

# MIKE URBAN Tools

## Result Verification

### Comparison between results



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## 1 Introduction

The MIKE URBAN 'Result Verification Tool' is intended for comparing results from hydraulic network computations produced by different variants of a collection system model. This could be comparison between results from a former version of the model and results from a new version updated with the latest information from an asset management system.

The tool can also be used for comparing results produced by detailed models with results produced by a simplified model for the same area. The tool will compare all result time series for locations found in both of the compared variants of the model.

The tool, 'Result Verification' can be selected from the Start menu. The tool can read files from MOUSE, MIKE 1D, SWMM and EPANET.



## 2 Functions

Before comparing two result files you will select which type of parameter to be compared. The parameters can be discharges, water levels or velocities.

In addition you can select between or combine various methods of comparison. For each method it is possible to set up criteria for acceptance or rejection of the comparison.

In total this gives a huge number of possible combinations for selecting parameters and setting up criteria. To handle this, the tool offers the possibility for defining comparison 'jobs'. By defining a number of jobs it is possible to separate individual methods of comparison, e.g. defining a job for comparing maximal discharge only.

Once a list of jobs has been created it is possible to execute jobs individually by interactive operation or a complete list of jobs can be executed in 'batch'. The batch execution will produce an overview report and individual reports from each job.

### 2.1 Job Specification

Each job will handle the comparison of results from two result files. The comparison is done based on the time series ID (Identification). By default, all the time series with data of the selected parameter type will be compared. It is also possible to reduce the number of time series by applying a MIKE URBAN selection file (.mus) which contains a list of links, nodes, pumps, weirs, etc.

When the tool is launched it opens the dialogue page shown in Figure 2.1. It is from this dialogue all jobs are defined. It is possible to save a list of jobs to a file for later reuse. Interactive execution of single job is done by applying the <Run Job> button. Execution of all active jobs in the list as a batch is started by pressing the <Batch Run> button.

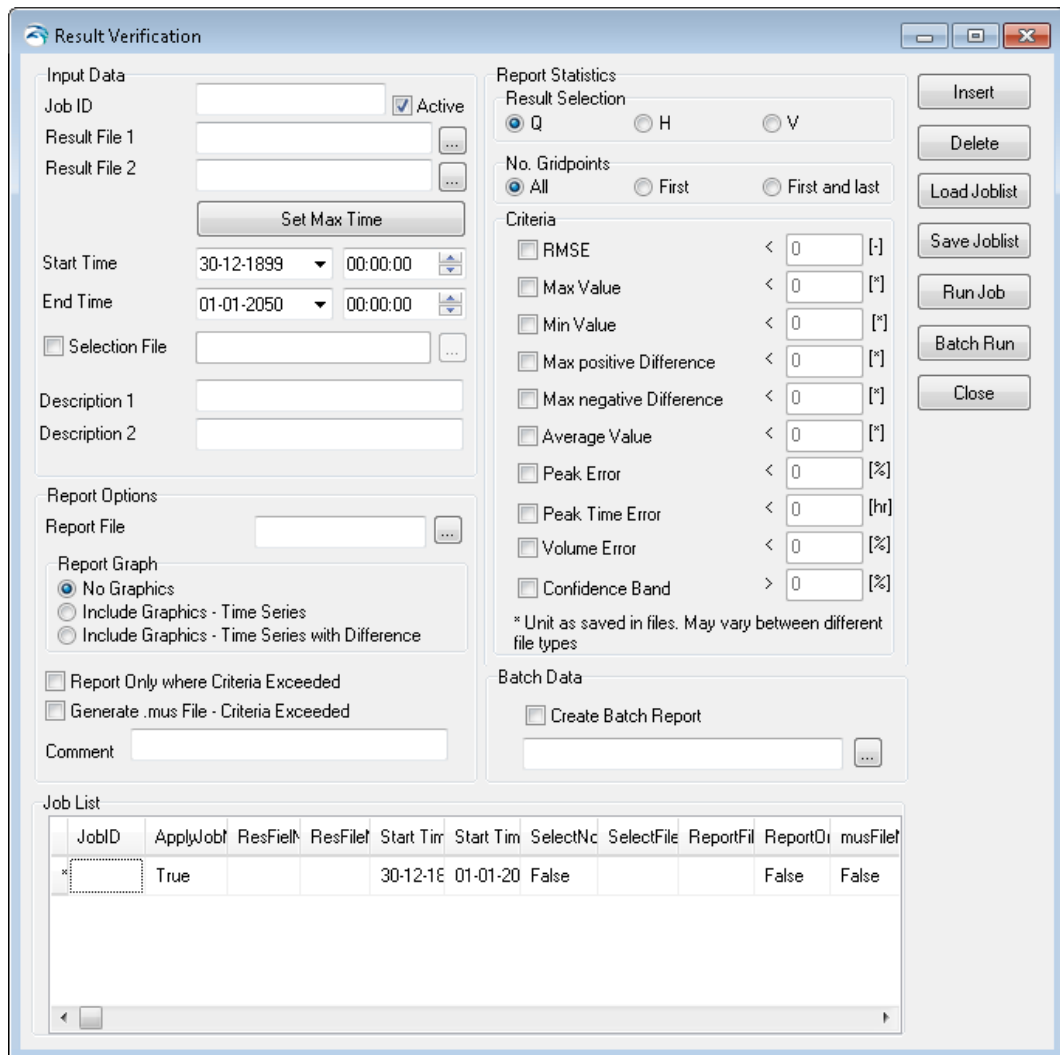


Figure 2.1 The result verification tool

The dialogue page is divided into a number of sections. Each section is described in details in the following.

## Input Data

'Job ID' – The field is used for specifying a name for the job. The name will also appear in the report produced by the job.

'Active' – This check box is used for switching jobs on or off in the batch execution. Only active jobs will be executed.

'Result File 1' and 'Result File 2' – These fields specify the two result files selected for the comparison. The files must be specified with full path and file name information. The button next to the field can be used to browse to the location of the files. The files can be located in different folders.

<Set Max Time> - This button can be used to set the common time interval for the two result files as the Start Time and End Time for the comparison.



'Start Time' and 'End Time' – The time interval for which the comparison is executed can be set here. It is possible to execute the comparison for a limited period less than the complete overlap between the files.

'Selection File' – If the check box is selected the comparison will be reduced to the time series of results from the elements listed in the specified MIKE URBAN selection file (\*.mus).

'Description' – If set, these labels are used in graphs to identify the two result files. "Description 1" is used for "Result File 1" and "Description 2" is used for "Result File 2". If empty, then "Measurement" is used for "Result File 1" and "Result file" is used for "Result File 2"

### Report Options

'Report File' – Specify the full path and file name for the report file. The report will be produced as an XML file which can be opened by using a web-browser, like Internet Explorer.

'Report Graph' – There are options for producing report without graphs or with graphs showing the compared time series and with graphs including a curve showing the difference between the time series. When graphs are included in the report there will be created a sub-folder which contains the graphics files included in the report.

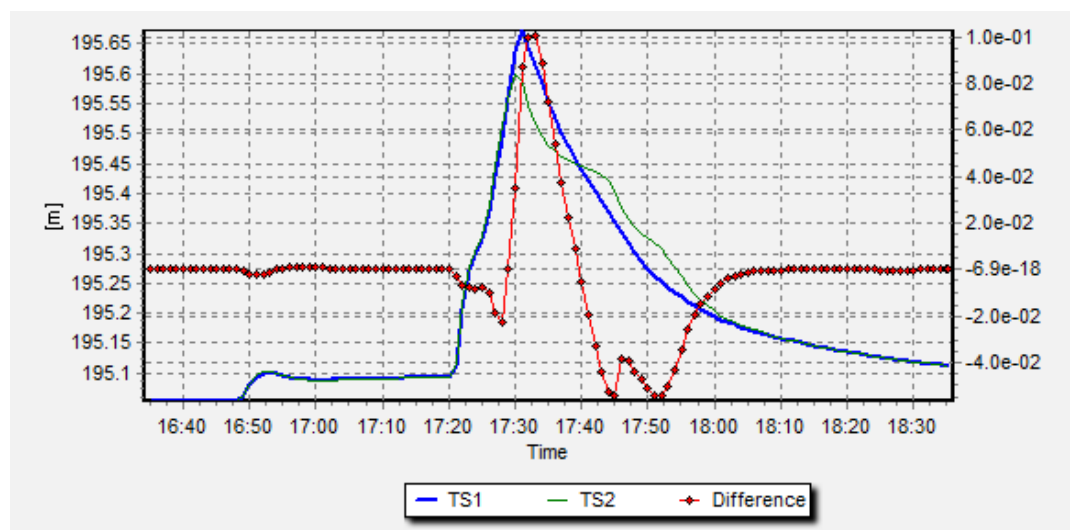


Figure 2.2 Example of graphs included in the report

An example of the graphs included in the report is shown in Figure 2.2. This example shows the comparison of the water level computed at the same location in the two variants of the model. The water levels refer to the left Y-axis, while the difference curve refers to the right Y-axis.

'Report Only where Criteria Exceeded' – Use this check box to reduce the produced report to only contain the time series where the criteria for acceptance are exceeded.

'Create .mus file – Criteria Exceeded' – By checking this box the tool will produce a \*.mus selection file for use in MIKE URBAN. By loading the selection file it is possible to get an overview of how the elements where the comparison is not accepted are distributed over the network. The file name of the produced file will be composed as:  
<JobID>\_CriteriaExceeded.mus

'Comment' – This field can be used for adding a comment line which will be included in the beginning of the report.

Figure 2.3 shows an example of a report.

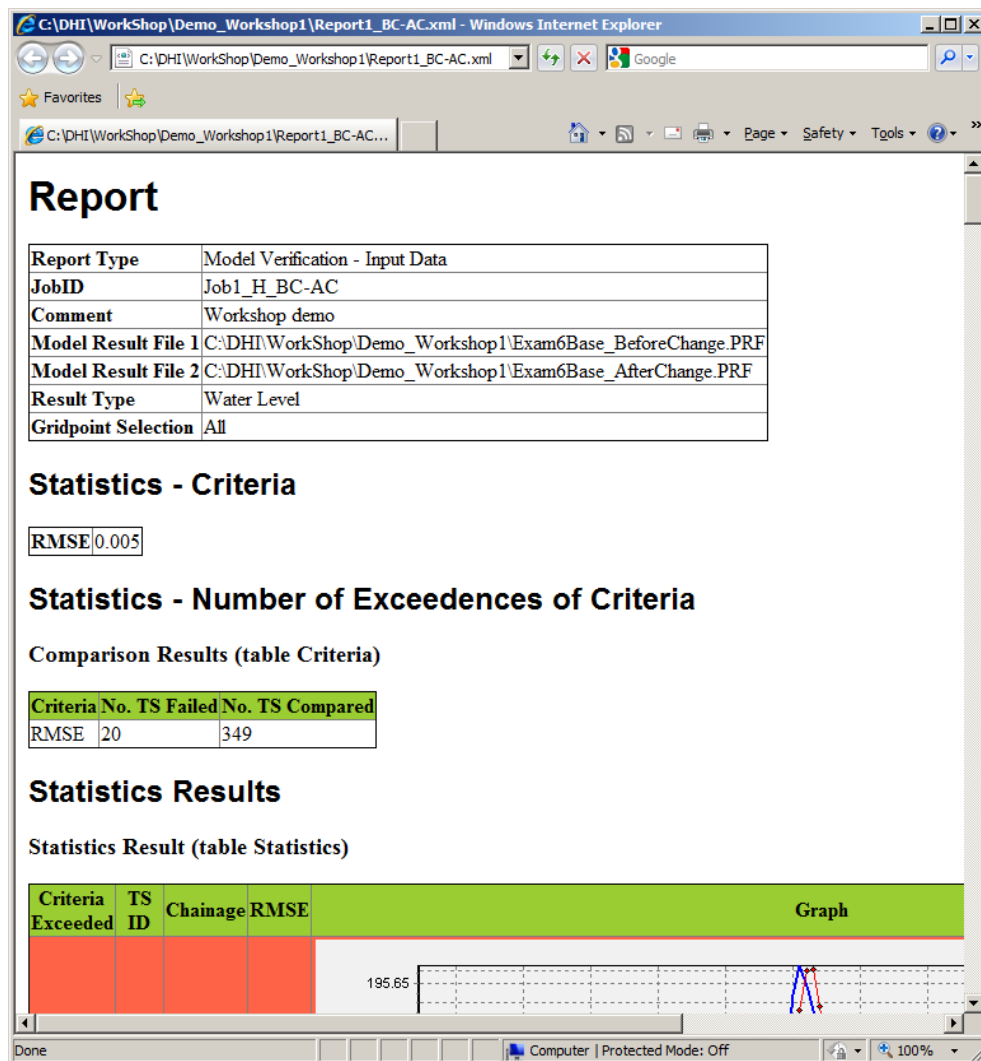


Figure 2.3 Report example

## Batch Data

This section controls the options for generating an overview report from a batch run. The report will list the executed jobs and report for how many time series the criteria were exceeded during the comparison. The batch run report is an XML file which can be opened by a web-browser. The file name should be entered with the full path.

In Figure 2.4 an example of a batch report for two jobs is shown. The details for each job are found in the reports produced by the individual jobs.

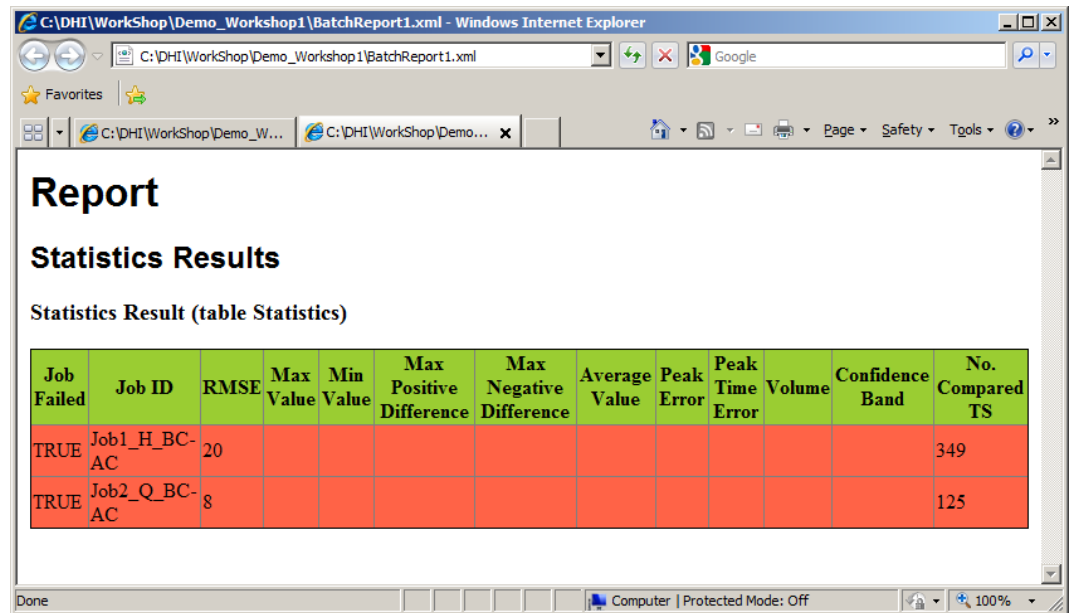


Figure 2.4 Example of batch report

## Report Statistics

'Result Selection' – Select if the comparison should be done for computed discharges (Q), computed water levels (H) or computed velocities (V). If you want to compare both discharges and water levels then this must be done using separate jobs.

'No. Gridpoints' – Here it is possible to specify how time series from computational grid points in links should be compared. There are options for comparing all grid points, reducing to only the first grid point or first and last grid point in each link

## Criteria

This section is applied for selecting the criteria included in the comparison executed by the current job. In addition the threshold parameters for each criterion can be specified.

The methods and algorithms behind the criteria are described in the following section.

## 2.2 Comparison Criteria

There are ten criteria available for making comparison of varying complexity when the two result files are compared. If a criterion cannot be applied for the selected parameter specified in 'Result Selection' then the criterion will be grayed. For example you cannot apply the 'Volume Error' criterion for water level and velocities.

In general, the result computed for the individual criterion is based on the absolute difference between the two time series being compared. This means that the result indicates if the time series deviate, but the result does not indicate which time series has e.g. the largest maximum value.

The ideal target will be that the value computed by each criterion is close to zero. This will mean that the time series are close to identical. The only exception is the 'Confidence Band' criterion where the ideal result for good comparison is 100.

If the computed value indicates that the time series deviate then a more detailed inspection of the time series is recommended to determine the importance of the difference.

In the next section the criteria will be described in details.

### 2.2.1 RMSE

The Root-Mean-Square-Error (RMSE) criterion can be applied as a measure for the magnitude of the deviation between the two time series over the period being investigated.

$$"RMSE" = \sqrt{\frac{\sum_{i=1}^n (y_{1,i} - y_{2,i})^2}{n}}$$

The values for the second time series (Result File 2) will be linear interpolated to match the time series from Result File 1 time wise.

### 2.2.2 Max Value

The criterion provides a value for the difference in maximum values found in the two compared time series.

$$"Max Value" = |\max(y_1) - \max(y_2)|$$

It should be noticed that the maximum value found in the two time series does not necessarily occur at the same point in time in the two series.

### 2.2.3 Min Value

The criterion provides a value for the difference in minimum values found in the two compared time series.

$$"Min Value" = |\min(y_1) - \min(y_2)|$$

It should be noticed that the minimum value found in the two time series does not necessarily occur at the same point in time in the two series.

### 2.2.4 Max Positive Difference

This criterion computes a value indicating how much the first time series (Result File 1) is above the second time series at the point in time where this difference has its maximum.

$$\text{"Max Positive Difference"} = |\max(y_1 - y_2)|$$

The values for the second time series (Result File 2) will be linear interpolated to match the time series from Result File 1 time wise.

### 2.2.5 Max Negative Difference

This criterion computes a value indicating how much the first time series (Result File 1) is below the second time series at the point in time where this difference has its maximum.

$$\text{"Max Negative Difference"} = |\min(y_1 - y_2)|$$

The values for the second time series (Result File 2) will be linear interpolated to match the time series from Result File 1 time wise.

### 2.2.6 Average Value

The average value is computed for both time series. Each value is given weight according to the actual time step. Values are assumed valid for the time interval since the previous value. As a consequence the first value is ignored.

$$\text{Average Value} = \left| \frac{\sum_{i=1}^n y_1 * (t_{1,i} - t_{1,i-1})}{t_{1,n} - t_{1,1}} - \frac{\sum_{i=1}^n y_2 * (t_{2,i} - t_{2,i-1})}{t_{2,n} - t_{2,1}} \right|$$

### 2.2.7 Peak Error

This criterion computes a value for the relative error for the maximum values.

$$\text{"Peak Error"} = \left| 1 - \frac{\max(y_1)}{\max(y_2)} \right| * 100$$

It should be noticed that the maximum value found in the two time series does not necessarily occur at the same point in time in the two series.

### 2.2.8 Peak Time Error

This criterion indicates how far in time the two maximum values are located away from each other. This criterion can be used to clarify if the criteria 'Max Value' and 'Peak Error' actually compare the same event.

$$\text{"Peak Time Error"} = |t_{1,\max(y_1)} - t_{2,\max(y_2)}|$$

### 2.2.9 Volume Error

This criterion computes the deviation in volume as percentage.

$$\text{"Volume Error"} = \left| 1 - \frac{\text{volumen}(y_1)}{\text{volumen}(y_2)} \right| * 100$$

### 2.2.10 Confidence Band

The purpose of this criterion is to verify that two time series are identical at all points. It is accepted that the two time series are shifted in time by maximum one time step and a tolerance (dx) is accepted.

$$\text{Inside Band} = \begin{cases} 1, & y_{2,i} \geq \min(y_{1,i-1}; y_{1,i}; y_{1,i+1}) - dx \\ & \text{and } y_{2,i} \leq \max(y_{1,i-1}; y_{1,i}; y_{1,i+1}) + dx \\ 0 & \end{cases}$$

$$\text{"Confidence Band"} = \frac{\sum_{i=1}^n \text{Inside Band}}{n} * 100$$

The values for the second time series (Result File 2) will be linear interpolated to match the time series from Result File 1 time wise. Tolerance (dx) is set to 0.01.

Note that for this criterion the ideal value is not zero but 100.

## 2.3 Run Job – Interactive Execution of a Single Job

It is possible to execute a single job from the list directly. This is done by activating the <Run Job> button. When data has been loaded from the specified result files and the comparison has been completed a new ‘Verification Plot’ dialogue presenting the result of the comparison is opened. The dialogue page is shown in Figure 2.5.

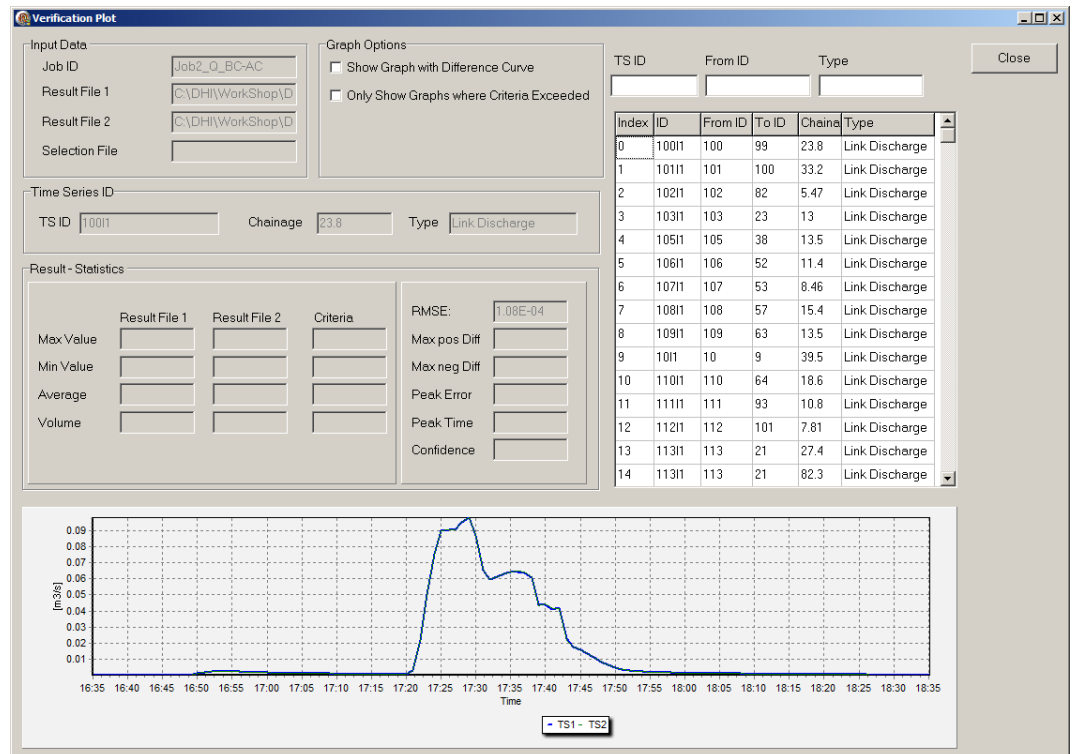


Figure 2.5 The verification plot

In the right panel of the dialogue page there is a list of all compared time series. The computed values from the comparison for the active criteria are shown in the dialogue for the time series in the currently selected row in the list.

The list can be reduced to contain only the time series where the threshold values for the active criteria are exceeded. In addition it is easy to search for a specific ID or type of parameters in the list. This is done from the fields above the list. These fields work as a ‘fast query’ feature. Type e.g. “12” and the list is reduced to contain only the lines with IDs matching “12...”. When the field is cleared the full list will again be shown.

In the lower part of the dialogue page a graph will show the two time series. It is possible to also add the curve showing the difference in the same graph.

The ‘Verification Plot’ dialogue contains the following sections:

### Input Data

Here you find information about the Job ID, the file names of the files being compared and the selection file if applied.

## Graph Options

'Show Graph with Difference Curve' - Here it is possible to switch the presentation of the difference curve on or off.

'Only Show Graphs where Criteria Exceeded' – This option is used for reducing the presentation to include only the time series where the criteria threshold has been exceeded. This works both on the list and the graph presentation.

## Time Series ID

Here you find the identification of the current time series, the distance is displayed when the time series origins from computational grid points in links. Finally, the type of the time series is shown.

## Result – Statistics

In this section the computed value for all active criteria is displayed. When the threshold value for the criteria is exceeded the value will be shown with red background, as shown in Figure 2.6.

	Result File 1	Result File 2	Criteria	
Max Value	<input type="text"/>	<input type="text"/>	<input type="text"/>	RMSE: <span style="background-color: red; color: white;">1.52E-02</span>
Min Value	<input type="text"/>	<input type="text"/>	<input type="text"/>	Max pos Diff <input type="text"/>
Average	<input type="text"/>	<input type="text"/>	<input type="text"/>	Max neg Diff <input type="text"/>
Volume	<input type="text"/>	<input type="text"/>	<input type="text"/>	Peak Error <input type="text"/>
				Peak Time <input type="text"/>
				Confidence <input type="text"/>

Figure 2.6 The Result - Statistics



### 3 Command Line Execution

The Result Verification Tool can be executed from a command line. This allows the process to be part of a scripted execution in CMD or BAT files.

When executed from a command line the tool takes two file names as parameters. That is the filename of a saved Job List and the filename of a file with additional parameters controlling the command line execution of the file. The command line takes the form:

```
<path>/DHI.MIKEURBAN.TSCompare.exe -i<ParameterFile> -c<JoblistFile>
```

The contents of a command file could be as the following example:

```
SET Bin=C:\Program Files (x86)\DHI\2016\bin\  
SET Work=C:\DHI\WorkShop\Example\  
"%Bin%DHI.MIKEURBAN.TSCompare.exe" "-i%Work%Param.txt"  
"-c%Work%JobList.xml"
```

In this example 'JobList.xml' is the job list file saved from the interactive usage of the Result Verification Tool.

The 'Param.txt' is the file containing additional parameters for controlling the command line execution. This file can have the following contents:

```
InputParam]  
  AutoRun = true  
  SilentRun = true  
  CompareAllTS = true  
  ErrorForMissingTS = true  
  ErrorForTimeOverlap = true  
  LogFileName = 'C:\Example\LogFileForErrors.txt'  
  ErrorForGeometryDifference = true  
  Tolerance = 0.01  
EndSect // InputParam
```

The following parameters are available:

**AutoRun** – 'true' will start the execution of the specified job list. 'false' will load the job list and open the main dialogue page of the tool for interactive operation. Default value: 'false'.

**SilentRun** – 'true' will execute the job list with a minimum of interaction. Progress bars will be shown during loading and processing of files. 'false' will make the tool present errors in message boxes during execution (not recommended). Default value: 'false'.

**CompareAllTS** – 'true' will compare all the time series in the two result files regardless of the user setting for result selection (H, Q, V). 'false' will respect the result selection by only comparing the time series equivalent with the user setting. Default value: 'false'.

**ErrorForMissingTS** – ‘true’ the tool reports an error if some time series exists only in one of the compared result files. ‘false’ the tool ignores time series which can only be found in one of the result files. Default value: ‘false’.

**ErrorForTimeOverlap** – ‘true’ the tool reports an error if the two result files are not covering the same time period. ‘false’ the tool ignores if the time period differs in the two result files and only compares results for the period that overlaps between them. Default value: ‘false’.

**LogFileName** – File name with full path for the file to which the tool writes an execution log. Default value is in ‘My Documents’.

**ErrorForGeometryDifference** – ‘true’ will use all available geometry information when identifying a time series from one result file in another. E.g. for a water level in a pipe also the names of upstream and downstream node, diameter of pipe etc. is compared. ‘false’ will only use ID, chainage and result type. Default value is false.

**Tolerance** – When a time series in one result file is identified in another result file a tolerance is used for e.g. comparing chainages. The provided tolerance will determine how close two grid points should be in order to be compared. Default value is 0.01.