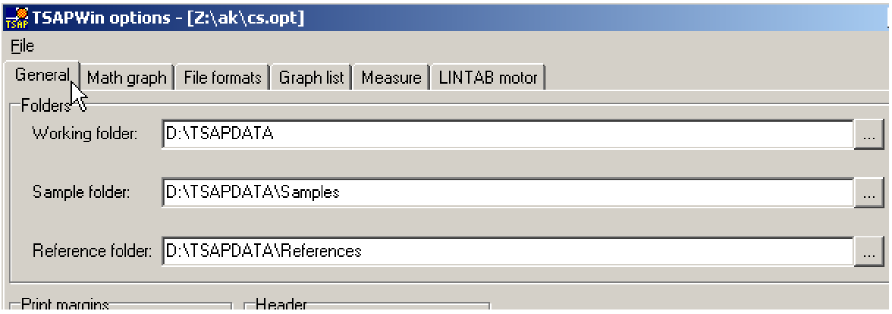
For data storage we recommend setting up a well-defined folder structure, classifying your data referring to the criteria which are most important to you (e.g. location/region, species). This helps you and others to work with your data and ensures that certain data can be easily found again - even years after they have been collected.

TSAP-Win contains three names of data stackss: samples, references and working data. Samples are mainly raw data measured with LINTAB, LignoVision or other devices. References are mostly site or regional chronologies. Working data are those series produced within a mathematical procedure by TSAP-Win, for example.

Corresponding to this order, TSAP-Win offers three different data folders:

- Sample folder
- Reference folder
- Working data folder

These folders can be individually chosen by the user in the option menu:



This structure also corresponds to the stack structure of TSAP-Win (see chapter "Data Stacks" in this section). We recommend you to use different subfolders for different projects and locations.

Please do not save any working data within the TSAP program directory.

DATA STRUCTURE

The data produced by TSAP is stored in the revised Heidelberg format, which contains two major parts:

1. HEADER: Data header, includes all header items specified by the user. Those header items which are not specified will be skipped and not saved.
2. DATA: Time series, ordered block-wise or column-wise.

This file structure was already used by the previous versions of TSAP. Switching to the Win-version, the previous format has been slightly extended. Format adaptations can be set in Options - > File formats (see screenshot on next page). TSAP data can be saved in a block and in a column based format. Mark the box "Save data as block" to choose the block format. To keep your data compatible with the TSAP-DOS-format, mark the corresponding box in the File formats options.

Example of data as block:

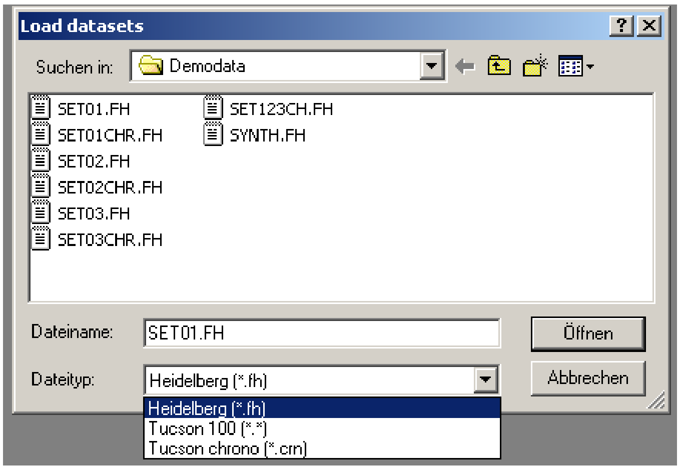
```
HEADER:
DateEnd=-66
KeyNo=27
Project=Growth studies
Length=103
Location=Test site
Species=PISY
SapWoodRings=14
WaldKante=WKF
State=Test town
PersId=FR
KeyCode=271017
Country=USA
DateOfSampling=19931106
TreeNo=5
CoreNo=1
Exposition=North-West
CreationDate=19940526
SoilType=Sand
DataFormat=Tree
Dated=Dated
DATA:Single
   125   130    99   120   115   145   151   130   135   151
   200   190   151   170   170   174   170   200   210   130
   180   197   210   160   180   155   180   199   140   150
   146   140   145   150   155   110   115   113   120   130
   110   120   150   120   120   110   115   160   160   145
   135   145   125   115   145   149   120   150   160    99
   110    75    70    82    96    90   120   151   155   130
   132   133   149   110   130   120   128   118   125   115
    95    90   110    98    80    85    97    88    70   100
    90    70    80    90    85    78    95    84    70    90
    80    75    70     0     0     0     0     0     0     0
```

Example of data as single column:

```
HEADER:
DateEnd=-66
KeyNo=27
Project=Growth studies
Length=103
Location=Oak Ridge
Species=PISY
SapWoodRings=14
WaldKante=WKF
State=Tennessy
PersId=FR
KeyCode=271017
Country=USA
DateOfSampling=19931106
TreeNo=5
CoreNo=1
Exposition=North-West
CreationDate=19940526
SoilType=Sand
DataFormat=Tree
Dated=Dated
DATA:Single
125
130
99
120
115
145
151
130
135
151
200
190
151
170
170
174
```

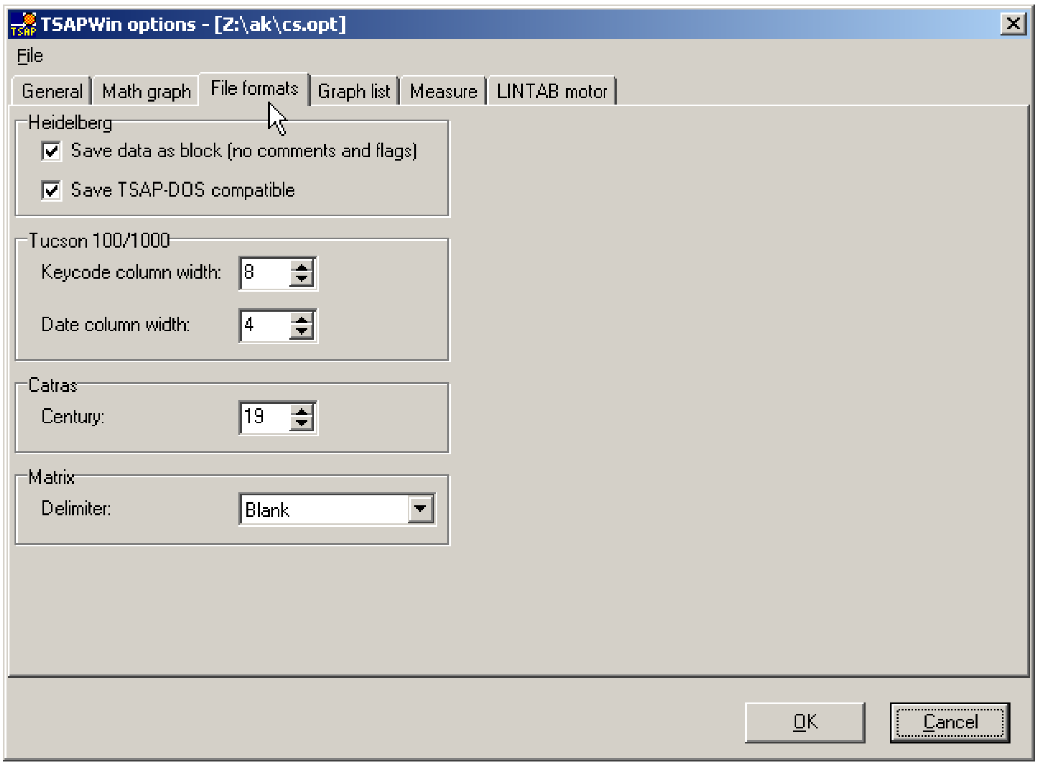
ALTERNATIVE FILE FORMATS

Besides the Heidelberg format, TSAP supports the Tucson measurement and Tucson Chronology format. The (optional) Format Library (see chapter 'Format Library') supports more formats, such as Matrix (Excel), CATRAS, Birmensdorf, Hohenheim, Belfast, V-Format. To open or save data in a certain format, select the requested format via "file-type" in the file selection window.



Please note that the Heidelberg format is the only format with full TSAP-Win compatibility. Other formats truncate more or less of the header data and even parts of the time series information (e.g. comments, marks). Consequently you should use the Heidelberg format to keep all available information within the data record.

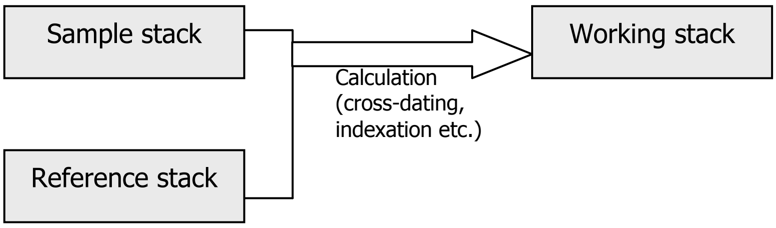
Properties of different Formats can be adapted in 'Options' -> 'File formats'

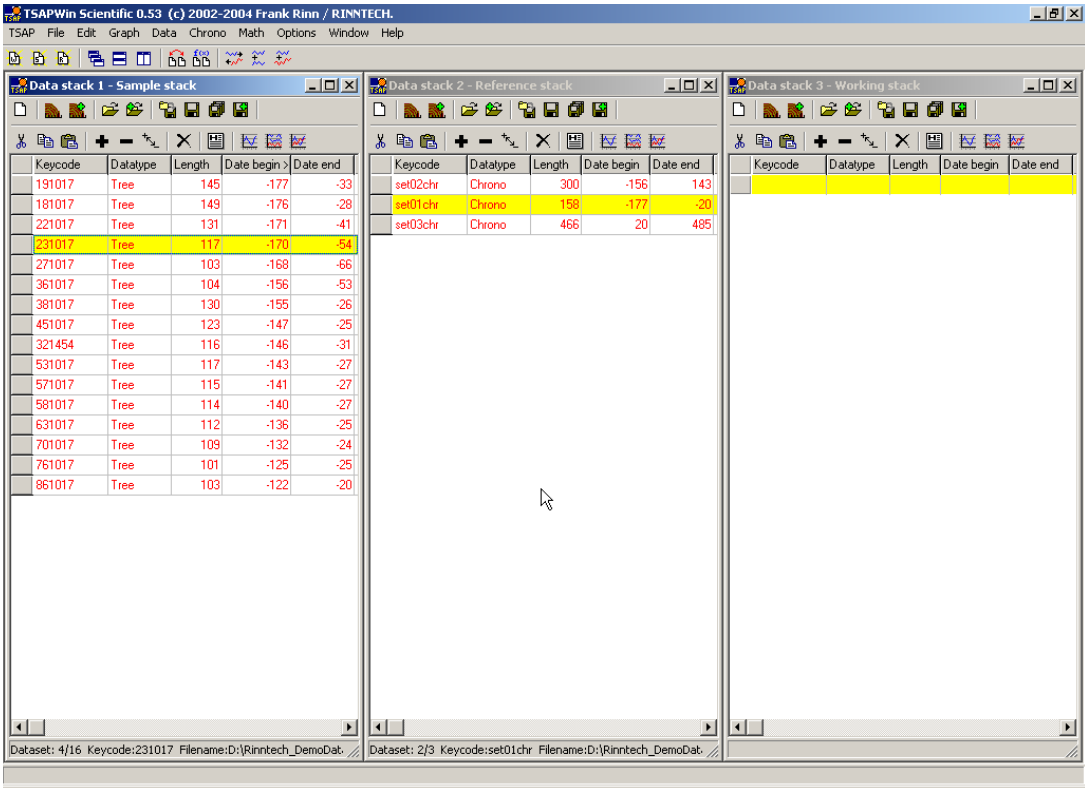


DATA STACKS

TSAP-Win manages the time series data via so-called "data stacks", as many of you already know from the DOS-version. Data which are measured, opened or computed will be listed in one of these stacks. For each type of series, TSAP-Win offers a certain data stack:

- Measurements and edited raw data should be assigned to the **sample stack**
- Site or regional chronologies or other reference curves should be assigned to the **reference stack,** if used as a reference for cross-dating.
- Computed time series will be assigned to the **working stack**





All the data stacks can be used to load, save, sort, select and display data. Depending on the purpose, stacks can be used for mathematical operations, cross-dating and chronology building. The pre-defined data stacks do not have to be used in this way, but it makes your work easier.

Alternate display: If you wish to display the data stacks tiled vertically (see image above) or horizontally, open the 'Window'-menu and select the pattern type you prefer.

The following information is normally presented within the list window of the data stack: keycode, data type (ring width, early/latewood width, density), length, date begin, date end, dated/undated, file name, file path, file format.

The following operations are available within the data listing:

Clear data stack: **c**lears the data stack from all data opened. This operation has no effect on the source data saved on disk or CD. Alternative: press "Del".

Measure: **o**pens the measurement screen for a new measurement (Read more details in the chapter "Measurement of a time series")

Edit: modifies a selected measurement. (Read more in the chapter "Edit time series")

Open data: **o**pens a file to the stack and lists the data records in the table.

Add data: Adds a file to the stack and lists the data records in the table.

Save /append data:

- **Save back:** saves the selected data back to the source file(s).
- **Save grouped as:** saves all selected data sets in one file to be specified.
- **Save separate as:** saves all selected data sets in separate files.
- **Append to:** **a**ppends the selected data to an existing file to be specified.

Cut, Copy and Paste: Similar to other Windows software cuts, copies or pastes selected data sets into another data stack. The same functions can be easily done by drag and drop using the mouse. Just select the requested data sets and drag them while holding the left mouse key to another stack (move). To copy the sets additionally, hold the Ctrl-Key.

Selecting: When a data set is opened, all series are selected as default. Data can be de-selected using the right mouse key. For quick de-selection, just hold the right mouse key and wipe over the requested series. Selected data are shown in red letters.

Select all: Click on the plus icon to select all data sets.

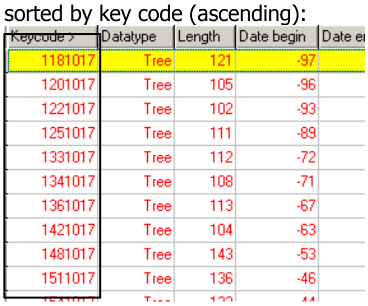
Select none: Click on the minus icon to select all data sets.

All operations are applied to the selected data only.

Invert selection: Selects the unselected and de-selects the selected data sets.

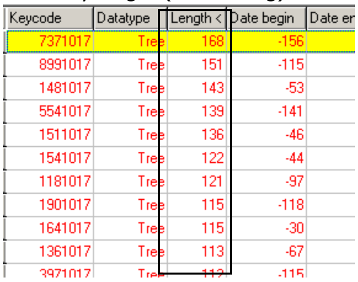
Sorting: Just clicking on the column header puts the corresponding data in ascending order. Clicking on the header again, orders the data descending.

sorted by key code (ascending):



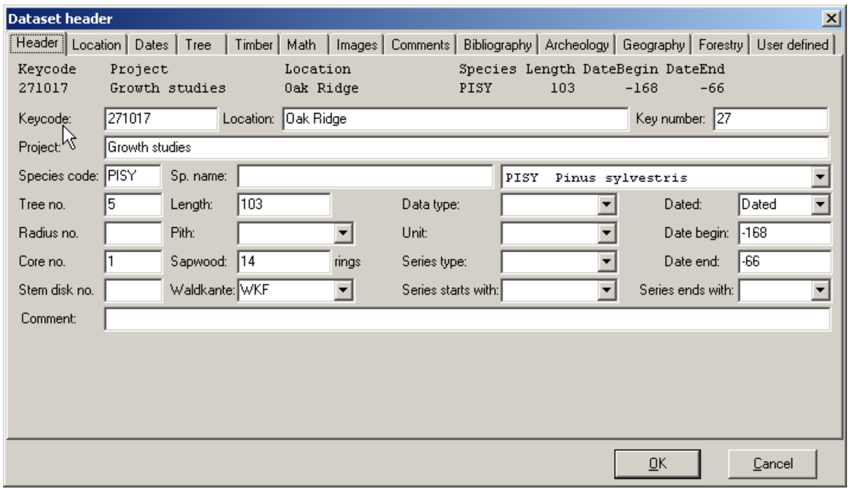
Keycode >	Datatype	Length	Date begin	Date en
1181017	Tree	121	-97	
1201017	Tree	105	-96	
1221017	Tree	102	-93	
1251017	Tree	111	-89	
1331017	Tree	112	-72	
1341017	Tree	108	-71	
1361017	Tree	113	-67	
1421017	Tree	104	-63	
1481017	Tree	143	-53	
1511017	Tree	136	-46	

sorted by length (descending):



Keycode	Datatype	Length <	Date begin	Date en
7371017	Tree	168	-156	
8991017	Tree	151	-115	
1481017	Tree	143	-53	
5541017	Tree	139	-141	
1511017	Tree	136	-46	
1541017	Tree	122	-44	
1181017	Tree	121	-97	
1901017	Tree	115	-118	
1641017	Tree	115	-30	
1361017	Tree	113	-67	

Edit header: opens the data set header of the series marked by the cursor.



The header items available and their explanations can be found in the Annex.

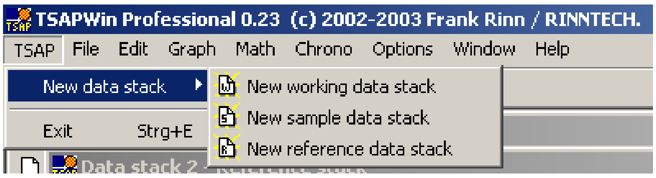
Clicking on "OK" confirms and saves the changes to the stack, "Cancel" ignores the changes. Alterations of data will be indicated in the stack list by a preceding "!" in the line.

Headers can be **pre-defined** as a header pattern in the Options menu. You can load, edit and save header patterns.

All these functions are also available via the "File" and "Edit" menu.

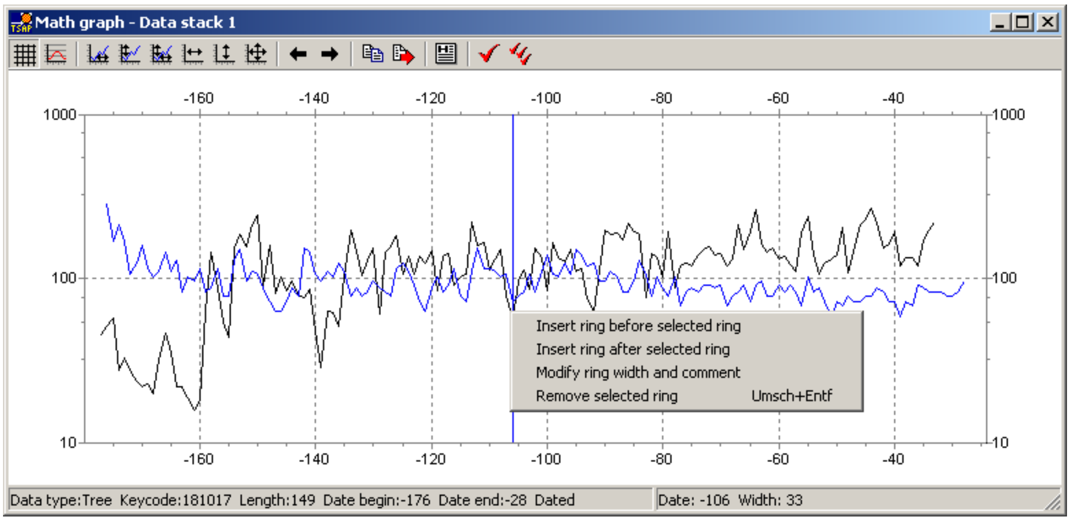
IMPORTANT: Operations on the data stacks **do not affect the data stored on your hard disk**. To store modifications permanently, save the data via the file-menu.

If desired, you can create additional data stacks of the above-mentioned types. Data stacks can be created via "TSAP" in the program menu (see image).



Math Graph

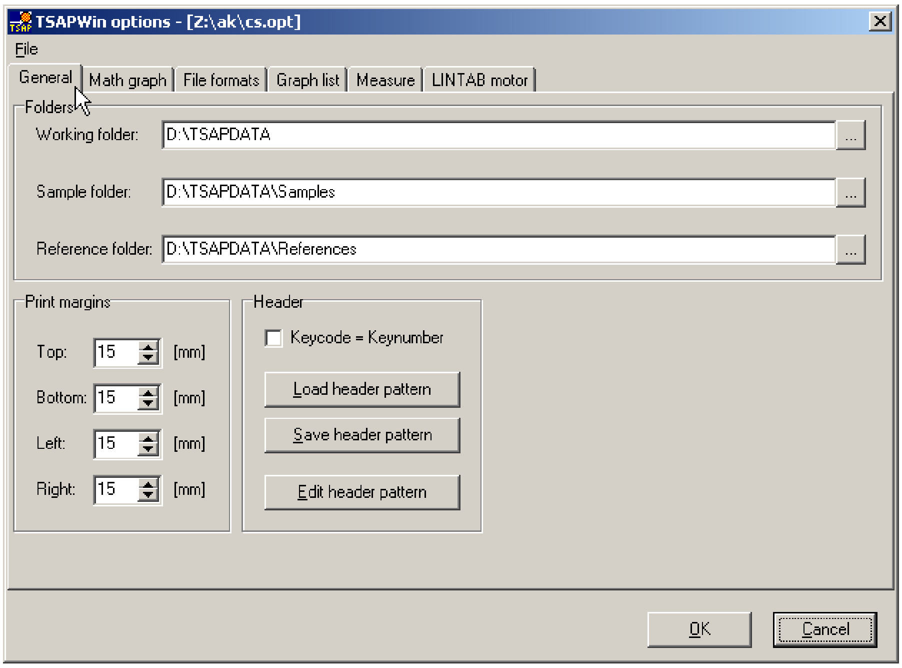
The so-called "*Math Graph*" is a traditional feature of TSAP. It offers a number of different operations and optional settings: Graphical presentation, editing, cross-dating and chronology building. In other words: *Math Graph* is the main platform for the analysis of dendrochronological data.



You will find more about *Math Graph* in the chapter "Graphs".

Options

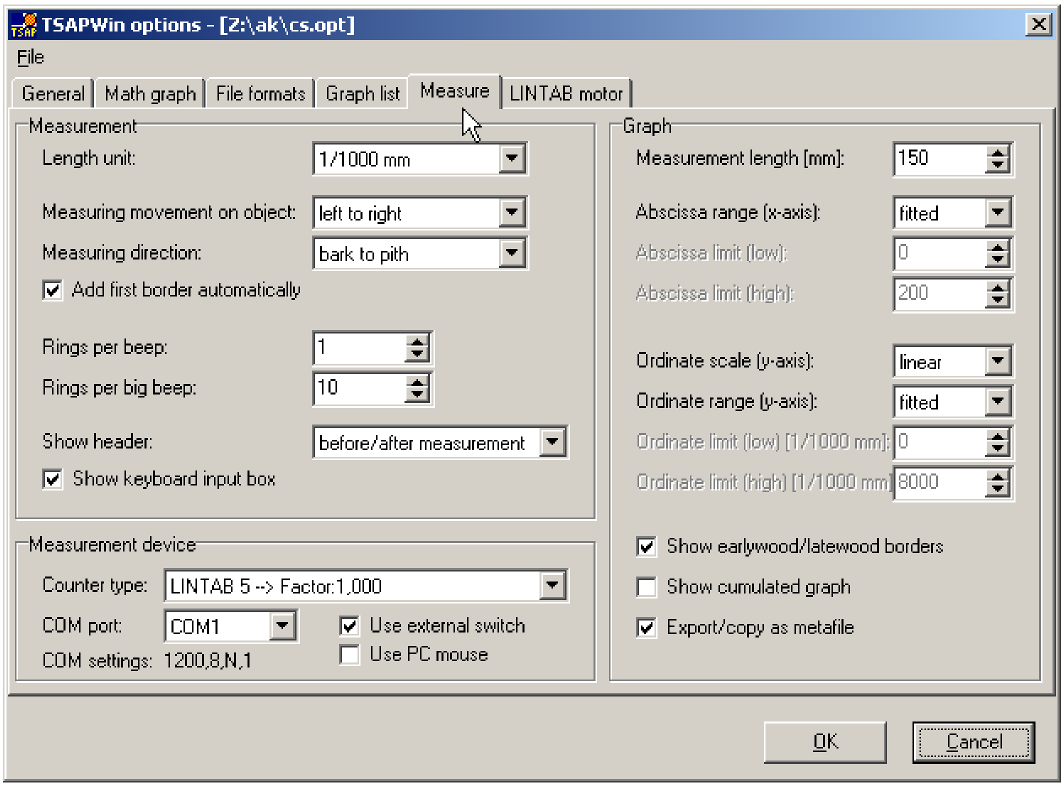
Properties of folders, Math graph, file formats, graph list, measurement devices, print margins and header patterns can be adapted in the 'Options' menu. Precise descriptions for each feature group can be found in the related chapters of this menu.



COMMON WORKING STEPS

MEASUREMENT OF TIME SERIES

PREPARATIONS



Measurement options Window from the 'Options' menu

Measurement: Within the section "Measurement" in the Options-menu you can furthermore adapt:

- Length unit (1 mm - 1/1,000 mm,
  please refer to the resolution of your measurement device)
- Measuring movement (left to right or vice versa)
- Measurement direction (pith to bark or vice versa)
- Rings per beep
- Rings per big beep
- Header display (before and/or after measurement)
- Show keyboard input box. (makes manual data input possible)

Measurement device: Before starting the measurement routine the first time, it is necessary to adapt the LINTAB specifications in TSAP-Win.

1. Be sure your measurement table is connected to your PC and the power supply works correctly (please refer to the manual of your tree-ring stage).
2. Open the "Options"-menu in TSAP-Win, choose the folder 'Measure' (see screenshot above) and change the setup of the measurement device (section at bottom left) if necessary. **Most important is the correct choice of measurement table ("Counter type").** The standard counter type for 1/100 mm resolution and 5 mm thrust per round is the one providing a factor of 10,000 (see image below). **Furthermore, the COM-port which connects the measurement device with your PC must be specified.** In

case you are using a USB-adaptor cable, please refer to your Windows device manager to check the assignment USB/COM-port.

3. Select the measurement button (input switch). Two different input switches can be used in TSAP:
   - An external desktop or foot-switch (default)
   - The PC-mouse. Check the box "Use mouse" in this case.

IMPORTANT: The correct assignment of the measurement device used is necessary for a precise calibration of the system. Incorrect assignments will lead to incorrect measurement results.

Graph: Define scale and range of abscissa and ordinate. In case you measure earlywood and latewood separately, the borders of both can be displayed in the core beam by selecting 'Show earlywood/latewood borders'. To display a cumulated time series during measurement activate 'Show cumulated graph'.

Sample preparation: Prepare the surface of your wooden sample in such a way that the tree-rings can be easily recognized in the cross section. Use sand paper, a sharp knife or a planing machine for surface preparation. If necessary, improve the image contrast with chalk.

Microscope setup: Optimize brightness and contrast, choose a suitable magnification and focus on your sample. If necessary, individually adapt the eyes-pieces to your eyes. Be sure that the measurement grid is focused. Please refer to your microscope manual if you have any problems with setting up the microscope.

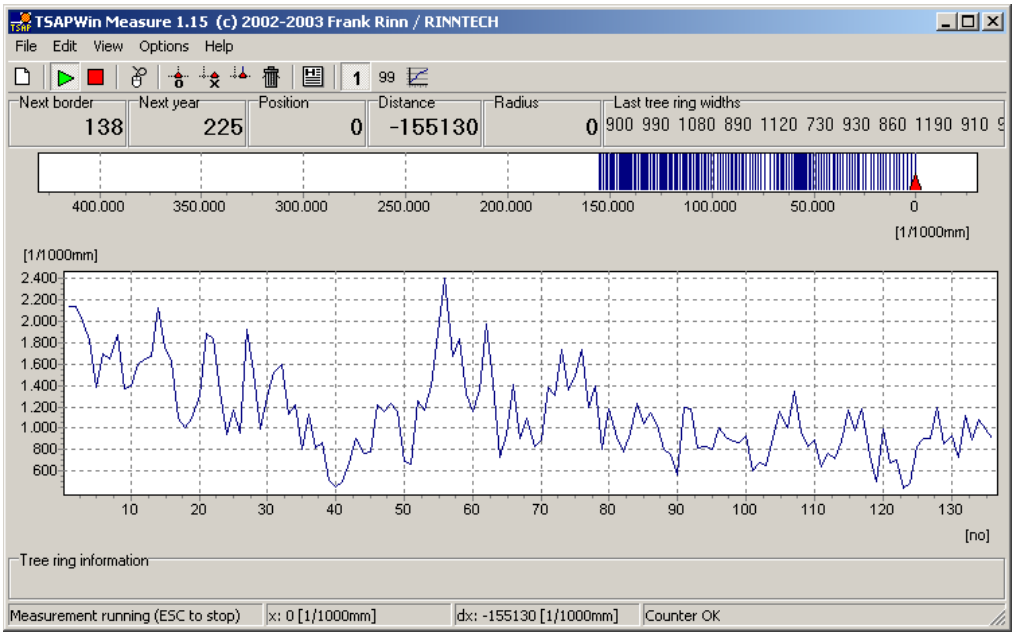
Other measurement devices: Please refer to the chapter 'Format library' to check, which foreign tables are supported by TSAP-Win.

HOW TO MEASURE

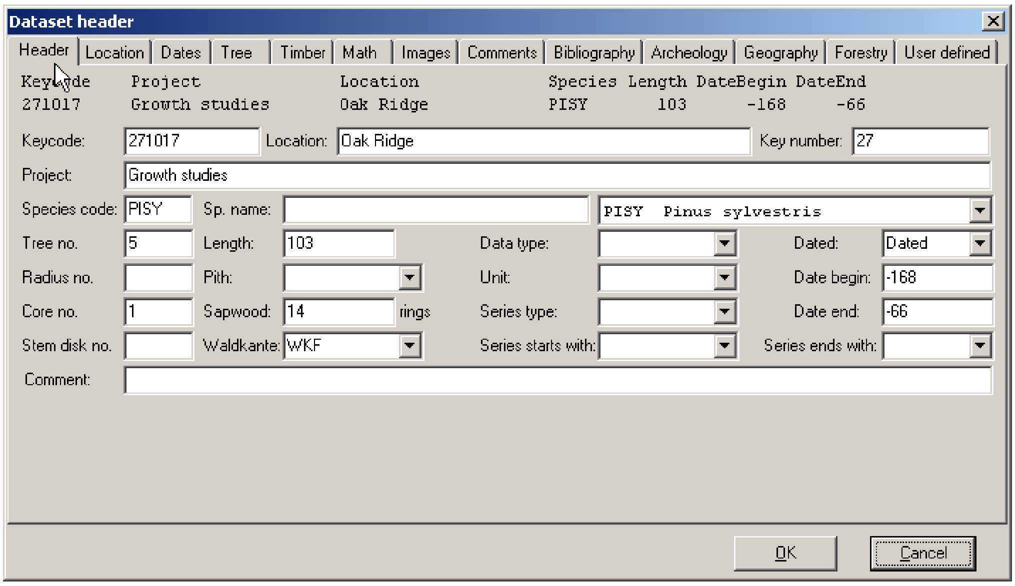
Measurements should be assigned to the sample stack. The measurement screen will be opened. Later, for cross-dating, it may also make sense to load measurement series on other stacks (e.g. the reference stack).

Measurement steps:

1. Just click on to start a new measurement. The measurement window and a blank header form (default) pops up.



2. Fill in the header form with the items you need. You can use predefined headers (see Options menu)



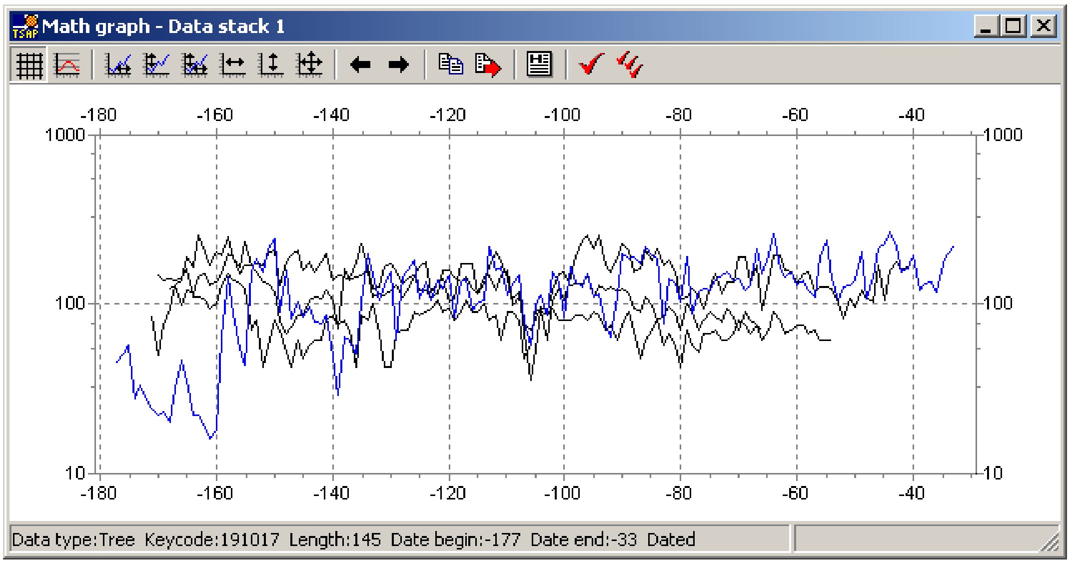
3. Click on the icon “Start measurement” (Ctrl+A) or open this function from the Edit-menu.
4. Start your measurement. Push the left button of your input switch to confirm a tree-ring border - or an earlywood / latewood transition if you want to record both variables separately.
5. Follow always the direction of the wood rays. If necessary, turn the sample to keep the ray direction. Avoid shifts while turning the sample.
6. To delete the last value just type the “Del”-key or click on the Trash-icon in the icon bar.
7. To delete, modify or insert a value at any other position, move the cursor to the desired position and press the right mouse key. Choose the requested function from the pop-up menu.
8. When your time series has been completely recorded, click on the icon “Stop measurement” (Ctr+T) or choose the same function from the Edit menu.

To proceed the measurement later, use the append function: Click on  or choose “Modify measurement” from the File-menu.

EDIT TIME SERIES

Time series can be edited in three ways:

- As long as you are within the measuring process, you can use the editing functions of the measurement screen (see previous chapter).
- At later steps, you should use the *Math Graph* to edit your series. The Math Graph offers the possibility of on-screen cross-dating and immediate editing of your samples to correct them, e.g. to remove false rings and add so-called "missing rings". Missing rings can be indicated by inserting a value of zero or one. For more details see "*Math Graph*" in the Graph chapter.
- When you are busy cross-dating your samples, you will use the extended Math Graph to edit time series (see chapter "Cross-dating").



CROSS-DATING

Cross-dating of time series will be used at two states of the analysis:

- For verification of series and the elimination of possible errors.
- To find the correct dated position in time.

After measurement, cross-dating is an important step before analysis of time series. The importance of this step cannot be over-estimated. Elimination of measurement errors, e.g. removal of so called "false rings" and insertion of "missing rings" are a must before you start any type of time series analysis.

TSAP-Win offers a combination of both visual (graphical) and statistical cross dating. Statistical models are excellent tools to find possible matches or to verify the dates of pre-dated time series. Nevertheless, the dendrochronologist should never rely on statistical tests alone. He must make his decision form visual <u>and</u> statistical procedures.

The cross-date procedure optionally uses two output features:

- The **output listing** (text format) includes the statistical parameters calculated for all suggested fitting positions.
- The **extended *Math Graph*** provides a graphical view of the sample and reference series. It allows on-screen shifting and editing of series providing the statistical parameters of each sample reference pair.

Within the cross-date window the user may select either both or just one of the output features.

CROSS-DATING PARAMETERS

In dendrochronology two main concepts are used to express the quality of accordance between time series: **Gleichlaeufigkeit** and/or **t-values**. While the t-statistic is a widely known test for correlation significance, Gleichlaeufigkeit was developed as a special tool for cross-dating of tree-ring series (ECKSTEIN and BAUCH 1969).

These concepts are characterised by a different sensitivity to tree-ring patterns. While Gleichlaeufigkeit represents the overall accordance of two series, t-values are sensitive to extreme values, such as event years. A combination of both is realized in the **Cross-Date Index (CDI)**. Since the CDI is a very powerful parameter in cross-dating, the possible matches are ordered by descending CDI in the output.

Note:	The formula for CDI calculation has changed (see following table) compared to the procedure used in TSAP-DOS.

Within TSAP-Win-chronologies the so-called 'signatures' are stored in addition to the time series and their replication. Signatures show the number of decreasing and increasing members derived from the source series. These signatures can be used to weigh the calculation of Gleichlaeufigkeit, the result is the **Signature Gleichlaeufigkeit** (SGlk), which is a more powerful parameter when calculating the accordance of a sample series with a chronology or between two chronologies.

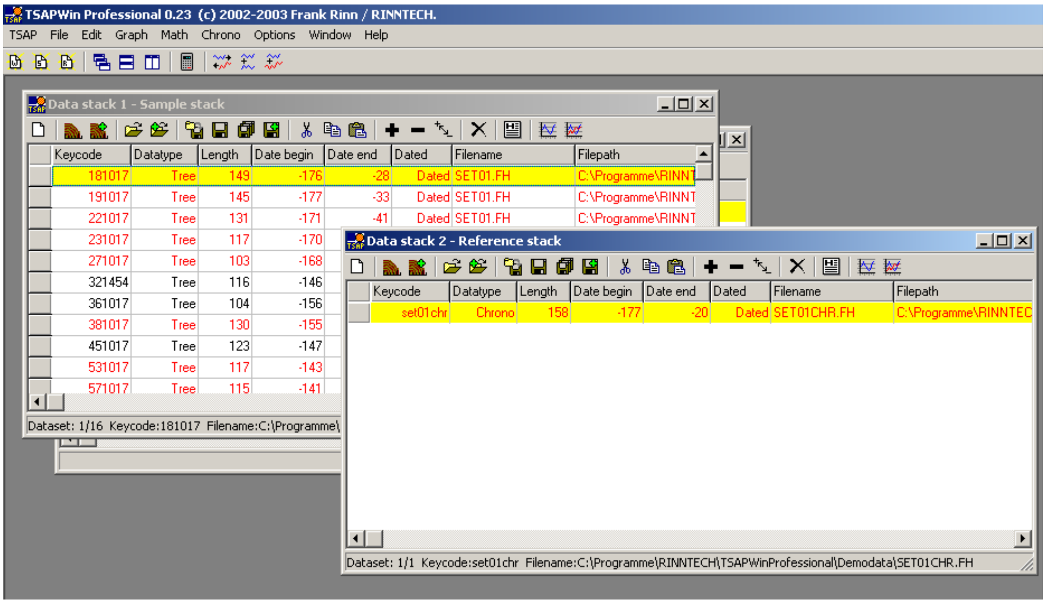
Parameter	**Equation**	**Explanation**
Gleichlaeufigkeit	$Glk = \sum (yi_j = x_{ij})$ in %	Sum of the equal slope intervals in %
Signature Gleichlaeufigkeit (SGlk.)	$SGlk = \sum (yi_j = x_{ij})$ in %	Sum of the equal slope intervals in %, calculated referring to chronology signature years only
Standard Signature Gleichlaeufigkeit (_SGlk)		Sample= Sample series Reference= Chronology
Signature Standard-Gleichlaeufigkeit (S_Glk)		Sample= Chronology Reference= Sample series
Signature-Signature Gleichlaeufigkeit (SSGlk)		Sample= Chronology Reference= Chronology
Cross correlation (CC)	$CC = \frac{\sum (s_i - s)*(r_i - r)}{\sqrt{\sum (s_i - s)^2 * \sum (r_i - r)^2}}$	Standard cross-correlation, range: -1…1
T-Value	$t = \frac{CC * \sqrt{n-2}}{\sqrt{(1-CC)^2}}$	Standard t-value
t-value Baillie-Pilcher (TV BP)		t-value after detrending with moving average with bandwidth =5 and logarithm to base e (BAILLIE and PILCHER 1973), max=100
t-value Hollstein (TV H)		t-value after detrending with the Wuchswert (HOLLSTEIN 1980), max=100 $w_i = 100 * \log 10 \frac{y_i}{y_{i-1}}$
Cross Date Index (CDI)	$CDI = \frac{(G - 50 + 50 * \sqrt{\frac{overlap}{\max overlap}}) * T}{10}$ $G = \frac{Glk + \_SGlk + S\_Glk + SSGlk}{n}$ $T = \frac{TVBP + TVH}{2}$ *(n = number of operators in the numerator)*	Date index, combined from t-values and Gleichlaeufigkeit, max=1.000

Significance fof the Glk-value	
* = 95.0%	$50 + \frac{1.654 * 50}{\sqrt{n}}$
** = 99.0%	$50 + \frac{2.326 * 50}{\sqrt{n}}$
*** = 99.9%	$50 + \frac{3.09 * 50}{\sqrt{n}}$
	n=number of points

Note: Never rely on a statistical parameter alone for cross-dating. This could lead to errors of grade 1 and 2. Thus, insufficient matches can be regarded as the correct match or the correct match will not be recognised (SANDER, LEVANIC 1997).

WORKING STEPS

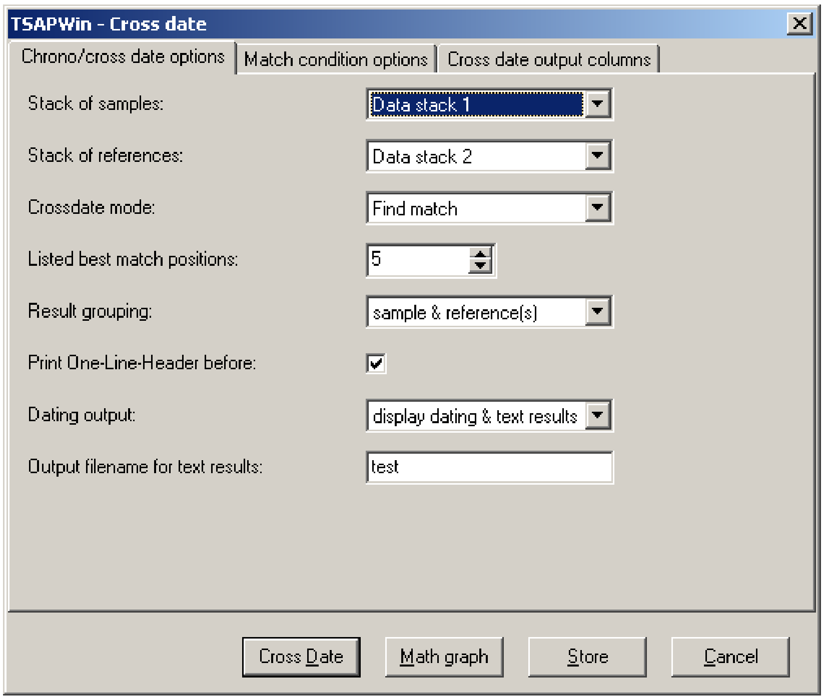
1. Load your samples on the sample stack (default: Data Stack 1) and the reference(s) on the reference stack (default: Data Stack 2). We recommend closing all other windows except the reference stack, if you want to proceed with chronology building.



2. If required, de-select those series on the sample stack (right mouse click) which you do not want to be included in the analysis. The selected series appear red, the unselected black.

3. Start Chrono and Cross-date from the main menu. The cross-date box opens.

   a. Adapt the Chrono/cross-date options:



Stack of samples/ references:
If you are not using the default stacks, you must specify the sample and reference stacks used. Samples and references can also be located on the same stack, e.g. to cross-check two series of one object against each other. The reference stack should be used for verified, cross-checked series or chronologies.

Cross-date mode:
Find match: Finds the best matches according to the cross-date index, which is calculated from t-value and "Gleichläufigkeit" (see statistical parameters).
Check dates: Gives the results for the dated position and the positions +1, -1, +10, -10 for comparison.

List best match conditions:
Specifies the number of best match to be listed (default: 5).

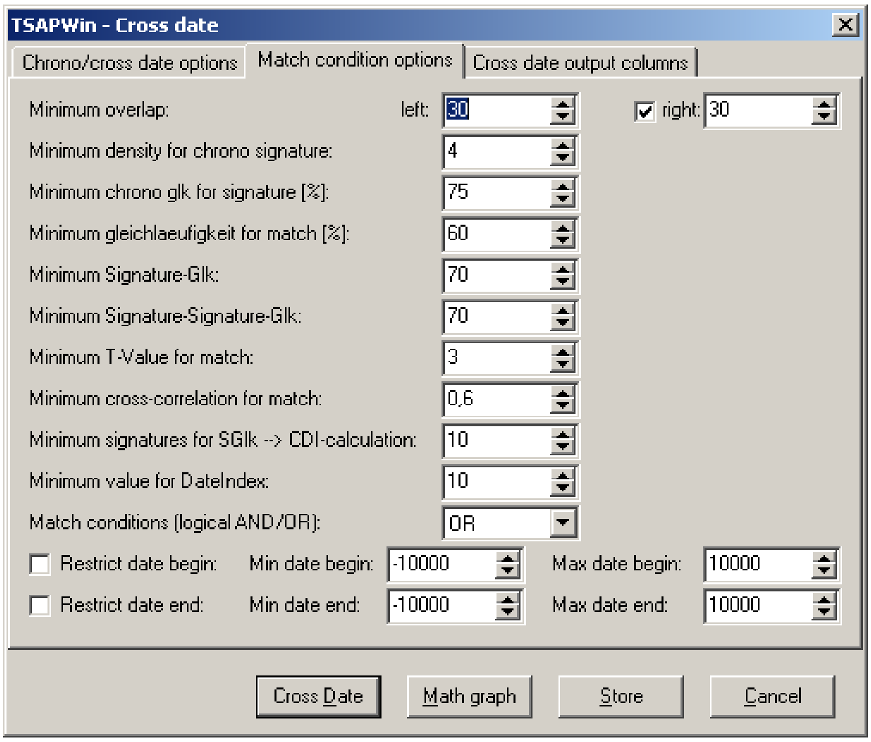
Result grouping:
Defines the order of displayed series (samples and references)

Print One-Line Header before:
If this box is checked, header information about sample and reference will be displayed in the output listing.

Dating output:
The results can be displayed as a graph, a listing (text) or both.

Output file name for test result:
To save the data in a certain file, please specify the file name here.

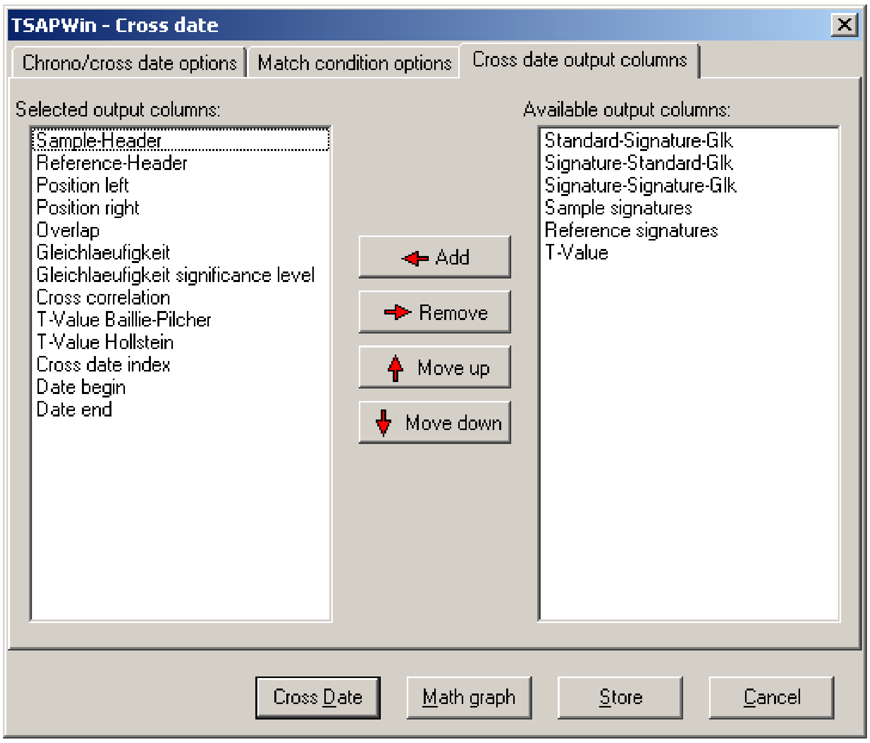
b. Adapt the Match condition options:



Statistical cross-date procedure: The listed statistical parameters define the minimum requirements for a listed match. They can be combined by a logical AND, in the case where all these criteria are fulfilled, or by a logical OR, if only one of these criteria appears true to result in a listing. If necessary, the time period can be limited. This may be useful if a long chronology is used as a reference.

Manual cross-date procedure: If you prefer a visual comparison of single series using *Math Graph*, you can skip the match condition options.

c. Adapt the cross-date output columns:

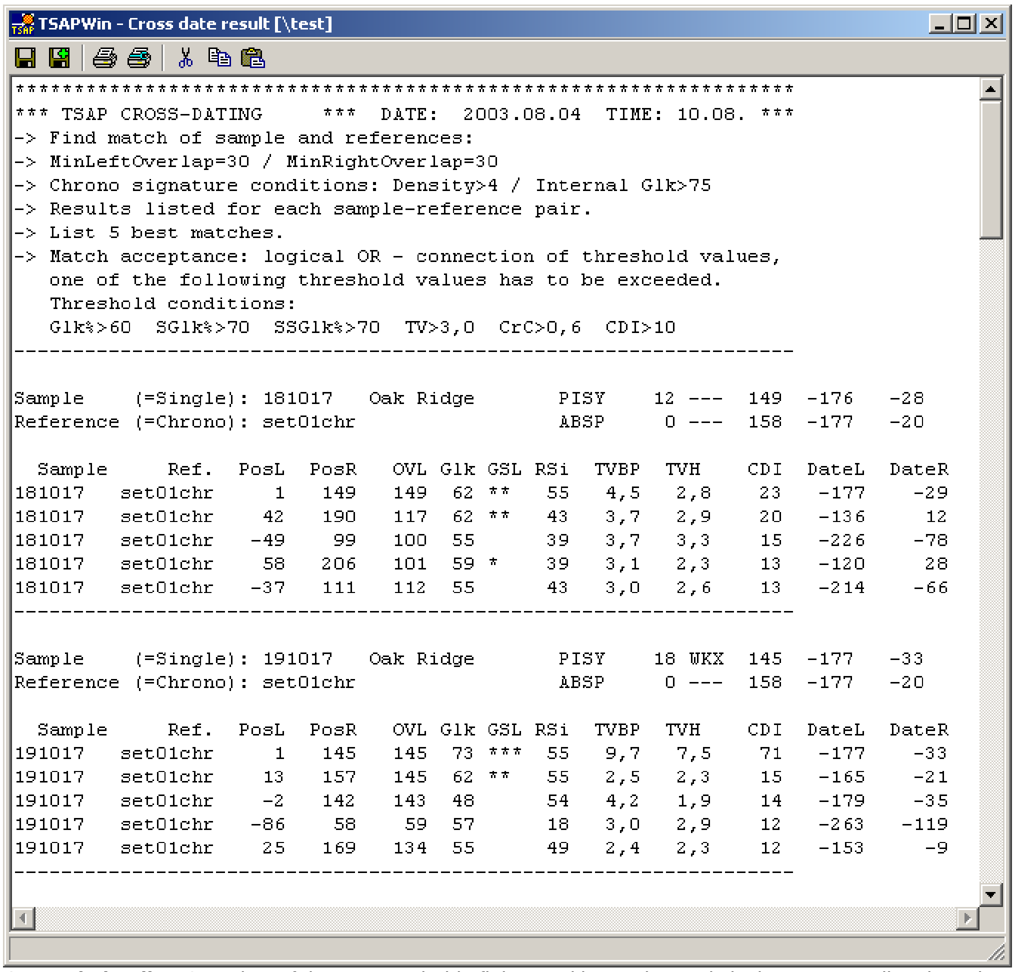


TSAP-Win offers a variety of possible cross-date criteria. None of them alone guarantees absolute safety in cross-dating. Even a significant level of a statistical parameter does not ensure a correct matching position. You may find that several positions can reach the statistical significance. Therefore, the user probably prefers to use a combination of several parameters to base his decision on. Thus, feel free to adapt the output list to your demands. We found that the cross-date index (CDI) gives a fairly good indication for the correct match, since it combines t-value and Gleichlaeufigkeit.

4. Start the cross-date process:
   a. "*Math Graph*" will open the extended *Math Graph* window and you can start with a manual cross-date procedure. This procedure is ideal to cross-check single series of one object to eliminate measurement errors. Choose a sample and a reference from the series listing left of the graph. At the bottom of the window the statistical parameters will be displayed to support you in finding the correct match. Use the features explained in the "*Math Graph*"-chapter to shift and edit the series. If series are pre-dated, TSAP-Win will display them in the dated positions as default.
   b. "Cross-date" (at the bottom of the box) will start the statistical cross-date procedure and the results will be listed according to the default setup or the changes in the options you made before. This procedure is best for verified series (without measurement errors).

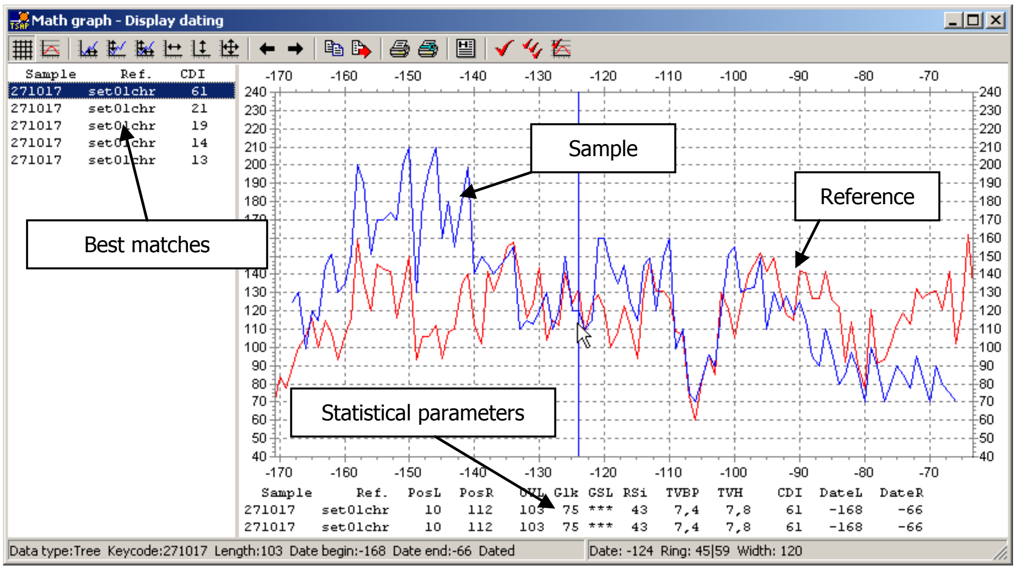
IMPORTANT:	We strongly recommend you to manually cross-check your measured series in *Math Graph* first, before starting the statistical cross-date procedure. Measurement errors may reduce the feasibility for statistical cross-dating of a series.

If you clicked "Cross-date" TSAP-Win will show the cross-dating list and/or the extended *Math Graph*, depending on your selection in the Chrono/cross-date options.




```
**********************************************************************
*** TSAP CROSS-DATING      ***  DATE:  2003.08.04  TIME: 10.08.  ***
-> Find match of sample and references:
-> MinLeftOverlap=30 / MinRightOverlap=30
-> Chrono signature conditions: Density>4 / Internal Glk>75
-> Results listed for each sample-reference pair.
-> List 5 best matches.
-> Match acceptance: logical OR - connection of threshold values,
   one of the following threshold values has to be exceeded.
   Threshold conditions:
   Glk%>60  SGlk%>70  SSGlk%>70  TV>3,0  CrC>0,6  CDI>10
----------------------------------------------------------------------

Sample    (=Single): 181017   Oak Ridge       PISY    12 ---  149  -176   -28
Reference (=Chrono): set01chr                 ABSP     0 ---  158  -177   -20

  Sample      Ref.   PosL  PosR   OVL Glk GSL RSi  TVBP  TVH    CDI  DateL  DateR
181017   set01chr     1   149   149  62 **   55   4,5   2,8    23   -177    -29
181017   set01chr    42   190   117  62 **   43   3,7   2,9    20   -136     12
181017   set01chr   -49    99   100  55      39   3,7   3,3    15   -226    -78
181017   set01chr    58   206   101  59 *    39   3,1   2,3    13   -120     28
181017   set01chr   -37   111   112  55      43   3,0   2,6    13   -214    -66
----------------------------------------------------------------------

Sample    (=Single): 191017   Oak Ridge       PISY    18 WKX  145  -177   -33
Reference (=Chrono): set01chr                 ABSP     0 ---  158  -177   -20

  Sample      Ref.   PosL  PosR   OVL Glk GSL RSi  TVBP  TVH    CDI  DateL  DateR
191017   set01chr     1   145   145  73 ***  55   9,7   7,5    71   -177    -33
191017   set01chr    13   157   145  62 **   55   2,5   2,3    15   -165    -21
191017   set01chr    -2   142   143  48      54   4,2   1,9    14   -179    -35
191017   set01chr   -86    58    59  57      18   3,0   2,9    12   -263   -119
191017   set01chr    25   169   134  55      49   2,4   2,3    12   -153     -9
----------------------------------------------------------------------
```

Cross-dating list: Overview of the most probable fitting positions. The statistical parameters listed can be selected in the options.



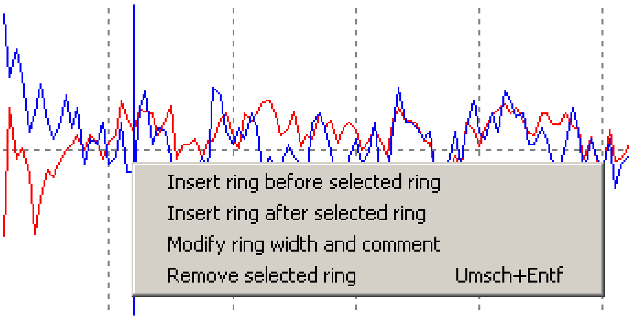
Extended *Math Graph*: Graphical comparison of sample (blue) and reference (red). The sample can be shifted in both horizontal and vertical directions using the cursor keys. The statistical changes will be displayed in the legend (below graph).
Legend below graph: The upper line shows the statistical parameters of the position derived by shifting the series manually. The lower line shows the statistical parameters of the position highlighted in the sample/reference listing left of the graph.

5. Choose the correct match position:
   TSAP-Win offers one or several possible match positions based on the statistical parameters you have selected. These suggestions are listed in the series list concerning the cross-date index (CDI). The highest CDI position is always listed first. You will recognize that several positions may reach a significant level. Thus, be sure to base your decision on both visual and statistical procedures. Shifting the series left and right may help to find possible errors in the series (see step 7).
   When you have found the correct position, confirm it by clicking on the apply button  for a single or  for all series. This position or these positions respectively will be saved on the source data on your stack.

IMPORTANT:	The statistical cross-dating analysis gives one or several suggestions. Never rely on these suggestions alone.

If no further editing of data is necessary, the cross-date procedure is finished at this point.

6. Edit the series if necessary (see also the section *Math Graph*):
   The cross-date procedure may reveal measurement errors. After returning to your sample to verify your measurements, errors can directly be corrected in ***TSAP-Win***. To modify, delete or insert a tree-ring, move the mouse cursor to the position in question and click the right mouse key. Select the requested function from the pop-up menu.



7. Finally shift the series for the correct fit:
   After editing, adapt the edited series to the best matching position and apply the corrections according to step 6.

CHRONOLOGY BUILDING

BASICS

After carefully cross-dating your samples you can combine them to create a chronology or implement them into an existing chronology.

Chronologies are represented by a mean time series (average values of several different series) and additional information on density and slope behavior. TSAP-Win chronologies contain 4 values per year. The series which are included in a chronology are called members, no matter whether they are single time series or chronologies themselves. Only dated series are included in the calculation.

Column in file	Series	Explanation
1	Value	Average of all values of implemented series in this year
2	Density	Number of all series implemented in this year
3	Increasing	Number of all increasing values in this year
4	Decreasing	Number of all decreasing values in this year

The values of the increasing and decreasing series refer to the slope from the preceding to the current values. The first value of the increasing and decreasing series is always 0.

Example:

```
HEADER:
DateEnd=-20
Length=158
Species=ABSP
WaldKante=---
KeyCode=set01chr
DATA:Chrono
   46    1    0    0  149    2    1    0   93    2    1    1  102    2    1    1
   81    2    1    1   47    2    0    2   65    3    1    1   84    4    1    2
   78    4    2    2   89    5    2    2  100    5    4    1  106    5    4    1
  116    5    3    2  100    5    1    4  115    5    2    1  108    5    2    3
   93    5    0    5  107    5    5    0  116    5    3    2  159    5    5    0
  136    5    1    4  120    6    0    5  146    7    3    2  143    7    3    3
  142    7    4    3  116    7    0    7  132    7    5    2  150    7    5    2
   93    7    0    7  106    7    3    4  106    8    2    5  112    9    6    1
   94    9    2    6  109    9    8    1  110   10    4    5  135   10    7    2
  140   11    7    3  113   12    2    9  102   12    4    7  142   12   10    2
  131   12    3    9  140   13    4    8  155   13    9    3  158   13    6    7
    …
```

TYPES OF CHRONOLOGY

TSAP chronologies contain four different series (value, density, increasing and decreasing members). Chronologies in the TUCSON format only include information on value and density, but not on increasing and decreasing members. If such a TUCSON - format chronology is contained in the set of series which are to be combined to a chronology by 'Chrono'\'Build Chrono', the user has to decide how this TUCSON-format chronology should be treated: since the TUCSON-format does not contain information on increasing and decreasing members, it can only be treated as a single time series, if a TSAP chronology with four series has to be built. The problem is that in this case, the density and with the significance of the variations of a TUCSON chronology can not be included with the appropriate statistical weight. It is impossible to include the density information because then the series on increasing and decreasing members will not fit to the density series.

The only way to include the density information, and thus the statistical significance of a TUCSON chronology into a new chronology, is to build up a chronology in the TUCSON format again. The switch

Half Chrono -> Half Chrono

allows the user to decide whether the resulting chronology is built in TUCSON format again, if a TUCSON-format chronology is a member of the set of series which are to be combined to a new chronology. 'Half Chrono' is the name for the TUCSON format.
If this switch is on ('Yes'), the resulting chronology is in TUCSON-format, if not ('No'), the resulting chronology is stored in TSAP format.

Half Chrono -> Half Chrono option switch	
Entry	**Explanation**
Yes	If a Half Chrono (=chrono in TUCSON-format) is included in the set of series (= 'member set'), which has to be implemented in a chronology, the resulting chronology is stored in TUCSON format. Chronologies of the member set stored in TUCSON or TSAP-format are implemented in the new chronology with the density series as weights for the value implementation.
No	The new chronology is build in TSAP format (four series). Series in TUCSON-chronology format are implemented as single series without respect to density.

TSAP-Win provides two modes for chronology building: core-averaging and extend-averaging:

Averaging mode	**Explanation**
Core	Only those years are regarded, where all members are represented (= common interval). Therefore, the density is constant along the length of the chronology. If different members do not overlap, the chronology building stops without result.
Extend	All values of all overlapping series are included.

CALCULATION

The values are calculated according to the following equations:

Chronology value year = $\sum_{m=0}^{M} x_m + \sum_{k=0}^{K} (d_k * y_k)$

d = density

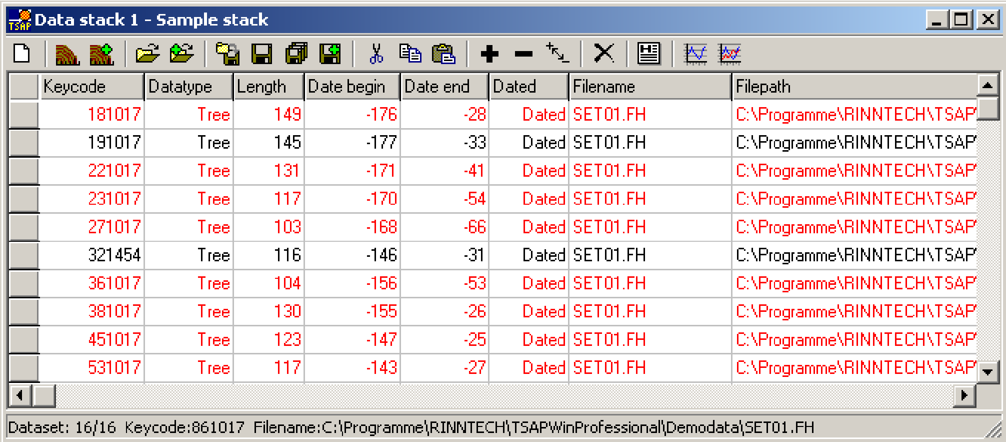
M = Number of single series values included in the year(i).

K = Number of chronology series values included in the year(i).

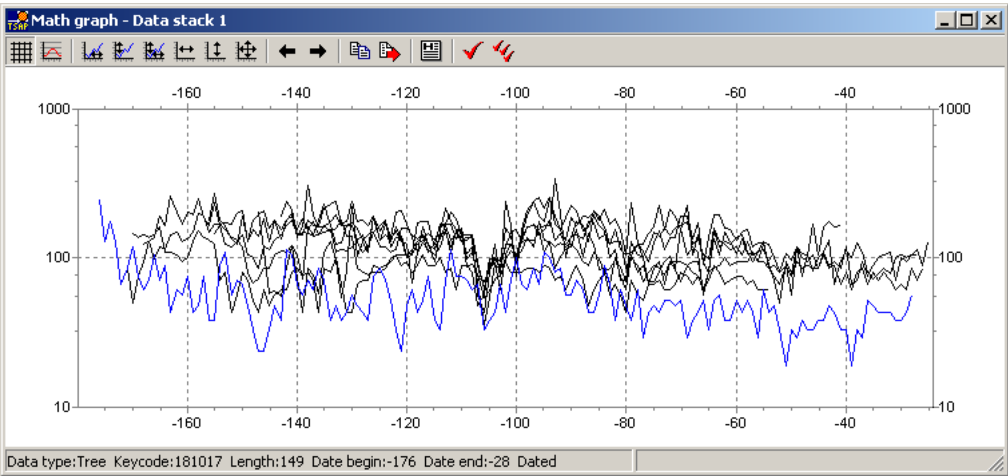
The averaging is processed without weighting for single time series. The chronology values are multiplied by the density of the corresponding year.

BUILD UP A CHRONOLOGY

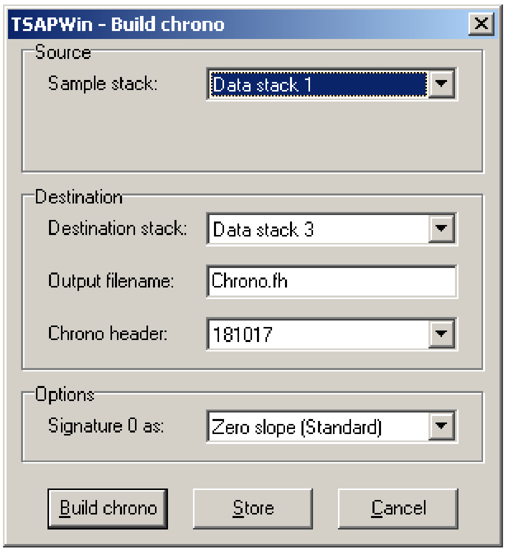
1. **Select the cross-dated series** to be included into the chronology from one of your stacks. Deselect the samples, which are not be included by a right mouse click. Undated series will be omitted anyway.



2. **Open the Math-Graph Window** (from the stack icon bar) for a final check of the series positions. Do your final corrections if necessary. Close the *Math Graph* window and return to your data stack. If you are convinced in advance that the series are all in the right match position, you can skip this step.



3. **Open the Chrono-menu**. There are 3 options to build a chronology:
   a. **Build new chrono from samples**
      This will probably the most used function. ***TSAP-Win*** takes the selected samples from the default stack for chronology building.

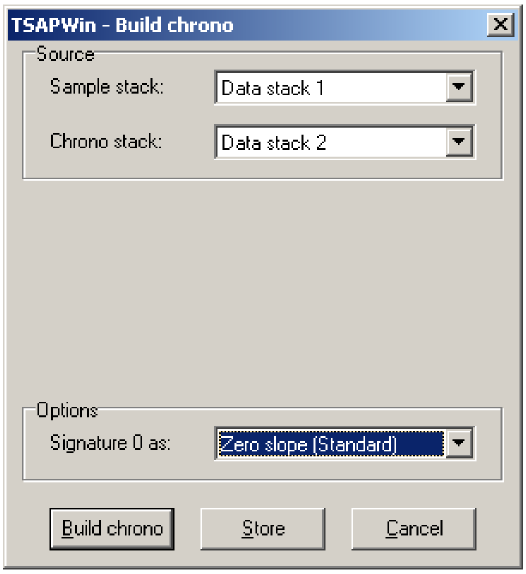


Destination stack: Define the stack where the chronology is to be stored.

Output file name: Type in the requested file name for the chronology file.
Chrono header: Choose the header which is to be used as default for the chronology series. It can be edited later.

Options: Please define how a signature of 0 shall be defined. Default: Zero slope.

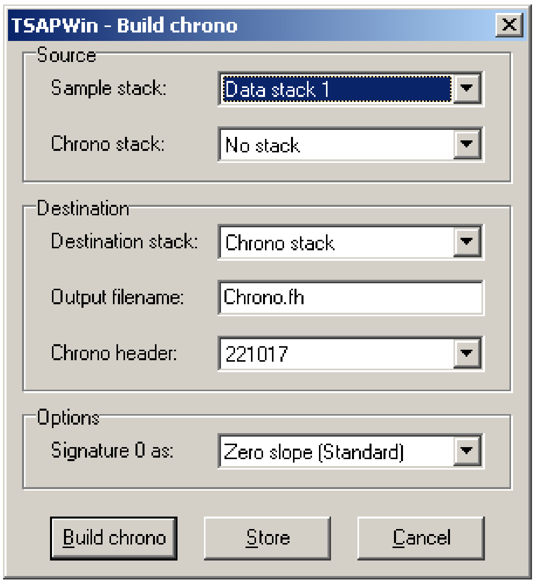
   b. **Implement samples into chrono**
      The selected samples from a stack to be selected will be implemented into an existing chronology. Sample and chrono stack must be selected.



The advantage of this function is that it avoids time-consuming updates of a chronology from all sample data. Just the new series will be included, taking the weights into account.

Options: Please define how a signature of 0 shall be defined. Default: Zero slope.

c. **Build chrono**
This option offers all opportunities. Source, destination and options can be set by the user.



Destination stack: Define the stack were the chronology is to be stored.

Output file name: Type in the requested file name for the chronology file. Chrono header: Choose the header which is to be used as default for the chronology series. It can be edited later.

Options: Please define how a signature of 0 shall be defined. Default: Zero slope.

IMPORTANT:	To **include singe series** into an existing chronology, use the function "Implement samples into chrono" only. All other chronology building functions will lead to an uneven weight of the source series in the chronology.

4. **Click on the button "Store"** if you wish to store the option settings for future chronology building.
5. **Press "Build chrono"** to let TSAP-Win compute the chronology. It will be stored on the selected destination stack.

GRAPHS

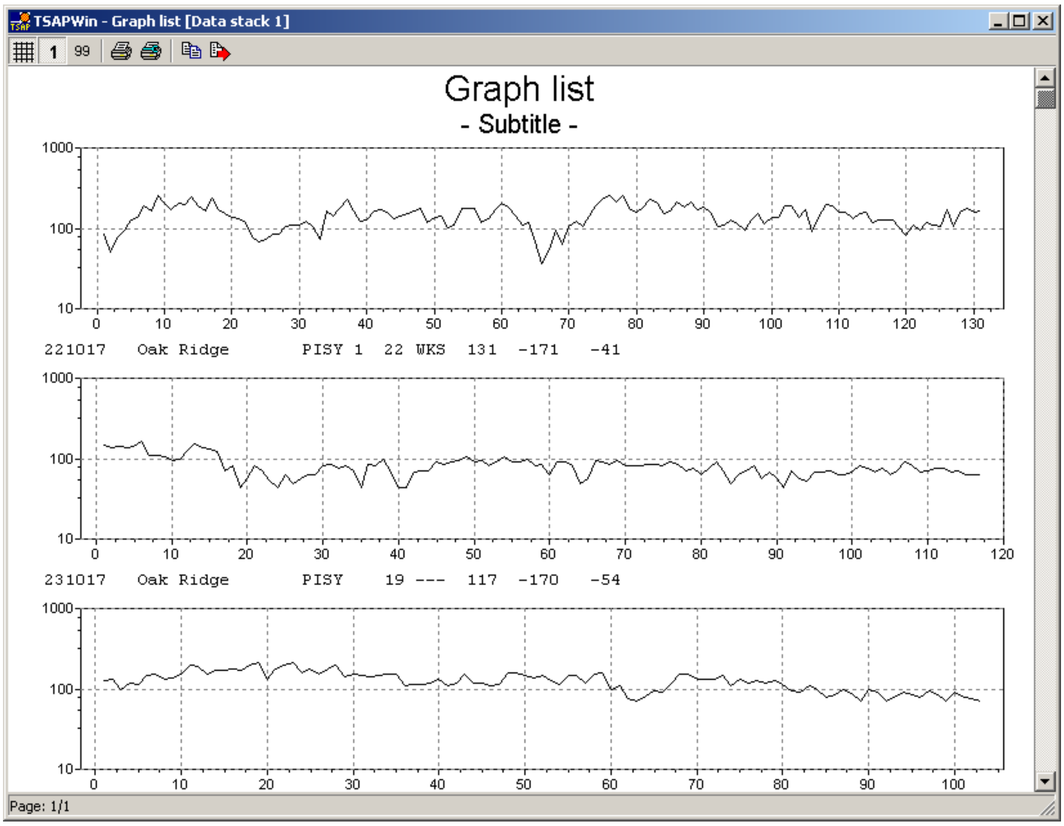
TSAP-Win Professional offers two types of graphs:

- Graph list to display, export and print time series.
- *Math Graph* to edit, shift and export time series.

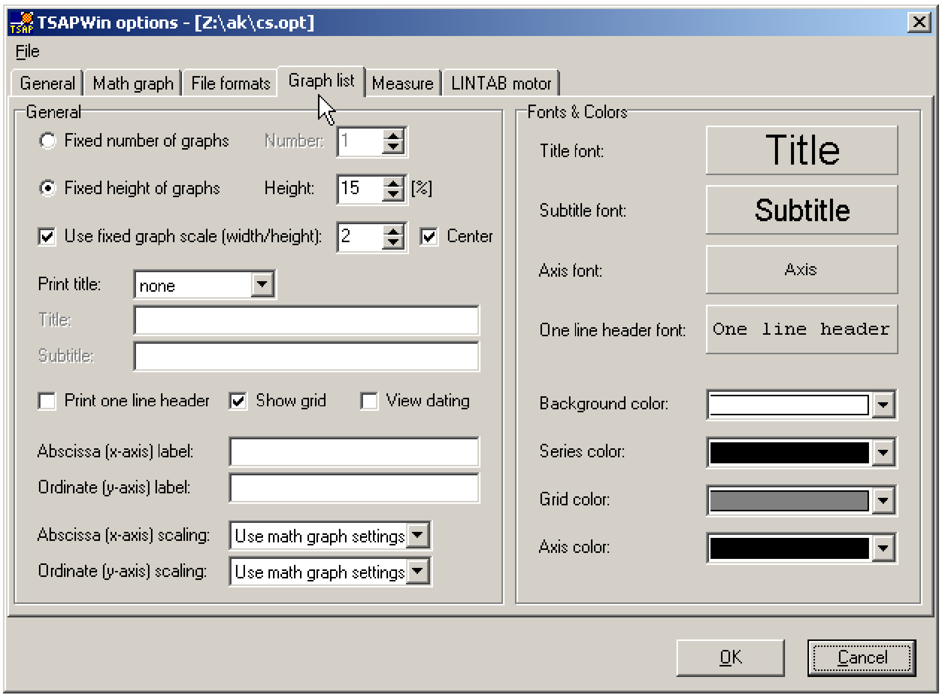
Additional graphical features are available in the **Graph Library**, which is included in **TSAP-Win Scientific** or as an additional module for **TSAP-Win Professional** (sidegrade)

GRAPH LIST

This graph type lists the selected series from the active stack. Display features can be changed in the Graph options (Options menu).



GRAPH LIST OPTIONS



The Graph List display can be edited using the Graph List Options in the 'Options' menu.

The graph layout can be influenced by either selection of **Fixed number of graphs** or **Fixed height of graphs**. Additionally the relation of graph width to graph height can be defined by choosing 'Use fixed graph scale (width/height)'.

If requested you can add titles, labels, grid, dates, fonts and colors. Axes scales can be either automatically maximized or set to the same values selected for Math Graph.

MATH GRAPH

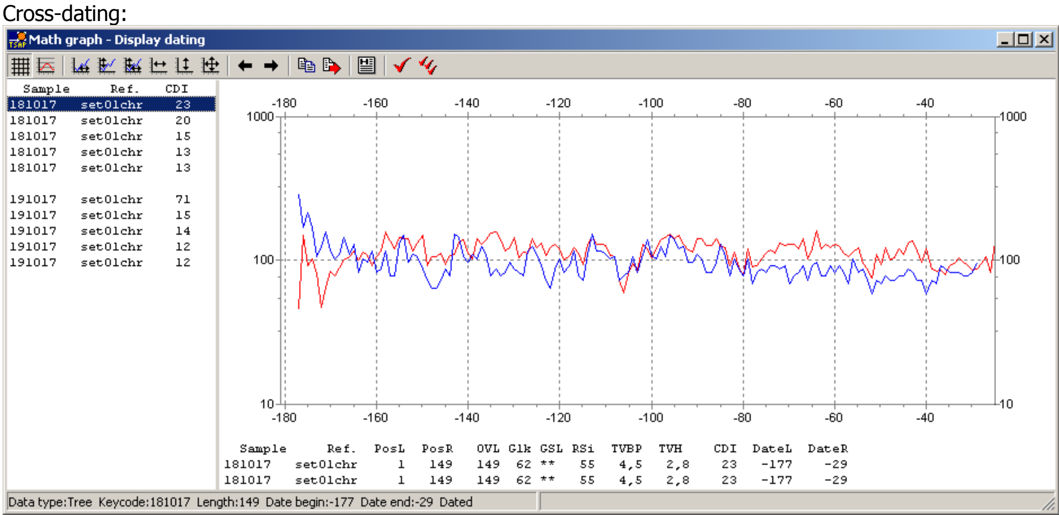
The *Math Graph* is a powerful tool for editing time series. Experienced TSAP-users already know this "classic feature" from the DOS-version. Editing single values, precise annual positioning of the series as well as shifting whole time series along the time line can be performed with *Math Graph*. You can furthermore squeeze, stretch or shift the series in the vertical direction for cross-dating purposes - not affecting the value level. You will learn more about cross-dating in the chapter "Common steps of work".

Last, but not least, the Math Graph window can be easily adapted to your requests. Scaling factors, range of values, linear or logarithmic representation of data, colors – almost everything can be changed. Open the options menu and just try out what suits you best.

To open your series for editing in *Math Graph,* just move the file cursor to the series to be edited and click on the *Math Graph* icon in the icon bar of the data stack. If several series were selected in the stack, all of them will be displayed. The one marked is emphasized. To select a different series, press the "blank"-key of your keyboard until the requested time series is emphasized.

Graphical editing:

Cross-dating:



For cross-dating a number of series against each other or one or several references, the extended *Math Graph* displays the statistical parameters together with the sample/reference pair for graphical comparison. The user can select the sample/reference pair as well as the overlap position of the two series selected. For details, please refer to the chapter "Cross-dating" in the description of common steps.

SHIFT, ZOOM AND EDIT SERIES

Selection of a series: To switch from one series to the next in the graph, press the "blank" key or "Shift"+"Blank" to switch backwards. Alternatively the arrow keys ( ) from the icon bar can be used

Shift series: Use the cursor keys to move the active series in a horizontal and vertical direction. Moving in vertical direction influences the display but will not affect the level of values. Holding the "Shift"-key while using the cursor keys will lead to larger steps in movement.

Shrink, stretch: The window scale can be changed using the + – keys (abscissa) and the * / keys (ordinate).

Zoom: Draw a rectangle from the left top to the right bottom of the requested part of the graph. To reset the zoom just draw the rectangle vice versa: from the right bottom to the left top.

Insert, modify or remove: Move the mouse cursor over the selected time series and press the right mouse key at the desired position to insert, remove or modify a value (or comment).

Average: To show the average of the displayed series type "a" or click on the icon .

Copy and export graph: Click on from the icon bar to copy the *Math Graph* to clipboard.
Click on to export the *Math Graph* to a JPEG or bitmap-file.

Apply changes: All changes you do are temporary. To permanently store the changes to the series, just apply these changes by clicking on the "apply"-button of the Math Graph window:
saves the active series (emphasized)
saves all series shown in *Math Graph*

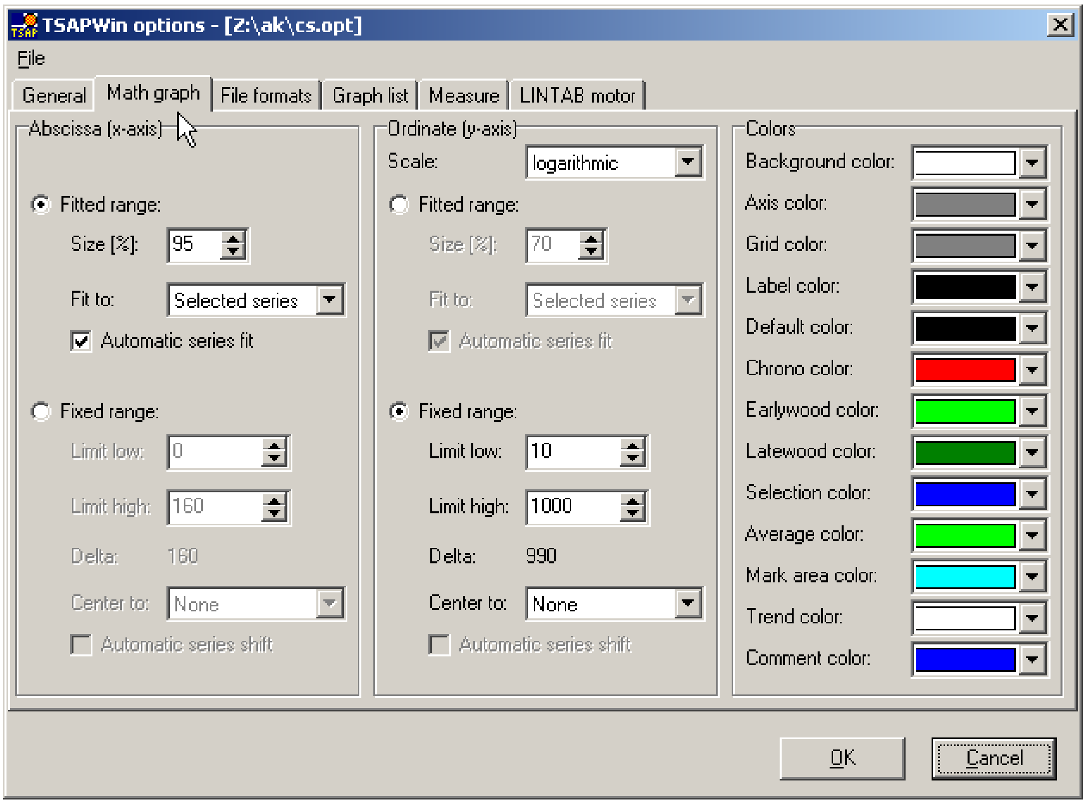
More functions can be reached via different hot keys. See next chapter.

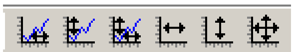
HOT KEYS IN MATH GRAPH

```
Key shortcut              Math Graph function
---------------------------------------------------------------------
Strg + TAB                Next time series
Strg + Shift + TAB        Previous time series
SPACE                     Next time series
Shift + SPACE             Previous time series
Left                      Shift right one year
Right                     Shift left one year
Up                        Shift up one unit
Down                      Shift down one unit
Shift + Left              Shift right 10 years
Shift + Right             Shift left 10 years
Shift + Up                Shift up 10 units
Shift + Down              Shift down 10 units
Strg + Left               Scroll 1/4 screen right
Strg + Right              Scroll 1/4 screen left
Strg + Up                 Scroll 1/4 screen up
Strg + Down               Scroll 1/4 screen down
Shift + Strg + Left       Scroll 3/4 screen right
Shift + Strg + Right      Scroll 3/4 screen left
Shift + Strg + Up         Scroll 3/4 screen up
Shift + Strg + Down       Scroll 3/4 screen down
*                         Ordinate window smaller (stretch chart y)
/                         Ordinate window larger  (shrink chart y)
+                         Abscissa window smaller (stretch chart x)
-                         Abscissa window larger  (shrink chart x)
Shift + *                 Ordinate window smaller (stretch chart y)
Shift + /                 Ordinate window larger  (shrink chart y)
Shift + +                 Abscissa window smaller (stretch chart x)
Shift + -                 Abscissa window larger  (shrink chart x)
a or A                    Calculate average (Show/Hide average)
Y                         Expand active series values (stretch graph y)
y                         Compress active series (shrink graph y)
Strg + Del                Remove and unselect current series
Shift + Del               Remove current value
o                         Reset shift of active series
O                         Reset shift of all series
d or D                    Set series dated
u or U                    Set series undated
```

These hotkeys can also be displayed in the *Math Graph* by pressing "F1".

MATH GRAPH OPTIONS

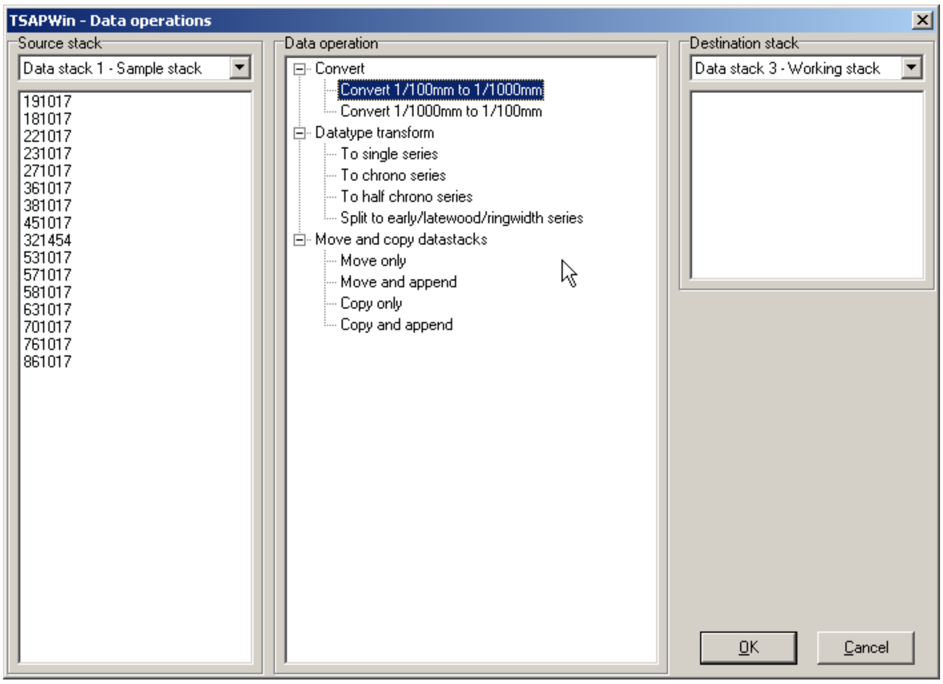


The scale of the axes can be fixed to absolute values or fitted to a selected series or all series. The Ordinate (y-axis) can furthermore be set to a logarithmic scale, which makes comparison of series easier. Some of these functions are also available via the icon bar of the *Math Graph* Window: 

If you wish to change the graph colors, feel free to choose your favorite spectrum.

DATA OPERATIONS

The 'Data' menu contains functions for data handling, such as covert, data type transform, move and copy data stacks.



CONVERT

Since data can be stored with different resolution, either 1/100 mm or 1/1,000 mm, TSAP-Win offers routines to transfer the data from one format to the other.

Choose a source and a destination stack. Keep in mind that only the selected data of the source stack will be processed.

DATA TYPE TRANSFORM

Source series can be transformed to

- Single series (sample series)
- Chrono series
- Half-chrono series

Please note that chrono and half-chrono series usually contain replication and signatures respectively. If singe series are transformed to these formats, this information will be missing.

MOVE AND COPY DATA STACKS

Move or copy the selected series from one stack to another. Data can also be moved or copied by the drag and drop function using the mouse. Hold the Ctrl-Key to copy the data.

Graph Library

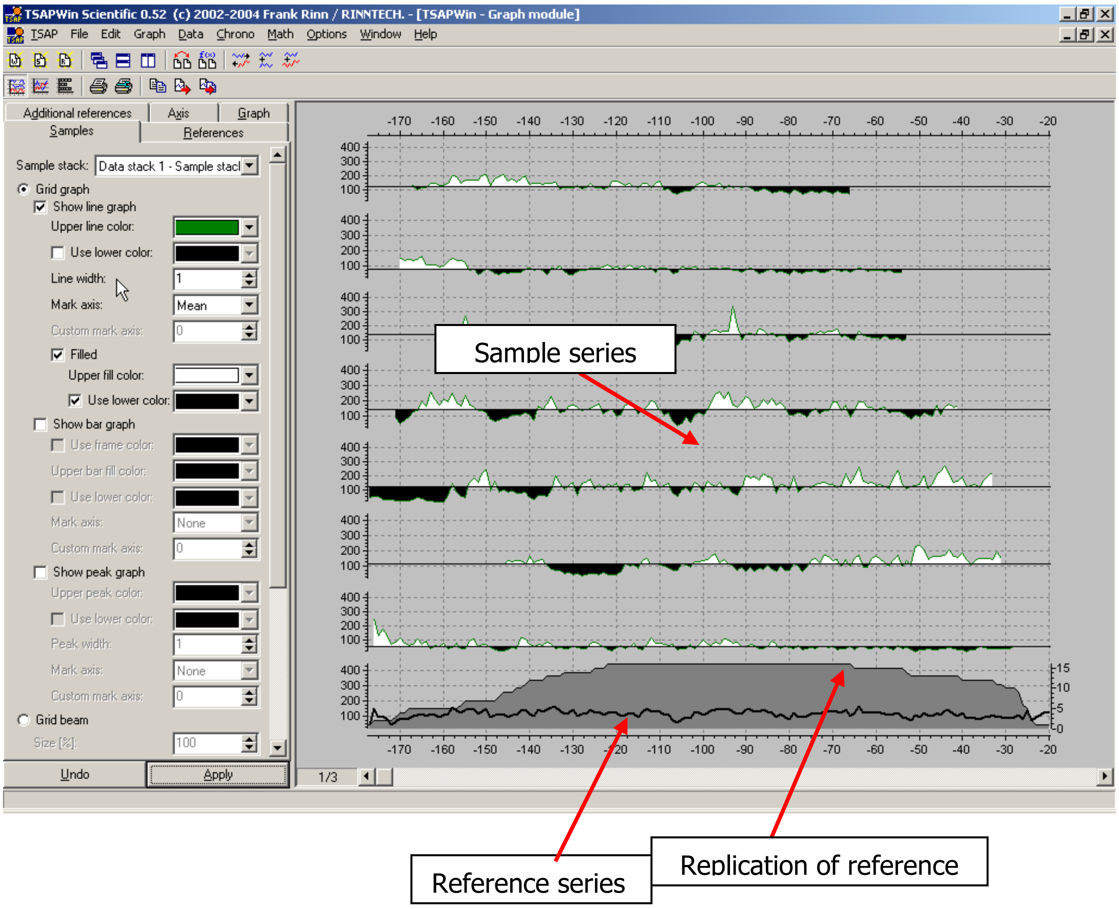
> **Please note:** The Graph Library is part of ***TSAP-Win Scientific***, but can be purchased as an additional module for the Professional version too.

General

The Graph Library provides:

- Line graphs
- Bar graphs
- Core graphs
- Peak graphs
- A combination of types

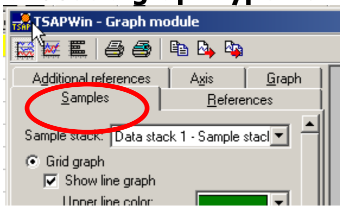
As an option references and its replication can be displayed with the series. Example:



DISPLAY AND EDIT

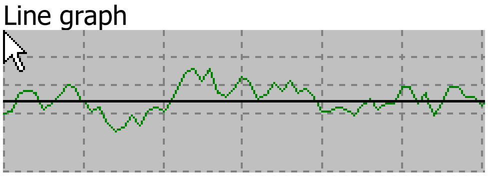
To display and edit graphs the Graph Module, please do the following:

1. **Select the series** you want to include from the stack.
2. **Sort the series** by clicking on the header of the requested variable (e.g. key code, date end). A repeated click will switch between ascending and descending order.
3. **Click on the Graph Module button** from the icon bar or choose Graph module from the Graph menu.
4. **Choose a graph type** from the samples folder (left of the graph window)

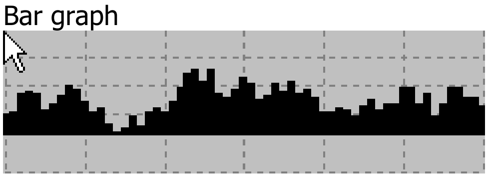


The following graph types are available:

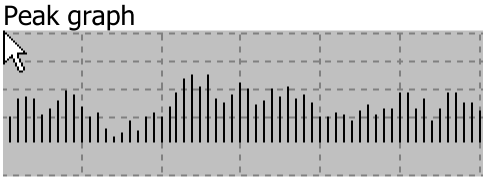
- **Grid graphs**
  - Line graph



  - Bar graph

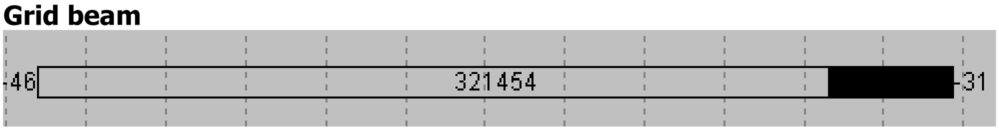


  - Peak graph



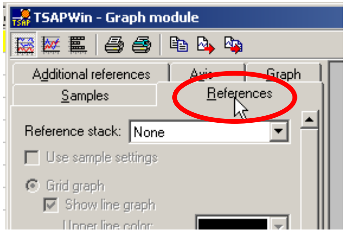
These types can be displayed solely or in combination.

- **Grid beam**



5. **Select additional features** which you wish to add to the graphs from the sample folder:
   - Line or frame color and width
   - Axis position (mean, minimum, maximum, zero, common mean, common max., common min., custom)
   - Fill colors
   - Width of peaks
   - Size of grid beams
   - Marks and legends of grid beams (Waldkante, pith, sapwood etc.)

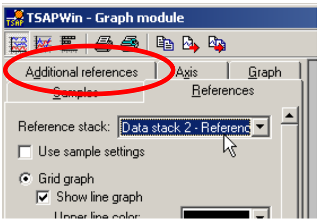
6. **Add a reference (optional)** If you wish to add one or more references to the series list, click on the Reference folder (left of the graph window) and select the requested reference stack. TSAP-Win includes all selected references from that stack at the bottom of the graph window.



For the reference(s) you can specify special features following the same procedure as presented above. But if you want to use the same features as for the samples , please mark "Use sample settings".

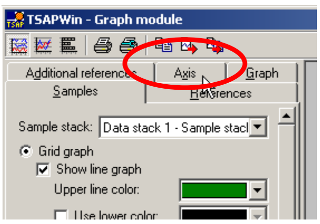
Together with the reference(s) the replication will be displayed in the graph. Please note that a reference must be stored in the chrono-format.

7. **Add additional references (optional)**



If requested you can also add additional references from other stacks. Choose the folder "Additional references" and follow the procedure as described.

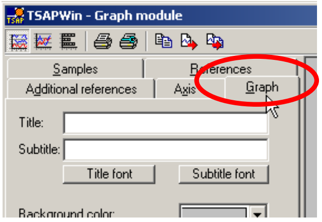
8. **Edit axis settings**



Some features can be separately set for the abscissa (x-axis), the ordinate (y-axis) and the axis of the reference replication:

- **Show grid**: Displays grid lines
- **Dated**: Uses calendar years as scale
- **Logarithmic** (y-axis only): Displays the series with logarithmic scale.
- **Auto min./max.**: Uses lowest/highest value of the whole set of series as minimum/maximum value. Alternatively, a time window can be defined manually.
- **Common overlap/scale**: Displays the time window, which is covered by all series.
- **Axis label:** Displays a user-defined label.

9. **Edit graph settings**:



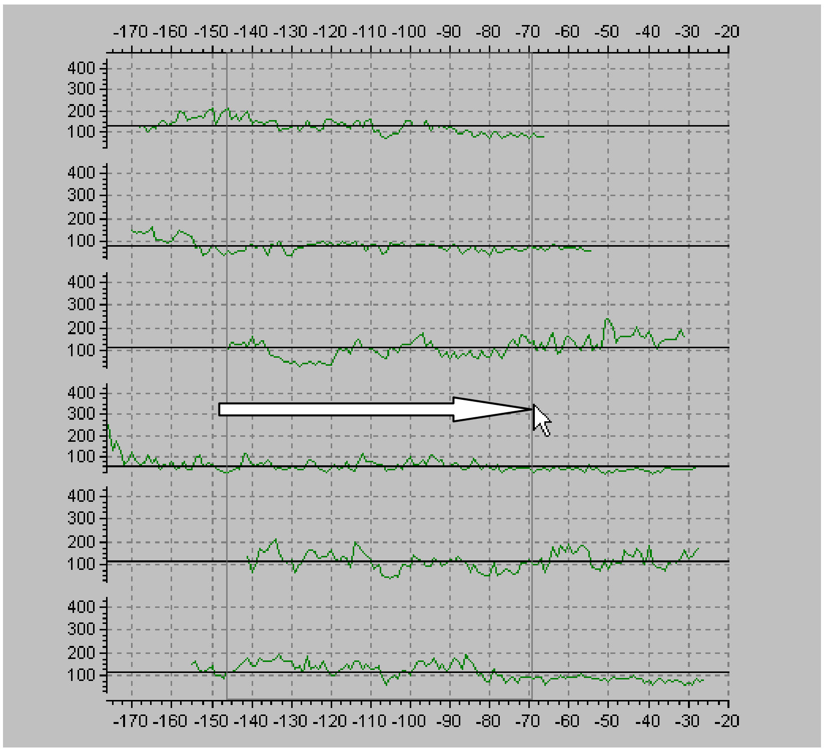
The following general features which affect the entire graph can be changed:

- **Title and subtitle** as well as their fonts.
- **Background, grid and axis color** as well as the axis font.
- **Page layout**: Choose whether you prefer to display all graphs on one page or define a fixed number of series per page.

10. **Apply changes**: Click on the "Apply" button to activate the feature changes or click on the "Undo"-button to discard your changes.

ZOOM

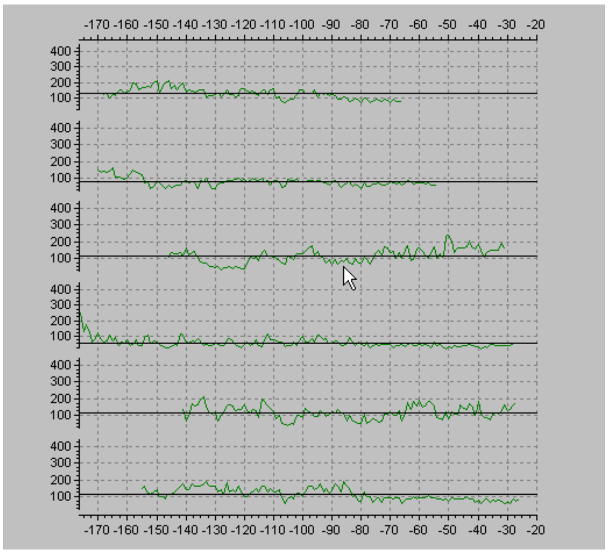
Zoom in: To magnify a part of the time scale just draw the mouse over the requested time span while pressing the left mouse key (see image below).



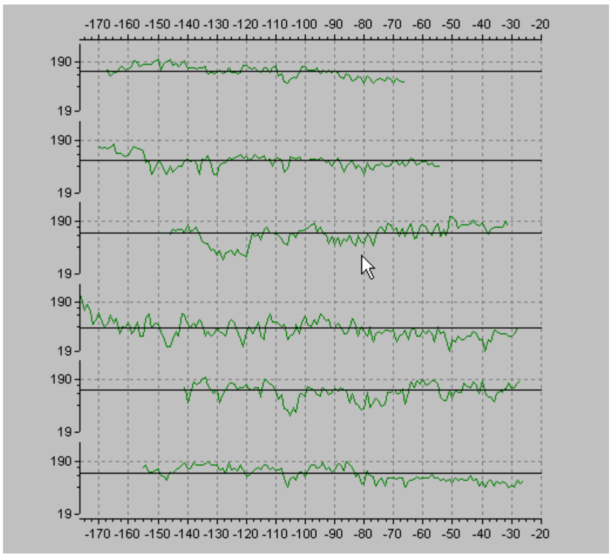
Zoom in

Zoom out: Draw the mouse over the graph from right to left while pressing the left mouse key. The image will display the complete time axis again.

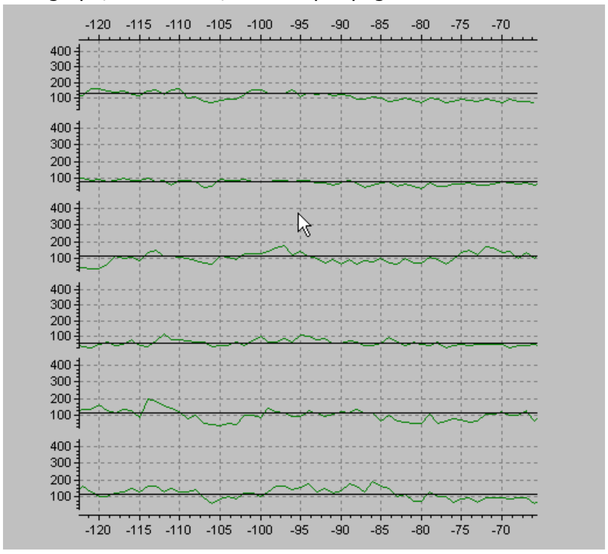
EXAMPLES



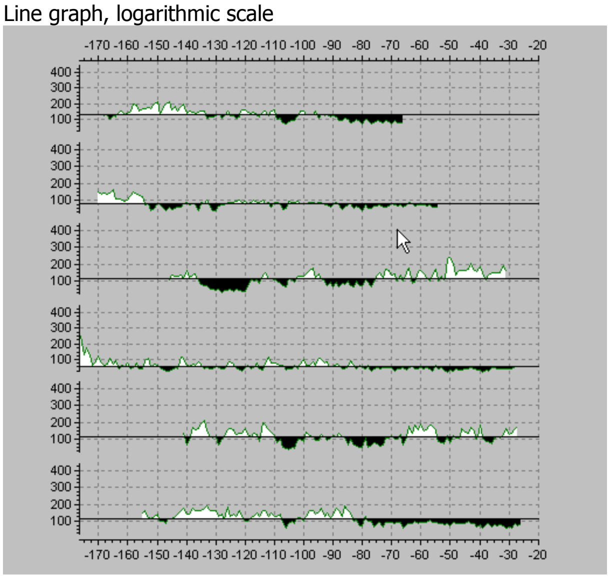
Line graph, linear scale, 6 series per page



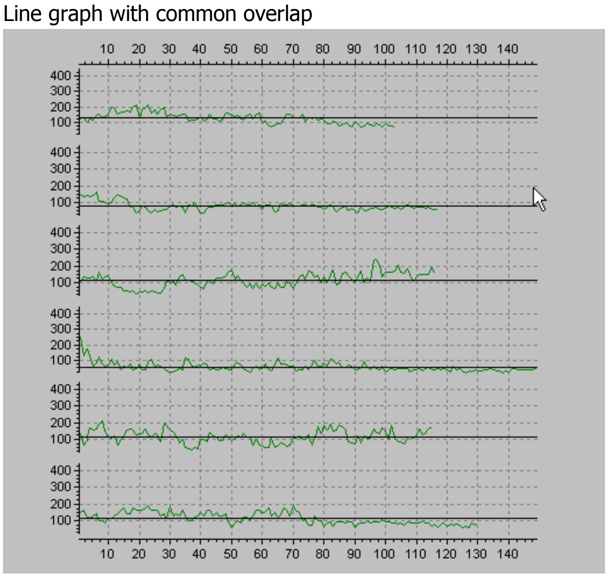
Line graph, logarithmic scale



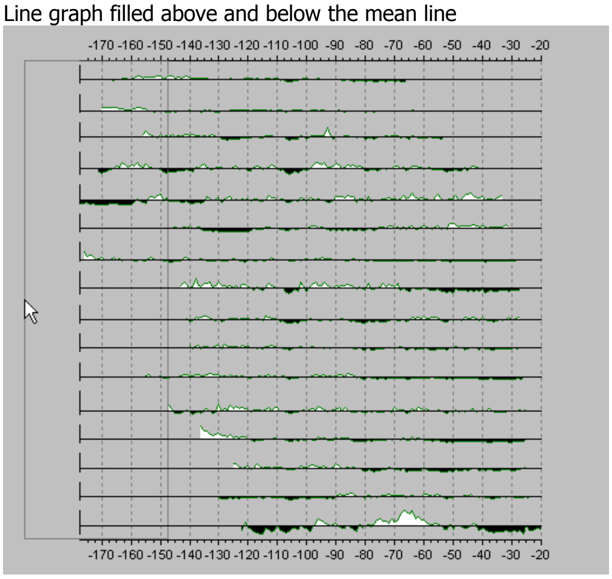
Line graph with common overlap



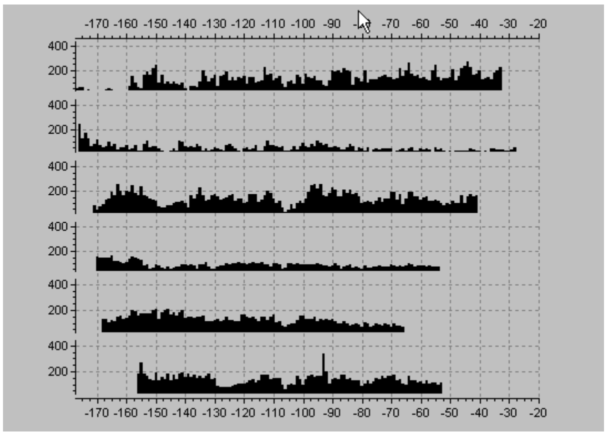
Line graph filled above and below the mean line

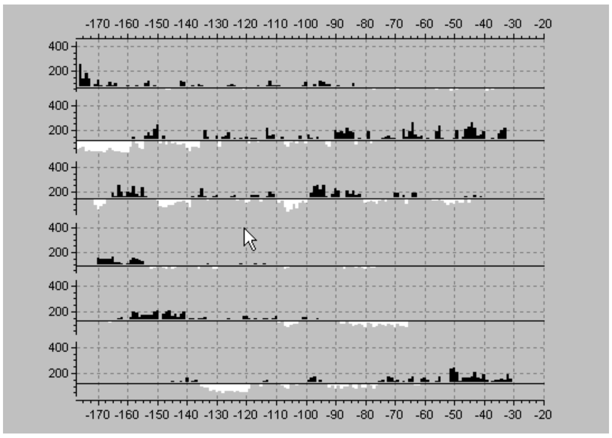


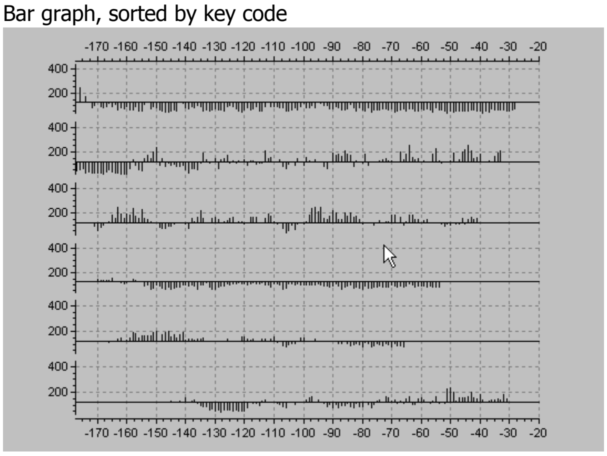
Line graph, undated

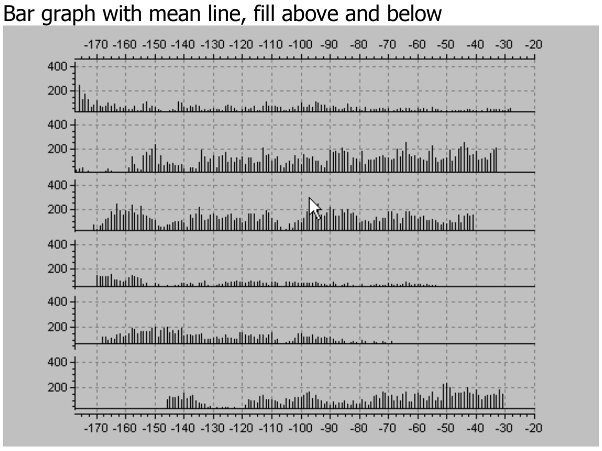


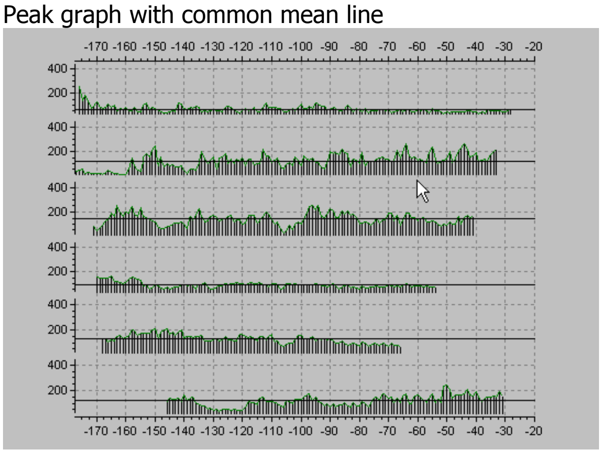
Line graph, all series in one

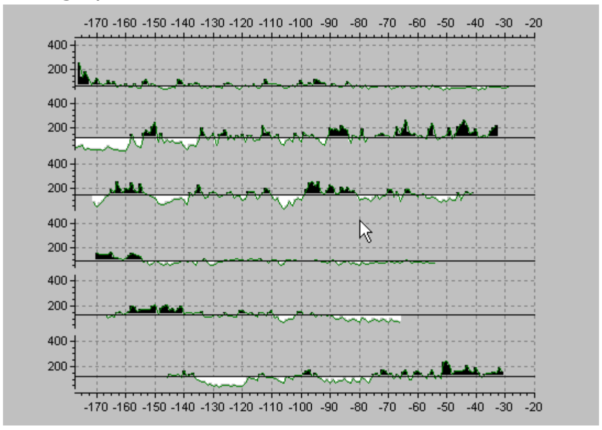

Bar graph, sorted by key code

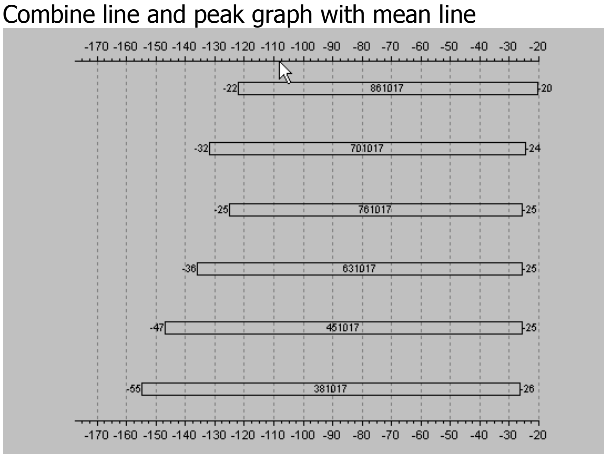

Bar graph with mean line, fill above and below


Peak graph with common mean line

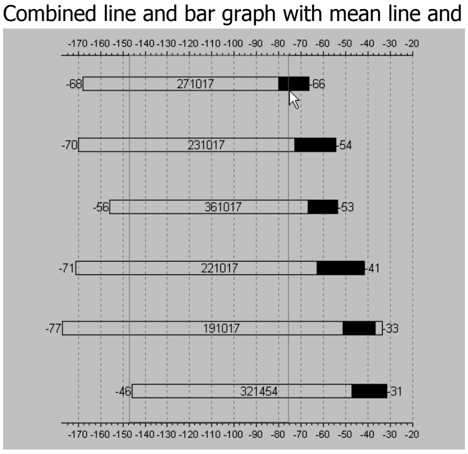

Peak graph with zero lines


Combine line and peak graph with mean line


Combined line and bar graph with mean line and filling.



Grid beam, sorted by date end



Grid beam indicating date begin, key code, sapwood and date end.

MATH LIBRARY

Please note: The Math Library is part of ***TSAP-Win Scientific***, but can be purchased as an additional module for the Professional version.

OVERVIEW

The **Math Library** provides a variety of mathematical and statistical functions - from easy operations to indexation and trends - for the scientific use of TSAP-Win.

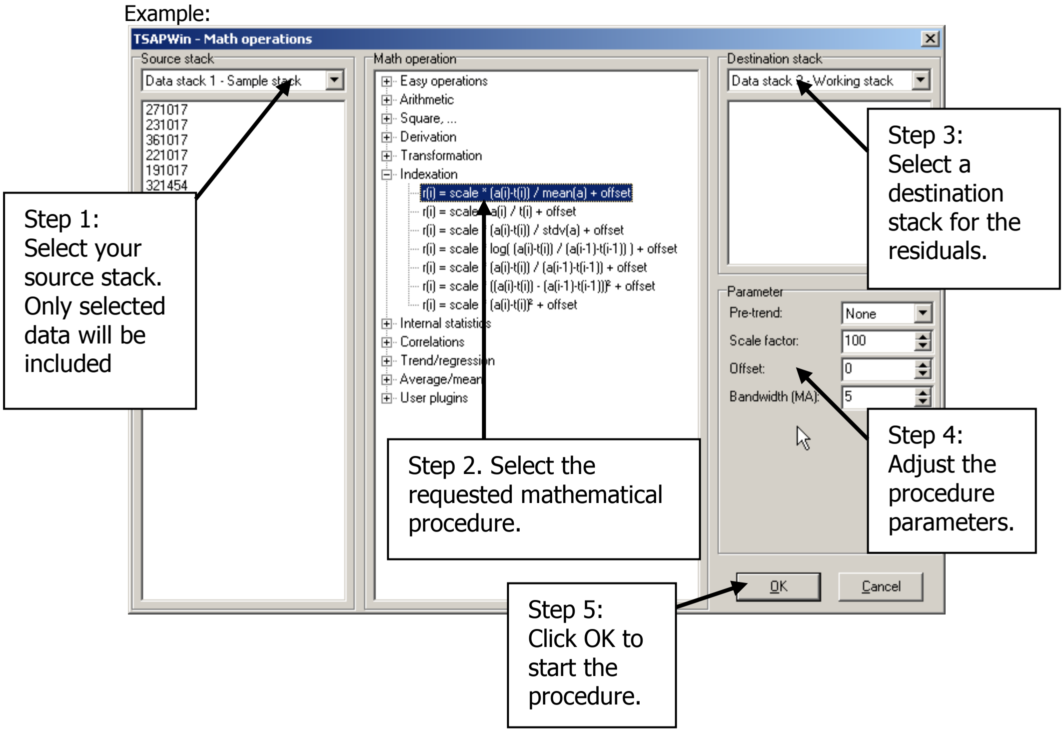
Sub menu	Short description
Easy operations	Reverse, mirror, summarize, value distribution table, link series from different stacks (Comcat).
Arithmetic:	Add, subtract, multiply, divide, subtract mean, add constant etc.) using either two series or a series and a constant for calculation.
Square:	Calculates squares and square roots from series values.
Derivation	Derivations of the series themselves or their smoothed residual can be calculated.
Transformation	Create cumulated series, incremental area series, or neighbor differences series. Shift series to a user-defined minimum, maximum or mean. Furthermore: trend elimination by the Baillie-Pilcher and the Hollstein procedure.
Indexation	Index series derived from different indexation procedures (running means).
Internal statistics	Statistic tables as well as an autocorrelation calculation and running-windows statistics.
Correlations	Simple correlations, Kendall coefficient Special tool for cross-dating: Cross-date check, which follows the procedures developed by Richard Holmes and first implemented in the software COFECHA .
Trend/regression	Let TSAP- Win find the optimal trend of your time series or fit a determined trend.
Average/mean	Averages of series within one stack or between two stacks can be calculated.
User plug-ins	This chapter opens the possibility to implant user defined procedures into TSAP-Win. .

You will find a detailed description of all procedures on the following pages. For more information on mathematical and statistical procedures in dendrochronology please refer to the dendrochronological literature (e.g. FRITTS 1976, COOK 1985, COOK and KAIRIUKSTIS 1991, RIEMER 1994).

THE LIBRARY WINDOW

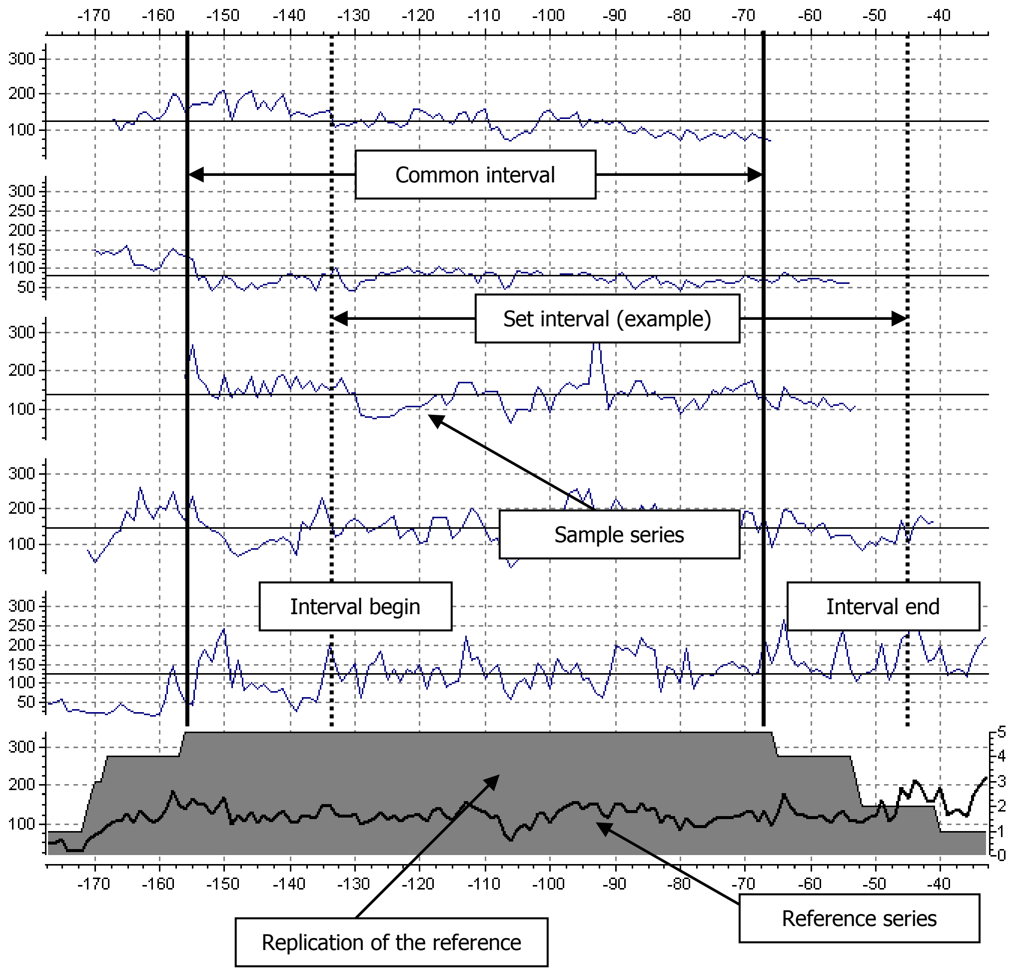
Within the Math Library window the user chooses the requested procedure and its parameters, specifies source data stack and destination data stack. Please keep in mind that only selected series from the source data stack will be included in the transformation process. The picture below shows the recommended steps.

Example:



Please note: To avoid a mix-up of source data with residual data we recommend storing the residuals or calculation results in a separate working stack.

TIME SERIES TERMS



Term	Explanation
Common interval	Interval covered by all series
Set interval	Interval defined by user
Internal begin	Start of user defined interval
Interval end	End of user defined interval
Reference	Series (mainly a chronology) sample series are referred to
Replication	Number of samples within a reference (chronology)

EASY OPERATIONS

Easy operations contains simple functions for analysis and modification of the data, for example "Reverse" which reverses the succession of the series values.

Easy operations	
Reverse	Reverses the succession of series t with n points: $r_i = a_n \,;\, r_2 = a_{n-1} \,;\, \ldots \,;\, r_n = a_1$
Mirror	Mirrors the series referring to its mean value or a user defined mirror value. Negative event years are converted to positive ones: $ri = mean(a) + (mean(a)-ai)$
Concat	Appends the first selected series of a data stack to the first selected series of another stack, then the second series and so on …
Value distribution	Produces distribution data for each selected series in the stack. The class width can be defined by the user.
Sum of all series	Adds up all corresponding values of n series $ri = ai + bi + \ldots + ni$ If requested the residual values can be divided by a constant.
Signed sum of all series	Adds up all corresponding signatures of n series following the same procedure as above.

ARITHMETIC

'Arithmetic' contains arithmetic operations for one and two stacks. The first group of functions works on two stacks and allows you to add, subtract, divide or multiply the values of the series taken in pairs from the two stacks (source stack 1 and source stack 2). The first selected series of source stack 1 is processed with the first series of source stack 2. Afterwards, the second series of source stack 1 is processed with the second series from source stack 2 and so on. If one of these two stacks contain more series than the other one, the overhanging number of series are not regarded. The results are stored onto data stacks

If the two series to be processed do not have the same length, TSAP takes the minimum length of the two.

The second group of functions provides possibilities for

- adding a constant to the series or
- subtracting a constant from the series or to
- dividing the series by a constant or to
- multiplying the series with a constant value.

In this case, TSAP takes the selected series of the active data stack in the predefined succession.

The following table lists the menu items:

a: series of source stack 1

b: series of source stack 2

c: constant value, given by the user

i: index running over the series length

r: resulting series, stored on the destination stack

s: scale factor, given by the user.

Arithmetic operations	
Add	$r_i = a_i + b_i$
Subtract	$r_i = a_i - b_i$
Multiply	$r_i = a_i * b_i$
Divide	$r_i = a_i / b_i$, $r_i = 0$ if $b_i = 0$
Add constant	$r_i = a_i + c$
Subtract constant	$r_i = a_i - c$
Multiply constant	$r_i = (a_i * c) * s$, s= user defined scale factor
Divide constant	$r_i = (a_i / c) * s$, s= user defined scale factor

SQUARE…

Produces square, signed square, cubic, inverse, square roots and signed square roots of the series values selected in the source stack. The inverse and square root operations are altered by a scale factor.

Square …	
Square	$r_i = a_i^2$
Signed square	$r_i = a_i^2 ;\ a_i > 0$ $r_i = -(a)_i^2 ;\ a_i < 0$
Cubic	$r_i = a_i^3$
Inverse	$r_i = scale / a_i$
Square root	$r_i = \sqrt{scale \times a_i}$
Signed square roots	For $a_i > 0$: $r_i = \sqrt{scale \times a_i}$ For $a_i = 0$: $r_i = 0$ For $a_i < 0$: $r_i = -\sqrt{scale \times a_i}$

DERIVATION

TSAP-Win offers two kinds of derivation routines: direct and smoothed. The direct derivation refers to the non-weighted neighbor values of the original series, the smoothed derivation is calculated with the help of a weighted moving average based on an optimal kernel (Lagrange polynomial, see GASSER and MÜLLER 1984 or RINN 1988.

Before and after calculating the direct derivation, a non-parametric regression (moving average with defined bandwidth) can be calculated to smooth the profile. The direct derivation can be scaled optionally by setting the scale and the offset value. The offset can be the mean value of the series or a given constant.

Derivation	
First direct derivation	$r_i = scale * (a_i - a_{i-1}) + offset$
Second direct derivation	$r_i = scale * (a_{i-1} - 2 * a_i + a_{i+1}) + offset$
First smoothed derivation	Weighted moving average with optimal kernel order (1,3), bandwidth = 2
Second smoothed derivation	Weighted moving average with optimal kernel order (2,4), bandwidth = 4

TRANSFORMATION

The transformation procedures of TSAP-Win allow the user to cumulate or shift series, change the amplitudes, eliminate trends by certain models or calculate neighbor differences.

Transformation, Overview	
Cumulate	Creates a series of cumulated values starting with the pith or a given start value.
Neighbor differences	Transforms series by taking the difference of each series value and its subsequent value (comparable to derivation of neighbor differences series).
Increment area	Calculates incremental area of ring width series. Useful for determination of forest yield.
Set min to	Shifts series so that min equals a given value.
Set mean to	Shifts series so that the mean equals a given value.
Set max to	Shifts series so that max equals given value
Set rnin-max to	Changes the series amplitude to given min-max values
Set stdv[1] to	Set stdv to: scale series so that the standard deviation equals Set stdv to given value. Changes the amplitude of the series.
Baillie-Pilcher-Transformation	5 year moving average (= specific trend elimination)
Hollstein-Transformation	Wuchswert-Transformation -> logarithmic detrending

The user should be aware that any transformation of time series leads to a loss of information. Please carefully check the goal and outcome of any transformation procedure. The following table gives a detailed description of the procedures offered by TSAP-Win Scientific.

Transformation	
Cumulate	The cumulated series is often used for forestry purposes. The last value of the cumulated series l_n equals the total sum of all values of the series. If the series represents the ring widths of a tree starting with the pith and ending at the bark, the cumulated sum is the radius of the tree. It cumulates the values of the series t to the series 1 with the same length of n points: $r_1 = a_1$; $r_2 = r_1 + a_2$; $r_3 = r_3 = r_2 + a_3$;…; $r_n = r_{n-1} + a_n$ Before calculation, a start value can be defined which can be of interest if the first ring of the series, for example, is not the pith, but the distance to the pith is known. Additionally, you are asked to set the factor for division of the result values. If 1,000 is taken, and the original series is a ring width radius of a tree, the resulting series represents the radius development in time in units of centimeters.

[1] Stdv = standard deviation

Transformation, proc.	
Neighbor differences	The neighbor differences can be described and used as a form of indexation. $r_1=0$; $r_2=a_2-a_1$; $r_3=a_3-a_2$;…; $r_n=a_n-a_{n-1}$ Before the run is processed, you are asked to decide which centering mode (none, mean or constant) should be used. The resulting series will have this center value as a mean after calculation.
Increment Area	The procedure creates a series representing the incremental growth area of a tree from tree-ring series. $r_i = \prod((\sum_1^i a)^2 - (\sum_1^{i-1} a)^2)$ Before calculation, a start value can be defined which can be of interest if the first ring of the series, for example, is not the pith, but the distance to the pith is known. Additionally, you are asked to set the factor for division of the result values. If 1,000 is taken, and the original series is a ring width radius of a tree, the resulting series represents the radius development in time in units of centimeters.
Set min to	The minimum ordinate value of the series is shifted to a given value. The procedure first determines the minimum value of the series, calculates the difference between this minimum and the desired value and then adds this difference to all series values.
Set max to	Shifts the series ordinate values in such a way that the maximum series value equals the desired value.
Set mean to	Shifts the series ordinate values in such a way that the mean series value equals the desired value.
Set max-min to	Scales the series by division or multiplication in such a way that the variation between minimum and maximum equals the given value. This transformation is used to equalize the amplitude of series.
Set stdv[2] to	Scales the series by division or multiplication so that the standard deviation equals the given value. This routine serves to scale the profile for better comparison with others, for example.
Baillie-Pilcher-Transform	This procedures carries out a simple standardization using a five year running mean. Normalization is achieved by taking *log* to base *e* of the residual values (BAILLIE, PILCHER 1973).
Hollstein-Transform	The series will be transformed by Hollsteins so called Wuchswert-formula (HOLLSTEIN 1980) $w_i = 100 * \log 10 \frac{y_i}{y_{i-1}}$

[2] Stdv = standard deviation

INDEXATION

GENERAL

TSAP-Win Scientific provides several different indexation routines. They differ concerning reference, the method and the operation of indexation. The reference describes to which value the actually indexed value is related, for example the mean of the series, the left neighbor or the trend value at the same point. The ‘method’ describes the mathematical operation which is applied, such as subtraction or division. The 'mode' describes the mathematical operation which is applied to scale or transform the result, such as logarithm of the difference between the actual value and the trend value. Since most of the different references, methods and modes can be combined, many different indexation routines are available.

Since indexation generally reduces information included in the original series, the mean level and the sensitivity of the resulting series have to be determined by optional settings of offset and scale values. These settings are subjective and should be seen in relation to the desired interpretation of the series and its information included, which is pronounced by the indexation process. The scaling is important, especially for division of the series values, since most of the series consist of integer values. When two relatively small integer values are divided, the result can appear to make no sense without scaling before division: for example, 3/4=0 as integer values, but (3/4)*scale_factor=75, if scale_factor=100.

Before indexation, the series can be detrended optionally by the TSAP-Win standard smoothing routines. For more information, please check the corresponding chapter.
The dendrochronological literature documents several different indexation routines. We would suggest naming only those mathematical methods 'indexation' where the original series value is divided through a reference, such as mean, standard deviation or trend. The methods where the reference value is subtracted from the series value should be called trend elimination. Nevertheless, we provide the possibility of calculating index series with division and subtraction.

We recommend referring to the dendrochronological literature on indexation and detrending to receive more information on the topic.

INDEXATION STEPS

Original series: a: $a_1 \dots a_n$

↓

Optional: Trend elimination by
- moving average
- linear regression
- exponential regression

↓

Indexation routine
Optional:
- scaling and offset
- reference (mean, standard deviation, neighbor, trend)
- operation referring reference (division, subtraction)
- method of referencing (logarithm, square, square root)

↓

Resulting index series, length n or n-1: $a_1 \dots a_n$, $a_1 \dots a_{n-1}$ or $a_2 \dots a_n$

The calculation of index refers to the general form

$$\text{Index-value } r_i = scale * method\ [a_i(operator)\ reference] + offset$$

Options	Example
Scale	Float value
Offset	Float value
Reference	Mean or standard deviation of series or trend value
Method	Square, square root

USED TERMS

<table>
<tr><th colspan="3">Indexation terms of TSAP-Win Scientific</th></tr>
<tr><td>Reference</td><td>Constant value to which the calculation of the index refers</td><td rowspan="4">The index value is derived from the original value related to the reference. The relation can be subtraction or division. The reference can be either the average of the series (mean), the standard deviation (stdv), the min-max distance or another, user given constant number.</td></tr>
<tr><td>Mean, m</td><td>Average value of the original series</td></tr>
<tr><td>Constant</td><td>Constant reference value (user defined)</td></tr>
<tr><td>Min-Max</td><td>Distance between minimum and maximum of the series values</td></tr>
<tr><td>a_i</td><td colspan="2">Original value for year i</td></tr>
<tr><td>r_i</td><td colspan="2">Resulting index value after operation</td></tr>
<tr><td>s</td><td>Scale factor for index value</td><td>The core of the indexation procedure as shown in the equations below determines the internal variance (sensitivity) of the index series. With the Scale factor s this variance can be modified.</td></tr>
<tr><td>c</td><td>Offset: constant value</td><td>The offset enables the user to shift the resulting series along the y axis. Generally, index series and detrended series vary around 0. With Offset c this center or mean of the series can be shifted to plus or minus.</td></tr>
<tr><td>1</td><td>Scale for logarithm operand</td><td>The operand of the log function can be scaled with this constant scale factor.</td></tr>
<tr><td>q</td><td>Scale for square operand</td><td>The operand of the square function can be scaled with this constant scale factor.</td></tr>
<tr><td>t_i</td><td>Value of pre-trend series</td><td>This value is only involved, if a pre-trend function is applied.</td></tr>
<tr><td>u</td><td>Scale for square root operand</td><td>The operand of the square root function can be scaled with this constant scale factor.</td></tr>
<tr><td>sign(x)</td><td colspan="2">Sign of operand x = +1 , 0 or -1</td></tr>
<tr><td>abs(x)</td><td colspan="2">Absolute value of x</td></tr>
<tr><td>stdv(a)</td><td colspan="2">Standard deviation of series a</td></tr>
<tr><td>Min(a), Max(a)</td><td colspan="2">Minimum and Maximum value of series a.</td></tr>
</table>

Example of a typical indexation routine:

$$r_i = s(\frac{a}{m}) + c \text{ , i=} 1 \ldots n$$

In this case the series values are divided by the constant reference value which can be the mean of the series or the standard deviation for example. Subsequently the result of this division is multiplied with the scale value and the optional offset is added.

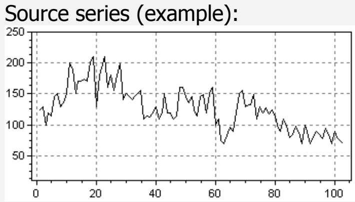
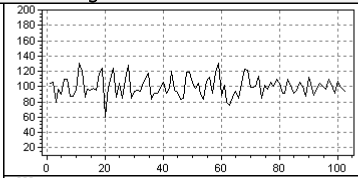
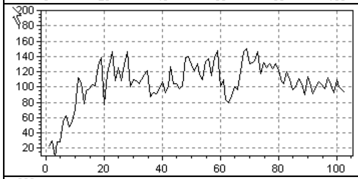
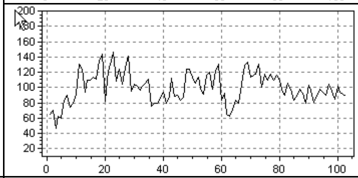
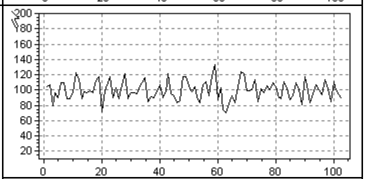
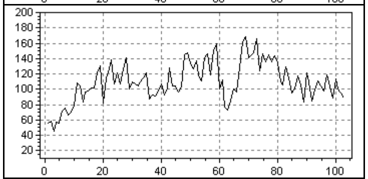
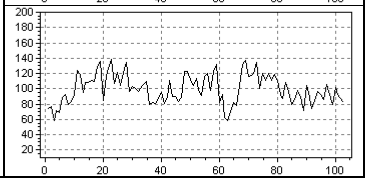
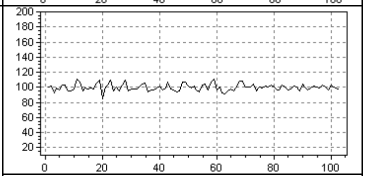
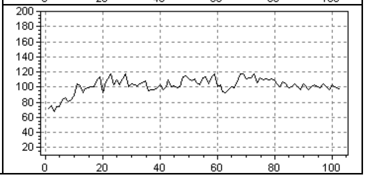
BASIC MATHEMATICAL OPERATIONS

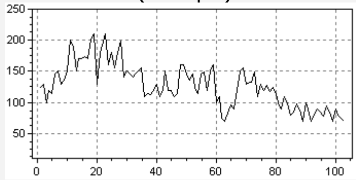
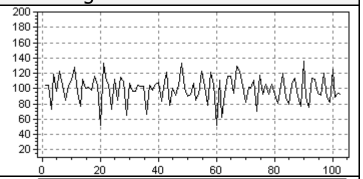
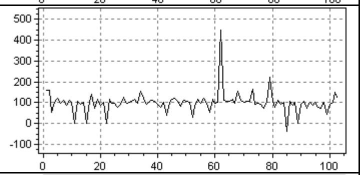
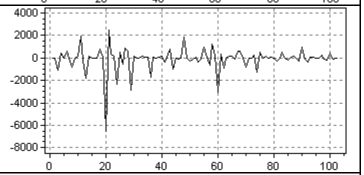
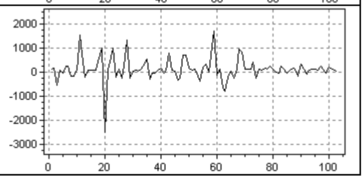
TSAP-Win Scientific provides several different mathematical operations to transform the original series values to index values. This transformation first contains the kernel part of calculation, such as division or subtraction, as well as the method to transform this relation, e.g. scale & offset, percent, logarithm, square and square root.

Basic mathematical operations	
Scale & offset	$r_i = scale \times (\frac{a}{m}) + offset$
Percent	$r_i = 100 \times \frac{(a_i - m)}{m}$
Logarithm	$r_i = s \times \log(l \times \frac{a_i}{m})$
Square	$r_i = scale \times (\frac{a_i - m}{q})^2 + offset$
Signed square	$r_i = scale \times sign(a_i - m) \times (\frac{a_i - m}{q})^2 + offset$
Square root	$r_i = scale \times \sqrt{(u \times abs(a_i - m))} + offset$
Signed square root	$r_i = scale \times sign(a_i - m) \times s \times \sqrt{(u \times abs(a_i - m))} + offset$
Remarks: m= reference value, for example the w value at point a_i, mean(a) or stdv(a) 'Signed' indicates that the resulting index value has the same sign as the relation (a_i-reference)	

INDEXATION ROUTINES

The following indexation routines are available in TSAP-Win Scientific:

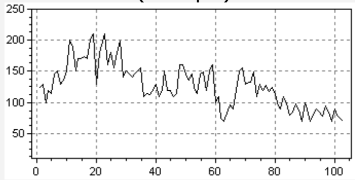
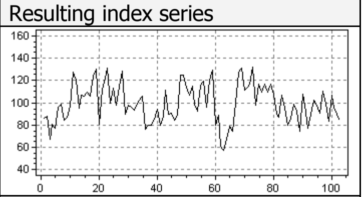
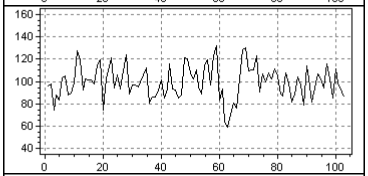
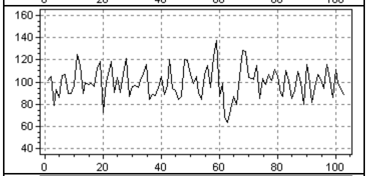
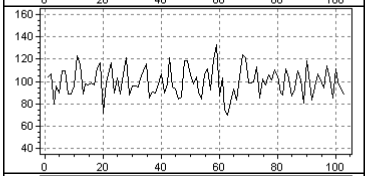
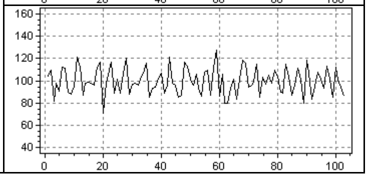
#	Option	Entry	Equation	Source series (example):  Resulting index series
A	Pre-trend Reference Operation Method	5-yr moving average Mean Division Percent		
B	Pre-trend Reference Operation Method	Exponential regression Mean Division Percent	$r_i = 100 * \frac{a_i - t_i}{mean(a)}$	
C	Pre-trend Reference Operation Method	Linear regression Mean Division Percent		
D	Pre-trend Reference Operation Method	5-yr moving average Trend value Division Scale-offset		
E	Pre-trend Reference Operation Method	Exponential regression Trend value Division Scale-offset	$r_i = 100 * \frac{a_i}{t_i}$	
F	Pre-trend Reference Operation Method	Linear regression Trend value Division Scale-offset		
G	Pre-trend Reference Operation Method	5-yr moving average Standard deviation Division Scale-offset	$r_i = 10 * \frac{a}{stdv(a)} * 100$	
H	Pre-trend Reference Operation Method	Exponential regression Standard deviation Division Scale-offset		

#	Option	Entry	Equation	Source series (example):  Resulting index series
I	Pre-trend Reference Operation Method	- Neighbor left Division Logarithm	$r_i = 100 * \log(\frac{a_i - t_i}{a_{i-1} - t_{i-1}})$	
J	Pre-trend Reference Operation Method	7-yr moving average Neighbor left Division Percent	$r_i = 100 * (\frac{a_i - t_i}{a_{i-1} - t_{i-1}})$	
K	Pre-trend Reference Operation Method	5-yr moving average Neighbor left Subtraction Square	$r_i=100*((a_i-t_i)-(a_{i-1}-t_{i-1}))^2$	
L	Pre-trend Reference Operation Method	5-yr moving average Trend Subtraction Square	$r_i=100*(a_i-t_i)^2$	

From the table above it becomes obvious that different indexation procedures lead to very different residual series. In any case, indexation as well as transformation removes information from the time series. This important fact must be taken into consideration prior to selecting a certain index procedure. The indexation function must be carefully chosen by the researcher.

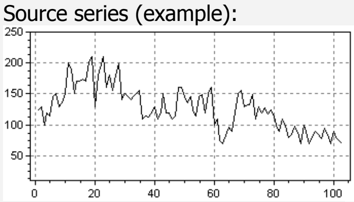
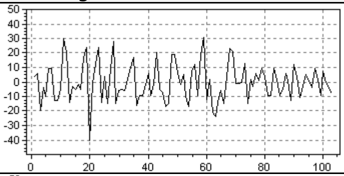
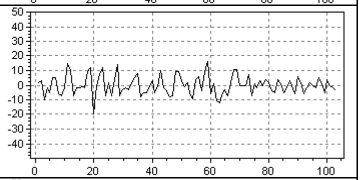
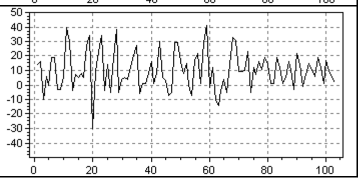
PRE-TREND ELIMINATION

In many cases time series contain a trend or long scale variations that, depending on the research interest, possibly should be removed from the series. In the case of a subsequent cross-dating analysis, the trends must be completely removed to receive normal distributed samples. In other cases a "conservative" or even no detrending may be the best solution. There is no general rule for the best detrending method. Always keep in mind that pre-trend elimination removes information from the series. The result of indexation strongly depends on the method and strength of pre-trend elimination. The moving average routine of TSAP-Win Scientific provides the parameter 'bandwidth' to modify the trend elimination. Large bandwidths lead to a stiff trend line while a small bandwidth adapts smoothly to the time series.

#	Option	Entry	Equation	Source series (example):  Resulting index series
1	Pre-trend Reference Operation Method	21-yr moving average Trend value Division Scale offset		
2	Pre-trend Reference Operation Method	11-yr moving average Trend value Division Scale offset		
3	Pre-trend Reference Operation Method	7-yr moving average Trend value Division Scale offset	$r_i = 100 * \frac{a_i}{t_i}$	
4	Pre-trend Reference Operation Method	5-yr moving average Trend value Division Scale offset		
5	Pre-trend Reference Operation Method	3-yr moving average Trend value Division Scale offset		

SCALING AND OFFSET OPTIONS AND CONSEQUENCES

Scaling and offset options serve to pronounce and/or discriminate specific information contained in the series. As a result the series will be either stretched of shifted along the ordinate (y-axis).

#	Option	Entry	Equation	Source series (example):  Resulting index series
1	Pre-trend Reference Operation Method	5-yr moving average Mean Division Percent	$r_i = 100 * \frac{a_i - t_i}{mean(a)}$	
2	Pre-trend Reference Operation Method	5-yr moving average Mean Division Percent	$r_i = 50 * \frac{a_i - t_i}{mean(a)}$	
3	Pre-trend Reference Operation Method	5-yr moving average Mean Division Percent	$r_i = 100 * \frac{a_i - t_i}{mean(a)} + 10$	

INTERNAL STATISTICS

OVERVIEW

The sub menu *Internal statistics* contains several operations for analysis of internal properties of the time series itself. Two items combine the calculation of different properties: The Statistics table and the Autocorrelation table.

Internal statistics items	**Explanation**
Statistics table	Statistics table listing internal statistical properties of the series
Statistics table chrono	Statistics table chrono listing specific internal statistical properties of chronology series
Autocorrelation table	Autocorrelation table listing autocorrelation value for different lags
Autocorrelation function	Time series of the autocorrelation versus lag, calculated for the corresponding series.
Running windows statistics	Calculates statistical parameters for a given time window which is subsequently moved of the whole series length.

STATISTICS TABLE

The statistics table gives an overview of statistical parameters for each selected time series of the active data stack. The table will be displayed in a window.

Example output:

```
**********************************************************************
*** INTERNAL STATISTICS TABLE ***  DATE:  2004.08.27  TIME: 17.37. ***
Time interval refers to absolute dates
Time interval = common overlap of all samples = -122  -  -66
Internal statistical properties of time series:
+----------+------+------+----------+------+------+------+------+------+------+------+------+-------+---+---+---+
|    NO.   |POINTS|  LEN |  HWP/SWP |  MIN | MEAN |  MAX |MEANSW|MEANHW|  CSUM|  VAR | STDV |AC(  1)|MS%|RMS|TC%|
+----------+------+------+----------+------+------+------+------+------+------+------+------+-------+---+---+---+
|    181017|    57|   149|  137/  12|    24|    58|   114|    58|     0|  3324|   424|  20,6|   0,48| 29| 41| 70|
|    191017|    57|   145|  127/  18|    58|   135|   221|   135|     0|  7686|  1550|  39,4|   0,31| 27| 44| 70|
|    221017|    57|   131|  109/  22|    36|   150|   257|   150|     0|  8526|  2435|  49,3|   0,72| 23| 31| 61|
|    231017|    57|   117|   98/  19|    43|    76|   105|    76|     0|  4349|   218|  14,8|   0,53| 16| 38| 75|
|    271017|    57|   103|   89/  14|    70|   109|   160|   109|     0|  6232|   780|  27,9|   0,76| 14| 27| 63|
|    321454|    57|   116|  100/  16|    42|   106|   176|   106|     0|  6042|  1058|  32,5|   0,65| 22| 34| 66|
|    361017|    57|   104|   90/  14|    63|   138|   340|   138|     0|  7879|  1537|  39,2|   0,44| 18| 32| 66|
|    381017|    57|   130|  117/  13|    62|   122|   195|   122|     0|  6934|  1109|  33,3|   0,67| 19| 32| 66|
|    451017|    57|   123|  107/  16|    54|   105|   175|   105|     0|  6013|   862|  29,4|   0,43| 23| 41| 61|
|    531017|    57|   117|  101/  16|    43|   158|   252|   158|     0|  8994|  2357|  48,5|   0,32| 30| 46| 64|
|    571017|    57|   115|  102/  13|    39|   103|   197|   103|     0|  5868|  1266|  35,6|   0,63| 23| 31| 55|
|    581017|    57|   114|  104/  10|    67|   116|   181|   116|     0|  6602|   666|  25,8|   0,48| 18| 39| 68|
|    631017|    57|   112|  101/  11|    58|   107|   168|   107|     0|  6117|   702|  26,5|   0,57| 18| 35| 66|
|    701017|    57|   109|   94/  15|    41|   110|   190|   107|   139|  6261|  1096|  33,1|   0,77| 17| 27| 64|
|    761017|    57|   101|   91/  10|    46|   120|   215|   123|    93|  6814|  1395|  37,3|   0,63| 20| 32| 54|
|    861017|    57|   103|   85/  18|    33|   176|   438|   140|   253| 10006|  8115|  90,1|   0,81| 30| 25| 50|
+----------+------+------+----------+------+------+------+------+------+------+------+------+-------+---+---+---+
  NO=KeyCode/KeyNo, POINTS=Number of regarded points, LEN=Length of series,
  MIN/MEAN/MAX=Minimum/Mean/Maximum value, MEANHW/MEANSW=Mean heartwood/sapwood value,
  CSUM=Cumulated sum, VAR=Variance, STDV=Standard deviation, AC(1)=Auto correlation [lag=1],
  MS=Mean sensitivity[%], RMS=Relative mean sensitivity[%], TC=Tendency changes[%]
```

The following table gives an overview and explanation of the parameters calculated:

Stat. parameter	**Explanation**
NO.	Key number of series
POINTS	Number of values included in the analysis (These values differ from the series length if a common interval or a certain range is defined)
LEN	Total length of the series
HWP/SWP	Number of hardwood points (HWP) and sapwood points (SWP)
MIN	Minimum value of series
MEAN	Mean value (arithmetic) of series
MAX	Maximum value of series
MEANSW	Mean sapwood value
MEANHW	Mean heartwood value
CSUM	Cumulated sum of series
VAR	Variance of series
STDV	Standard deviation of series
AC (N)	Autocorrelation lag N of series
MS%	Mean sensitivity of series in % $MS = \frac{200}{N}\sum_{1}^{N}\left\|\frac{a_n - a_{n-1}}{a_n + a_{n-1}}\right\|$
RMS	Relative mean sensitivity of series $RMS = \frac{\sum_{n=1}^{N-1}(a_n - a_{n-1})}{\sqrt{N\sum_{n=0}^{N-1}a_n^{\ 2} - (\sum_{n=0}^{N-1}a_n)^2}}$
TC%	Tendency changes of series in % $TC = \frac{\sum_{N=1}^{N-2} s_n <> b_n}{N-1}$ $\quad \mathrm{sgn}(x) := \begin{cases} +1 : x > 0 \\ 0 : x = 0 \\ -1 : x < 0 \end{cases}$ $b_n := \begin{cases} 0 : \mathrm{sgn}(a_n - a_{n-1}) = \mathrm{sgn}(a_{n+1} - a_n) \\ 1 : \mathrm{sgn}(a_n - a_{n-1}) \neq \mathrm{sgn}(a_{n+1} - a_n) \end{cases}$

The following options can be individually set by the user:

Statistics table parameters (options)	**Entry**
Time mode	Dated, undated
Overlap mode	Max range, common interval, set interval
Interval begin	First and last value used when 'set interval' is selected as overlap mode
Interval end	
Autocorrelation lag	Values ≥ 1

Note:	Please regard that the output only refers to the chosen interval. To receive data referring for the whole length of series, max. range must be selected as a parameter.

STATISTICS TABLE CHRONO

The chrono statistics gives information on signatures, mean density, variance, Gleichläufigkeit, standard deviation, autocorrelation, sensitivity and tendency changes. This feature works only with series in TSAP chrono format.

```
***********************************************************************
*** INTERNAL STATISTICS TABLE ***  DATE:  2004.08.30  TIME: 16.56. ***
Time interval refers to length of series (undated)
Time interval = maximum interval of all samples = 1  -  466
Internal statistical properties of chronologies:
+----------+------+------+----+----+----+----+----+----+----+----+----+----+---+---+------+------+------+------+------+-------+---+---+---+
|    NO.   |POINTS|  LEN |MDEN|100%|100+|100-| 90%| 90-| 90+| 75%| 75+| 75-|GLK|WGL|  MIN | MEAN |  MAX |  VAR | STDV |AC(  1)|MS%|RMS|TC%|
+----------+------+------+----+----+----+----+----+----+----+----+----+----+---+---+------+------+------+------+------+-------+---+---+---+
|  set01chr|   158|   158|  12|   7|   4|   3|  10|   6|   4|  40|  19|  21| 63| 69|    46|   114|   162|   502|  22,4|   0,52| 15| 37| 61|
|  set02chr|   300|   300|   9|  11|   6|   5|  21|  11|  10|  55|  27|  28| 49| 71|    32|   101|   260|  1024|  32,0|   0,80| 15| 24| 62|
|  set03chr|   466|   466|   7|  82|  40|  42|  12|   5|   7| 140|  66|  74| 67| 74|    62|   146|   275|  1510|  38,9|   0,64| 17| 32| 63|
+----------+------+------+----+----+----+----+----+----+----+----+----+----+---+---+------+------+------+------+------+-------+---+---+---+
  NO=KeyCode/No, PTS=Number of regarded points, LEN=Length of series, MDEN=Mean density (mean number of members),
  100%=Total number of signatures with internal Glk >= 100[%], 100+=Number of increasing signatures with internal Glk >= 100[%],
   90+=Number of increasing signatures with  90[%] <= internal Glk < 100[%],
   75+=Number of decreasing signatures with  75[%] <= internal Glk <  90[%],
  GLK=Internal gleichlaeufigkeit (=slope equivalence), WGL=Density weighted internal Glk, MIN/MEAN/MAX=Minimum/Mean/Maximum value,
  VAR=Variance, STDV=Standard deviation, AC(1)=Auto correlation [lag=1],
  MS=Mean sensitivity[%], RMS=Relative mean sensitivity[%], TC=Tendency changes[%]
```

Stat. parameter	Explanation
NO.	Key number of series
POINTS	Number of values included in the analysis (These values differ from the series length if a common interval or a certain range is defined)
LEN	Total length of the series
MDEN	Mean density (mean number of members)
100%	Total number of signatures with internal Glk ≥ 100[%]
100+	Number of increasing signatures with internal Glk ≥ 100[%]
100-	Number of increasing signatures with internal Glk ≤ 100[%]
90%	Total number of signatures with internal Glk ≥ 90[%]
90+	Number of increasing signatures with internal Glk ≥ 90[%]
90-	Number of increasing signatures with internal Glk ≤ 90[%]
75%	Total number of signatures with internal Glk ≥ 75[%]
75+	Number of increasing signatures with internal Glk ≥ 75[%]
75-	Number of increasing signatures with internal Glk ≤ 75[%]
MIN	Minimum value (arithmetic) of series
MEAN	Mean value (arithmetic) of series
MAX	Maximum value of series
MEANSW	Mean sapwood value
MEANHW	Mean heartwood value
CSUM	Cumulated sum of series
VAR	Variance of series
STDV	Standard deviation of series
AC (N)	Autocorrelation lag N of series
MS%	Mean sensitivity of series in %
RMS	Relative mean sensitivity of series
TC%	Tendency changes of series in %

AUTOCORRELATION TABLE

The autocorrelation table shows the autocorrelation for different lags. The top line contains the lag value. The columns contain the autocorrelation of the series, identified by the Key Code written in the first column. An asterisk (*) indicates that the autocorrelation exceeds the threshold value as given before starting the routine within the parameters. Chronologies, half chronos and single series are treated in the same way.

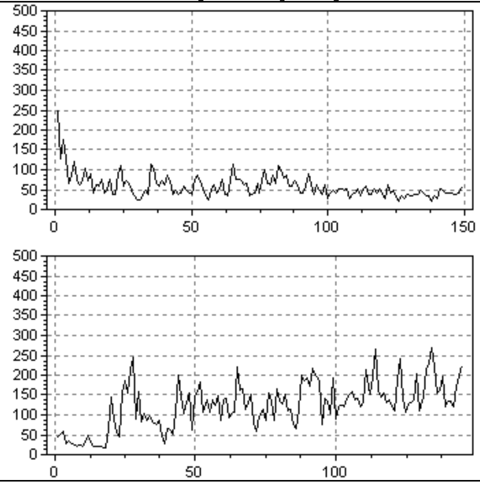
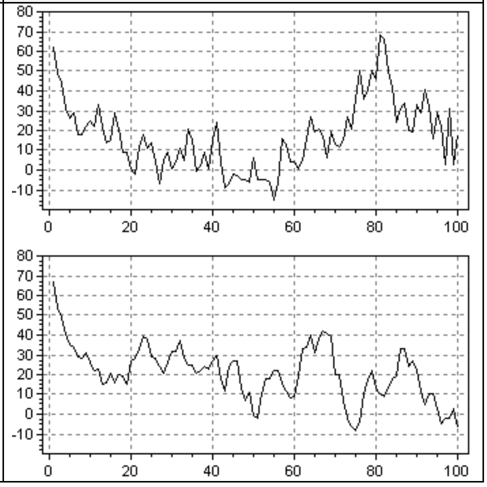
```
***********************************************************************
*** STATISTICS AUTOCORRELATION ***  DATE:  2004.08.30  TIME: 17.24. ***
Time interval refers to absolute dates
Time interval = maximum interval of all samples = -177  -  -20
+----------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+
| No.  | Lag|      1|      2|      3|      4|      5|      6|      7|      8|      9|     10|
+----------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+
|     181017|*  0,62|   0,49|   0,44|   0,31|   0,26|   0,29|   0,18|   0,18|   0,22|   0,25|
|     191017|*  0,67|   0,54|   0,49|   0,41|   0,35|   0,34|   0,29|   0,28|   0,31|   0,26|
|     221017|*  0,70|   0,53|   0,41|   0,27|   0,20|   0,03|  -0,07|  -0,15|  -0,29|  -0,34|
|     231017|*  0,79|*  0,65|   0,55|   0,48|   0,45|   0,41|   0,39|   0,35|   0,33|   0,28|
|     271017|*  0,79|*  0,70|*  0,69|*  0,67|*  0,60|   0,56|   0,55|   0,48|   0,46|   0,46|
|     321454|*  0,75|*  0,64|   0,59|   0,58|   0,51|   0,42|   0,36|   0,34|   0,31|   0,30|
|     361017|   0,52|   0,35|   0,29|   0,23|   0,20|   0,14|  -0,01|  -0,06|   0,05|  -0,18|
|     381017|*  0,79|*  0,72|*  0,68|*  0,65|   0,56|   0,49|   0,50|   0,47|   0,45|   0,44|
|     451017|   0,35|   0,24|   0,14|   0,17|   0,04|   0,05|  -0,05|  -0,06|  -0,10|  -0,13|
|     531017|   0,58|   0,46|   0,52|   0,50|   0,45|   0,28|   0,38|   0,45|   0,35|   0,32|
|     571017|*  0,63|   0,49|   0,40|   0,22|   0,06|  -0,01|  -0,06|  -0,05|  -0,05|  -0,07|
|     581017|   0,44|   0,39|   0,42|   0,32|   0,25|   0,26|   0,29|   0,19|   0,29|   0,33|
|     631017|*  0,87|*  0,84|*  0,78|*  0,73|*  0,73|*  0,70|*  0,64|*  0,61|   0,57|   0,54|
|     701017|*  0,72|*  0,60|   0,48|   0,42|   0,34|   0,19|   0,16|   0,15|   0,22|   0,28|
|     761017|*  0,73|   0,60|   0,60|   0,57|   0,46|   0,40|   0,48|   0,45|   0,36|   0,31|
|     861017|*  0,84|*  0,78|*  0,70|*  0,66|   0,59|   0,54|   0,49|   0,45|   0,39|   0,32|
```

Note:	Before starting the routine, the optional settings for positioning and overlap mode can be adapted. Please regard that the calculated values only refer to the selected overlap interval in the given dated or undated position of the series.

Autocorrelation table parameters	**Entry**
Time mode	Dated, undated
Overlap mode	Max range, common interval (of all series), set interval
Interval begin	First and last value used when 'set interval' is selected as overlap mode
Interval end	
Minimum lag	Values ≥ 1 (default : 1)
Maximum lag	Values ≥ 1 (default : 10)
Minimum overlap	Minimum overlap of correlated series (default: 10)
AC marker unit	Values above limit will be emphasised with an asterisk (default: 0.6).

AUTOCORRELATION FUNCTION

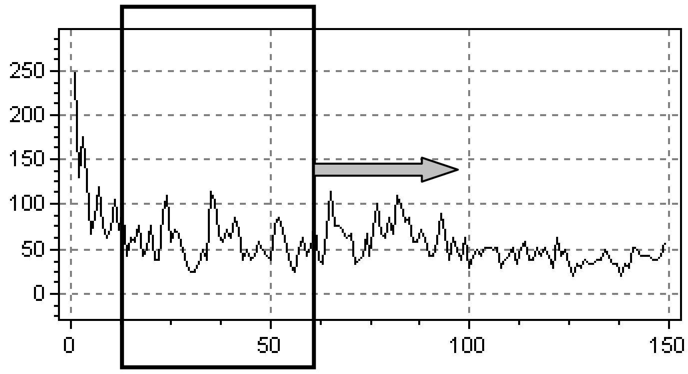
The autocorrelation function visualizes the changes of autocorrelation over the interval defined in the feature parameters.

Source series (examples)	**Autocorrelation functions**
	

Autocorrelation function parameters	**Entry**
Time mode	Dated, undated
Overlap mode	Max range, common interval (of all series), set interval
Interval begin	First and last value used when 'set interval' is selected as overlap mode
Interval end	
Minimum lag	Values ≥ 1 (default: 1)
Maximum lag	Values ≥ 1 (default: 100)
Minimum overlap	Minimum overlap of correlated series (default: 10)

RUNNING WINDOWS STATISTICS

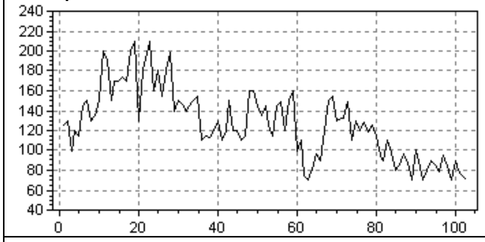
TSAP-Win calculates up to 12 different statistical parameters creating a new time series for each parameter. This new series shows the variations of the calculated parameter along the original series, calculated over the points of the running window.



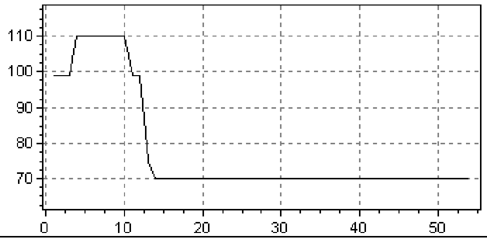
Running window statistics parameters	Entry (defaults)	Explanation
Statistical parameter:	Select from: Minimum, Mean, Maximum, Variance, Standard deviation, Autocorrelation, Mean sensitivity, Relative mean sensitivity, Tendency changes, Gleichlaeufigkeit, Signature-Gleichlaeufigkeit, All parameters	
Running window points:	50	Window width in points:
Result alignment	Begin, center, end	Alignment of result series according to the begin, center or end of the window
Autocorrelation lag	1	Autocorrelation lag
Min density for signature:	4	Minimum density for signature:
High sign. level [%]	100	High signature level [%]
Mean sign. level [%]	90	Mean signature level [%]
Low sign. level [%]	75	Low signature level [%]

Running window statistics, examples

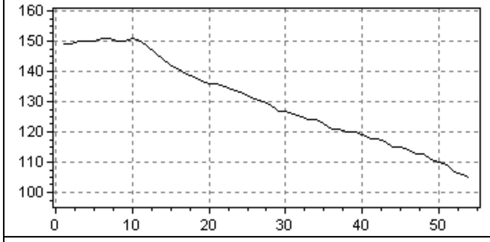
Sample series:



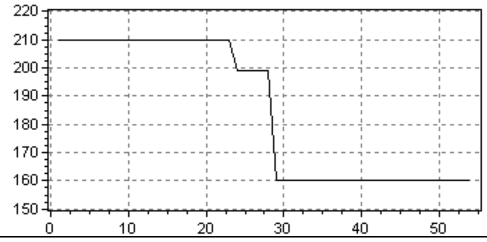
Minimum:



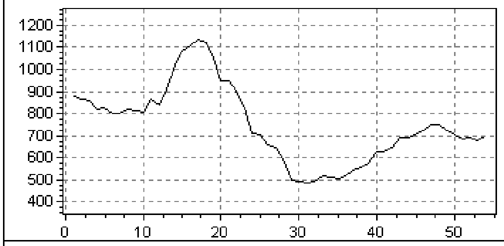
Arithmetic mean



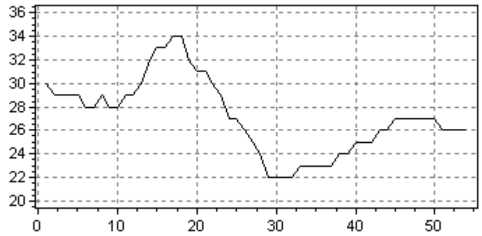
Maximum:



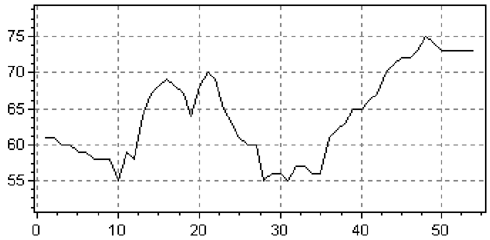
Variance:



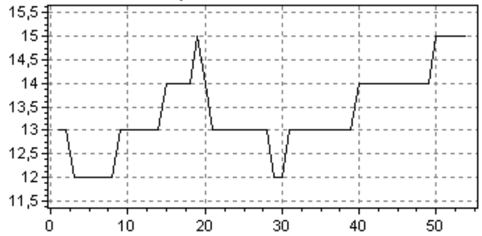
Standard deviation:



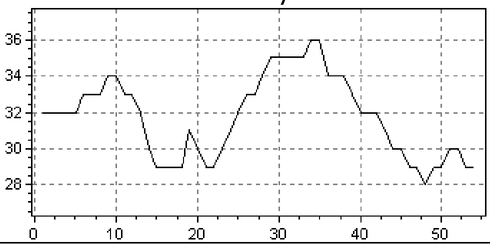
Autocorrelation:



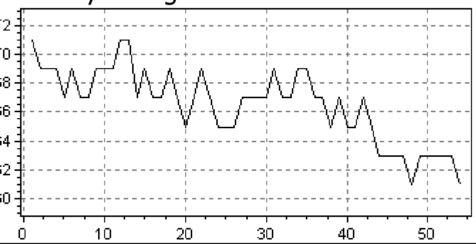
Mean sensitivity:



Relative mean sensitivity :



Tendency changes



CORRELATIONS

This submenu contains several correlation functions. Except for the Kendall coefficient, the correlation routine takes the series paired from the stacks you selected.

CORRELATION TABLE

The correlation table shows the correlation of each selected series of a sample stack against each selected series of a reference stack. If you wish to calculate correlations within the sample stack, select the sample stack as a reference (example below).

```
*******************************************************************
*** TSAP CORRELATION-TABLE ***  DATE:  2004.08.31  TIME: 10.44. ***
Time interval refers to absolute dates
Correlation value:
TBP = T-Value with Baillie-Pilcher-Standardization (0<=TVBP<=100)

+--------------+--------------+--------------+--------------+--------------+--------------+
|No/Len:TBP/Ovl|  181017/  149|  191017/  145|  221017/  131|  231017/  117|  271017/  103|
+--------------+--------------+--------------+--------------+--------------+--------------+
|  181017/  149|*  100,0/  149|     0,2/  144|     0,0/  131|     0,2/  117|     0,5/  103|
|  191017/  145|     0,2/  144|*  100,0/  145|*    4,7/  131|     3,1/  117|     3,4/  103|
|  221017/  131|     0,0/  131|*    4,7/  131|*  100,0/  131|     2,3/  117|     3,5/  103|
|  231017/  117|     0,2/  117|     3,1/  117|     2,3/  117|*  100,0/  117|     1,7/  103|
|  271017/  103|     0,5/  103|     3,4/  103|     3,5/  103|     1,7/  103|*  100,0/  103|
+--------------+--------------+--------------+--------------+--------------+--------------+
```

TSAP-Win Scientific offers the same statistical parameters for listing as used in the cross-date procedure. Please refer to the Chapter 'Cross-Dating' within the 'Common working steps' to read more about parameter definitions.

Correlation table parameters	Entry (defaults)	Explanation
Time mode	Dated, undated	
Correlation parameter	Gleichlaeufigkeit, Sign. Gleichlaeufigkeit, t-value Baillie-Pilcher, t-value Hollstein, t-value[3] Cross-Date Index, Cross correlation[3], All	Select a single correlation parameter to be listed in the table or select all
Interval begin	1	First and last value used when 'set interval' is selected as overlap mode
Interval end	100	
(S)Glk. marker limit	70	Values equal or higher than these values will be emphasized with an asterisk (*)
TV marker limit	4	
CDI marker limit	100	
CC marker limit	0.6	

Note:	Please be aware that a correlation analysis requires normal distributed values. Thus, the use of non-detrended series as samples or references will probably lead to insufficient results when calculating t-value or cross-correlation. Only t-value BP, t-value H and CDI perform a pre-detrending before the analysis.

[3] without pre-detrending

KENDAL COEFFICIENT

The Kendal test is a non-parametric procedure which compares ranked series. This test is performed when a parametric test like Pearson's cross-correlation cannot be used.

Excerpt:

```
**********************************************************************
*** TSAP KENDALL COEFFICIENT ***  DATE:  2004.08.31  TIME: 16.18. ***
Calculation of Kendall coefficient of concordance

  Table of rank series:
-------------------------------------------------------------------------------------------------------
Series\Years  -156  -155  -154  -153  -152  -151  -150  -149  -148  -147  -146  -145  -144  -143  -142
-------------------------------------------------------------------------------------------------------
    271017:    151   170   170   174   170   200   210   130   180   197   210   160   180   155   180
    231017:    133   124    71    81    43    57    81    71    52    43    62    48    57    62    62
    361017:    180   270   182   165   135   125   190   130   155   140   185   130   175   135   180
    221017:    167   234   169   155   137   133   119    80    68    73    86    86   106   111   109
    191017:     55    44   155   186   156   215   244    90   159    82   103    85    97    78    77
-------------------------------------------------------------------------------------------------------
Rank sum:      686   842   747   761   641   730   844   501   614   535   646   509   615   541   608

Number of time series                     k =      5
Total number of points                    N =     91
Mean rank sum                               =    614
Down scale factor                           =     10    (rank sums are divided by this factor)
Variance of rank sums                     s =   9946
Theoretical maximum variance              t = 1569750
Kendall coefficient of concordance  w = s/t =  0,006    w[%] =   0,63
chi-square                  k * (N-1) * w =   2,85    df = N-1 = 90
```

Kendal Coefficient parameters	Entry (defaults)	Explanation
Time mode	Dated, undated	
Overlap mode	Max. range, common interval, set interval	The total series range or parts of it
Interval begin	1	First and last value used when 'set interval' is selected as overlap mode
Interval end	100	
Down scale factor	10	Rank sums are divided by this factor

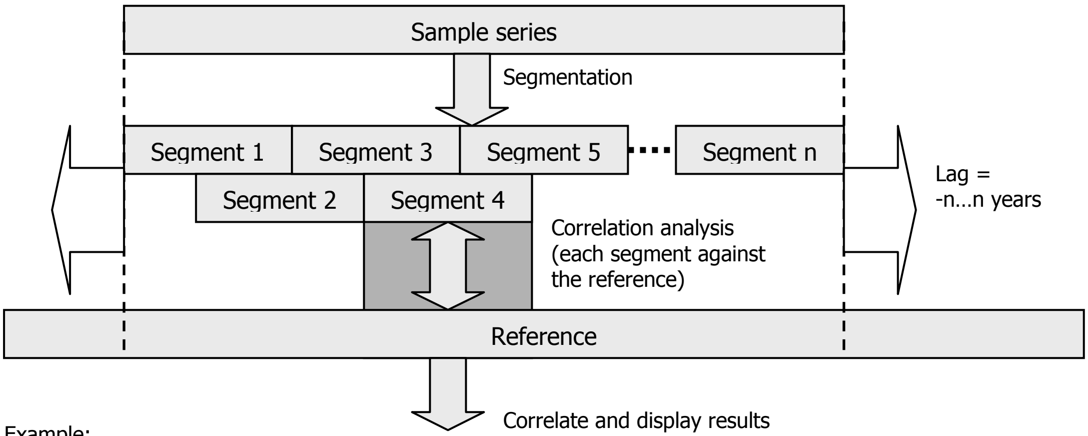
CROSS-DATE CHECK

Measurements, even if carried out with great care may still contain errors. Cross-dating is used to eliminate these errors and to match undated series with dated series. Since the standard Cross-Date procedure (see chapter 'Cross-Dating') is performed over the whole length of the series, errors caused by false or missing rings may remain "hidden" in the series. This may cause severe misinterpretations of tree-ring series.

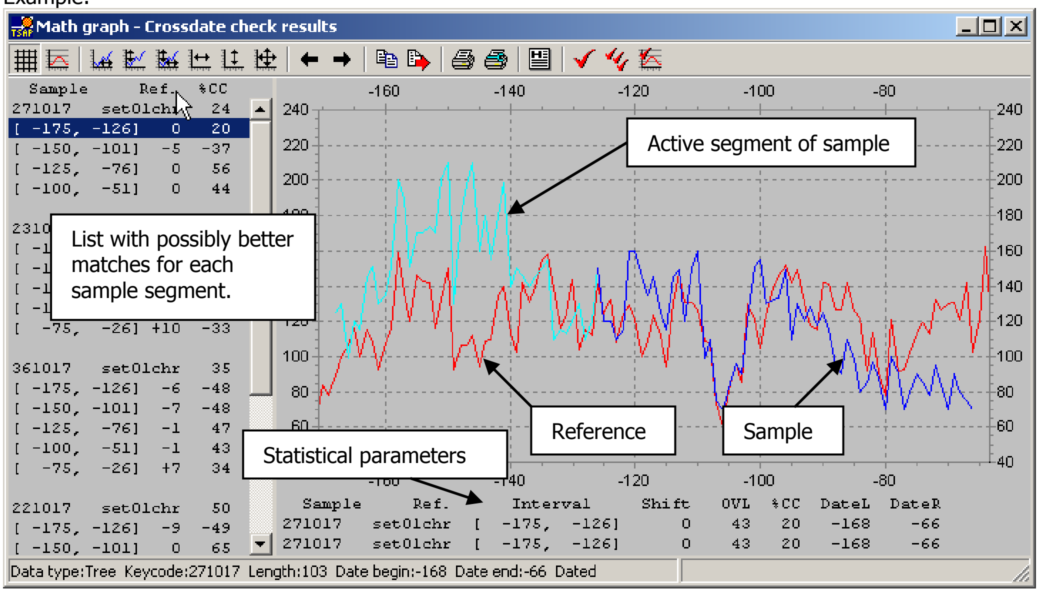
The Cross-Date Check is designed to find these errors by segment-wise cross-correlation analysis. The segment width (default: 50 points) and lag (25 points) can be adapted by the user. As a result an extended Math Graph Window is displayed with alternative better matches for each segment. This procedure was first written by Richard Holmes and implemented in a Fortran program called COFECHA (HOLMES et al. 1986).

The sample series must be dated. Undated samples cannot be computed during this routine. In contrast to COFECHA the user must also select a reference. Nevertheless the reference can of course be derived from the sample series set. In this case it is strongly recommended to let TSAP-Win remove the active sample before the correlation (see Cross-Date Check parameters).

Steps:



Example:



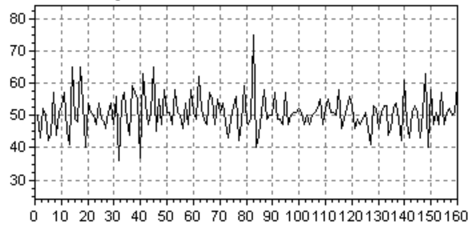
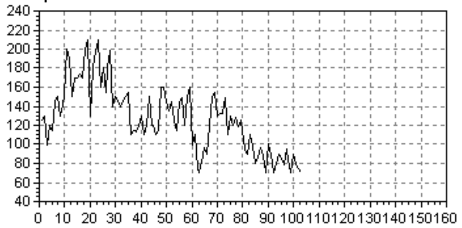
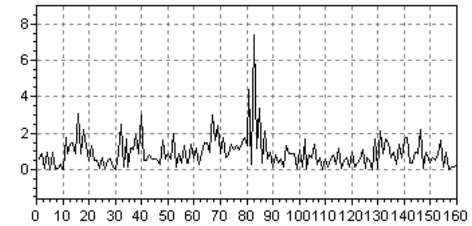
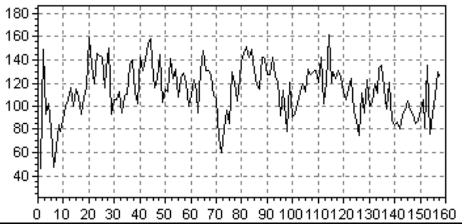
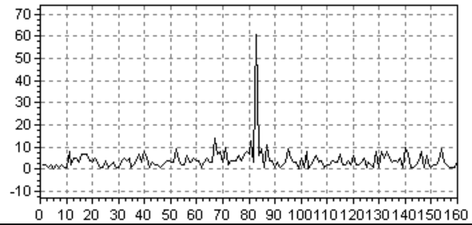
The list in the left window displays the results grouped by series. Each line represents one segment and contains segment range (1. column), segment shift related to dated position (2. column) and cross-correlation in % (3. column).

A double-click on one of the proposed better matches will execute the shift in the Math Graph and shows the whole sample with the emphasized active segment in the proposed better position plus the superimposed reference. The statistical parameters are given at the bottom of the Math Graph window. Advanced cross-dating can now be done by shifting and editing of the series using the cursor keys (see chapter 'Math Graph').

Cross-Date Check Parameters	**Entry (default)**	**Explanation**
Take out sample	Yes, no	Removes the active segment from the chronology before the correlation
Segment size	50	Size of the single segments (years)
Lag size	25	Lag from one segment to the next (years)
Minimum overlap	30	Minimum overlap for correlation
Maximum shift	10	Correlation steps carried out in both directions of the series

CROSS-DATE FUNCTION

This procedure computes a time series of an accordance parameter to be selected. During the procedure the sample series is shifted over the reference. The resulting series shows changes of correlation or Gleichlaeufigkeit for each match. Only high values can be considered as possibly correct matches.

Sample and reference	**Cross-date function (examples)**
Cross-date function: Minimum overlap: 30 Result dating: Date end Scale factor: 1	Gleichlaeufigkeit: 
Sample: 	t-value BP: 
Reference: 	Cross-Date Index: 

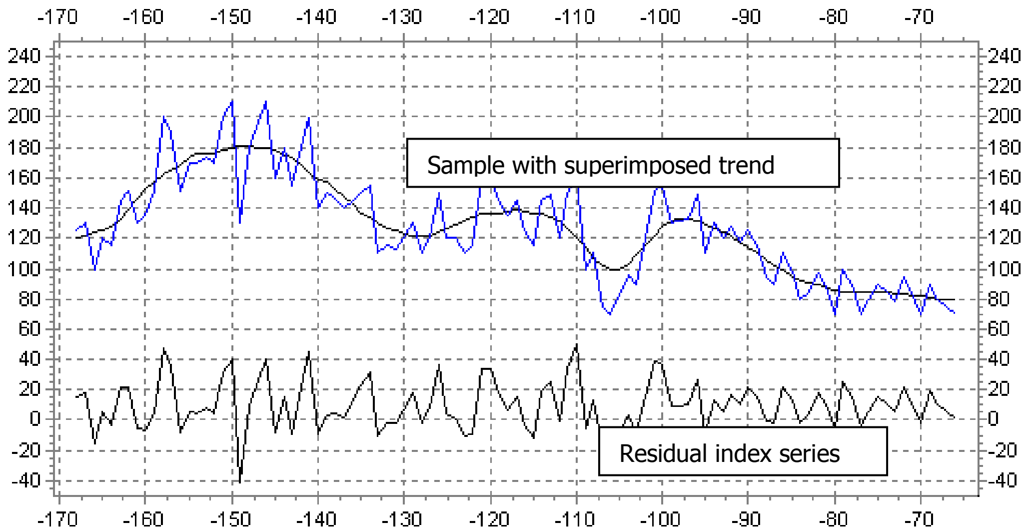
Cross-date function Parameter	**Entry (default)**	**Explanation**
Cross-Date param.	Select	Parameter to be used
Minimum overlap	(30)	Minimum of series overlap for calculation
Result dating	Date begin, (Date end), zero, one	Dates the resulting function to the selected date
Scale factor	(100)	Scale factor for resulting series

TREND/REGRESSION

TSAP provides several different methods for trend calculation, smoothing and regression. The submenus optimal and determined trend process all select(ed) data records of a Data Stack. The resulting trend function and index series can be stored in different Stacks.

Optimal trend elimination means that a trend function is calculated individually for each selected series. **Determined trend** is available for parametric trend methods, such as exponential or linear regression. In this case, the parameters of the trend curve are given by the user before trend elimination. Then the trend curve is calculated for the maximum length of the selected series to detrend. Subsequently this curve is subtracted from the series.

MOVING AVERAGE



Example: 5 year moving average

The TSAP-Win moving average routine processes a sliding convolution with a weighted kernel referring to the rules of kernel density estimation for optimal non-parametric regression. For details on weighting see Gasser and Müller 1984 or Rinn 1988. The bandwidth defines the characteristics of the smoothing routine. A small bandwidth leads to strong reduction of information.

$$y_i = \frac{\sum_{j=i-bw,\,k=-bw}^{j=i+bw,\,k=bw} w_k * x_j}{\sum_{k=-bw}^{k=bw} w_k}$$

where

y =	Smoothed series value
x =	Original series value
i =	Index running over the entire original time series to smooth
j =	Index running over the points which are included in calculating the smoothed value y depending on the original value x and the surrounding original values of series x
k =	Index running from (-)bandwidth to (+)bandwidth of the set of weights.
w =	Weights reflecting the importance of the corresponding value x_j for calculation of the value y_j and for norming.

The number of points included in the calculation of the new value y is 2*bw+1. Bandwidth =1 means that three points are included in the calculation, one on both sides of the original value t.

The weight array [1,1,...,1,1] equals to a arithmetic moving average. The weights defined by Gasser and Müller **allow calculating a regression function with the statistical properties of a spline but only require a few percent of the computing time needed for spline calculation**. The weights are derived from Laplace-functions. They are available for kernels of different orders and derivations. For TSAP-Win, we have chosen the kernel for optimal smoothing with minimizing of IMSE (integrated mean square error) and variance (noise).

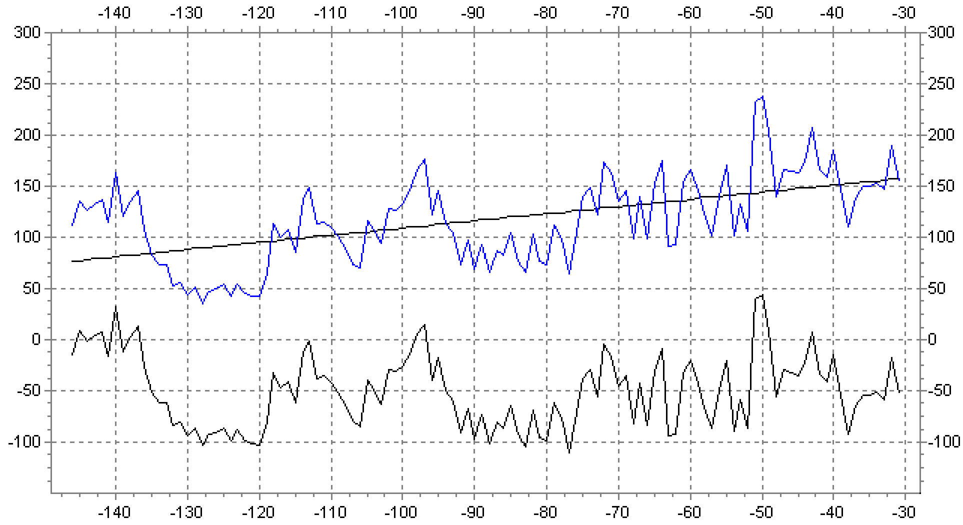
As a typical weight series for standard smoothing by weighted moving average, TSAP-Win uses the following Lagrange equation:

$$w_k = (0.75 * (1.- \frac{k^2}{bw^2}))$$

where k = -bw, -bw+1, ...,0, ..., bw-1, bw.

Since this moving average is a non-parametric method, it has several advantages as compared to parametric methods, such as exponential regression. Parametric regression methods pre-determine the results by their equation and parameter settings. There are many cases where this pre-determination is advantageous, but many other cases where the non-parametric regression or smoothing is better.

LINEAR REGRESSION



TSAP calculates the following linear regression:

$$y_i = a * x_i + b$$

The constants a and b are determined using the following equations:

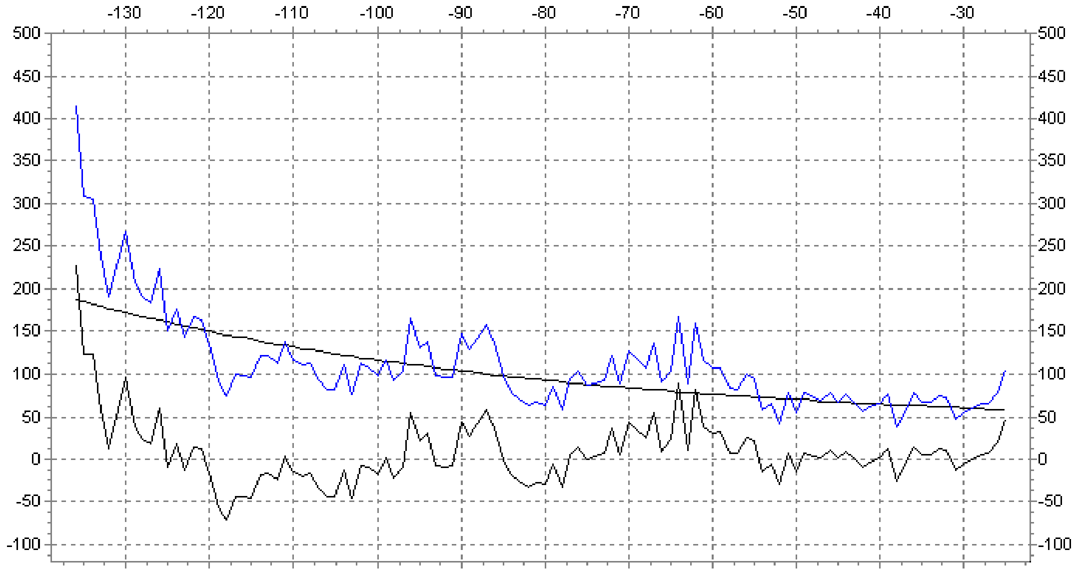
$$a = \frac{\left(\sum_{i=1}^{n} x_i * y_i - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i * \sum_{i=1}^{n} y_i\right)\right)}{\sum_{i=1}^{n} x_i^2 - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i\right)^2}$$

$$b = \frac{1}{n} * \left(\sum_{i=1}^{n} y_i + a * \sum_{i=1}^{n} x_i\right)$$

The *determination* or correlation coefficient is calculated referring to the following equation:

$$\frac{\left[\sum_{i=1}^{n} x_i * y_i - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i * \sum_{i=1}^{n} y_i\right)\right]^2}{\left(\sum_{i=1}^{n} x_i^2 - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i\right)^2\right) * \left(\sum_{i=1}^{n} y_i^2 - \frac{1}{n} * \left(\sum_{i=1}^{n}\right.\right.}$$

EXPONENTIAL REGRESSION



Example

TSAP calculates an exponential regression referring to the following equation:

$$y_i = a * e^{b * x_i} + c$$

The coefficients are determined referring to the equations:

$$a = e^{\frac{1}{n} * \left(\sum_{i=1}^{n} \ln(y_i) - b * \sum_{i=1}^{n} x_i\right)}$$

$$b = \frac{\left(\sum_{i=1}^{n} x_i * \ln(y_i) - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i * \sum_{i=1}^{n} \ln(y_i)\right)\right)}{\sum_{i=1}^{n} x_i^2 - \frac{1}{n} * \left(\sum_{i=1}^{n} x_i\right)^2}$$

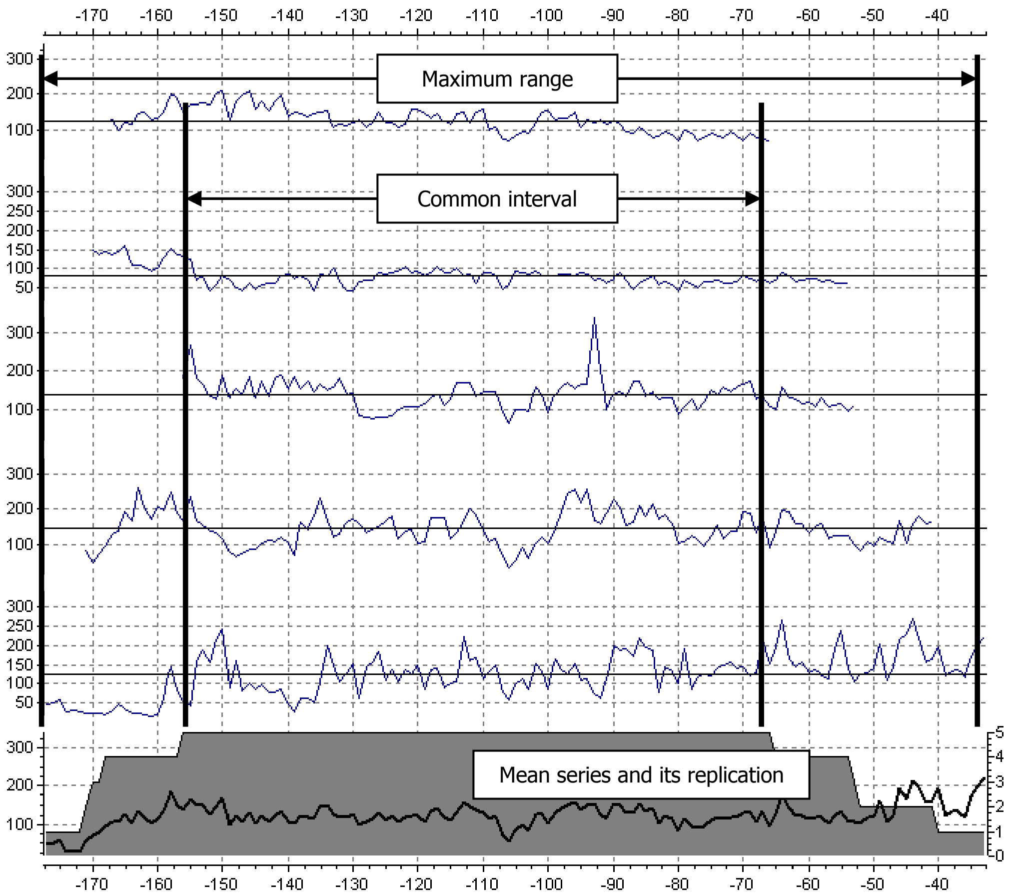
PARAMETER SETUP

Trend/Regression Parameter	Entry (defaults)	Explanation
Trend method	Moving average, linear regress., exp. regression	Selection of trend method
Centering mode	Constant, mean	Method of residual alignment
Center value	(0)	Constant value for centering the residual
Scale	(1)	Residual scale factor
Exp. Scale	(1)	Calculated for the optimized exp. Regression
Linear slope	(1)	Slope of the regression line
Offset	(0)	Offset of the residual
Regr. Coeff.	Calculated	Calculated for the optimized regressions
Bandwidth	(5)	Bandwidth of moving average

Dependent on the procedure used, different parameters can be adapted by the user. The optimal trend procedures calculate certain parameters which can subsequently be used in a determined routine. The following table shows which parameters can be set by the user, which are pre-defined and which parameters are calculated by the procedure itself.

Trend Method	Optimized trend			Determined trend	
	Mov. average	Lin. Regress.	Exp. Regress.	Lin. Regress.	Exp. Regress.
Centering mode	User	User	User	User	User
Center value	User	User	User	User	User
Scale	-	-	Calculated	-	User
Exp. Scale	-	-	Calculated	-	User
Linear slope	-	Calculated	-	User	-
Offset	-	Calculated	Calculated	User	User
Regr. Coeff.	-	Calculated	Calculated	-	-
Bandwidth	User	-	-	-	-

AVERAGE/MEAN



Example

The submenu Average allows the user to average series in various ways. First the number of stacks has to be selected. One stack means that the series of the active data stack are included in the calculation. Two stacks mean that TSAP-Win takes the series paired from the first and second data stack.

Subsequently, the positioning of the series relative to each other have to be defined as described above (dated, undated or positioned) and the overlap mode is selected. The averaging is done arithmetically for the series. If chronologies are used, the replication can be considered and therefore provides a weighted mean (see parameters).

Average parameter	Entry (defaults)	Explanation
Time mode	Dated, undated	Select undated if you wish to ignore dates
Weight mode	Non-weighted	Weighted replication in chronologies will be considered
Overlap mode	Max. range, common interval, set interval	Only the common interval (or a shorter range) will ensure a mean series with even replication
Interval begin	(1)	Start of the interval
Interval end	(100)	End of the interval

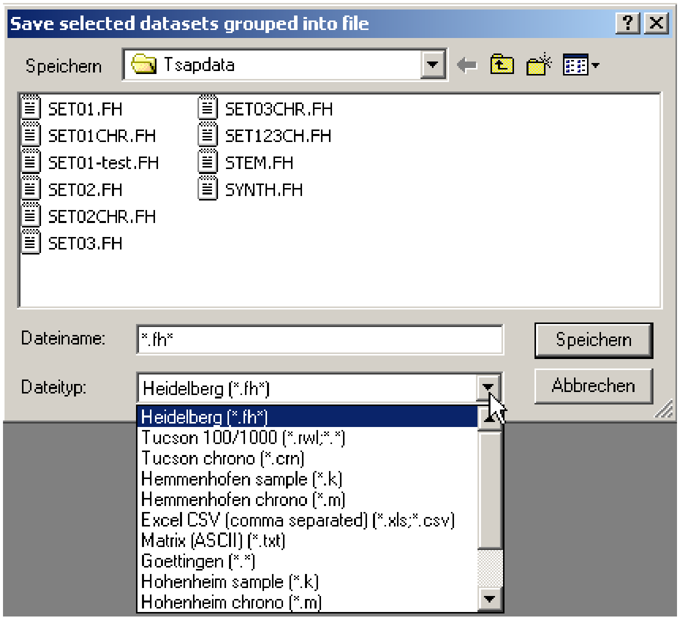
USER PLUGINS

This section is open for user defined routines, which can be implemented by RINNTECH. Please contact us for your needs.

FORMAT LIBRARY

Please note:	The Format Library is part of ***TSAP-Win Scientific***, but can be purchased as an additional module for the Professional version.

The TSAP-Win Format Library offers various foreign data formats for import and export of time series data to enable a data exchange with other software applications. To open or save data in a certain format, select the requested format via "file-type" in the file selection window.



TSAP-Win supports the following data formats:

- Heidelberg (standard)
- Tucson 100/1000
- Tucson chrono
- Hemmenhofen sample
- Hemmenhofen chrono
- Excel CSV (comma separated)
- Matrix (ASCII)
- Göttingen
- Hohenheim sample
- Hohenheim chrono
- INRA
- CATRAS
- Birmensdorf
- Sheffield (D-Format)
- V-Format 2.0
- Stanley

Please note that the Heidelberg format is the only format with full TSAP-Win compatibility. Other formats truncate more or less of the header data and even parts of the time series information (e.g. comments, marks). This may lead to a loss of important information.

Matrix format: Data to be imported in matrix format must fulfill the following requirements:

- Data must be in ASCII-format
- Values must be integer (without decimal point)
- Data must me ordered in columns with a defined delimiter. The latter one can be defined in Options/File Formats.
- Years must appear in ascending order in the first column, followed by the time series in the next columns.
- The first line should contain a header containing the key codes for each series
- Missing values should be represented by 0 (zero).

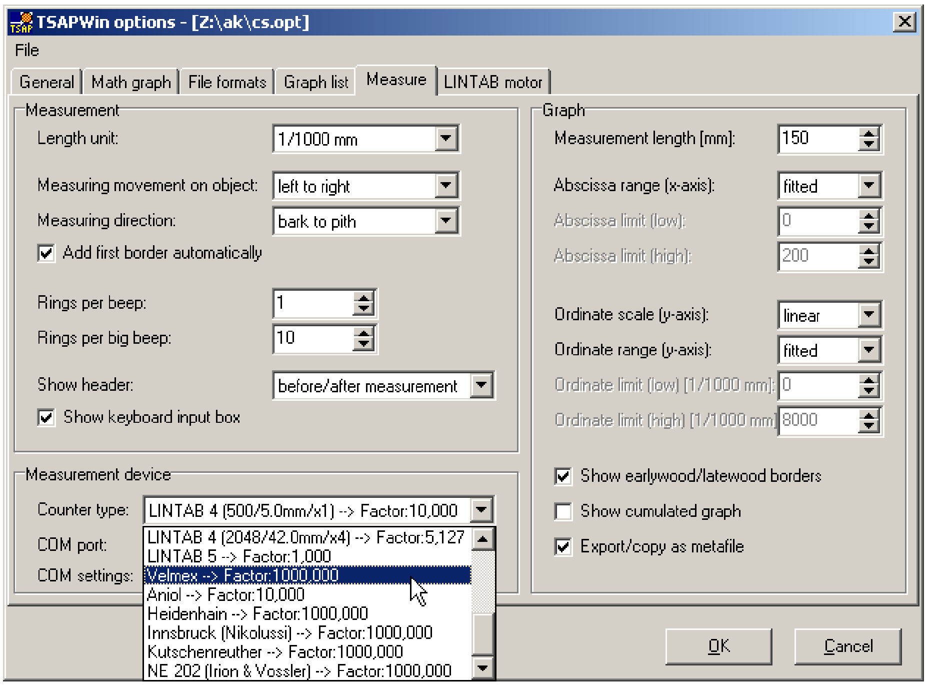
Matrix-Format Example:

Year	271017	231017	361017	221017	191017
1888	0	95	0	73	87
1889	0	100	0	86	49
1890	0	129	180	86	29
1891	0	152	270	106	64
1892	0	138	182	111	62
1893	125	133	165	109	51
1894	130	124	135	122	103
1895	99	71	125	106	200
1896	120	81	190	72	148
1897	115	43	130	164	105
1898	145	57	155	143	130
1899	151	81	140	179	154
1900	130	71	185	231	61
1901	135	52	130	167	145

TABLE MODULE

The standard tree-ring measurement table TSAP-Win is designed for is LINTAB. For those who prefer other measurement devices, the table module offers the possibility to connect tables of other origin with your PC and record the measurement data within TSAP-Win.

To setup the table within TSAP, please open the ‘Measurement options’ within the ‘Options’-menu. Click on the pull down menu for ‘Counter type’ and select the requested device.



The following devices are supported by TSAP-Win:

- Velmex
- Aniol
- Heidenhain
- Kutschenreuther
- NE 202 (Irion & Vosseler)

LITERATURE

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http://www.rinntech.com

Notice: In case you have problems using **Microsoft Windows**, please start the Microsoft Help ( /Help). There, you will receive specific help to solve your problem. For beginners we recommend an introductory training. RINNTECH cannot give any support for soft- or hardware of other origin.

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USER REMARKS

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APPENDIX

HEADER STRUCTURE

Key	Entry in header form	Predefined values	Comment
AcceptDate	Order accept date		
Age	Tree age		
AutoCorrelation			used for Tucson file format
Bark	Bark	B (Bark available) - (Bark not available)	
BHD	Breast height diameter		
Bibliography			deprecated; use Bibliography*[n]* and BibliographyCount
Bibliography*[n]* BibliographyCount	Bibliography		
Bundle	Timber bundle		
CardinalPoint			
ChronologyType			used for Sheffield file format
ChronoMemberCount	Chrono members		
ChronoMemberKeycodes	Chrono members		
Circumference	Sample height circumference		
Client	Client name		
ClientNo	Client number		
Collector	Sampling personal ID		
Comment	Comment		single line comment
Comment*[n]* CommentCount	Comments		multi line comment
Continent	Continent		
CoreNo	Core no.		
Country	Country		
CreationDate			deprecated; see DateOfSampling and FirstMeasurementDate
DataFormat		Tree HalfChrono Chrono EarlyWoodLateWood Table (reserved) Unknown (reserved)	needed for file format
DataType	Data type	Ringwidth Earlywood Latewood EarlyLateWood Min density Max density Earlywood density Latewood density Pith age Weight of ringwidth	needed for file format
DateBegin	Date begin		
Dated	Dated	Undated Dated RelDated	
DateEnd	Date end		
DateEndRel			deprecated; use DateRelEnd*[n]* and DateRelCount
DateOfSampling	Sampling date		
DateRelBegin*[n]* DateRelEnd*[n]* DateRelReferenceKey*[n]* DateRelCount			
DeltaMissingRingsAfter	Missing rings to bark delta		
DeltaMissingRingsBefore	Missing rings from pith delta		
DeltaRingsFromSeedToPith	Rings from seed to pith delta		
Disk			used for INRA file format
District	District		
EdgeInformation			used for Sheffield file format
EffectiveAutoCorrelation			used for CATRAS file format
EffectiveMean			used for CATRAS file format
EffectiveMeanSensitivity			used for CATRAS file format
EffectiveNORFAC			used for CATRAS file format

Key	Entry in header form	Predefined values	Comment
EffectiveNORFM			used for CATRAS file format
EffectiveStandardDeviation			used for CATRAS file format
Eigenvalue			deprecated
Elevation	Elevation		
EstimatedTimePeriod	Estimated time period		
Exposition	Exposition		
FieldNo	Field number		
FilmNo			used for Birmensdorf file format
FirstMeasurementDate	First measurement date		
FirstMeasurementPersID	First measurement personal ID		
FromSeedToDateBegin			deprecated
GlobalMathComment*[n]* GlobalMathCommentCount	Global math comment		
GraphParam			deprecated
Group			used for Sheffield file format
HouseName	House name		
HouseNo	House number		
ImageCellRow			deprecated
ImageComment*[n]* ImageFile*[n]* ImageCount	Images		
ImageFile			deprecated; use ImageFile*[n]* and ImageCount
Interpretation			used for Sheffield file format
InvalidRingsAfter	Invalid rings at end		
InvalidRingsBefore	Invalid rings at begin		
JuvenileWood	Juvenile rings		
KeyCode	Keycode		
KeyNo	Key number		
LabotaryCode	Labotary code		
LastRevisionDate	Last revision date		
LastRevisionPersID	Last revision personal ID		
Latitude	Latitude		
LeaveLoss	Leave loss		
Length	Length		
Location	Location		
LocationCharacteristics	Location characteristics		
Longitude	Longitude		
MajorDimension			used for Sheffield file format
MathComment			deprecated; use MathComment*[n]* and MathCommentCount
MathComment*[n]* MathCommentCount	Math modifications		
MeanSensitivity			used for Tucson file format
MinorDimension			used for Sheffield file format
MissingRingsAfter	Missing rings to bark		
MissingRingsBefore	Missing rings from pith		
NumberOfSamplesInChrono			deprecated; see ChronoMemberCount
NumberOfTreesInChrono			deprecated; see ChronoMemberCount
PersId	Personal ID		
Pith	Pith	P (Pith present) - (Pith absent)	
Project	Project		
ProtectionCode			used for CATRAS file format
Province	Province		
QualityCode	Sample quality code		
Radius			used for INRA file format
RadiusNo	Radius no.		
RelGroundWaterLevel	Rel. ground water level		
RingsFromSeedToPith	Rings from seed to pith		
SampleType			used for Sheffield file format
SamplingHeight	Sampling height		
SamplingPoint	Sampling point		
SapWoodRings	Sapwood; Sapwood rings		
Sequence			

Key	Entry in header form	Predefined values	Comment
SeriesEnd	Series ends with	Ring width Earlywood Latewood	
SeriesStart	Series starts with	Ring width Earlywood Latewood	
SeriesType	Series type	Single curve Mean curve Radius Chronology Autocorrelation	
ShapeOfSample	Sample shape		
Site			used for INRA file format
SiteCode	Site code		
SocialStand	Social stand; Tree social stand		
SoilType	Soil type		
Species	Species code	see ITRDB species code list in header form	
SpeciesName	Sp. name		
StandardDeviation			used for Tucson file format
State	State		
StemDiskNo	Stem disk no.		
Street	Street		
Timber			used for Sheffield file format
TimberHeight	Timber height		
TimberType	Timber type		
TimberWidth	Timber width		
TotalAutoCorrelation			used for CATRAS file format
TotalMean			used for CATRAS file format
TotalMeanSensitivity			used for CATRAS file format
TotalNORFAC			used for CATRAS file format
TotalNORFM			used for CATRAS file format
TotalStandardDeviation			used for CATRAS file format
Town	Town		
TownZipCode	Town zip code		
Tree			used for INRA and Sheffield file format
TreeHeight	Tree height		
TreeNo	Tree no.		
Unit	Unit	mm 1/10 mm 1/100 mm 1/1000 mm	unit of ordinate axis
UnmeasuredInnerRings			used for Sheffield file format
UnmeasuredOuterRings			used for Sheffield file format
WaldKante	Waldkante	WKE (Earlywood) WKL (Latewood) WKX (Unknown) WK? (Indistinct) --- (None)	
WoodMaterialType	Wood material type		
WorkTraces	Working traces		

SPECIES LIST

The following species codes are used in TSAP-Win. These codes were standardized for the International Tree-Ring Databank.

Code	Latin name and authority	Common name
ABSP	Abies Mill. fir	fir
ABAL*	Abies alba Mill.	silver fir, European fir
ABAM*	Abies amabilis Dougl. ex Forbes	Pacific silver fir
ABBA	Abies balsamea (L.) Mill.	balsam fir
ABBO*	Abies borisii-regis Mattf.	Bulgarian fir, King Boris fir
ABBN	Abies bornmuelleriana Mattf.	Bornmueller's fir
ABBR	Abies bracteata (D.Don) Nutt.	bristlecone fir
ABCE*	Abies cephalonica Loud.	Greek fir
ABCH	Abies chensiensis van Tiegh	Chensien fir
ABCI	Abies cilicica (Ant. & Kotschy) Carr.	Cilician fir
ABCO*	Abies concolor (Gord. & Glend.)	
	Lindl. ex Hildebr.	white fir
ABEQ	Abies equi-trojani Aschers. & Sint.	
	Abies ernestii Rehd. = Abies recurvata var. ernestii (Rehd.) Kuan	
ABFX	Abies faxoniana Rehd. & Wils.	Faxon fir
ABFI	Abies firma Sieb. & Zucc.	Japanese fir, Momi fir
ABFO	Abies forestii Rogers	Chinese fir
ABFR	Abies fraseri (Pursh) Poir.	Fraser fir
ABGR	Abies grandis (Dougl. ex D. Don) Lindl.	grand fir, giant fir
ABHO	Abies holophylla Maxim.	Manchurian fir
ABKA	Abies kawakamii (Hayata) Ito	Taiwan fir
ABKO	Abies koreana Wils.	Korean fir
ABLA*	Abies lasiocarpa (Hook.) Nutt.	subalpine fir, corkbark fir
ABMA*	Abies magnifica A. Murr.	California red fir
ABMR	Abies mariessi Mast.	Marie's fir
ABMC	Abies marocana Trabut	Moroccan fir
ABNB	Abies nebrodensis (Lojac.) Mattei	Sicilian fir
ABNE	Abies nephrolepis Maxim.	East Siberian fir
ABNO*	Abies nordmanniana (Stev.) Spach	Caucasian fir
ABNU	Abies numidica De Lannoy ex. Carr.	Algerian fir
ABPI*	Abies pindrow (Royle) Spach	Himalayan silver fir, West Himalayan fir
ABPN*	Abies pinsapo Boiss.	Spanish fir
ABPR*	Abies procera Rehd.	noble fir
ABRC	Abies recurvata Mast.	Min fir
ABRE	Abies religiosa Schlecht.	Mexican fir, sacred fir
ABSA	Abies sachalinensis (Schmidt) Mast.	Sachalin fir, todo
ABSI	Abies sibirica Ledeb.	Siberian fir
ABSB*	Abies spectabilis (D. Don) Spach	silver fir, East Himalayan fir
ABSQ	Abies squamata Mast.	flaky fir
ABVI	Abies vietchii Lindl.	Vietch's silver fir
ACAL	Acacia alpina F.Muell.	
ACCA	Acacia catechu Willd.	cutch, Indian acacia
ACGI	Acacia giraffae Willd.	camel thorn
ACHO	Acacia hotwittii	
ACME	Acacia melanoxylon R.Br.	blackwood
ACNI	Acacia nilotica (L.) Willd. ex Delile	gum arabic tree
ACRA	Acacia raddiana Savia	Israelian acacia
ACSP	Acer L.	maple
ACCA	Acer campestre L.	hedge maple, field maple
ACNE	Acer negundo L.	boxelder, ash-leaved maple
ACMO	Acer mono Maxim.	maple
ACOP	Acer opalus Mill.	Italian maple
ACPE	Acer pensylvanicum L.	striped maple
ACPL	Acer platanoides L.	Norway maple
ACPS	Acer pseudoplatanus L.	sycamore maple, plane tree

ACRU	Acer rubrum L.	red maple
ACSA*	Acer saccharinum L.	silver maple
ACSH*	Acer saccharum Marsh.	sugar maple
ACSC	Acer spicatum Lam.	mountain maple
ACTU	Acer turkestanica Pax	
ADDI	Adansonia digitata L.	baobab, monkey bread tree
ADFA	Adenostoma fasciculatum Hook. & Arn.	chamise, greasewood
ADHO*	Adesmia horrida Gill.	
ADUS*	Adesmia uspallatensis Gill.	
AEHI	Aesculus hippocastanum L.	horse chestnut
AEPU	Aextoxicon punctatum R. & Pav.	olivillo, tique
AFAF	Afzelia africana Smith	afzelia, apa, doussie, alinga, papao
AFQU	Afzelia quanzensis Welw.	afzelia, mambokofi, chanfuta, mbembakofi
AGAU*	Agathis australis (D.Don) Lindley	kauri pine
AGMA	Agathis macrophylla	Fijian kauri
AGMO	Agathis moorei Mast.	kauri
AGOV	Agathis ovata Warb.	kauri
AGPA	Agathis palmerstoni F.v.M.	North Queensland kauri, Australian agathis
AGRO	Agathis robusta (C. Moore ex F. Muell) Bailey	kauri pine, Queensland kauri
AGVI	Agathis vitiensis (Seeman)	
	Benth. & Hook.f. ex Drake	Fiji kauri, dakua
AIAL	Ailanthus altissima (Mill.) Swingle	Tree of Heaven
ALVE	Allocasuarina verticillata (Lam.) L.A.S. Johnson	
ALSP	Alnus Mill.	alder
	Alnus crispa = Alnus viridis var. crispa (Ait.) Turrill	green alder
ALGL	Alnus glutinosa (L.) Gaertn.	common alder, European alder, black alder
ALHI	Alnus hirsuta (Spach.) Rupr.	
ALIN	Alnus incana (L.) Moench	grey alder, white alder
ALMA	Alnus maximowiczii Callier	
ALRH	Alnus rhombifolia Nutt.	white alder
ALRU	Alnus rubra Bong.	red alder
ALRG	Alnus rugosa (Du Roi) Spreng.	speckled alder, rough alder
ALSE	Alnus serrulata (Ait.) Willd.	hazel alder
ALSI	Alnus sinuata (Regel.) Rydb.	Sitka alder
ALVI	Alnus viridis (Chaix) DC. in Lam. & DC.	green alder
ALCR	Alnus viridis var. crispa (Ait.) Turrill	American green alder
AMSP	Amelanchier Medik.	serviceberry
AMOV	Amelanchier ovalis M.	
AMLU	Amomyrtus luma (Mol.) Legr. & Kaus.	luma
ANCO	Andira coriacea Pulle	Saint Martin rouge
ANSP	Annona spraguei ARSP Araucaria A.L. Juss.	araucaria
ARAN	Araucaria angustifolia (Bertol.) Kuntze	Parana araucaria, Parana pine, candelabra tree
ARAR*	Araucaria araucana (Molina) K. Koch	monkey puzzle, araucaria, pehuen, Chile pine
ARBI	Araucaria bidwilli Hook.	bunya pine, bunya
ARCU	Araucaria cunninghamii Aiton ex D. Don	hoop pine, Moreton bay pine, colonial pine
ARHE	Araucaria heterophylla (Salisb.) Franco	Norfolk Island pine
ARHU	Araucaria hunsteinii Klinki	pine
ARGL	Arctostaphylos glauca Lindl.	bigberry manzanita
ARTR	Artemisia tridentata Nutt.	big sagebrush
ATCU*	Athrotaxis cupressoides D. Don	pencil pine, smooth Tasmanian cedar
ATSE*	Athrotaxis selaginoides D. Don	King Billy pine
AUKL	Aucoumea klaineana Pierre	okoume
AUCH*	Austrocedrus chilensis (D. Don)	Chilean cedar, cipres de la cordillera,
	Florin & Boutelje	Chilean incense cedar
BAAE	Balanites aegyptiaca Del.	Jericho balsam, heglig
BLTA	Beilschmiedia tawa (A. Cunn.)	Kirk tawa
BBVU	Berberis vulgaria L.	common barberry
BTEX	Bertholletia excelsa H.B.K.	Brazil nut, yuvia, tutury, para nut tree
BESP	Betula L.	birch
	Betula alaskana Sarg. = Betula papyrifera var. neoalaskana (Sarg.) Raup	Alaska paper birch
	Betula alba L. = Betula pubescens Ehrh.	common white birch

BEAB	Betula albosinensis Burk.	Chinese birch
BEAL	Betula alleghaniensis Britton	yellow birch
	Betula carpatica Walldst. & Kit. ex Willd. = Betula pubescens var. carpatica (Willd.) Ascherson & Graebner	Carpathian birch
BEER	Betula ermanii Cham.	Japanese birch, dakekaba
BEGL	Betula glandulosa Michx.	bog birch, dwarf birch
BEGR	Betula grossa Sieb. & Zucc.	Japanese cherry birch
BELE	Betula lenta L.	sweet birch, black birch
BENI	Betula nigra L.	river birch
BEPA	Betula papyrifera Marsh.	paper birch
BEAK	Betula papyrifera var.	
	neoalaskana (Sarg.) Raup	Alaska paper birch
BEPE	Betula pendula Roth = Betula verrucosa Ehrl.	silver birch, European white birch
BEPL	Betula platyphylla Suk.	jagjag-namu, Japanese birch
BEPO	Betula populifolia Marsh.	gray birch
BEPU	Betula pubescens Ehrh.	downy birch, mountain birch, white birch
BEUT	Betula utilis D.Don	Himalayan birch
BEVE	Betula verrucosa Ehrl.	silver birch, European white birch
BOQU	Bombacopsis quinata (Jaqu.) Dugand	
BOMA	Bombax malabaricum DC.	semul, ngiu, ngiew, gon run do
BUGR	Bursera graveolens (Kunth) Triana & Planch.	palo santo
BUSI	Bursera simaruba (L.) Sarg.	gumbo-limbo, West-Indian birch
BUSE	Buxus sempervirens L.	common box, boxwood
CASP	Callitris Ventenat	
CACO	Callitris columellaris F. Muell.	cypress pine
CAIN	Callitris intratropica Baker & Smith	cypress pine
CAMA	Callitris macleayana (F. Muell.) F. Muell	brush cypress pine
CAPR*	Callitris preissii Miq.	Rottnest Island pine
CARO*	Callitris robusta R. Br. ex Bailey = Callitris preissii Miq.	Rottnest Island pine
CADE	Calocedrus decurrens (Torr.) Florin	California incense cedar
CABU	Canthium burttii	canthium
	Capparis angulata Ruiz & Pav. ex DC. = Capparis scabrida Kunth	sapote
CASC	Capparis scabrida Kunth	sapote
CAPC	Carapa procera C.DC.	carapa
CPBE	Carpinus betulus L.	hornbeam
CYSP	Carya Nutt.	hickory
CYCO	Carya cordoformis (Wangenh.) K. Koch	bitternut hickory
CYGL	Carya glabra (Mill.) Sweet	pignut hickory
CYIL	Carya illinoensis (Wagenh.) K. Koch	pecan
CYOV	Carya ovata (Mill.) K. Koch	shagbark hickory
CYTO	Carya tomentosa (Poir.) Nutt.	mockernut hickory
CAGL	Caryocar glabrum Aubl.	chawari
CACR	Castanea crenata Sieb. & Zucc.	Japanese chestnut
CADN	Castanea dentata (Marsh.) Borkh.	American chestnut
CASA	Castanea sativa Mill.	sweet chestnut, European chestnut
CSLI	Casuarina litoralis Salisb.	black she-oak
	Casuarina verticillata Lam. = Allocasuarina verticillata (Lam.) L.A.S. Johnson	
CTSP	Catalpa speciosa Warder ex Engelm.	northern catalpa
CNCR	Ceanothus crassifolius Torr.	hoaryleaf ceanothus
CESP	Cedrela P.Br.	cedrela
CEAN*	Cedrela angustifolia Sesse & Mocino ex DC.	cedro salteno
	Cedrela balansae C. DC. = Cedrela angustifolia Sesse & Mocino	
CEFI	Cedrela fissilis Vell.	central American cedar, cigarbox cedar
CELI*	Cedrela lilloi C. DC.	cedro salteno
CEOD	Cedrela odorata L.	
CETO	Cedrela toona Roxb. ex. Rottler = Toona australis (F. Muell.)	Harms red cedar, Australian cedar, toon, yomhom
CDSP	Cedrus Trew	cedar
CDAT	Cedrus atlantica (Endl.) Manetti	Atlantic cedar, Atlas cedar
CDBR*	Cedrus brevifolia Henry = Cedrus libani var. Brevifolia	Cyprian cedar
CDDE	Cedrus deodara (D. Don) G. Don	deodar cedar, Himalayan cedar
CDLI*	Cedrus libani A. Richard	Cedar of Lebanon

CLSP	Celtis L.	hackberry
CLAU	Celtis australis L.	southern nettle tree, hackberry
CLCA	Celtis caucasica Willd.	Caucasian nettle tree
CLLA	Celtis laevigata Willd.	sugarberry
CLOC	Celtis occidentalis L.	hackberry
CLRE	Celtis reticulata Torr.	netleaf hackberry
CEOC	Cephalanthus occidentalis L.	buttonbush
CEMI	Cercidium microphyllum (Torr.) Rose & Johnst.	yellow paloverde
CRSP	Cercocarpus Kunth	cercocarpus
CRBE	Cercocarpus betuloides Nutt.	birchleaf mountain-mahogany
CRLE	Cercocarpus ledifolius Nutt.	curlleaf mountain-mahogany
CRMO	Cercocarpus montanus Raf.	alderleaf cercocarpus
CHFO	Chamaecyparis formosensis Matsum.	Formosan false cypress, Taiwan red cypress
CHNO	Chamaecyparis nootkatensis (D. Don) Spach	Alaska yellow-cedar, Nootka cypress
CHOB	Chamaecyparis obtusa (Sieb. & Zucc.) Endl.	hinoki cypress, Formosan cypress
CHPI	Chamaecyparis pisifera Sieb. & Zucc.	sawara cypress
CHTH	Chamaecyparis thyoides (L.) B.S.P.	Atlantic white-cedar
CLEX	Chlorophora excelsa Benth. & Hook.f.	iroko, kambala, mvule
CHSP	Chorisia speciosa St. Hil.	paneira
CIFR	Citharexylum fruticosum L.	Florida fiddlewood
COCO	Copaifera coleosperma Benth.	Rhodesian copalwood, mehibi
CONI		Various conifers
COAL	Cordia alliodora Oken	laurel corriente, lauro amarillo, ajo ajo
COAP	Cordia apurensis Agostini	
COBI	Cordia bicolor A.DC.	
COEL	Cordia elaeagnoides DC.	
COTR	Cordia trichotoma Vell.	lauro pardo, peterebi
COSP	Cornus L.	dogwood
COFL	Cornus florida L.	flowering dogwood
COSA	Cornus sanguinea	
COAV	Corylus avellana L.	common hazel
COSI	Corylus sieboldiana	blume hazel
CTCO	Cotinus coggygria Scop.	European smoketree
CTSP	Cotoneaster Medik.	cotoneaster
CRAZ	Crataegus azarolus L.	azarole
CRMO	Crataegus monogyna	
CMJA*	Cryptomeria japonica (L. f.) D. Don	Japanese cedar, sugi, cryptomeria
CUAZ	Cupressus arizonica Greene	Arizona cypress
CUAT	Cupressus atlantica Gaussen	Atlas cypress
CUDU	Cupressus dupreziana Camus	
CUGI	Cupressus gigantea Cheng & L.K. Fu	
CUGL	Cupressus glabra Sudworth	smooth Arizona cypress
	Cupressus lindleyi Klotzsch. = Cupressus lusitanica Mill.	
CULU	Cupressus lusitanica Mill.	Mexican cypress
CUSE	Cupressus sempervirens L.	Italian cypress, Mediterranean cypress
CYRA	Cyrilla racemiflora L.	swamp cyrilla, leatherwood
DADA	Dacrycarpus dacrydioides (A. Rich.) Laubenf.	kahikatea, white pine
DABD	Dacrydium bidwillii	New Zealand mountain pine
DABI*	Dacrydium biforme (Hook.) Pilger = Halocarpus biformis Hook.	pink pine
DACO*	Dacrydium colensoi Hook. = Lagarostrobos colensoi (Hook.) C.J.	silver pine
DACU	Dacrydium cupressinum Lamb.	rimu, red pine
DAFR	Dacrydium franklinii Hook f.	Huon pine
DIGU	Dicorynia guianensis Amsh.	angelique
DSVI	Diospyros virginiana L.	common persimmon
DITO	Discaria toumatou Raoul	matagouri, tumatu-kuru, wild Irishman
DITR	Discaria trinervis Reiche.	
DRLA	Dracophyllum latifolium Cunn.	neinei
DRWI	Drimys winteri J.R. & G. Forst	canelo, winter bark
DUVI	Duschenkia viridis Opiz = Betula ovata Schrank	.
DYMA	Dysoxylum malabaricum Bedd.	Bombay white cedar, Indian white cedar

ELGL	Elaeoluma glabrascens (C. Mart. & Eichler) Aubrév.	
EMRU	Empetrum rubrum Vahl ex. Willd.	murtilla
ENCA	Enkianthus campanulatus (Miq.) Nichols	
ENAN	Entandrophragma angolense C.DC.	gedu nohor, kalungi, tiama, edinam
ENCA	Entandrophragma candollei Harms	kosipo, omu, entandrophragma mahogany
ENCY	Entandrophragma cylindricum Sprague	sapeli, sapele, sapelli, assi
	Entandrophragma macrophyllum A. Chev. = Entandrophragma angolense C.DC.	
ENUT	Entandrophragma utile Sprague	sipo, utile EPSP Ephedra L. ephedra
EUCA	Eucalyptus camaldulensis Dehnh.	river red gum
EUDE	Eucalyptus delegatensis R. Baker	alpine ash
EUGL	Eucalyptus globulus Labill.	Tasmanian bluegum
EUMA	Eucalyptus marginata Donn. ex Sm.	jarrah
EUMI	Eucalyptus miniata Cunn. ex Shauer	Darwin woolybutt
EUNE	Eucalyptus nesophila Blakely	Melville Island bloodwood
EUOR	Eucalyptus oreades R.T. Baker	Blue Mountains ash
EUPA	Eucalyptus pauciflora Sieb.	snow gum, cabbage gum
EUST	Eucalyptus stellulata Sieb. ex DC	black salee
EUTE	Eucalyptus tetradonta F. Muell.	Darwin stringybark
EUVI	Eucalyptus viminalis Labill.	ribbongum
EUCO	Eucryphia cordifolia Cav.	ulmo, muermo
EUJA	Eugenia jambolana Lam.	jaman, kelat eugenia
EXCU	Exocarpus cuppressiforme Labill.	native cherry
FASP	Fagus L.	beech
FAGR*	Fagus grandifolia Ehrh.	American beech
FAOR	Fagus orientalis Lipsky	Oriental beech, eastern beech
FASY*	Fagus sylvatica L.	European beech, common beech
FCSP	Ficus L.	fig
FICU*	Fitzroya cupressoides (Molina) Johnston	alerce, Patagonian cypress
FRSP	Fraxinus L.	ash
FRAM	Fraxinus americana L.	white ash
FRCA	Fraxinus caroliniana Mill.	Carolina ash
FACR	Fagus crenata Blume	bunya beech
FREX*	Fraxinus excelsior L.	European ash, common ash
FRMA	Fraxinus mandshurica Rupr.	Manchurian ash, yachidamo
FRNI*	Fraxinus nigra Marsh.	black ash
FRPE	Fraxinus pennsylvanica Marsh.	green ash, red ash
FRSP	Fraxinus spaethiana Lingelsh.	ash
FRVE	Fraxinus velutina Torr.	velvet ash
GEAV	Gevuina avellana	avellano
GIBI	Gingko biloba L.	maidenhair tree, gingko
GLTR	Gleditsia triacanthos L.	honey locust
GMAR	Gmelina arborea Roxb.	gumari, gumbar, yemane, gmelina, gamari
GOLA	Gordonia lasianthus (L.) Ellis	loblolly-bay
GOGL	Goupia glabra Aubl.	goupia
GRVI	Grevillea victoriae F. Muell.	
GUCE	Guarea cedrata Pellegr.	bosse, guarea, white guarea, scented guarea
HABD	Halocarpus bidwillii	bog pine
HABI*	Halocarpus biformis (Hook.) Quinn	pink pine
HAKI	Halocarpus kirkii	manoao
HAVI	Hamamelis virginiana L.	witch hazel
HEAN	Hedycaria angustifolia A. Cunn.	native mulberry
HEAR	Heteromeles arbutifolia (Lindl.) M.J. Roem.	toyon
HEBR	Hevea brasiliensis	
	(Wild. ex Adr. de Juss.) Muell. Arg.	rubber tree
ILAQ	Ilex aquifolium L.	English holly
ILCA	Ilex cassine L.	dahoon, dahoon holly
ILCO	Ilex coriacea (Pursh) Chapm.	large gallberry, sweet gallberry
ILGL	Ilex glabra (L.) Gray	inkberry, gallberry
ILIN	Ilex inundata Poepp. ex Reisseck	
ILOP	Ilex opaca Ait.	American holly
JACO	Jacaranda copaia D.Don	copaia, gobaja, futui, caroba
JGAU*	Juglans australis Griseb.	Argentine walnut
JGCI	Juglans cinerea L.	butternut
JGNI	Juglans nigra L.	black walnut

JGRE	Juglans regia L.	common walnut
JUSP	Juniperus L.	juniper
JUCH	Juniperus chinensis L.	Chinese juniper
JUCO	Juniperus communis L.	common juniper
JUDE	Juniperus deppeana Steud.	alligator juniper
JUDR	Juniperus drupacea Labill.	Syrian juniper
JUEX	Juniperus excelsa Bieb.	Greek juniper, Grecian juniper
JUFO	Juniperus foetidissima Willd.	stinking juniper
	Juniperus indica = Juniperus semiglobosa Regel	
JUMA	Juniperus macropoda Boiss.	Himalayan pencil pine
JUMO	Juniperus monosperma (Emgelm.) Sarg.	one-seed juniper
JUOC*	Juniperus occidentalis Hook.	western juniper
JUOS	Juniperus osteosperma (Torr.) Little	Utah juniper
JUOX	Juniperus oxycedrus L.	prickly juniper
	Juniperus palycarpos = Juniperus seravschanica Komar.	
JUPH	Juniperus phoenicea L.	Phoenicean juniper
JUPI	Juniperus pinchotii Sudw.	redberry juniper, Pinchot juniper
JUPC	Juniperus procera Hochst. ex Endl.	Uganda juniper, African pencil cedar, East African juniper
JUPR	Juniperus przewalskii Kom.	Qilianshan juniper
JURE	Juniperus recurva Buch.-Ham. ex D. Don	drooping juniper
JUSC*	Juniperus scopulorum Sarg.	Rocky Mountain juniper
JUSM	Juniperus semiglobosa Regel	
JUSE	Juniperus seravschanica Komar.	
JUTH	Juniperus thurifera L.	Spanish juniper
JUTU	Juniperus turkestanica Komar.	Turkestan juniper
JUVI*	Juniperus virginiana L.	eastern red-cedar
KHGR	Khaya grandifolia C.DC.	acajou, Benin mahogany, African mahogany
KRDR	Krenevaja drevesina	
KUER	Kunzea ericoides (A. Rich.) J. Thompson	kanuka, white tea tree
LBGL	Labatia glomerata	
LBAN	Laburnum anagyroides Medik.	common laburnum
LGCO*	Lagarostrobus colensoi (Hook.) C.J. Quinn = Dacrydium colensoi Hook.	
LGFR	Lagarostrobus franklinii C.J. Quinn	huon pine
LSFL	Lagerstroemia flos-reginae Retz.	pyinma, banaba, banglang, jarul
LSPA	Lagerstroemia parviflora Roxb.	lendia
LSLA	Lagerstroemia lanceolata Wall.	benteak, nana
LASP	Larix Mill.	larch
	Larix cajanderi Mayr = Larix gmelinii	
	Larix chinensis Beissn. = Larix potaninii Batal.	
	Larix dahurica Turcz. ex Trautv. = Larix gmelinii (Rupr.) Litvin.	
LADE*	Larix decidua Mill.	European larch
LAGM*	Larix gmelinii (Rupr.) Litvin.	Dahurian larch
LAGR	Larix griffithiana (Lindl. & Gord.) Carr.	Himalayan larch
LAJA	Larix japonica Carr.	Japanese larch
	Larix kaempferi (Lamb.) Carr. = Larix japonica Carr.	
	Larix kurilensis Mayr = Larix gmelinii var. japonica (Regel) Pilg.	
LALA*	Larix laricina (Du Roi) K. Koch	tamarack, eastern larch
	Larix leptolepis (Sieb. & Zucc.) Gordon = Larix japonica Carr.	
LALY*	Larix lyalli Parl.	subalpine larch
LAOC*	Larix occidentalis Nutt.	western larch
LAPO	Larix potanini Batal.	Chinese larch
	Larix russica (Endl.) Sabine ex Trautv. = Larix sibirica Ledeb.	
LASI*	Larix sibirica Ledeb.	Siberian larch
	Larix sukachevii Djil. =	
	Larix sibirica Ledeb.	Ural larch
LAPH	Laurelia philippiana Looser	tepa
LASE	Laurelia sempervirens Tul.	laurelia, Chilean laurel, huahuan
LAHU	Laxopterigium huasango	haltaco

LECO	Lecythis corrugata Poit.	angelique
LEIN	Lepidothamnus intermedius (Kirk) Quinn	yellow-silver pine
	Leptospermum ericoides = Kunzea ericoides	
LEFL	Leptospermum flavescens Sm.	tea tree
LESC	Leptospermum scoparium Forster & Forster f.	manuka, red tea tree, black manuka, red manuka
LISP	Libocedrus Endl. incense-cedar	
LIBI*	Libocedrus bidwillii Hook. f.	New Zealand cedar, pahautea, kaikawaka
	Libocedrus decurrens Torr. =	
	Calocedrus decurrens (Torr.) Florin	incense-cedar
LIPL	Libocedrus plumosa (D.Don) Sarg.	kawaka, plume incense cedar
LGVU	Ligustrum vulgare L.	
LIST	Liquidambar styraciflua L.	sweetgum
LITU*	Liriodendron tulipifera L.	tuliptree, yellow-poplar, tulip-poplar
LOFR	Lomatia fraseri R.Br.	silky lomatia, tree lomatia
LOHI	Lomatia hitsuta (Lam.) Diel ex. Macbr.	radal
LOXY	Lonicera xylosteum L.	
LOTR	Lovoa trichilioides Harms	dibetou
MAAC	Magnolia accuminata L.	cucumbertree
MAGR	Magnolia grandiflora L.	southern magnolia
MAVI	Magnolia virginiana L.	sweetbay, swampbay
MASY	Malus sylvestris L.	apple tree
MABI	Manilkara bidentata A. Chev.	balata franc
MICH	Michelia champaca L.	champak
MINI	Michelia niligirica Zenker	pilachampa, champak
MIX		Various taxa
MOCO	Moronobea coccinea Aubl.	manil montagne, mountain manil
MOAL	Morus alba L.	white mulberry
MORU	Morus rubra L.	red mulberry
MYCE	Myrica cerifera L.	southern bayberry, bayberry
MYGA	Myrica gale L.	sweet gale, bog myrtle
NEAM	Nectandra amazonum	
NTLO	Notelaea longifolia Vent.	large mock-olive
NOAL	Nothofagus alpina (Poepp. & Endl.) Oerst.	rauli
NOAN	Nothofagus antarctica (Forst) Oerst.	Antarctic beech, nirre
NOBE*	Nothofagus betuloides (Mirb.) Blume	coihue de Magallanes, guindo
NOCU	Nothofagus cunninghamii Oerst.	Australian nothofagus, myrtle beech
NODO	Nothofagus dombeyi (Mirb.) Blume	coihue, Dombey's southern beech
NOFU	Nothofagus fusca (Hook. f.) Oerst.	red beech, New Zealand red beech
NOGU*	Nothofagus gunnii (Hook. f.) Oerst.	tanglefoot beech
NOME*	Nothofagus menziesii (Hook. f.) Oerst.	silver beech, Menzies's red beech
NONE	Nothofagus nervosa Dim. et Mil.	rauli
NONI	Nothofagus nitida Reiche	roble chicote
NOOB	Nothofagus obliqua (Mirb.) Blume	southern beech, roble
NOPU*	Nothofagus pumilio (Poepp. & Endl.) Oerst.	lenga
NOSO*	Nothofagus solandri (Hook. f.) Oerst.	mountain beech, black beech
NYOG	Nyssa ogechee Bartr. ex Marsh.	Ogeechee tupelo
NYSY	Nyssa sylvatica Marsh.	black tupelo, blackgum
OCUS	Ocotea usambarensis Engl.	ocotea, camphor, East African camphorwood
OSCA	Ostrya carpinifolia Scop.	hop hornbeam
OXAR	Oxydendrum arboreum (L.) DC	sourwood
PARI	Parapiptadenia rigida Benth.	
PAAU	Parkia auriculata	
PATO	Paulownia tomentosa (Thumb.) Steud.	empress tree
PECA	Peronema canescens Jack.	sunkai, koeroes
PEBO	Persea borbonia (L.) Spreng.	redbay, shorebay
PELI	Persea lingue Nees	lingue
PELN	Petrophile linearis R.Br.	pixie mops
PBPO	Phoebe porfiria Mez.	
PHAL*	Phyllocladus alpinus Hook. f.	mountain toatoa, alpine celery top pine
PHAS*	Phyllocladus aspleniifolius	
	(Labill.) Hook. f.	celery top pine
PHGL*	Phyllocladus glaucus Carr.	toatoa
PHTR*	Phyllocladus trichomanoides D. Don in Lamb.	tanekaha, celery pine
PCSP	Picea A. Dietr.	spruce

PCAB*	Picea abies (L.) Karst.	Norway spruce
	Picea ajanensis Fisch. = Picea jezoensis (Sieb. & Zucc.) Carr.	
PCAS	Picea asperata Mast.	dragon spruce
PCBA	Picea balfouriana	
PCBR	Picea brachytyla (Franch.) Pritz.	
PCCA	Picea cajanensis Lindl. et Gord.	
PCCH	Picea chihuahuana Martinez	chihuahua spruce
	Picea crassifolia Komarov = Picea asperata Mast.	
PCEN*	Picea engelmannii Parry ex Engelm.	Engelmann spruce
	Picea excelsa (Lam.) Link = Picea abies (L.) Karst	
PCGL*	Picea glauca (Moench) Voss	white spruce
PCGN	Picea glehnii (Fr. Schmidt) Mast.	Sakhalin spruce
PCJE	Picea jezoensis (Sieb. & Zucc.) Carr.	Yezo spruce, Hondo spruce
PCLI	Picea likiangensis (Franchet) Pritzel	Likiang spruce
PCMA*	Picea mariana (Mill.)	
	Britt., Sterns & Poggenb.	black spruce
	Picea obovata Ledeb. = Picea abies subsp. obovata (Ledeb.) Hultén	Siberian spruce
PCOM*	Picea omorika (Panc.) Purk.	Serbian spruce, Pancic spruce
PCOR*	Picea orientalis (L.) Link	eastern spruce, Oriental spruce
PCPU*	Picea pungens Engelm.	blue spruce, Colorado spruce
PCPR	Picea purpurea Mast.	
PCRU*	Picea rubens Sarg.	red spruce
PCSH	Picea shrenkiana Fisch. & Meyer	Shrenk's spruce
PCSI*	Picea sitchensis (Bong.) Carr.	Sitka spruce
PCSM	Picea smithiana (Wall.) Boiss.	Himalayan spruce
PCTI	Picea tienschanica Rupr.	Tien-shan spruce
PLUV*	Pilgerodendron uviferum (Pilger) Florin	cipres de las Guaytecas
PISP	Pinus L.	pine
PIAL*	Pinus albicaulis Engelm.	whitebark pine
PIAR*	Pinus aristata Engelm. in Parry & Engelm.	Rocky Mountain bristlecone pine

	Pinus aristata var. longaeva = Pinus longaeva D.K. Bailey	
PIAM*	Pinus armandii Franchet	David's pine, Armand's pine
PIBA*	Pinus balfouriana Grev. & Balf. in A. Murr.	foxtail pine
PIBN*	Pinus banksiana Lamb.	jack pine
PIBR*	Pinus brutia Ten	Calabrian pine, brutia pine, see kiefer
PIBU	Pinus bungeana Zucc.	lacebark pine
PICN	Pinus canariensis Chr. Sm. ex DC	Canary Island pine
PICA	Pinus caribaea Mor.	Caribbean pine, Cuban pine
PICE*	Pinus cembra L.	Swiss stone pine, Arolla pine
PICM*	Pinus cembroides Zucc.	Mexican pinyon, Mexican nut pine
PICH	Pinus chihuahuana Engelm.	chihuahua pine
PICO*	Pinus contorta Dougl. ex Loud.	lodgepole pine
PICL	Pinus coulteri D.Don	Coulter pine, bigcone pine
PIDN	Pinus densata (See note at bottom)	
PIDE*	Pinus densiflora Sieb. & Zucc.	Japanese red pine
PIEC*	Pinus echinata Mill.	shortleaf pine
PIED*	Pinus edulis Engelm. in Wisliz.	pinyon, Colorado pinyon
PIEL	Pinus elliottii Engelm.	slash pine
PIEN	Pinus engelmannii Carr.	Apache pine
PIFL*	Pinus flexilis	James limber pine
PIGE	Pinus gerardiana Wall. ex D. Don.	chilgoza pine, Gerard's pine
PIHA*	Pinus halepensis Mill.	Aleppo pine, Jerusalem pine
	Pinus hallii = Podocarpus hallii Kirk	
PIHE	Pinus heldreichii Christ	Heldreich's pine, panzer fohre
PIJE*	Pinus jeffreyi Grev. & Balf. in A. Murr.	Jeffrey pine
PIKE	Pinus kesiya Royle ex Gordon	Khasi pine
PIKO	Pinus koraiensis Sieb. & Zucc.	Korean pine
PILG	Pinus lagunae M.-F. Passini	laguna pinyon
PILA*	Pinus lambertiana Dougl.	sugar pine
	Pinus laricio Poir. = Pinus nigra Arnold	
	Pinus leiophylla var. chihuahuana (Engelm.) Shaw = Pinus chihuahuana chihuahua pine	

PILE*	Pinus leucodermis Ant.	Bosnian pine, greybark pine, pino loricato
PILO*	Pinus longaeva D.K. Bailey	Intermountain bristlecone pine
	Pinus longifolia Roxb. = Pinus roxburghii Sarg.	
PIMA	Pinus massoniana Lamb.	Masson pine
PIMK	Pinus merkusii Jungh. & De Vriese	Merkus pine, mindoro pine, Tenasserim pine
PIME	Pinus mesogeensis Fieschi & Gaussen	cluster pine
PIMO*	Pinus monophylla Torr. & Frem. in Frem.	singleleaf pinyon
	Pinus montana Mill. = Pinus mugo Turra	
PIMZ	Pinus montezumae Lamb.	Montezuma pine
PIMC	Pinus monticola Dougl. ex D. Don in Lamb.	western white pine
PIMU*	Pinus mughus Scop. = Pinus mugo Turra	krummholz pine
PIMG	Pinus mugo Turra	mountain pine, stone pine
PIMR	Pinus muricata D.Don	bishop pine
PINI*	Pinus nigra Arnold	Austrian pine, black pine
PIOC*	Pinus occidentalis Swartz	West Indian pine
PIOO	Pinus oocarpa Schiede	Nicaraguan pitch pine, ocote pine
	Pinus pallasiana Lamb. = Pinus nigra Arnold	
PIPA*	Pinus palustris Mill.	longleaf pine
PIPT	Pinus patula Schiede & Deppe	Mexican weeping pine
PIPE*	Pinus peuce Griseb.	Macedonian pine, Balkan pine
PIPI*	Pinus pinaster Ait.	maritime pine, cluster pine
PIPN*	Pinus pinea L.	Italian stone pine, umbrella pine
PIPO*	Pinus ponderosa Dougl. ex Laws.	ponderosa pine, western yellow pine
PIPM	Pinus pumila (Pall.) Regel	dwarf Siberian pine, Japanese stone pine
PIPU*	Pinus pungens Lamb.	Table Mountain pine
PIQU	Pinus quadrifolia Parl. ex Sudw.	Parry pinyon
PIRA	Pinus radiata D. Don	Monterrey pine
PIRE*	Pinus resinosa Ait.	red pine
PIRI*	Pinus rigida Mill.	pitch pine
PIRO	Pinus roxburghii Sarg.	chir pine
PISI	Pinus sibirica Du Tour	Siberian stone pine
PISF*	Pinus strobiformis Engelm.	southwestern white pine
PIST*	Pinus strobus L.	eastern white pine, Weymouth pine
PISY*	Pinus sylvestris L.	Scots pine, Scotch pine
PITB	Pinus tabulaeformis Carr.	Chinese pine
PITA*	Pinus taeda L.	loblolly pine
PITH	Pinus thunbergii Parl.	Japanese black pine
PITO	Pinus torreyana Parry ex Carr.	Torrey pine
PIUN	Pinus uncinata Mill. ex Mirb. in Buffon	mountain pine
PIVI	Pinus virginiana Mill.	Virginia pine, scrub pine
PIWA	Pinus wallichiana A.B. Jackson	Himalayan pine, kail pine, blue pine
PSGR	Pisonia grandis R.Br.	
PTSP	Pistacia L.	pistache
PTAT	Pistacia atlantica Desf.	Atlas pistache, betoum
PTKH	Pistacia khinjuk Stocks.	kakkar
PTPA	Pistacia palaestina Boiss.	Israelian pistache
PTVE	Pistacia vera L.	green mastic, real mastictree
PLAC	Platanus acerifolia (Ait.) Willd.	London plane tree
PLOC	Platanus occidentalis L.	American sycamore
PLOR	Platanus orientalis L.	Oriental plane tree
PLIN	Platonia insignis Mart.	parcouri
PLOR	Platyeladus orientalis	Chinese pine
PYSA	Polyscias sambucifolius (Sieber ex DC.) Harms	elderberry panax, elderberry ash
POSP	Podocarpus L'Heritier ex Persoon	
	Podocarpus dacrydioides = Dacrycarpus dacrydioides	
POFA	Podocarpus falcatus (Thumb.) Br.	yellowwood, oteniqua
	Podocarpus ferrugineus = Prumnopitys ferruginea (D. Don) Laubenf.	
POHA	Podocarpus hallii Kirk	Hall's totara
POLA	Podocarpus lawrencei Hook. f.	Tasmanian podocarpus
PONE	Podocarpus neriifolius D.Don	thitmin
PONI	Podocarpus nivalis Hook.	snow totara

PONU	Podocarpus nubigensus Lindl. ex Paxt	manio de hojas punzantes, manio macho
POPA	Podocarpus parlatorei Podocarpus spicatus = Prumnopitys taxifolia (D. Don) Laubenf.	
POTO	Podocarpus totara D. Don	totara
PPSP	Populus L.	cottonwood, poplar
PPAL	Populus alba L.	white poplar
PPAN	Populus angustifolia James	narrowleaf cottonwood
PPBA	Populus balsamifera L.	balsam poplar
PPDE	Populus deltoides Bartr. ex Marsh.	eastern cottonwood
PPEU	Populus euphratica Oliv.	charab poplar, Indian poplar
PPFA	Populus fastigiata	
PPFR	Populus fremontii Wats.	Fremont cottonwood
PPGR	Populus grandidentata Michx.	bigtooth aspen
PPNI	Populus nigra L.	lombardy poplar, black poplar
PPSI	Populus sieboldii Miq.	Japanese aspen
PPTR	Populus tremuloides Michx.	quaking aspen
PPTC	Populus trichocarpa Torr. & Gray.	black cottonwood
PRMX	Premna maxima T.C.E. Fries	muchichio
PROS	Prosopis L.	mesquite
PRFL	Prosopis flexuosa DC.	
PRGL	Prosopis glandulosa Torr.	honey mesquite
PMAN	Prumnopitys andina = Podocarpus andinus	lleuque
PMFE	Prumnopitys ferruginea (D. Don) Laubenf.	miro
PMTA	Prumnopitys taxifolia (D. Don) Laubenf.	matai, black pine
PNAM	Prunus americana Marsh.	American plum
PNAV	Prunus avium L.	wild cherry
PNIL	Prunus ilicifolia (Nutt. ex	
	Hook & Arn.) D. Dietr.	hollyleaf cherry
PNMA	Prunus mahaleb L.	
PNPE	Prunus pennsylvanica L.f.	pin cherry
PNSE	Prunus serotina Ehrh.	black cherry
PNSP	Prunus spinosa Ehrh.	
PSMU	Pseudobombax munguba Mart. & Zucc.	muguba, huira

PSSE	Pseudobombax septenatum (Jacq.) Dugand	
PSJA	Pseudotsuga japonica (Shirasawa) Beissn.	Japanese Douglas-fir
PSMA*	Pseudotsuga macrocarpa (Vasey) Mayr	bigcone Douglas-fir
PSME*	Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
PSAX	Pseudowintera axillaris	
	(Forster & Forster f.) Dandy	horopito
PSCO	Pseudowintera colorata (Raoul) Dandy	mountain horopito, pepper tree
PSXA	Pseudoxandra polyphleba (Diels) R.E. Fr.	
PTAN	Pterocarpus angolensis DC.	muninga, mninga, brown African padauk
PTVE	Pterocarpus vernalis Pittier	
PTRH	Pterocarya rhoifolia Sieb. & Zucc.	Japanese wing nut
PTPA	Pteronia pallens DC.	
PUSP	Purshia DC. ex Poir.	
PUTR	Purshia tridentata (Pursh) DC.	bitter brush
QUSP	Quercus L.	oak
QUAC	Quercus acutissima Carruth.	
	Quercus aegilops L. = Quercus macrolepis Kotschy	Valonia oak
QUAF	Quercus afares Pomel	
QUAL*	Quercus alba L.	white oak
QUBI	Quercus bicolor Willd.	swamp white oak
QUBO	Quercus boissieri Reut.	Israelian oak
QUBR	Quercus brantii Lindley	
QUCL	Quercus calliprinos Webb	Kermes oak, Israelian oak
QUCA	Quercus canariensis Willd.	Mirbeck's oak, Algerian oak
QUCE	Quercus cerris L.	Turkey oak, Austrian oak
QUCO	Quercus coccinea Muenchh.	scarlet oak
	Quercus conferta Kit. = Quercus frainetto Ten.	
QUCP	Quercus copeyensis	
QUCR	Quercus costaricensis	
QUDE	Quercus dentata Thunb.	kashiwa oak, Daimio oak
QUDG	Quercus douglasii Hook. and Arn.	blue oak
QUDS	Quercus dschoruchensis K. Koch	

QUEL	Quercus ellipsoidalis E.J. Hill	northern pin oak
QUEM	Quercus emoryi Torr. in Emory	Emory oak
QUEN	Quercus engelmannii Greene	Engelmann oak
QUFG	Quercus faginea Lam.	Portuguese oak
QUFA	Quercus falcata Michx.	southern red oak
QUFR	Quercus frainetto Ten.	Hungarian oak
QUGA	Quercus gambelii Nutt.	Gambel oak
QUGY	Quercus garryana Dougl. ex Hook	Oregon white oak
QUGR	Quercus grisea Liebm.	gray oak
QUHA	Quercus hartwissiana Steven	
	Quercus humilis Mill. = Quercus lusitanica Lam.	
QUIL	Quercus ilex L.	holm oak, holly oak
QUIT	Quercus ithaburensis (Decne.) Boiss.	Mt. Tabor oak
QUKE	Quercus kelloggii Newb.	California black oak
QULA	Quercus laurifolia Michx.	laurel oak
QULO	Quercus lobata Nee	valley oak
QULU	Quercus lusitanica Lam.	oak
QULY*	Quercus lyrata Walt.	overcup oak
QUMA*	Quercus macrocarpa Michx.	bur oak
QUMC	Quercus macrolepis Kotschy	Valonia oak
QUML	Quercus marilandica Muenchh.	blackjack oak
QUMI	Quercus michauxii Walt.	swamp chestnut oak
QUMO	Quercus mongolica Fisch. ex Turcz.	Mongolian oak
QUGS	Quercus mongolica var. grosseserrata	
	(Bulme) Rehd. & Wils.	mizunara oak
QUMU	Quercus muehlenbergii Engelm.	chinkapin oak
QUNI	Quercus nigra L.	water oak
	Quercus pagodaefolia (Ell.) Ashe = Quercus falcata var. pagodifolia Ell.	
QUPA	Quercus palustris Muenchh.	pin oak
	Quercus pedunculata Ehrl. = Quercus robur L.	English oak, pedunculate oak
	Quercus persica Jaub. & Spach = Quercus brantii Lindley	
QUPE*	Quercus petraea (Mattuschka) Liebl.	durmast oak, sessile oak
QUPO	Quercus pontica K. Koch	Armenian oak
QUPR*	Quercus prinus L.	chestnut oak
QUPU	Quercus pubescens Willd.	downy oak, pubescent oak
QUPY	Quercus pyrenaica Willd.	Pyrenean oak
QURO*	Quercus robur L.	English oak
QURU*	Quercus rubra L.	red oak
	Quercus serrata Sieb. & Zucc. = Quercus acutissima Carruth.	
	Quercus sessiliflora Salisb. = Quercus petraea (Mattuschka) Liebl.	
QUSH	Quercus shumardii Buckl.	Shumard oak
QUST*	Quercus stellata Wangenh.	post oak
QUSU	Quercus suber L.	cork oak, cork tree
QUVE*	Quercus velutina Lam.	black oak
QUAC	Quintinia acutifolia Kirk.	Westland quintinia
RAGU	Rapanea guianensis Aubl.	guiana rapanea
RESP	Recordoxylon speciosum Normand & Mariaux	wacapou guitin
RHCA	Rhamnus caroliniana Walt.	Carolina buckthorn
RHCT	Rhamnus cathartica L.	
RHCR	Rhamnus crocea Nutt.	hollyleaf buckthorn
RHOV	Rhus ovata Wats.	sugar sumac
RONE	Robinia neomexicana Gray	New Mexico locust
ROPS	Robinia pseudoacacia L.	black locust
SBPI	Sabina pingu	
	Sabina przewalskii Kom. = Juniperus przewalskii Komarov	
SBRE	Sabina recurva	
SBSA	Sabina saltuaria	
SBTI	Sabina tibetica	
SBWA	Sabina wallichiana	
SASP	Salix L.	willow
SAAC	Salix acutifolia Willd.	pointed-leaved willow
SAAL	Salix alba L.	white willow

SAAM	Salix amygdalina L.	almond-leaved willow, peachleaf willow
SAAD	Salix amygdaloides Anderss.	peachleaf willow
SAAR	Salix arbusculoides Anderss.	littletree willow
SAAT	Salix arctica Pall.	Arctic willow
SABA	Salix babylonica L.	weeping willow
SACN	Salix candida Fluegge	sage-leaf willow, silver willow
SACA	Salix caprea L.	pussy willow, goat willow
SACR	Salix caroliniana Michx.	Coastal Plain willow
SADI	Salix discolor Muhl.	pussy willow, glaucous willow
SAEL	Salix elaeagnos Scop.	hoary willow
SAEX	Salix exigua Nutt.	sandbar willow
SAGL	Salix glauca L.	grayleaf willow
	Salix interior Rowlee = Salix exigua Nutt.	
SALA	Salix lanata L.	Richardson's willow
SALS	Salix lasiolepis Benth.	arroyo willow, white willow
SAMY	Salix myrsinifolia Salisb.	
SAPH	Salix phylicifolia L.	tea-leaf willow
SAPL	Salix planifolia Pursh	sandbar willow, lakeshore willow, diamondleaf willow
SAPU	Salix purpurea L.	purple willow, purple osier
	Salix triandra L. = Salix amygdalina L.	
SAVI	Salix viminalis L.	basket willow, common osier
SNAL	Santalum album L.	sandalwood, santalin, chandal
SSAL	Sassafras albinum (Nutt.) Nees	sassafras
SSAL	Sapium styllare Muell. Arg.	
SACO	Saxegothaea conspicua Lindl.	Prince Albert's yew, manio de hojas cortas, manio hembra
SCTR	Schleichera trijuga Willd.	ta-kro, kusum, kusamo
SCMI	Schleronema micranthum Ducke.	cordeiro, scleronema
SCVE	Sciadopitys verticillata (Thunb.) Sieb. & Zucc.	Japanese umbrella pine, koyamaki pine
SESE	Sequoia sempervirens (D. Don) Endl.	coast redwood
SEGI	Sequoiadendron giganteum (Lindl.) Buchholz	giant sequoia
SHRO	Shorea robusta Gaertn.f.	sal
SIAM	Simarouba amara Aubl.	simarouba
SOAM	Sorbus americana Marsh.	mountain ash
SOAR	Sorbus aria (L.) Crantz	whitebeam
SOAU	Sorbus aucuparia L.	mountain ash, rowan
SOTE	Sorbus torminalis (L.) Crantz	chequer tree, wild service tree
SODU	Sorocea duckei W.C. Burger	
	Stewartia koreana Rehd. = Stuartia pseudocamellia var. koreana (Rehd.) Sealy	
STPS	Stuartia pseudocamelliad var. koreana (Rehd.) Sealy	Korean stewartia
SWLA	Swartzia laevicarpa Amsh.	saboarana
SWMC	Swietenia macrophylla King	
SWMA	Swietenia mahagoni Jacq.	West Indies mahogany
SYGL	Symphonia globulifera L.F.	manil
TABA	Tabebuia barbata (E. Mey) Sandw.	Igapo-tree
TMAP	Tamarix aphylla Lanza	dur
TMCH	Tamarix chinensis Lour.	tamarisk, salt cedar
TMJO	Tamarix jordanis	
TPGU	Tapirira guianensis Aubl.	tapirira, cedroi, jobo
TMXE	Tasmannia xerophila M. Gray	
TAAS	Taxodium ascendens Brong.	pond cypress
TADI*	Taxodium distichum (L.) Rich.	baldcypress
TAMU	Taxodium mucronatum Ten.	Montezuma cypress
TABA	Taxus baccata L.	common yew, English yew
TACU	Taxus cuspidata Sieb. & Zucc.	Japanese yew
TEGR	Tectona grandis L. f.	teak
TEBR	Terminalia brownii	
TEGU	Terminalia guianensis Aubl.	
TETO	Terminalia tomentosa W. & A.	Indian laurel, taukkyan, sain
TEAR	Tetraclinis articulata (Vahl) Mast.	Arar tree, African thuya

THSP	Thuja L.	thuja
THOC*	Thuja occidentalis L.	northern white-cedar, American arborvitae
THOR	Thuja orientalis L.	Chinese arborvitae, Oriental arborvitae
THPL*	Thuja plicata Donn ex D. Don	western redcedar, giant arborvitae
THST	Thuja standishii (Gord.) Carr.	kurobe arborvitae, Japanese arborvitae
THDO	Thujopsis dolabrata (L.f.) Sieb. & Zucc.	hiba arborvitae
THHO	Thujopsis dolabrata var. hondai Makino	asunaro arborvitae
TISP	Tilia L.	linden, lime tree
TIAM	Tilia americana L.	American basswood
TICO	Tilia cordata Mill.	littleleaf linden, winter linden, small-leaved lime
TIPL	Tilia platyphyllos Scop.	broad-leaved linden, summer linden
TOCA	Torreya californica Torrey	California nutmeg
TRSC	Triplochiton schleroxylon K. Schum.	abachi, obeche, wawa, arere
TRCO	Tristania conferta R.Br.	Queensland box tree
TSSP	Tsuga Carr.	hemlock
TSCA*	Tsuga canadensis (L.) Carr.	eastern hemlock
TSCR*	Tsuga caroliniana Engelm.	Carolina hemlock
TSCH	Tsuga chinensis (Franch.) Pritz.	Chinese hemlock
TSDI	Tsuga diversifolia (Maxim.) Mast.	Japanese hemlock
TSDU	Tsuga dumosa (D.Don) Eichl.	East Himalayan hemlock
TSHE*	Tsuga heterophylla (Raf.) Sarg.	western hemlock
TSME*	Tsuga mertensiana (Bong.) Carr.	mountain hemlock
TSSI	Tsuga sieboldii Carr.	southern Japanese hemlock
ULSP	Ulmus L.	elm
	Ulmus campestris L. = Ulmus minor Mill.	
	Ulmus carpinifolia G. Suckow = Ulmus minor Mill.	
ULGL	Ulmus glabra Hudson	Wych elm, Scots elm, mountain elm
ULLA	Ulmus laevis Pall.	European white elm
ULMI	Ulmus minor Mill.	smooth-leaved elm, field elm, common elm
ULPU	Ulmus pumila L.	Siberian elm
ULRU	Ulmus rubra Muhl.	slippery elm
UNKN		Unknown
VBLA	Vibernum lantana L.	
VIME	Virola melinonii A.C. Smith	mountain yayamadou, montagne yayamadou
VIKE	Vitex keniensis Turr	moru, moru oak
VOAM	Vouacapoua americana Aubl.	wacapou
WERA	Weinmannia racemosa L.f.	kamahi
WETR	Weinmannia trichosperma Cav.	tineo, tenio, palo santo
WICE*	Widdringtonia cedarbergensis J.A. Marsh	Clanwilliam cedar
ZISP	Ziziphus spina-christi	Judas tree, Christ thorn
ZYSP	Zygophyllum L.	
ZYDU	Zygophyllum dumosum Boiss.	

Note: *Pinus densata* actually refers to two separate pine species that overlap in west-central China, *Pinus tabulaeformis* (Chinese pine) in the northern region and *Pinus yunnanensis* (Yunnan pine) in the south (Mirov and Hasbrouck 1976).

Source: http://web.utk.edu/~grissino/species.htm