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Scientific Assistance towards a Probabilistic Formulation of Hydraulic Boundary Conditions

Dependent Stratification software tool Manual

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Scientific Assistance towards a Probabilistic Formulation of Hydraulic Boundary Conditions

Dependent Stratification software tool Manual

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Abstract

The Dependent Stratification tool is a Matlab® software packet developed in commission of Flanders Hydraulic Research (FHR). The tool is a standalone executable which facilitates and automates the stratification of a main extreme value distribution and the dependent stratification of secondary extreme value distributions in order to generate synthetic quantiles with corresponding frequencies. The tool is part of a suite of software tools to facilitate the probabilistic formulation of hydraulic boundary conditions. This report is a manual for the tool. It assists the user when installing the tool. Furthermore it provides an in depth description of the workflow and the functionalities of the tool.

Contents

List of figures

1 Introduction

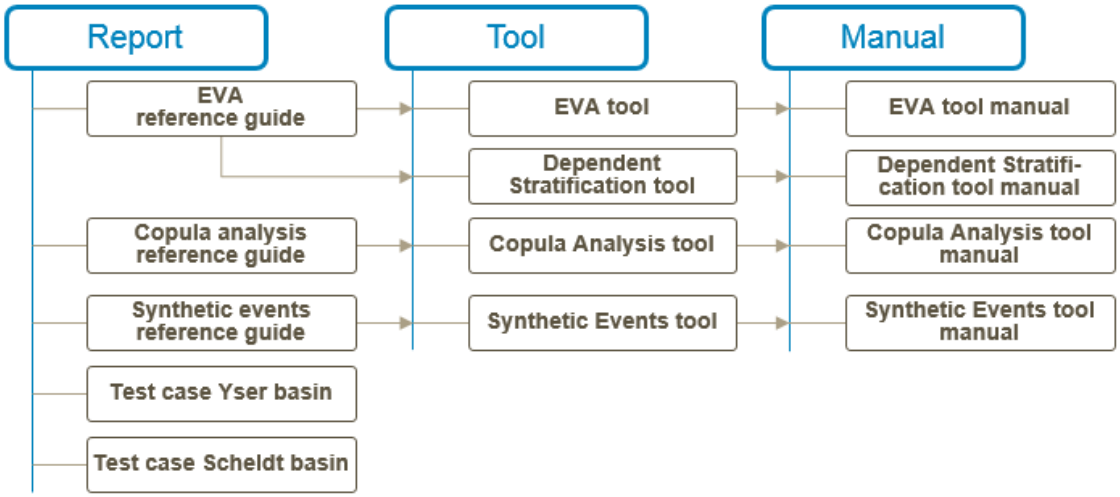
The Dependent Stratification tool is a Matlab® software packet developed in commission of Flanders Hydraulic Research (FHR). The tool is a standalone executable which facilitates and automates the stratification of a main extreme value distribution and the dependent stratification of secondary extreme value distributions in order to generate synthetic quantiles with corresponding frequencies.

The tool is part of a suite of software tools to facilitate the probabilistic formulation of hydraulic boundary conditions. An overview of the tools and corresponding reports and manuals is presented in Figure 1-1.

The tool has to be used in combination with the Extreme Value Analysis tool or the Copula Analysis tool.

The Extreme Value Analysis reference guide and the Copula Analysis reference guide give an overview of the methodology and a summary of the applied formulae. The theoretical techniques used are based on an extensive literature review of the standard Extreme Values literature (Coles, 2001; Kotz, 2000; Beirlant, 2004) in combination with the standard Copula literature (Nelsen, 2006; Genest, 2007).

Figure 1-1: Overview of reports, tools and manuals



2 Software

The Dependent Stratification tool has been developed by IMDC in a Matlab® environment and compiled into an executable, so there is no software license required to use the toolbox. The tool consists of three mean visual interfaces which give access to numerous of Matlab® functions.

The user needs to install the Matlab Compiler Runtime (MCR) before the first execution of the tool. The MCR is a Matlab® copy without the graphical interface that can be deployed royalty free and possesses all the strengths of the full Matlab® environment. You must have administrative privileges to install the MCR on a target machine since it modifies both the system registry and the system path. Running the MCRInstaller after the MCR has been set up on the target machine requires only user-level privileges.

2.1 Installation of MCR

The installation of the MCR Installer is guided by an installation GUI which requires the following steps. The latest version of the MCR can be downloaded at the Matlab site (http://www.mathworks.nl/products/compiler/mcr/index.html)

- When the MCR Installer wizard appears, click Next to begin the installation. Click Next to continue.
- In the Select Installation Folder dialog box, specify the location where you want to install the MCR and whether you want to install the MCR for just yourself or others. Click Next to continue.
- Confirm your selections by clicking Next.
- The installation begins. The process takes some time due to the amount of files that are installed.

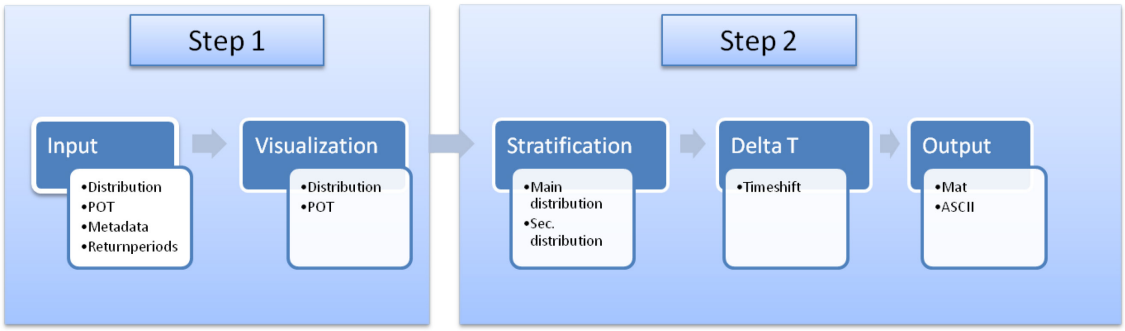
A more detailed explanation of the MCR can be found on Matlab (2011).

3 Workflow

The workflow of the stratification GUI has two mayor steps. In step one all the necessary input is loaded into the tool and the distributions and POT values are combined into one figure. This step can be used as a visualisation of multiple distributions.

During step 2 the distributions are stratified and the strata with probabilities of occurrence are exported. The median time shift between the peaks (POT) of the main variable and the peak of the secondary variables is also calculated.

Figure 3-1: Workflow of the Dependent Stratification tool



3.1 Input

For the specification of the input, the File and Input submenus of the tools menu bar presented in Figure 3-2 are used.

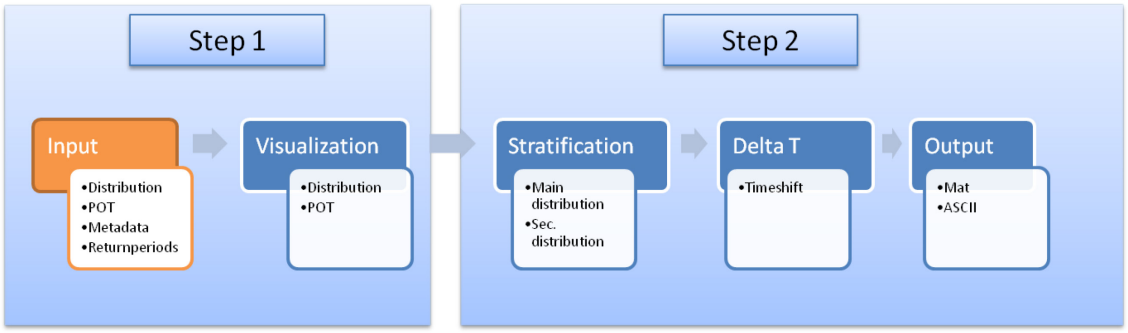
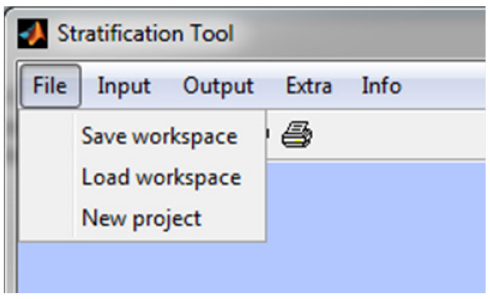
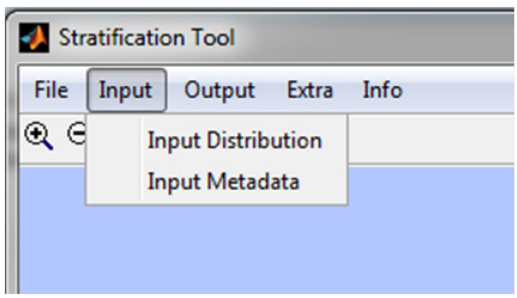


Figure 3-2: The File (left) and Input (right) menu





The File menu contains the following functions:

- Save and load workspace
  The entire workspace of the stratification tool can be saved during every step of the analysis and reloaded. This facilitates quick access to your work at a later date
- New project
  The new project button will clear the internal memory of the Dependent Stratification tool and reset all the variables to their default values.

The Input menu allows to import data generated by the EVA tool. These input files contain de distribution parameters and the POT values have a default name 'TS_POT_Distr_*.mat'. The files can be imported with the 'Input Distribution' function (Figure 3-2).

Once an appropriate file is selected a popup window will ask for the name of the distribution (Figure 3-3). This name will be used in the legend of the figure and the output files. The imported distribution will appear in the distributions list (Figure 3-4) of the control panel. Distributions in this list can be selected in the next steps.

Figure 3-3: Popup window asking for the name of the distribution

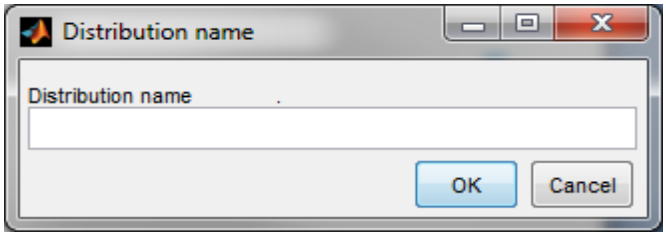
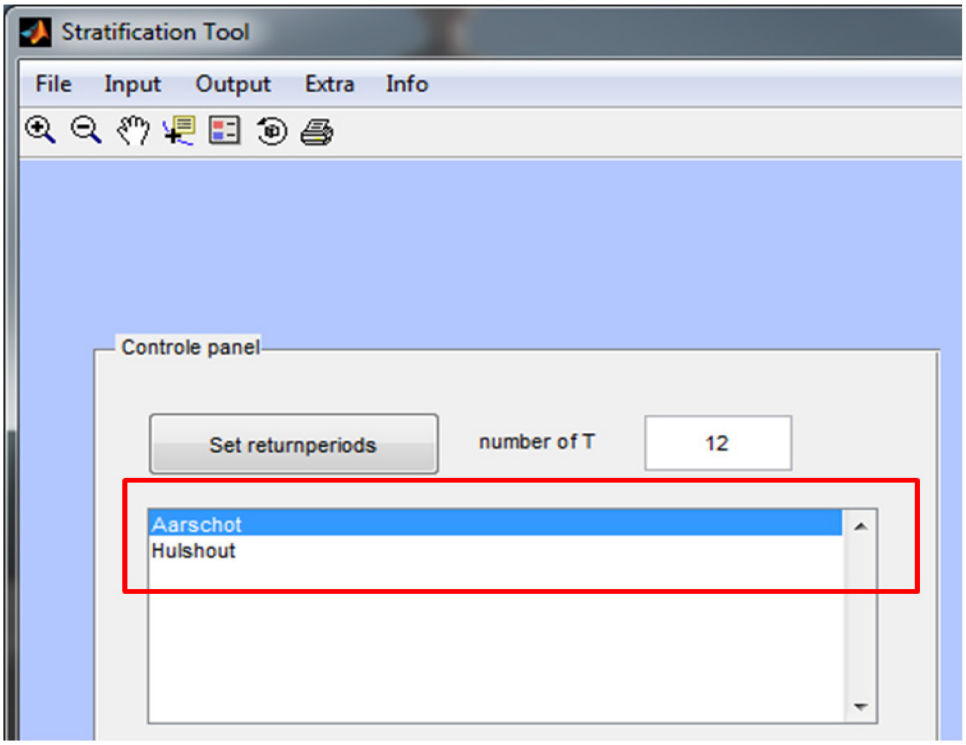
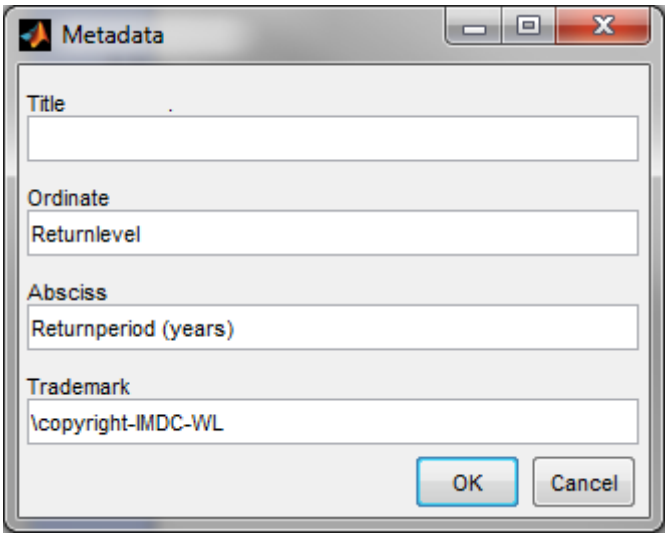


Figure 3-4: Distributions list

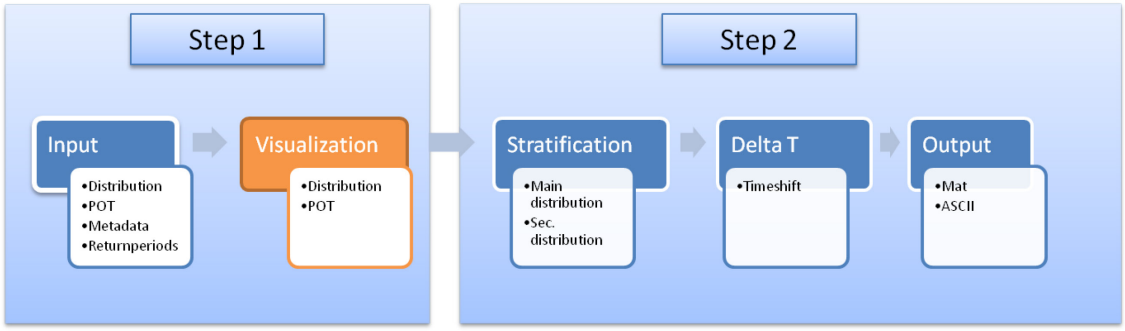


The 'Input Metadata' function of the Input menu allows the user to change the title, the ordinate and the abscissa of the figure. Also the trademark in the lower right corner of an exported figure can be changed (Figure 3-5).

Figure 3-5: Input metadata window



3.2 Visualization



The imported distributions and POT values can be visualized with the buttons 'Plot selected distribution' and 'Plot POT of selected distr' (Figure 3-6) in the control panel. The distribution is the selected in the list box in Figure 3-4. The distribution and corresponding POT values will be plotted in the same color. The entire figure can be cleared with the button 'Clear figure'. A distribution can also be deleted by 'Delete selected distribution'.

Once a figure is accepted, it can be saved with the 'Save current figure' function in the Output menu (Figure 3-7). The 'Set outputdir' of the Output menu allows the user to choose a default output directory.

Figure 3-6: Visualization buttons of the control panel

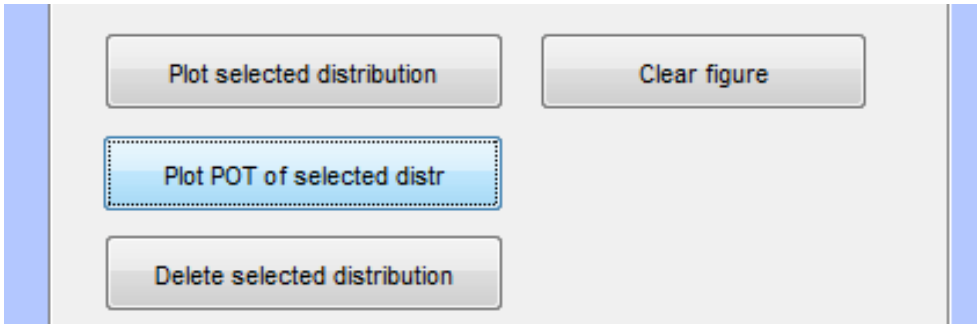
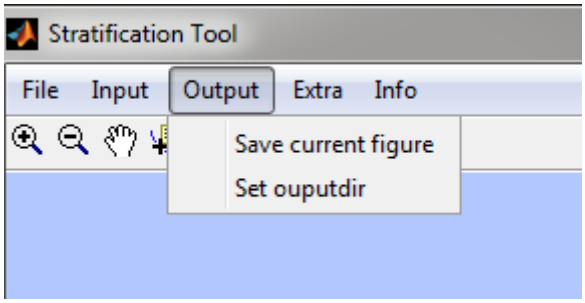
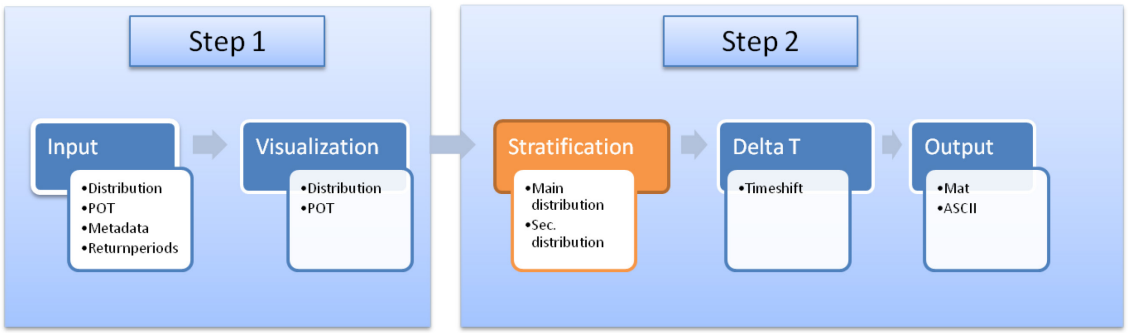


Figure 3-7: Output menu



3.3 Stratification



The stratification procedure consists of two steps. At first the main distribution will be stratified with the 'Stratify main distr' button of the control panel (Figure 3-8). If there is only one distribution this is considered the main distribution. A popup window allows the user to change the main distribution.

There are two methods of stratification available, a normal or new ('New' button) and a Copula based stratification (Figure 3-9). The latter should be used if the main distribution is already coupled with another variable by a Copula and the same strata boundaries have to be used. A new stratification allows the user to choose the strata boundaries (Figure 3-10). The minimal extreme quantile value has to be high enough so that the corresponding return period lies in the validity domain of all the distributions. The tool will automatically calculate this minimum. If the Copula based stratification is chosen the user has to set this minimum manually in the Copula tool. The Copula based stratification will require the user to load the synthetic extremes generated by the Copula Analysis tool (see Figure 1-1). The GUI will ask for this file when Copula based stratification is selected.

Figure 3-8: Stratification buttons

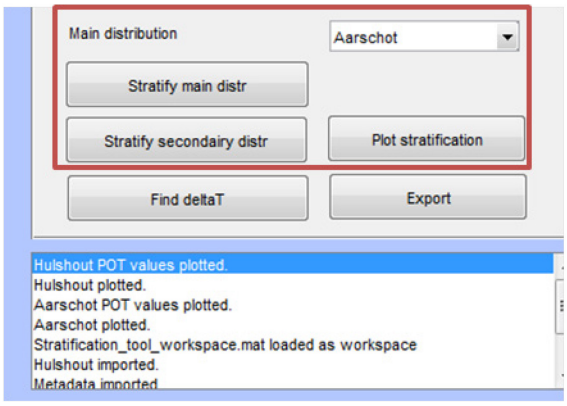


Figure 3-9: stratification method

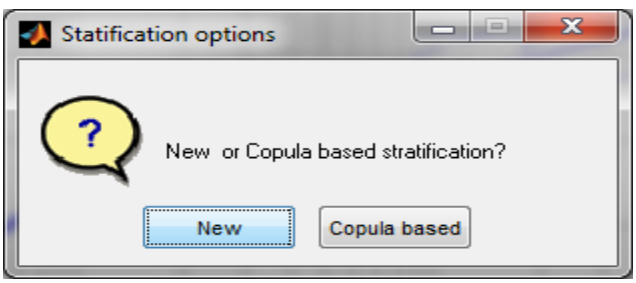
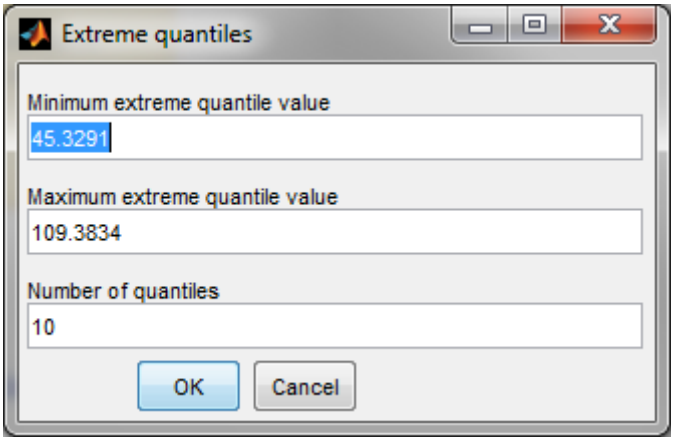


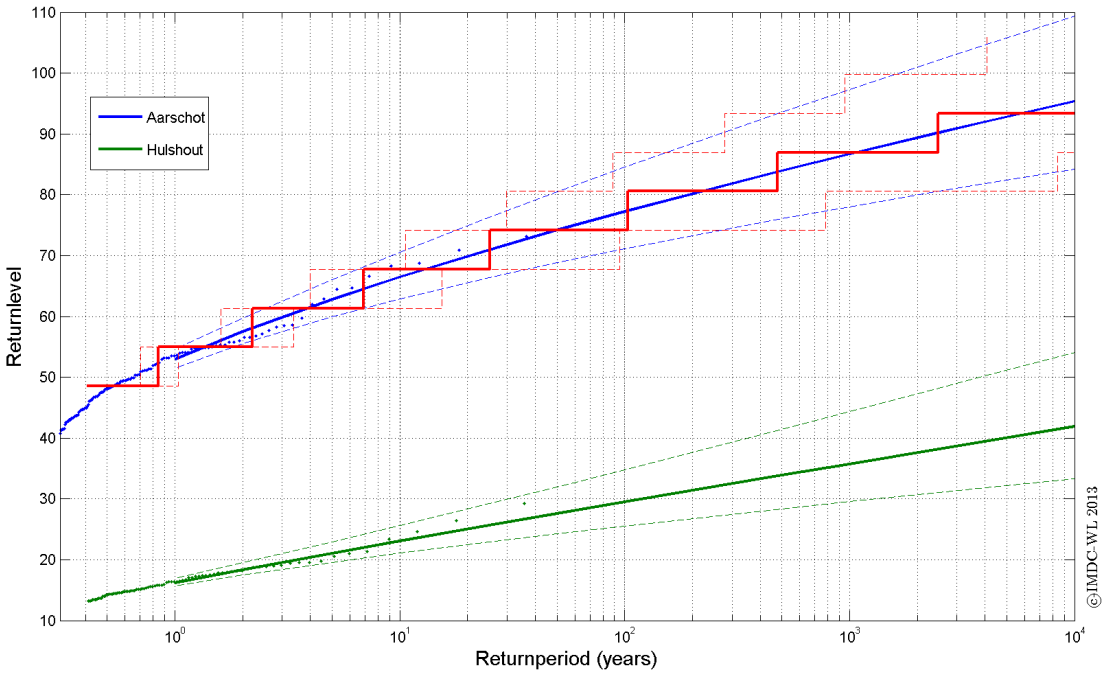
Figure 3-10: Set the number and boundaries of the strata for a new stratification



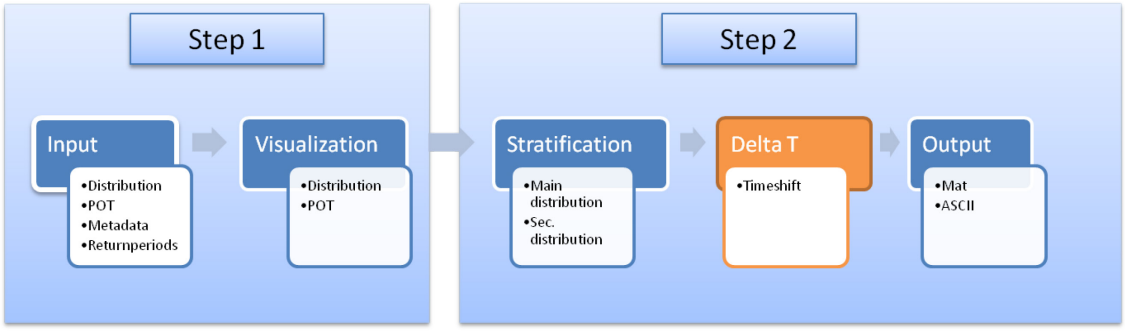
The stratification of the main distribution yields return levels of the strata boundaries. These return levels are used in the dependent stratification of the secondary distributions. This dependent stratification yields strata with the same probabilities of occurrence for each distribution.

The stratification of the distributions can be checked by plotting the accumulated distributions of the strata on the original distribution (Figure 3-11). This way the effect of the discretization can be estimated. It is always a tradeoff between an increase of the number of strata, and thus an increase in resolution, and the corresponding increase in computer calculation time.

Figure 3-11: Stratification plot



3.4 Delta T



If two variables are coupled with dependent stratification the relative time difference between the peaks can be calculated based on historic events (Figure 3-12). This time shift can be applied to the synthetic events (see Synthetic Events tool). Both the mean and the median are calculated and a possible relation between the time difference and the POT values can be visually inspected in the output figure (Figure 3-13).

Figure 3-12: 'Find Delta T' button in the control panel

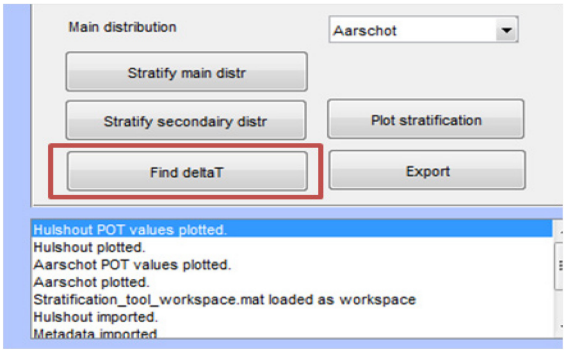
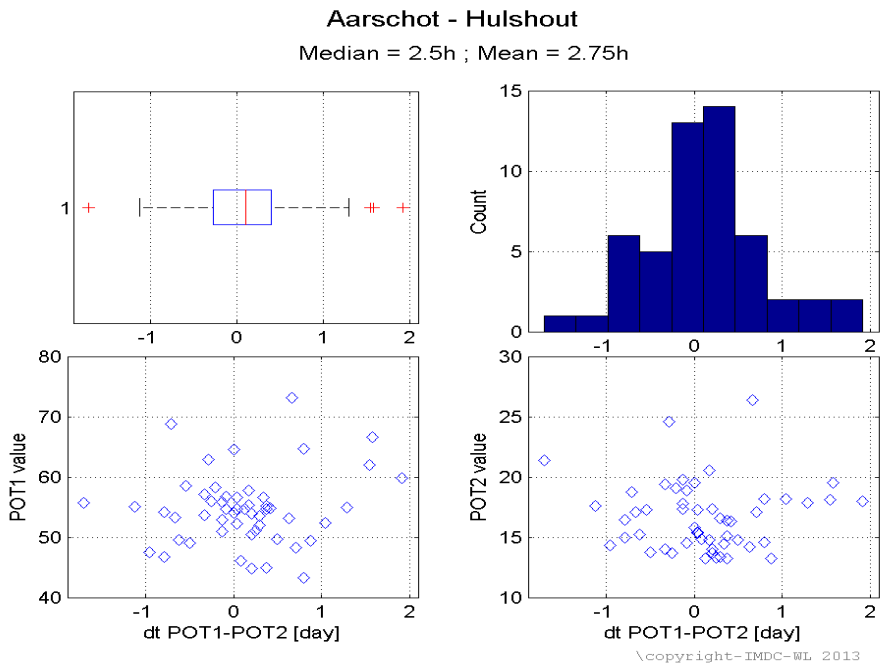
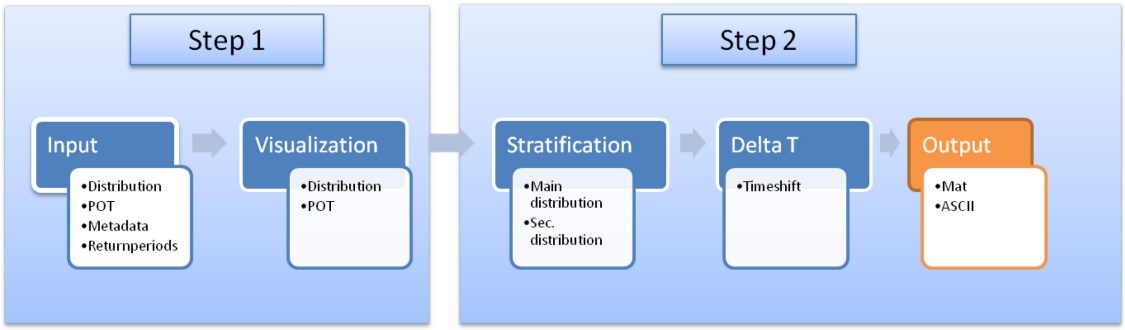


Figure 3-13: Visual inspection of the calculated delta T

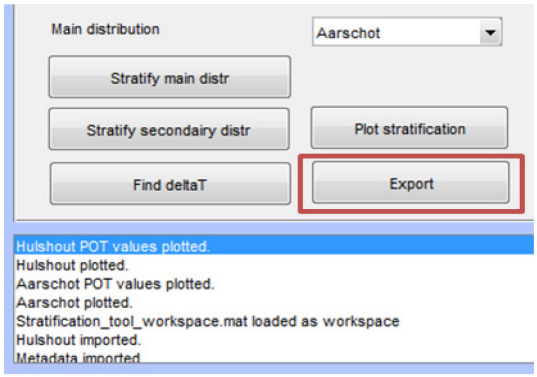


3.5 Output



The results of the stratification can be exported in '.mat' an ascii format with the 'Export' button in the control panel (Figure 3-14). The strata or synthetic quantiles are exported in the following format [mean value of strata; frequency of occurrence; upper limit of CI frequency of occurrence; lower limit of CI frequency of occurrence].

Figure 3-14: Export button in the control panel



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