

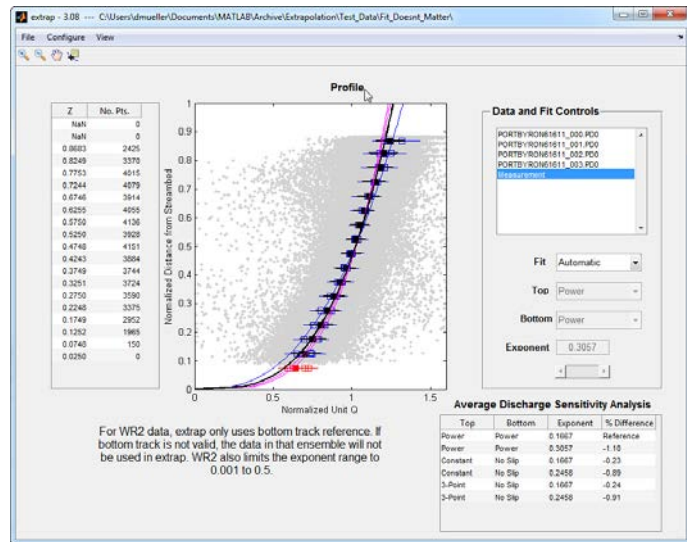
User's Guide for extrap Version 3.x

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Introduction

extrap is a Matlab program to aid in the selection of the appropriate top and bottom discharge extrapolation methods. Prior to the release of extrap, OSW recommended averaging multiple ensembles in WinRiver II to evaluate the discharge profile and select an appropriate extrapolation method for the top and bottom discharges. The approach works and is accurate, if the depth of flow is constant across the average. However, if the depth of flow is variable the resulting average may not be a good indicator of the profile shape. SonTek RiverSurveyor Live does not allow averaging.



The theoretical logarithmic velocity profile is based on normalized depths with zero being at the streambed. When an average is computed with variable depths in WinRiver II depth cells at different normalized depths are averaged together, which is incorrect. To avoid this problem extrap computes the relative depth of each depth cell and then groups the depth cells into 5% increments of normalized depth to provide a representation of the average profile.

Extrap provides the option to compare the data with common top (power or constant) and bottom (power and no slip) extrapolation methods. Version 3.x allows loading of all transects that comprise a discharge measurement and provides both automated and manual methods for selection of the appropriate extrapolation methods. The results of the extrapolation evaluation can be stored in an ASCII file and saved with your measurement. There is no interaction between extrap and WinRiver II or RiverSurveyor Live so the user must manually enter the selected extrapolation methods into WinRiver II or RiverSurveyor Live to compute the final discharge for the measurement.

How to Use

Extrap 3.x is intended for use with data collected from a moving boat and is not compatible with mid-section measurement files. The following is a generalized description of the steps for using extrap to evaluate and select the appropriate extrapolations methods for a measurement. Details of the supported data files, graphs, tables, and user interface are presented later in this guide.

1. Load appropriate data file(s). For TRDI data collected with WinRiver II it is recommended that you load the *.mmt file that has been saved with the transects checked that comprise the discharge measurement. For SonTek RiverSurveyor data, the data should be loaded into RiverSurveyor Live and the Matlab files generated. The Matlab files generated from RiverSurveyor Live for all of the transects comprising the discharge measurement should be loaded at one time. Moving bed tests or other transects not used in the computation of the final discharge should not be loaded into extrap, as they would affect the reported discharge sensitivity analysis.
2. Visually assess the automated fit generated by extrap.
3. Look at the Average Discharge Sensitivity Analysis table to determine how sensitive the final discharge is to the selected extrapolation. If the discharge is very sensitive, then extra care needs to be taken and perhaps documentation recorded as to why a particular extrapolation was selected.
4. If the automatically selected extrapolation is not satisfactory after steps 2 and 3, change the Fit to Manual and adjust the Top, Bottom, and Exponent to achieve the best fit.
5. Save the summary of the fit analysis to an ASCII file and store it with your measurement. The save summary feature will allow you to enter comments. This is a good place to document any considerations regarding the selection of the extrapolation methods.
6. Enter the selected extrapolation methods and exponent into WinRiver II or RiverSurveyor Live and reprocess the data to achieve the final discharge.

Supported Data Formats

Extrap allows loading of all transects that comprise a measurement. For TRDI ADCPs (Rio Grande, StreamPro, and RiverRay) the *.mmt, *.pd0, and *.000 files are supported. If the *.mmt file is loaded extrap will determine which raw files should be read (uses all checked transects) and associates the supporting data (transducer depth) with the raw data files. If TRDI raw data files (*.pd0 or *.000) are used independently from the *.mmt file, the user will be prompted for the transducer depth for each file, as this information is not in the raw data files. Extrap is not compatible with ASCII out files from WinRiver II. To use extrap with SonTek/YSI RiverSurveyor data the data must first be loaded into RiverSurveyor Live and Matlab files created. All the necessary data are contained in the Matlab files generated by RiverSurveyor Live.

Computations

The discharge is computed as the cross product of the water velocity for each depth cell and the boat velocity for the associated ensemble. The discharge in each depth cell is then normalized by summing the discharge for the depth cells in an ensemble to obtain an ensemble discharge. The discharge in each depth cell of the ensemble is then divided by the absolute value of the ensemble discharge to obtain the normalized depth-cell discharge. Once the normalized discharge is computed the sign of the discharge in each depth cell is checked. If all

the depth cells in an ensemble are negative then the sign of the whole ensemble is changed to make the ensemble positive. If, however, the value of any depth cell has a sign different from the others the signs are maintained. This procedure allows negative normalized discharges caused either by a reversal of boat travel or by a complete flow reversal to plot consistently with the remainder of the data, while maintaining the sign of the discharge for vertically stratified bi-directional flow situations.

The normalized depth is computed by dividing the depth to the centerline of the depth cell by the mean depth of the ensemble and subtracting this value from 1. This provides a normalized distance from the streambed (0) to the water surface (1).

If velocity is selected as the plotted variable, the mean x and y component in each ensemble is computed. The velocity in each depth cell of an ensemble is then projected into the direction of the mean x and y components. The projected velocity is then divided by the mean of the projected velocities for each ensemble to compute a normalized velocity. This normalized velocity is then plotted.

User Interface

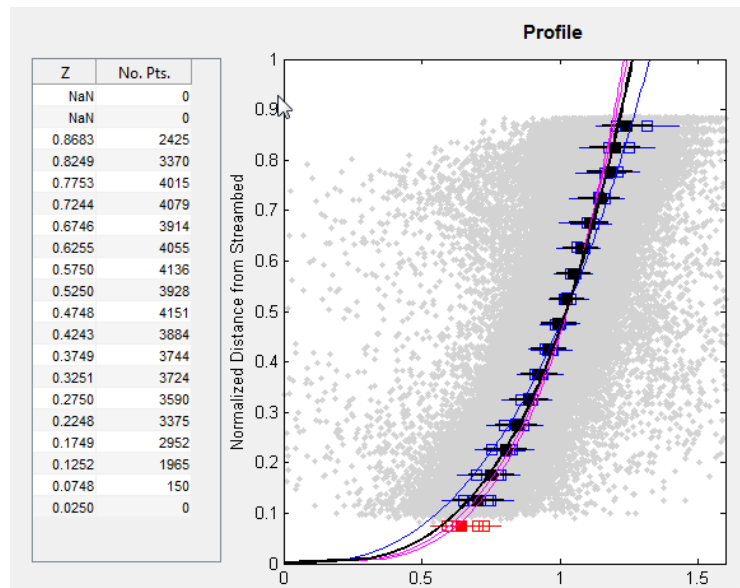
Description of Graph Elements

Raw Data (Gray Dots)

The raw data represent the normalized discharge or velocity in each depth cell for all transects selected in the Data and Fit Controls.

Median Points (Blue/Red/Black Squares)

The normalized distance from the streambed is divided into segments of size 0.05 from 0 to 1. A median value of the normalized unit discharge is then computed for each segment and the result assigned to the average normalized depth of the data in the segment. The location of the mean normalized depth for each segment and number of points used in each segment is reported in a table to the left of the graph. The median value was selected to minimize the effect of any outliers.



The median points are colored blue if the number of points in the segment exceeds the threshold. The default threshold is set to 20% of the median number of points for all segments. The threshold can be changed by the user (see Configuration Menu). To help ensure that the median profile is representative of the data and not overly influenced by a few points in the top

or bottom segments, only median values with sufficient points to exceed the threshold are used in the computation of the extrapolation. If the number of points in a segment does not exceed the threshold value the median point is colored red and it is not used in the computation of the extrapolation.

Solid black squares represent the median values of the composite of all transects in the measurement.

Whiskers (Horizontal Blue/Red/Black Lines)

The whiskers on each median value represent the 25th and 75th percentile of all the data in that 5% increment. Thus, 50% of the data for that increment fall within the limits of the whiskers. Colors are representative of the type of median value.

Extrapolation (Solid Blue/Magenta/Black Line)

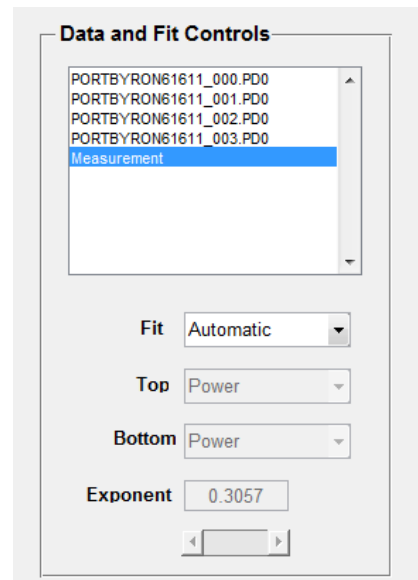
The extrapolation is computed using either the automated algorithm or the method manually selected by the user. The extrapolation fits are color coded such that magenta lines represent transects collected in the left to right direction, blue lines represent transects collected in the right to left direction, and the black line represents the composite of all transects in the measurement. The default fit type is set to automatic and the computer will attempt to select the appropriate top and bottom methods, however, the user can change the fit type to manual and change the top and bottom methods and the exponent.

Data and Fit Controls

The data and fit controls are comprised of the transect selection list, drop down menus to select the fit type and extrapolation methods, and an edit box and slider to manually change the exponent.

Transect Selection List

The transect selection list shows the filename all of the transects loaded and the composite for the measurement. The default is for the composite measurement to be shown. To view a specific transect, simply click on the transect filename and the graph and fit characteristics for that transect will be shown. The fit characteristics of an individual transect can be changed but this will not affect the average discharge sensitivity analysis. Extrap assumes only one set of fit characteristics should be applied to the measurement, so the average discharge sensitivity analysis is based on the fit characteristics of the measurement.



Fit

The fit dropdown menu allows the user to change the fit type from the default automatic algorithms to manual. If manual is selected, the top, bottom, exponent, and slider will become active.

Top

The top dropdown menu displays the top extrapolation method. This dropdown menu cannot be changed unless Fit is changed to manual. The options are Power and Constant.

Bottom

The bottom dropdown menu displays the bottom extrapolation method. This dropdown menu cannot be changed unless Fit is changed to manual. The options are Power and No Slip.

Exponent

The exponent edit box displays the exponent for the power or no slip extrapolations. The exponent cannot be changed unless Fit is changed to manual. If fit is changed to manual, the exponent can be changed by manually typing a value in the edit box or by using the slider below the box to incrementally change the value.

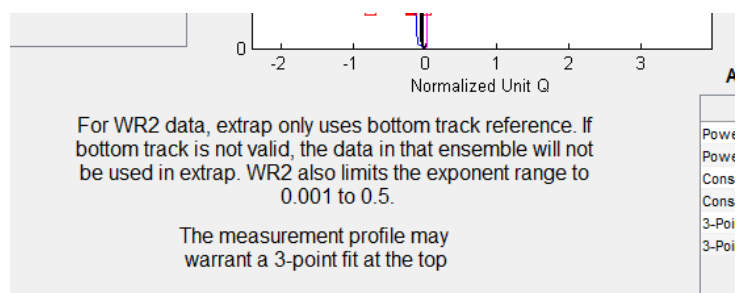
Average Discharge Sensitivity Analysis

The sensitivity of the extrapolation method for the top and bottom extrapolation is evaluated by computing the discharge for each combination of top and bottom extrapolation methods with a default and least squares fit exponents and reporting the percent difference from the $1/6^{\text{th}}$ power/power fit. If a manual fit is used for the composite measurement, then an additional line will be added to the table that represents the manual fit. This table can be used to help determine the effect of extrapolation choices on the final discharge. For the example shown in this user's guide, there is very little difference in the final discharge no matter what extrapolation method is chosen. This table can also be used to provide an estimate of the uncertainty of the top and bottom extrapolation methods on the final discharge when considering how to rate the measurement.

Top	Bottom	Exponent	% Difference
Power	Power	0.1667	Reference
Power	Power	0.3057	-1.10
Constant	No Slip	0.1667	-0.23
Constant	No Slip	0.2458	-0.89
3-Point	No Slip	0.1667	-0.24
3-Point	No Slip	0.2458	-0.91

Message Area

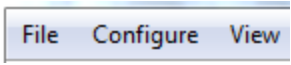
To the left of the Average Discharge Sensitivity Analysis and below the graph is an area where messages related to the extrapolation



evaluation may be displayed. Although the 3-point top extrapolation method is included in the sensitivity analysis it is not included as a top extrapolation option in the Data and Fit Controls and will not be selected when using automatic fit algorithms. If the data meet criteria that suggest a 3-point top extrapolation may be appropriate, a message will appear in this area. A statement on the limitations of extrapolation for TRDI data is also displayed when appropriate.

Menus

File Menu



Open TRDI *.mmt: Opens the selected mmt file and loads all checked transects.

Open TRD *.pd0, *r.000: Opens the selected TRDI raw data file(s). The user will be prompted to enter the transducer draft.

Open SonTek *.mat: Opens the selected Matlab file(s) created by RiverSurveyor Live.

Save Summary: Save a summary of the fit and discharge sensitivity analysis to an ASCII file. The user may add comments documenting any special considerations regarding the extrapolation method selection.

Exit: Exits the program.

Configure Menu

Data Type: Allows selection of discharge or velocity data. Discharge is the default and is recommended for all moving-boat measurements.

Threshold: Allows the user to change the cutoff threshold from the default value of 20% of the median number of points in all of the segments to a user determined value.

Subsection: Allows the user to look only at a subsection of the data by entering a lower and upper discharge range. The range is applied from the beginning of the transect independent of the starting bank. This is only applied to the profile evaluation and does not affect the discharge sensitivity analysis. For example, if the user wanted to look at the profile for the center 50% of the discharge they would enter 25 for the lower and 75 for the upper.

View Menu

Cell Data: Turns on and off the display of the cell data (gray dots).

Highlight Surface Cells: Highlights the cells that are the top cell for each ensemble.

Transect Fit: Turns on and off the display of the extrapolation fit for each transect.

Transect Medians: Turns on and off the display of the median points for each transect.


Measurement Fit: Turns on and off the display of the extrapolation fit for the composite measurement.


Measurement Median: Turns on and off the display of the median points for the composite measurement.


Tool Bar



Zoom In:  Allows zooming in on data in the graph.

Zoom Out:  Allows zooming out on data in the graph.

Pan:  Allows panning in the graphics window.

Probe Data:  Allows data values to be probed by clicking on the data points in the graphs.