extrap for ADCP Profile Extrapolation#

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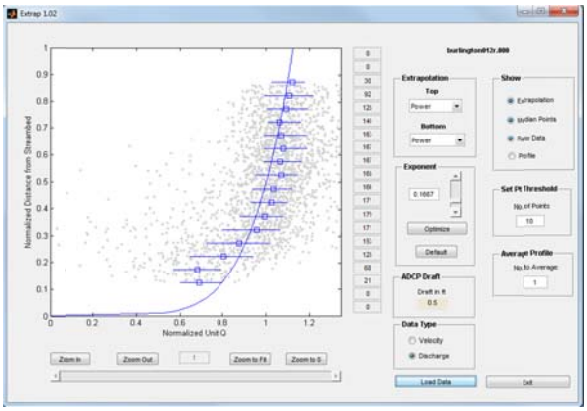
Introduction



extrap is a Matlab program to aid in the selection of the appropriate top and bottom discharge extrapolation. To evaluate the discharge profile and select an appropriate extrapolation method for the top and bottom discharges, the OSW has recommended averaging multiple ensembles in WinRiver II. 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. The logarithmic velocity profile is based on normalize 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. The user can also change the 1/6th exponent on the power fit either manually or through an automated optimization algorithm. There is no output from extrap so what is learned from evaluating data in extrap must be manually transferred to WinRiver II or RiverSurveyor Live in processing the transects for a final discharge.

Data Input

extrap is compatible with the raw data files from TRDI ADCPs (Rio Grande, StreamPro, and RiverRay). It 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.

Note: For TRDI ADCPs the raw data files are used. The raw data files do not contain the draft of the instrument in the water so the program will prompt for this value when a TRDI data file is selected.

Computations

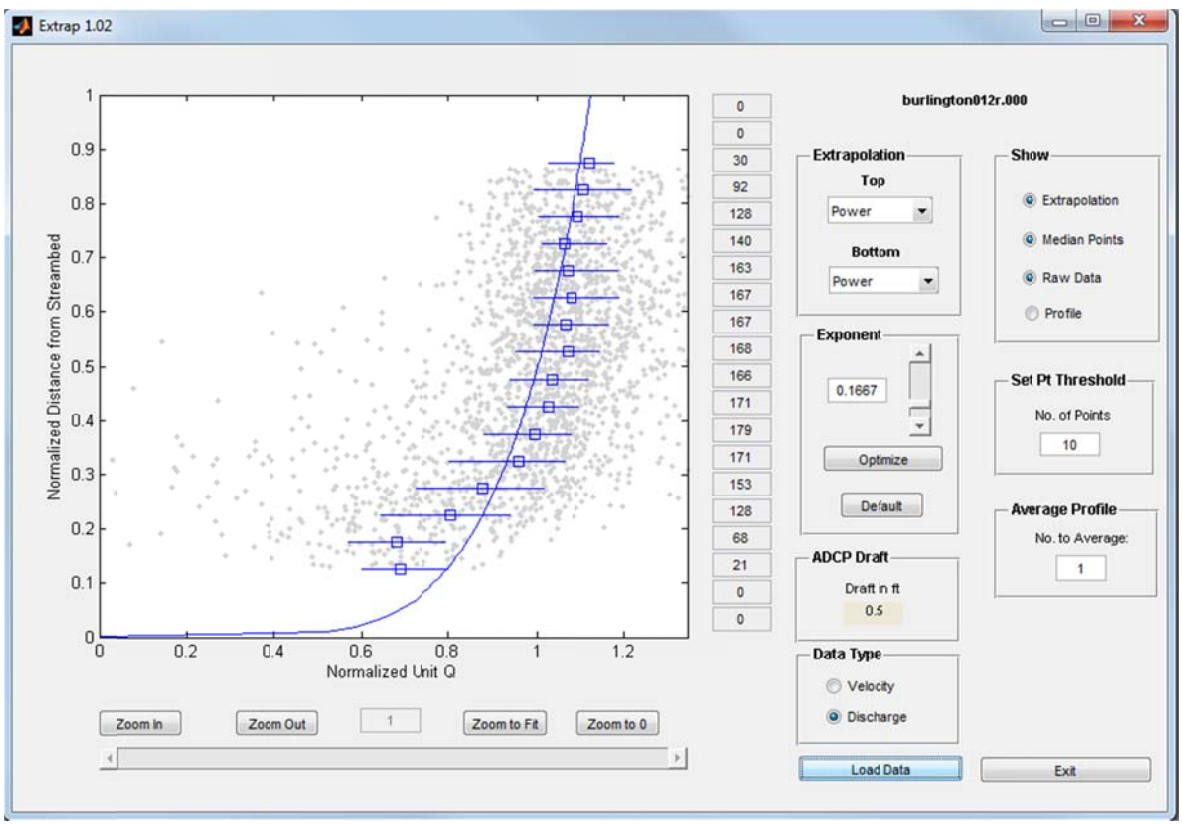
The discharge is computed as the cross product of the water velocity for each depth cell and the boat velocity for the associated ensemble. The discharge in each depth cell is then normalized by summing the discharge for the depth cells in each ensemble to obtain an

ensemble discharge. The discharge in each depth cell is then divided by the absolute value of the ensemble discharge to obtain the normalized depth cell discharge. The normalized depth is computed by dividing the depth to the centerline of the depth cell by the weighted 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).

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.

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.

Note: The discharge variable is the recommended plotting variable of moving-boat transects and the velocity variable is the recommended plotting variable for stationary transects.



Description of Graph Elements

Raw Data (Gray Dots)

The raw data represent the normalized discharge or velocity in each depth cell.

Median Points (Blue/Red 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 a normalized depth at the center of the segment. The number of points used in each segment is reported in the text boxes to the right of the graph. A 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 threshold is set to 10 by default but the user can change the value. 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. Only median values with sufficient points to exceed the threshold are used in the computation of the extrapolation.

Whiskers (Horizontal Blue/Red 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.

Extrapolation (Solid Blue Line)

The extrapolation is computed using the method chosen by the user and the blue colored median points. The default extrapolation is set to power/power with a 1/6 exponent. The exponent can be changed by entering a new value, by using the slider in the exponent panel, or by clicking the optimize button. The top extrapolation can also be set to constant, which extrapolates the topmost median point to the surface. The bottom method can be set to “No Slip” which will automatically set the top extrapolation method to constant. If “No Slip” is selected the algorithm will use all median points within 20 percent of the depth from the bottom (0.2) to compute the power fit from 0 to 0.2. In there are no median points in the lower 20% the last median point is used. The exponent adjustment can be used for the “No Slip” condition also, but can result in unreasonable exponents if there are few median values in the lower 20% of the flow.

Profile (Solid Black Line)

The normalize profile for each individual ensemble or average of ensembles can be plotted for comparison to the extrapolation, median points, and raw data. The profile is turned off by default but the user can click on the Profile radio button in the Show panel to turn the profiles on. The desired profile can be plotted by entering the profile number in the box below the graph and above the slider or by using the slider.

The user can average multiple ensembles together by entering the number of ensembles to average in the Average Profile panel. The averaging is consistent with that used in WinRiver II. The average discharge is computed for each depth cell using all available data in the averaging interval for that depth cell depth. Once the average discharge is computed the average discharge is normalized and plotted on the graph.

Description of User Interface

Load Data: Opens a dialog to load a TRDI PDO formatted data file.

Exit: Closes the program

Zoom In: Zooms in 5% or normalized discharge.

Zoom Out: Zooms out 5% of normalized discharge.

Zoom Fit: Zooms display to median points.

Zoom to 0: Zooms so that 0 normalized unit discharge and the median points are all present in the graph.

Extrapolation Panel: From the two drop down menus the user can select the appropriate extrapolation methods. Note: if no slip is selected for the bottom method the top method will automatically change to constant.

Exponent Panel: Allows the user to change the power exponent for the power or no slip extrapolation methods. The default is $1/6^{th}$ (0.1667). The user can either enter a different value directly in the text box, using the slider, or by clicking optimize to change the existing value. The graph is updated automatically.

Show Panel: The show panel allows the user to turn on or off different components in the graph. The graph is updated automatically.

Set Pt Threshold Panel: The number of points in a segment must exceed this amount for the median value of the segment to be used in the computation of the extrapolation. The default is 10. The number of points in each segment is displayed in the text boxes to the right of the graph.

Average Profile Panel: The number of profiles to average for display purposes is set by the user in this panel. The default is 1 or no averaging. For average profiles to be displayed the profile radio button in the Show Panel must be turned on. The Profile shown is the graph is determined by the value of the Profile slider and text box below the graph.

Profile Slider and Text Box: The slider and text box below the graph allows the user to move through the file and select a profile to display. The graph is updated automatically as the profile

number is changed. The profile number does not reflect the ensemble number and always starts at 1 and increments by 1. If profiles are averaged the profile number still begins at 1 and increments by 1 but the maximum profile number is reduced to the number of averaged profiles.

Data Type Panel: This allows the user to plot either normalized discharge or normalized projected velocity. Generally normalized discharge is the better option for moving boat applications and normalized projected velocity is better for stationary measurements. Discharge is the default.

Draft Panel: Displays the either the draft entered for TRDI data files or the draft read from the RiverSurveyor *.mat file.