QRev - Processing Moving-boat ADCP Discharge Measurements

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February 27, 2017

Overview

- Why QRev
- QRev Approach
- Using QRev
  - Help
  - Window details
  - Processing tidal measurements
  - Plotting transects in Google Earth
- Demo
- Dealing with warnings and errors
  - Why
 - Suggested approach
- Limitations

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The typical ADCP user will not be an ADCP expert!

Provide HELP and GUIDANCE through **SMART SOFTWARE**

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Computational Differences

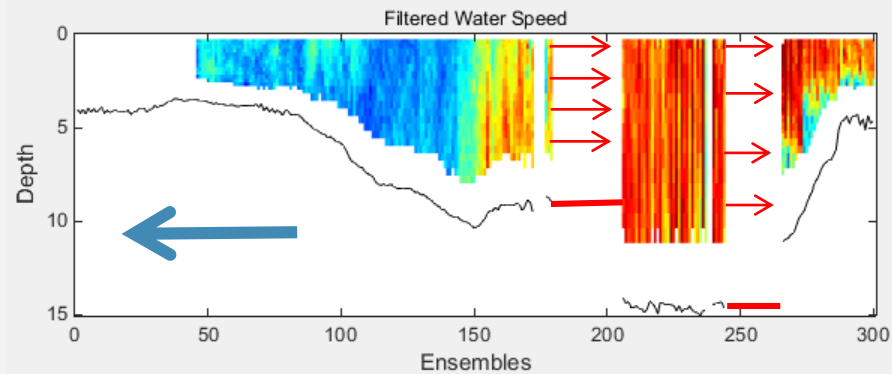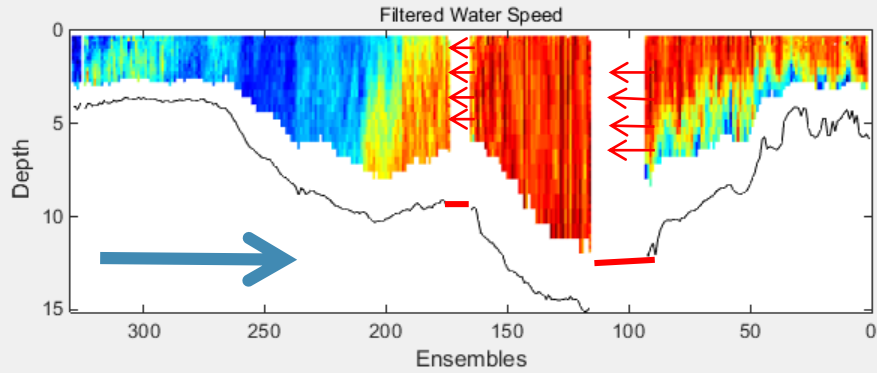| Characteristic	TRDI	SonTek	Qrev 3.19
GPS based boat velocity	Nearest in time	Use last valid	Manufacturer
Edge coefficient	vertical = 0.91	vertical = f(width/depth)	Manufacturer
Edge ensembles	10 or user valid	Edge samples only	Manufacturer
Edge velocity	Simple average to get magnitude of measured	Profile averaging includes extrapolation then projects the mean vector	Manufacturer
Bottom extrapolation type	Constant not allowed	Constant is an option	Constant not allowed
Extrapolation exponent	Single	Top and Bottom	Single, Automated
Invalid water track	Increase dt	N/A	Linear interpolation
Invalid bottom track	Increase dt	Hold last valid (9)	Linear interpolation
Invalid GPS	Hold last valid	Increase dt	Linear interpolation
Invalid depth	Increase dt	Hold last valid	Linear interpolation
Invalid depth cell	Interpolate or extrapolate	N/A	Interpolate or extrapolate
Data screening / filters	Manual	None	Automatic with manual override

Best Available Data
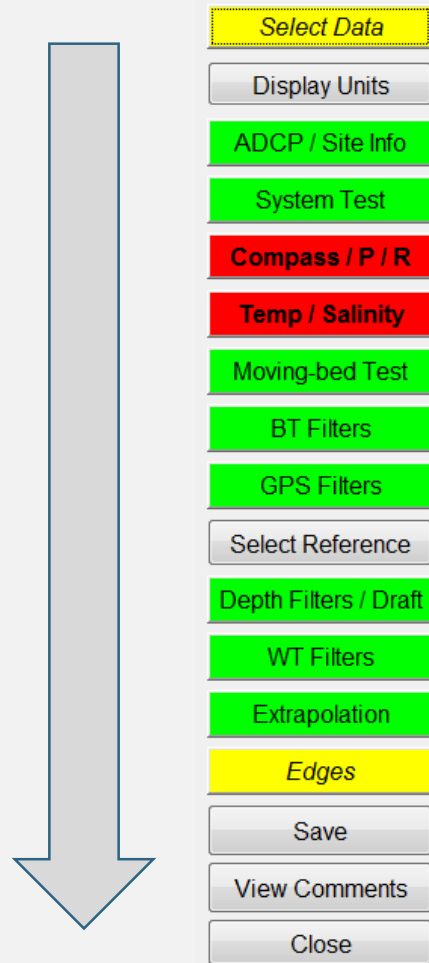
- Discharge
  - Water velocity
  - Depth
  - Boat speed
- Water velocity
  - Depth
  - Boat speed
- Depth
  - dependent on boat speed for cross section shape
- Boat speed
  - Bottom track
  - GPS

Select Data
Display Units
ADCP / Site Info
System Test
Compass / P / R
Temp / Salinity
Moving-bed Test
BT Filters
GPS Filters
Select Reference
Depth Filters / Draft
WT Filters
Extrapolation
Edges
Save
View Comments
Close

The QRev Difference

WinRiver II – Nav, Depth, WT => Ensemble

QRev – Nav, Depth, WT => Uses All Data

Q=112,400 cfs
Estimated 95% Uncertainty =40%
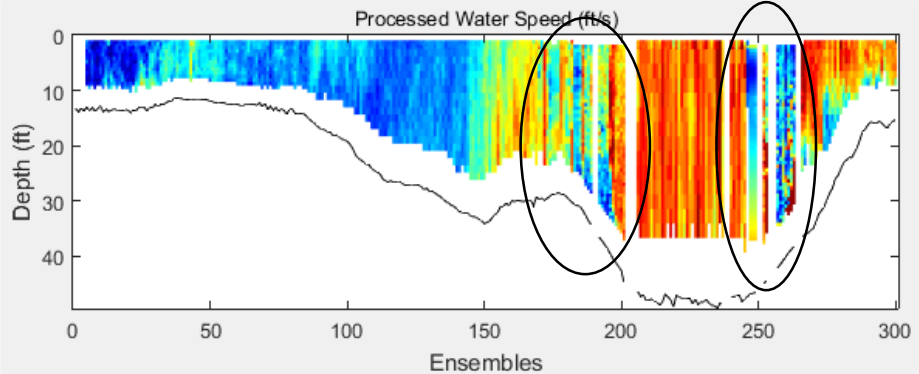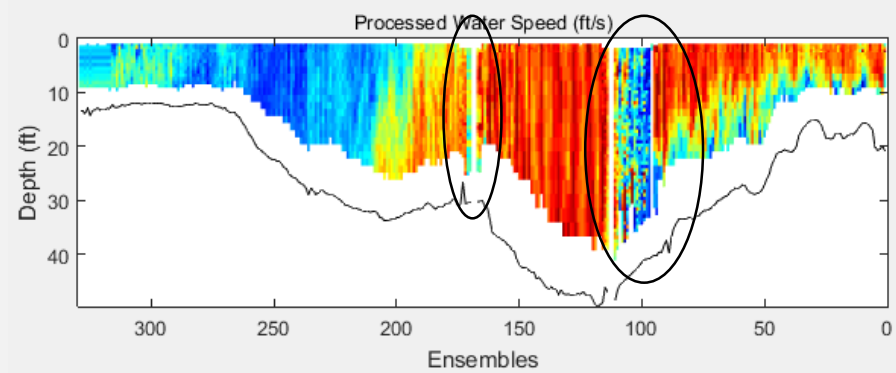
Q=95,000
Estimated 95% Uncertainty =14%

QRev – Goals & Requirements

- Process both SonTek and TRDI data
- Logical workflow
- Automated data quality review and feedback
- Consistent algorithms
- Use best available data
- Manual overrides
- Issue specific dialog windows
- Feedback to user on uncertainty
- Tablet friendly

Automated Review and Feedback

QRev
User guide

2. Main Window

2. Main Window

The Main Window is designed to be logical and tablet friendly. The Main Window has six sections: (1) buttons down the left side, (2) Measurement Details panel, (3) Messages panel, (4) Measurement Quality Assessment panel, (5) User Rating panel, and (6) Profile Extrapolation panel. Two buttons on the right allow the user to add comments and view this user's guide. The information available from this main window provides the user an overview of the measurement quality and totals. The color highlighting and messages alert the user to any potential issues detected by the automated data quality assessment. Other modal windows to explore the data or change the processing settings are accessed from this main window using the buttons on the left.

Web Browser - 11. BT Filters

11. BT Filters

Location: file:///C:/dsm/dsm_documents/MATLAB/BitBucket/QRev_Project/QRev/QRev_Help_Files/HTML/bt_filters.htm?st=MA%3D%3D&sct=MA%3D%3D&mw=MjQw&ms=AA%3D%3D

QRev
User guide

11. BT Filters

11. BT Filters

The BT Filters button opens a window that allows the user to evaluate the bottom track data for each transect and change the filter settings. Filter settings are applied to all transects and cannot be set for individual transects.

Graphics Toobar — 11
Summary Table — 1
Transect Displayed — 2
Filter Graph — 3
BT Speed Time Series — 4
Ship Track Graph — 5
Add Comment — 12
User's Guide — 13
Navigation Reference — 6
Beam Filter — 7
Error Velocity Filter — 8
Vertical Velocity Filter — 9
Other Filter — 10
Close Window — 14

1 Summary Table

Filename	# Ensembles	# <4 Beam	# Invalid Total	# Invalid Orig Data	# Invalid <4 Beam	# Invalid Error Vel	# Invalid Vert Vel	# Invalid Other	Discharge Prev. (ft3/s)	Discharge Now (ft3/s)	Discharge % Change
20160922153000r.mat	378	11	11	11	11	0	0	0	1442.55	1442.55	0.00
20160922153635r.mat	381	16	16	16	16	0	0	0	1535.51	1535.51	0.00

Comment Button

- Comment button –for adding comment

- Located in the top right of all QRev windows. Clicking opens comment windows. User comments are tagged with name of dialog where comments were entered and time tagged.

- All comments can be viewed by pressing the "View Comments" button on the main window

- Comments cannot be edited

COMMENT

Enter Comment:

QRev Main 01/25/2016 12:57:11:

OK   Cancel
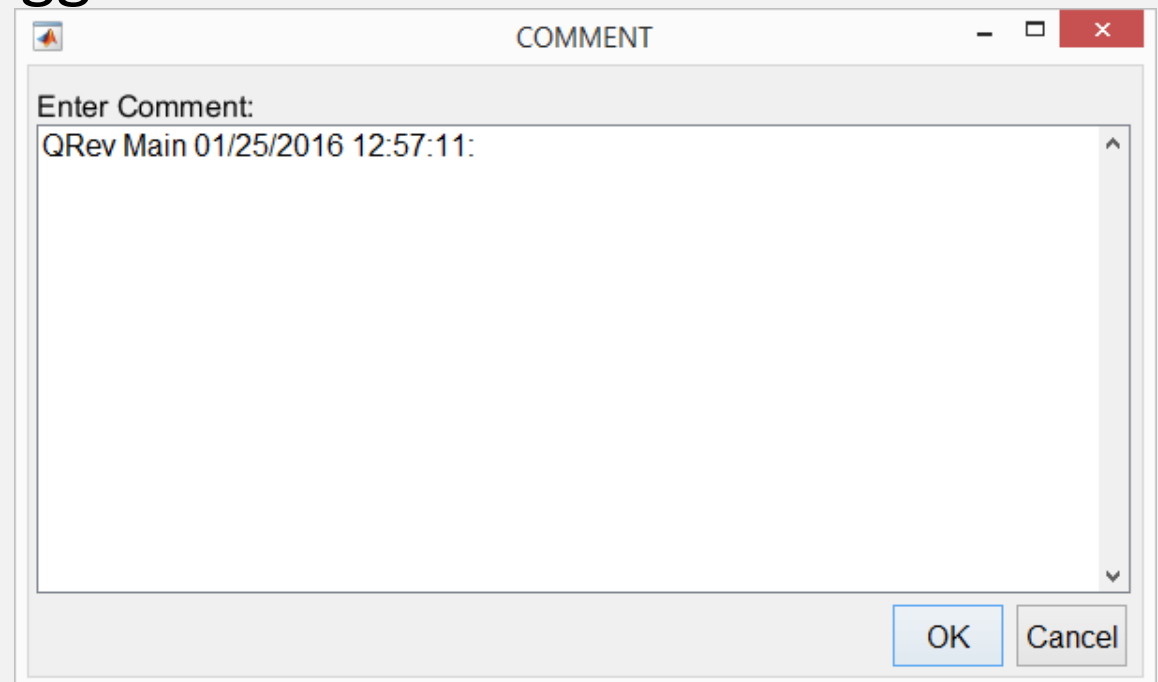
Measurement Details – Main Window

- Table of measurement results and configuration settings
- Navigate
  - Scroll bars
  - Click in table and use keyboard arrows
  - Column width changed by click and drag of column divider
- Use check box determines if transect used in total Q and only thing that can be edited in table
- Cells related to identified issues may have a background color of yellow or red

PARAMETERS	MEASUREMENT	60115143543r	60115143828r	60115144115r	60115144408r
DISCHARGE					
Use		✓	✓	✓	✓
Total Q (ft3/s)	**172.484**	**170.713**	**175.393**	**173.824**	**170.005**
Top Q (ft3/s)	75.777	75.194	77.073	76.549	74.293
Middle Q (ft3/s)	76.817	76.085	77.363	77.336	76.485
Bottom Q (ft3/s)	16.155	16.155	16.732	16.259	15.475
Left Q (ft3/s)	1.655	1.624	1.854	1.806	1.335
Right Q (ft3/s)	2.079	1.655	2.371	1.874	2.417
TIME					
Duration (sec)	619.0	148.0	150.0	157.0	164.0
Start Time (01/15/2016)	14:35:43	14:35:43 R	14:38:28 L	14:41:15 R	14:44:08 L
End Time (01/15/2016)	14:46:52	14:38:11	14:40:58	14:43:52	14:46:52
REFERENCE					
Navigation Ref		BT	BT	BT	BT
Composite Tracks		Off	Off	Off	Off
Depth Ref		BT	BT	BT	BT
MOVING-BED					
Moving-bed	No				
Correction	No				
CHARACTERISTICS					

Measurement Details (Units: English)

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QRev - Measurement Quality Assessment

- Random – uses the Q COV and # transects
- Invalid – 20% of the sum % discharge for invalid cells and ensembles
- Edge - 30% of total discharge in edges
- Extrapolation – % difference in Q from selected extrap to other extrap methods and average of best 4 options
- Moving-Bed –
  - Bottom track not reference = 0%
  - bottom track used
    - valid moving bed test with no moving bed = 1%.
    - moving bed present and correction applied = 1.5%.
    - moving bed test warnings, invalid, or not done = 3%
- Systematic – 1.5% (for biases in ADCPs and beam misalignment)
- User column for adjusting Automatic computed uncertainties

Measurement Quality Assessment

	COV %		% Q
Q:	1.48	Left/Right Edge:	0.96 / 1.21
Width:	0.93	Invalid Cells:	0.11
Area:	0.75	Invalid Ens:	0.24

Parameter	Automatic	User
Random Uncertainty	2.4	
Invalid Data Uncertainty	0.1	
Edge Q Uncertainty	0.6	
Extrapolation Uncertainty	1.3	
Moving-Bed Test Uncertainty	1.0	
Systematic Uncertainty	1.5	
Estimated 95% Uncertainty	4.2	4.2

User Rating

Not Rated

- Not Rated
- Excellent (< 2%)
- Good (2 - 5%)
- Fair (5 - 8%)
- Poor (> 8%)

Profile Extrap
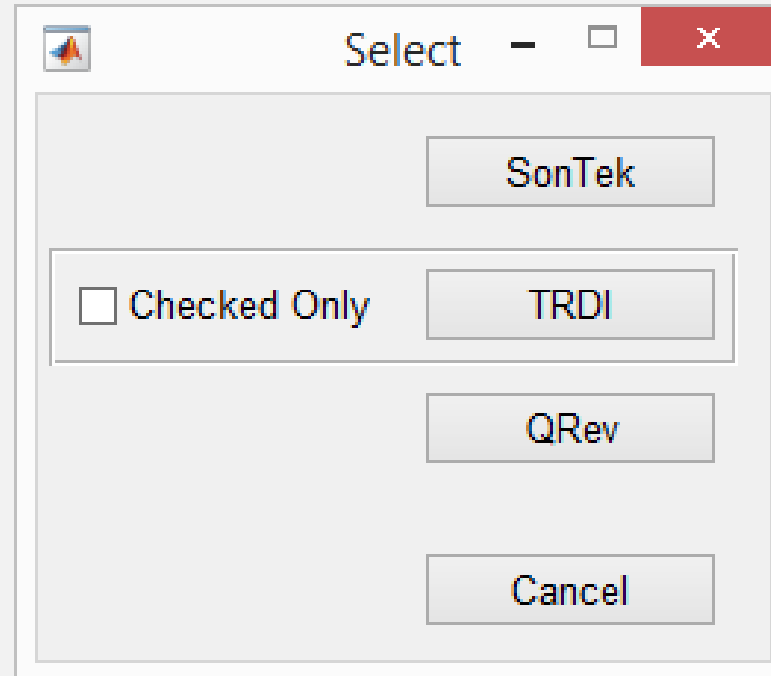
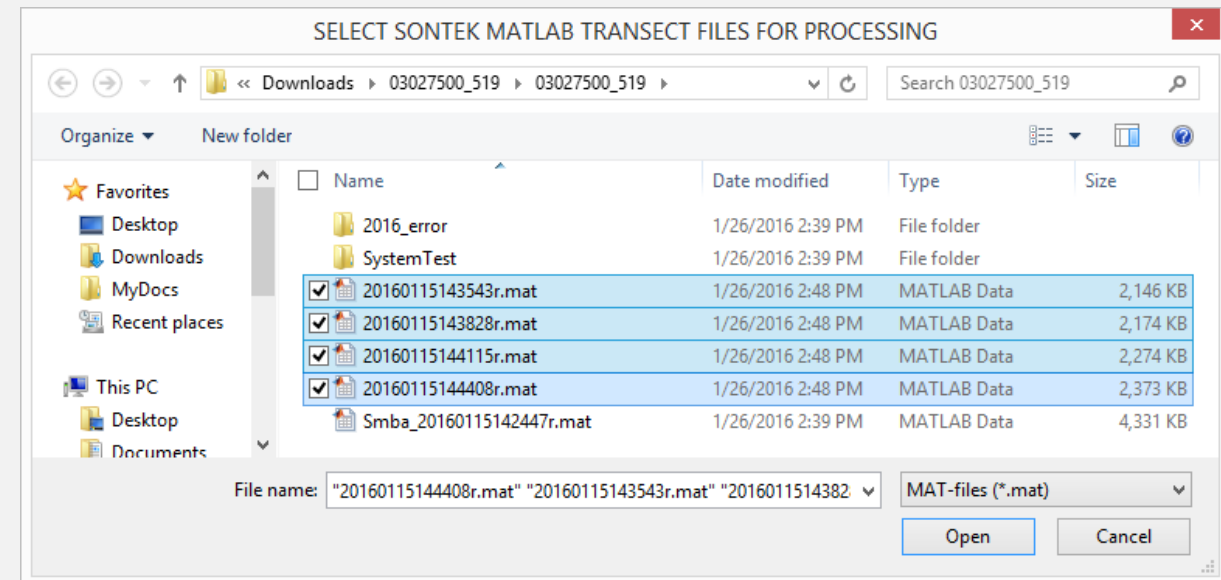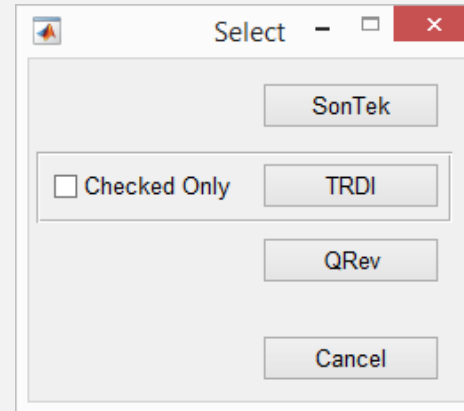Selected

Selecting Data to Process

- Used to load data into Qrev

- Opens dialog box to select data
  - SonTek RS Live Matlab output
 - WinRiver II .mmt and pd0 files
  - Previously saved Qrev .mat

Loading RSLive Measurement Data

- Must first export all transects and moving bed test to matlab using RSLive

- Select all transects to be used

- QRev will automatically load associated moving bed tests, system tests, and compass evaluations provide they follow standard RSLive naming and file storage conventions
  - Moving bed test must being with "Smba_" or "Loop_"
  - System tests and compass calibrations must be in subfolders named "System Test" and "CompassCal"
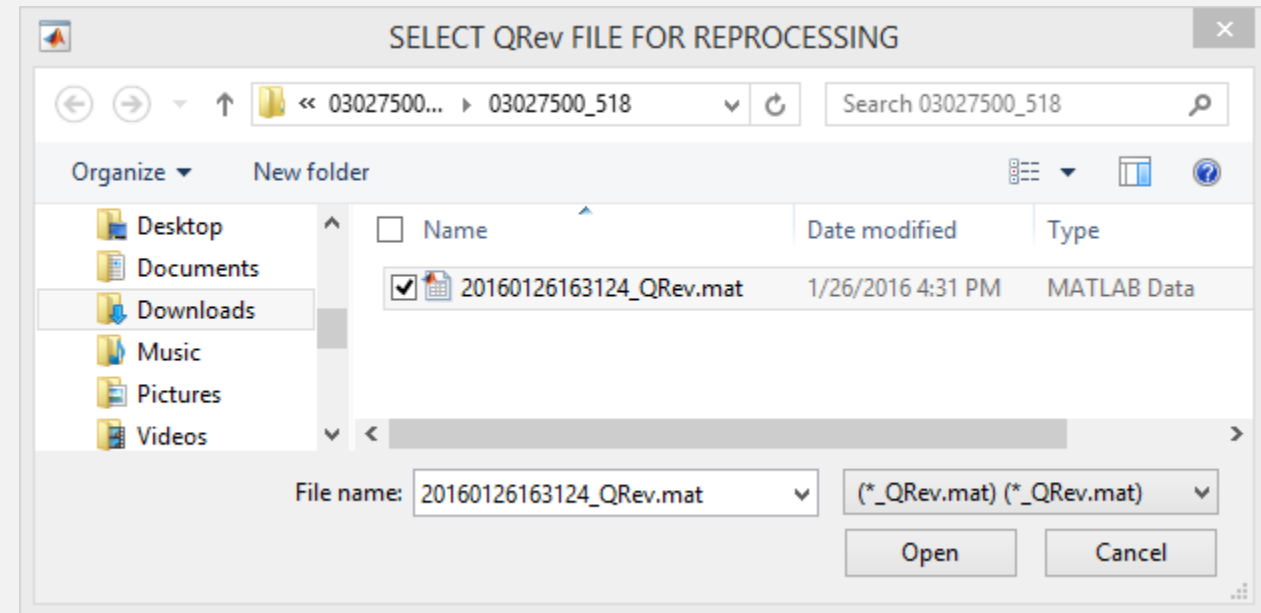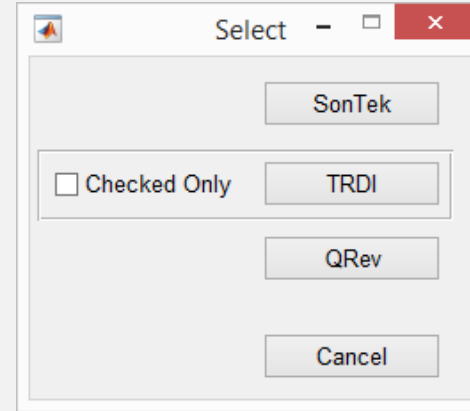
Loading WinRiver II Measurement Data

- Press TRDI button

- Select .mmt file in open dialog box and all transects and supporting data will be loaded

- If you only want to load transects that have been check in WinRiver II, click the "checked only" box prior to pressing the TRDI button
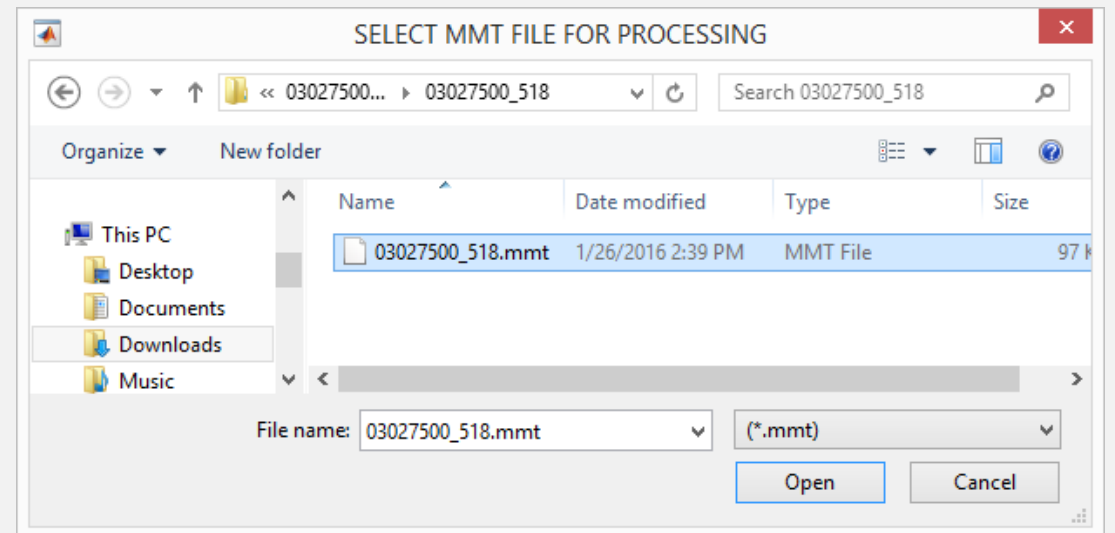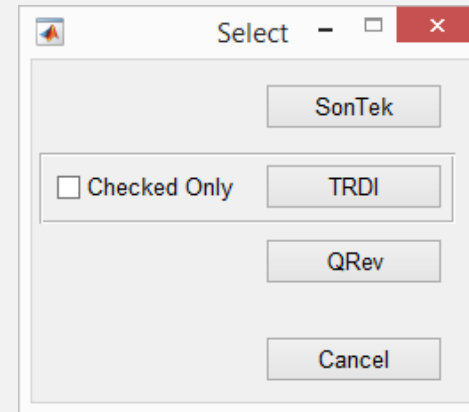
# Loading a Measurement Previously Processed in QRev

- Press the QRev button

- Select previously saved QRev file
  - Will have extension of _QRev.mat

- Note: After a measurement is processed in QRev, the QRev file should be saved and any reprocessing or reviewing of the measurement should be done by loading the QRev file NOT the original data files

Display Units

- Sets the units used for values displayed in Qrev
  - English (default)
  - SI
- Option chosen will continue to be used when QRev is restarted
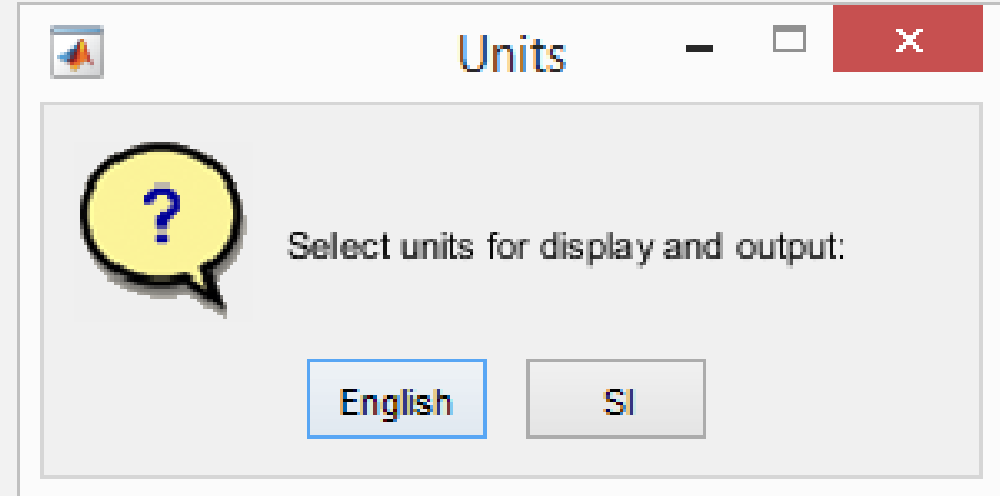
ADCP / Site Info

System Test

System Test

- User can review system tests collected with measurement
- Automatically loads tests from .mmt and RSLive tests found in "System Test" folder
- Test done outside normal procedures and not stored in default location or file can be loaded using the "Load Test Results Button"

System Test

05/01/01 00:16:53   Load Test Results   Number of Failed Tests: 0

```
=
StreamPro
Teledyne RD Instruments (c) 2010
All rights reserved.
Firmware Version: 31.13

>CR1
[Parameters set to FACTORY]

>
>TS?
TS 05/01/01,00:16:53.51
>
>PS0
   Serial Number:  885
       Frequency:  2000000 Hz
   Configuration:  4 BM, JANUS
      Beam Angle:  20 DEGREES
```

OK
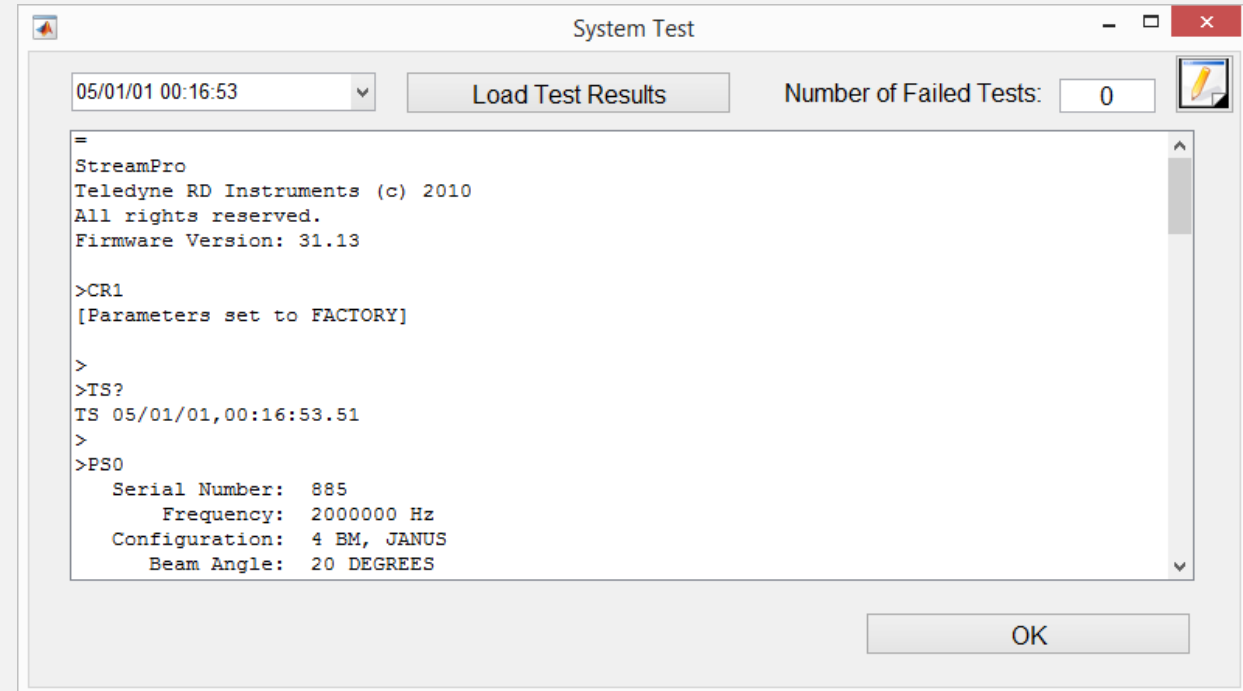
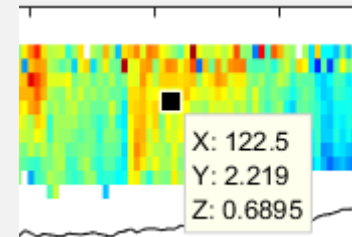# Compass /P/R   (Heading, Pitch, and Roll)

Compass / P / R

- For evaluation of the heading, pitch, and roll and adjustments to the magnetic variation and heading offset

Common Features in QRev Windows

- Tool Bar
  - Each window with graphs has a toolbar at the upper left

  - Zoom In:

  - Zoom Out:

  - Pan:

  - Probe Data: Clicking on a data point displays data values

X: 122.5
Y: 2.219
Z: 0.6895

Common Features in QRev Windows

- Tables
  - Many windows have a table displaying transects as a row with columns of associated info
  - Scrollbars located a the right and bottom can be used to move through the table
  - After clicking in a table, keyboard can be used to navigate
  - Graphs typically only display data from a single transect. The transect being displayed can be changed by changing the row selected in the table (up/down arrow keys)
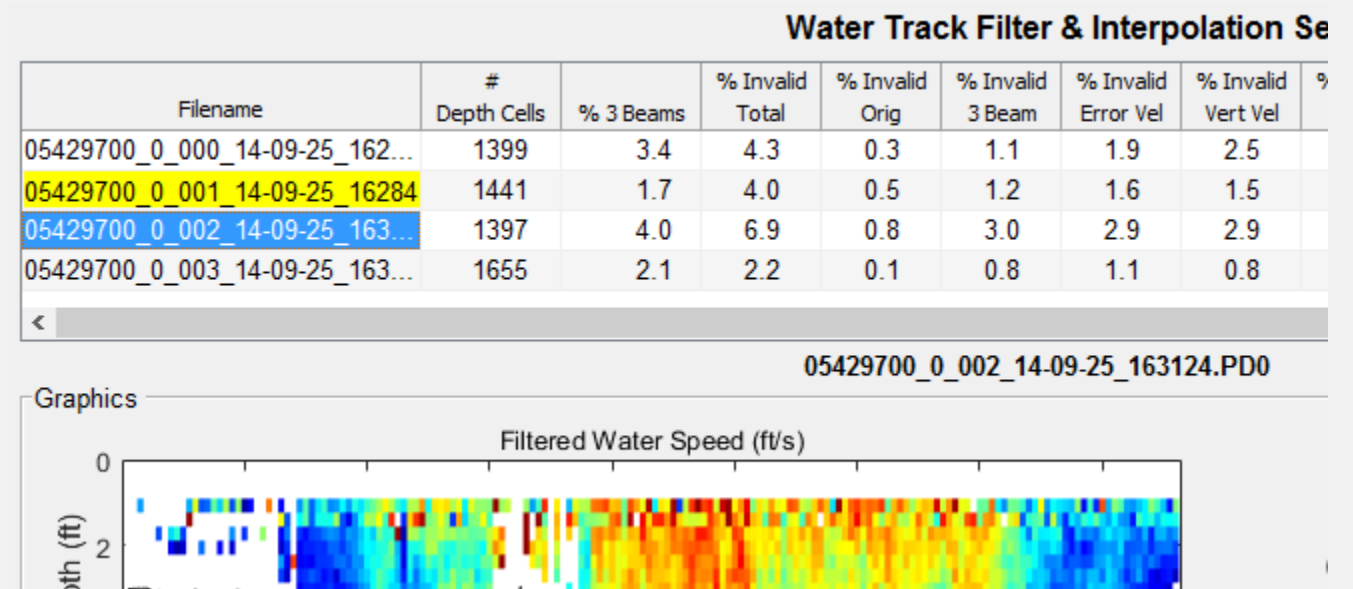
Compass /P/R   (Heading, Pitch, and Roll)

Compass / P / R

- Can plot multiple transects in graphs using the "Plot" checkbox in table

- Can adjust
  - Magnetic Variation
  - Heading Offset (only applicable if using external heading, such as GPS heading)
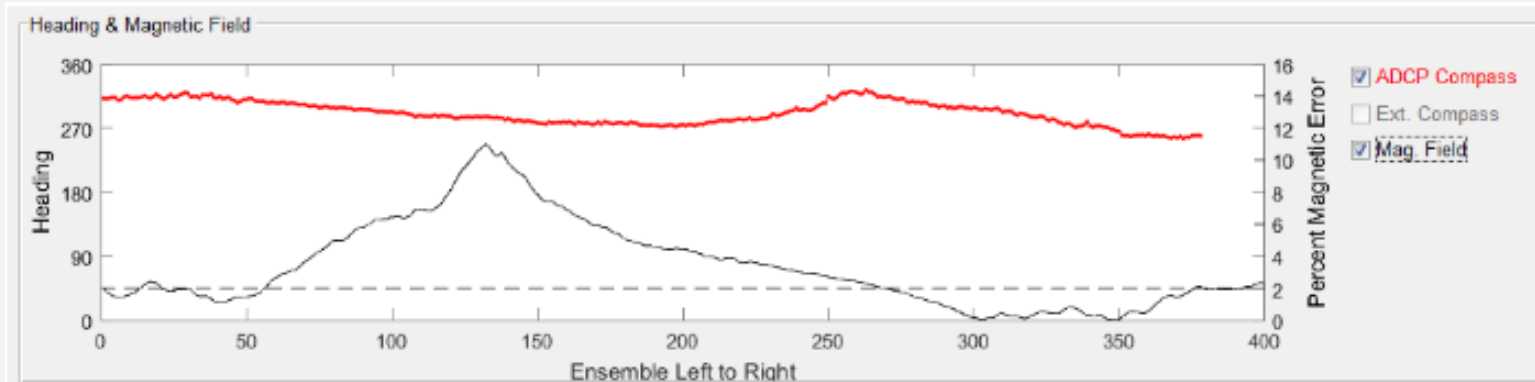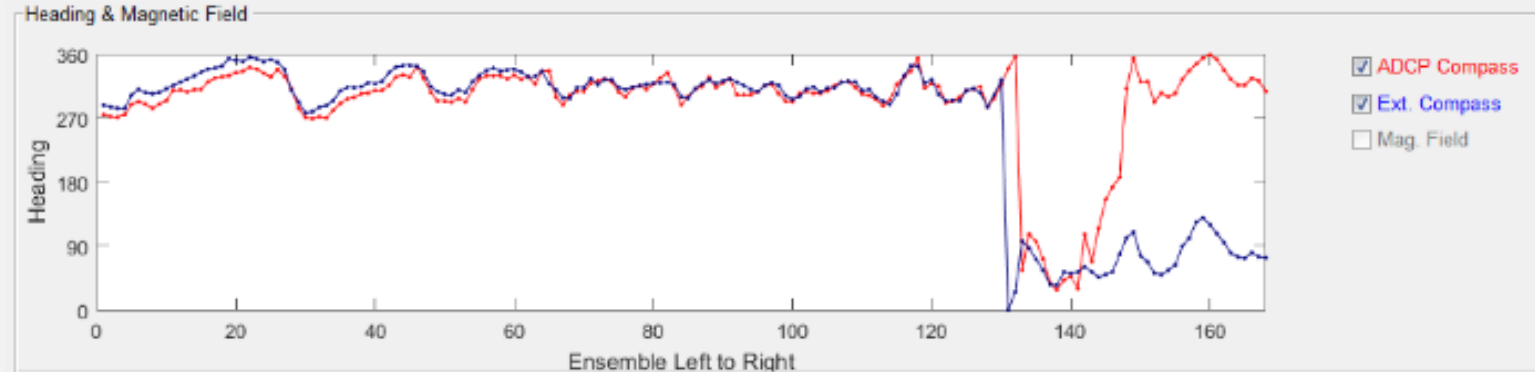 - Heading source
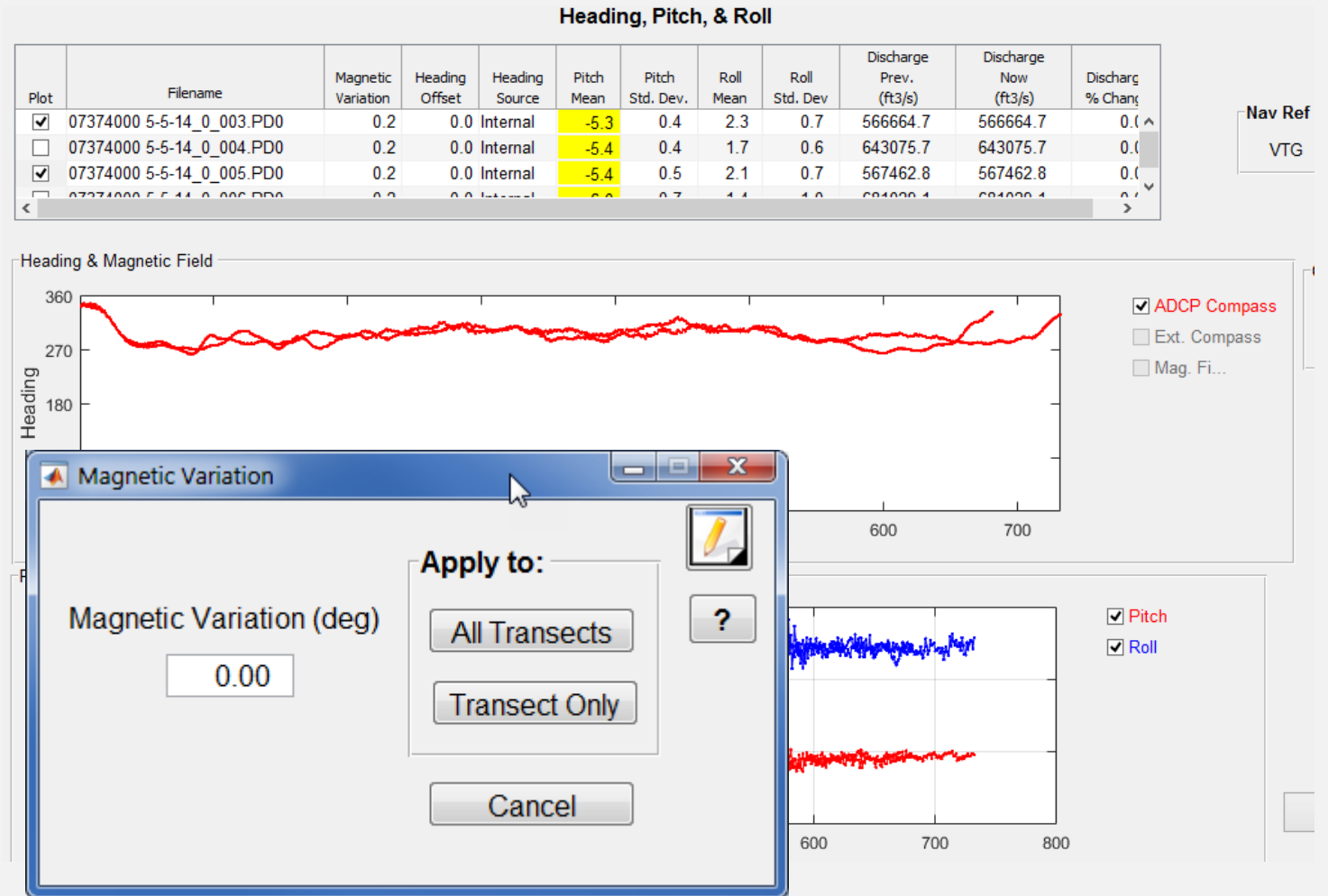
Compass /P/R   (Heading, Pitch, and Roll)

Compass /P/R

Compass Time Series

- ADCP internal compass heading

- Any External Compass heading

- Magnetic field change (for SonTek RiverSurveyor M9/S5)

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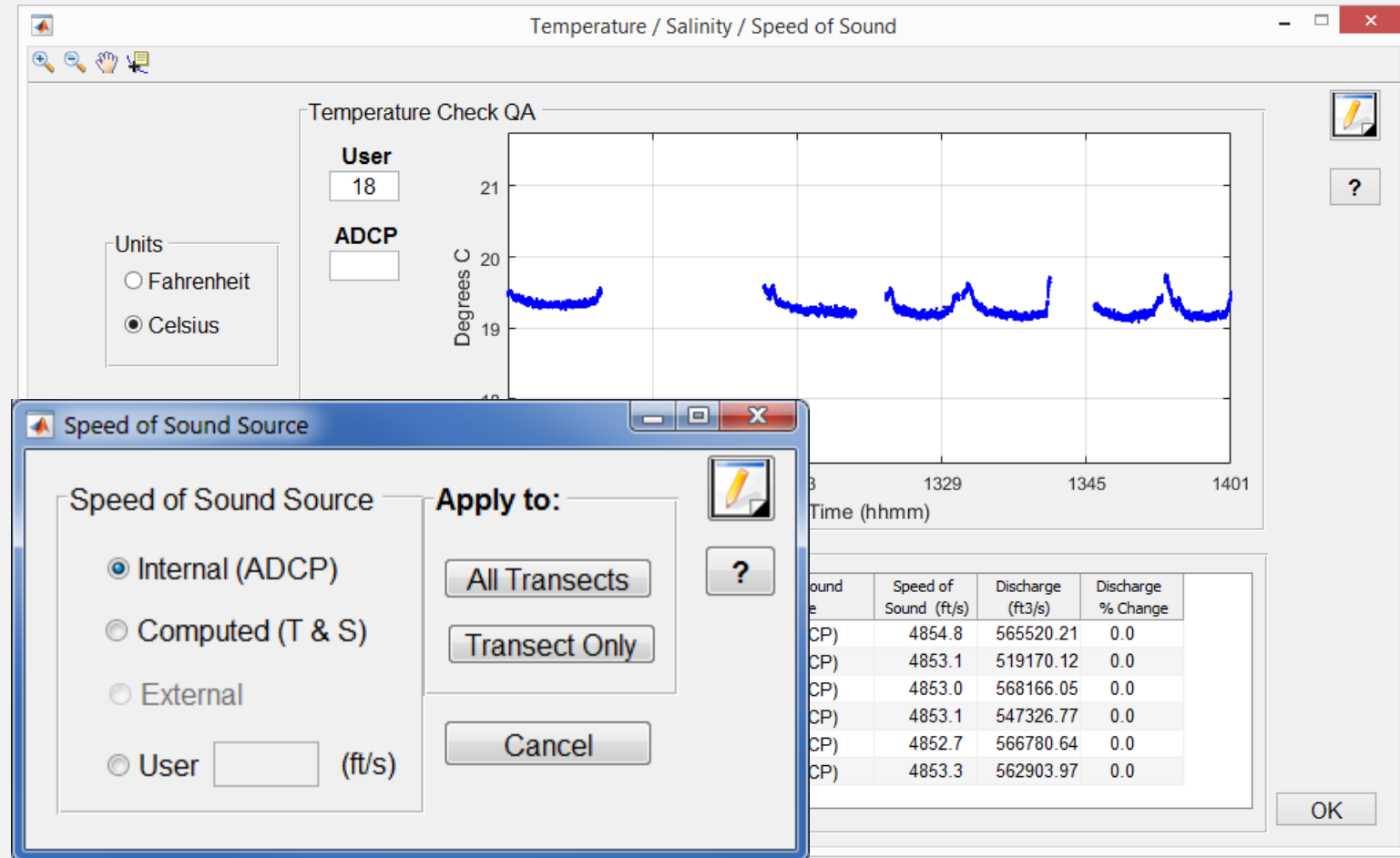
Compass /P/R   (Heading, Pitch, and Roll)

- To review compass calibration and evaluations press View button

- Automatically loads calibration and evaluations from .mmt and RSLive calibrations found in "CompassCal" folder

- Calibration done outside normal procedures and not stored in default location or file can be loaded using the "Load Test Results Button"
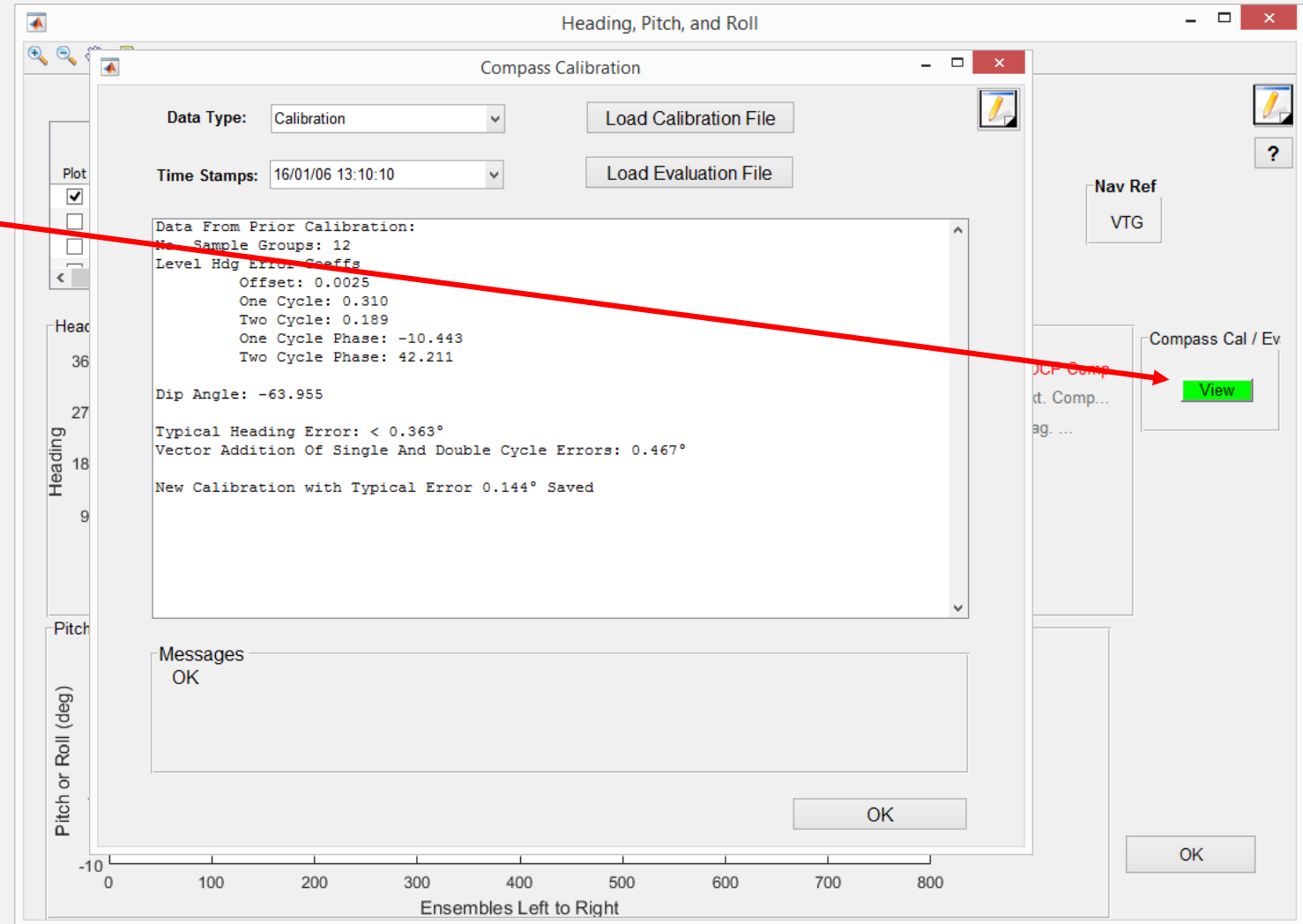
Temperature / Salinity / Speed of Sound

- Graph of water temperature during measurement

- Can change units

- Enter external temperature check – auto loads "Water Temp" from .mmt file in "User"

- Table for speed of sound settings

BT Filters

- Evaluate bottom track data and change filter settings

- Graphs show transect selected in to table

- Radio buttons can select the types of graphs displayed
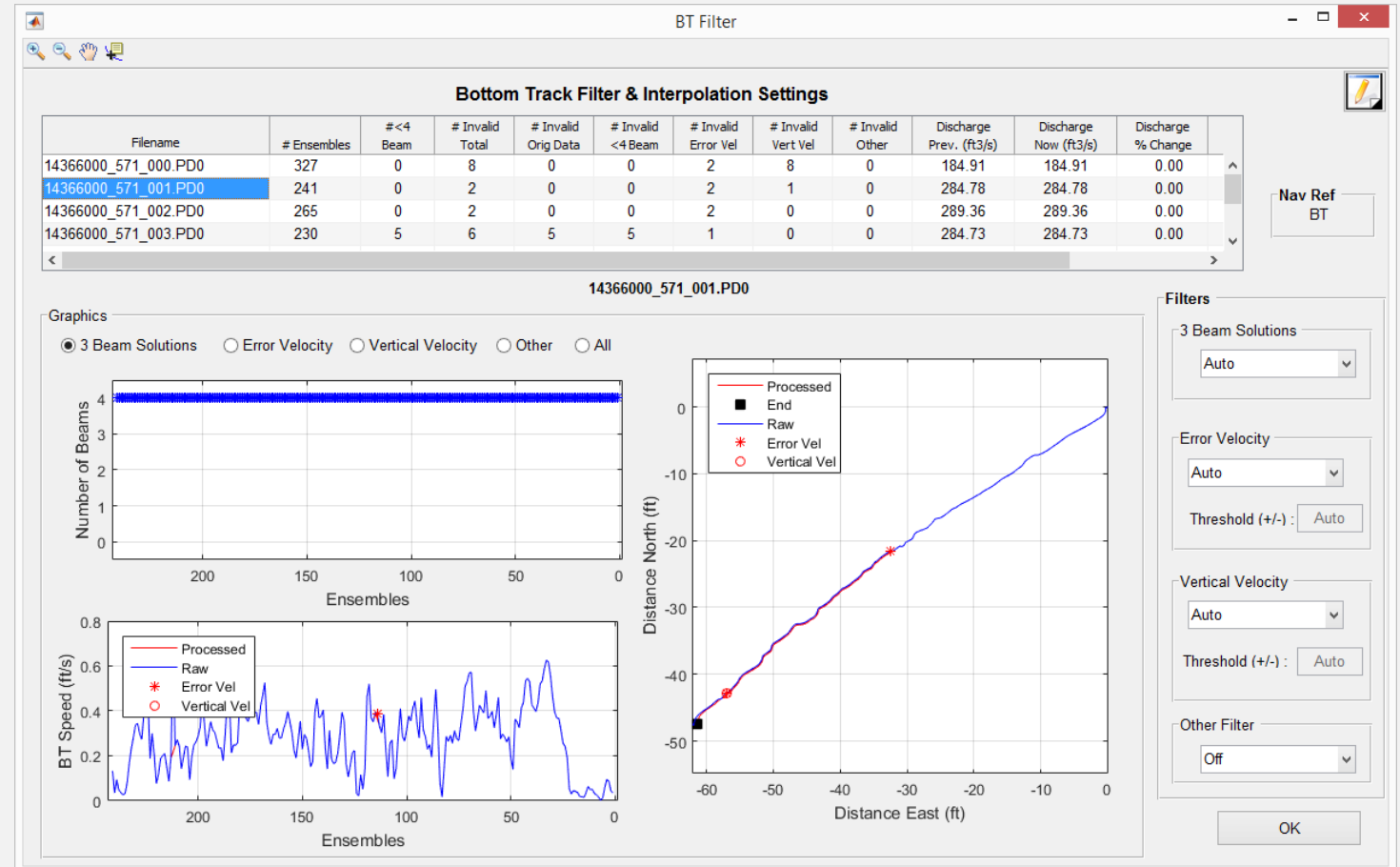
BT Filters – 3-Beam Solutions

- Auto
  - Default
  - Evaluates 3-beam solutions using neighboring data if within 50% uses as valid
- Allow - will use 3-beam solutions
- 4-Beam Only – requires all 4 beams to have valid velocity
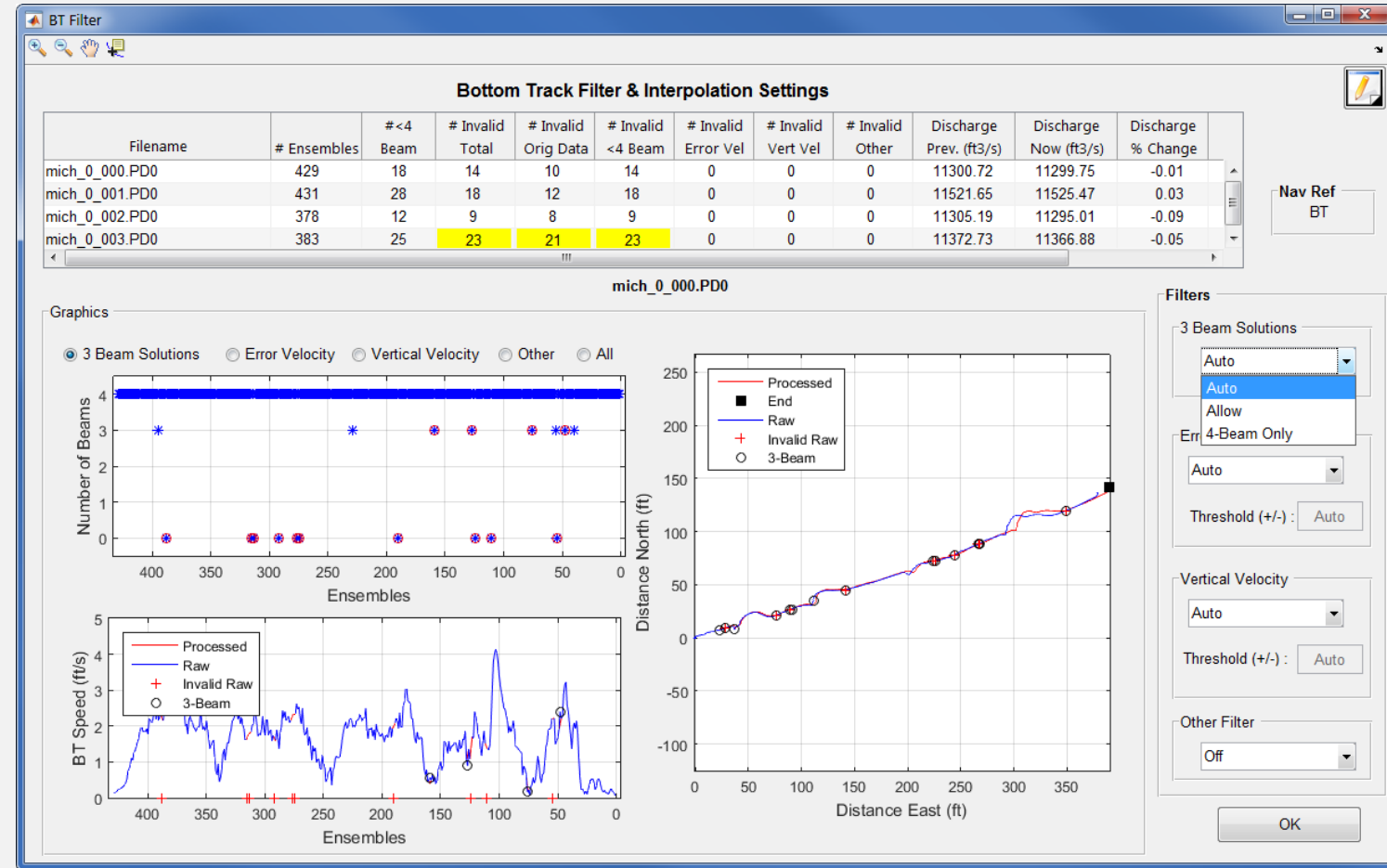
BT Filters - Error Velocity and Vertical Velocity

- Auto
  - Default
  - Use variance of error velocity data to automatically set threshold limits for each transect
- Manual
  - Users enters value that is applied to all transects
- Off
  - No error velocity filter applied
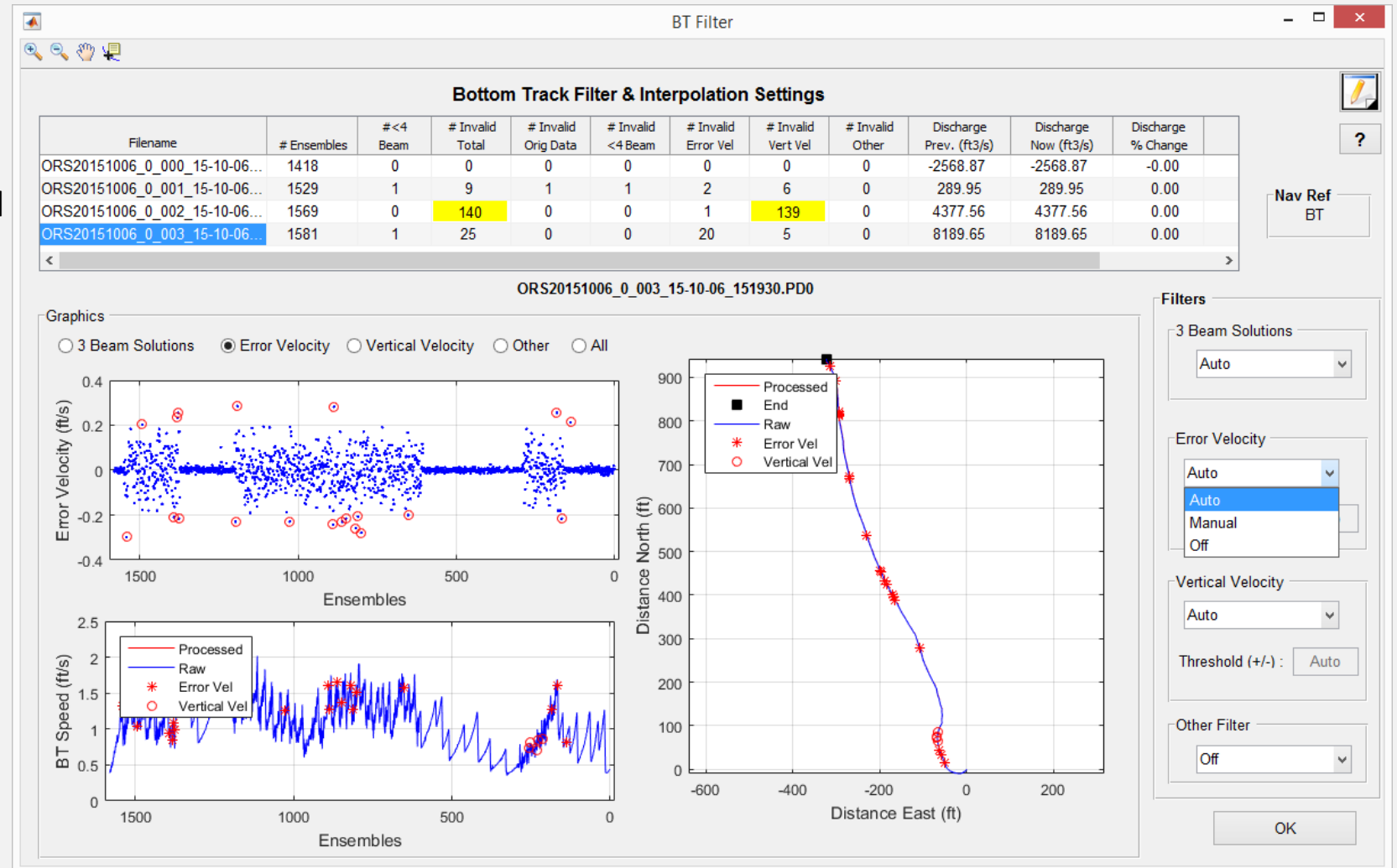
BT Filters – Other Filters

- Smooth
  - LOWESS smooth filter with dynamic moving window applied to detect and remove spikes
- Off
  - Default
  - No spike detection filter applied
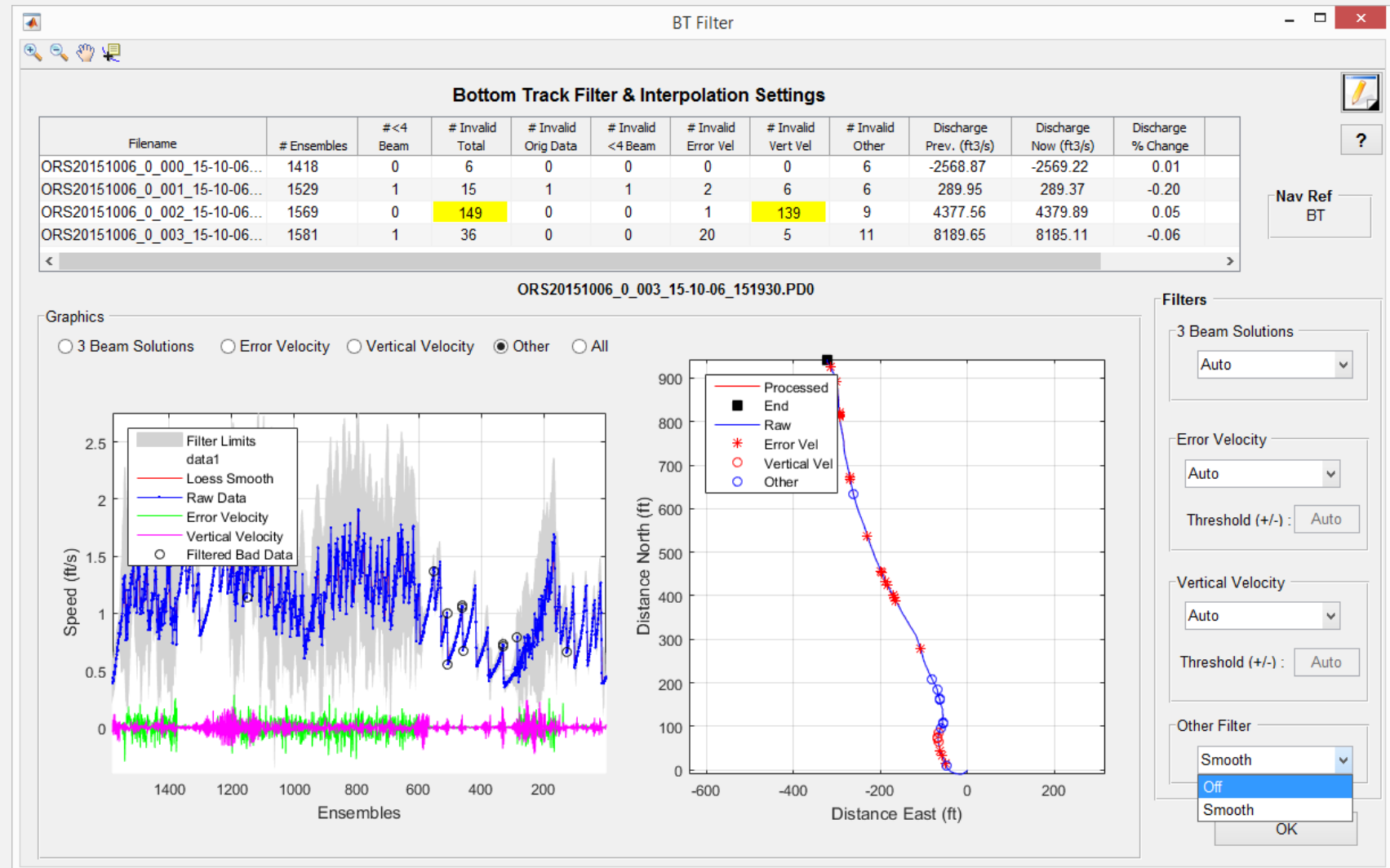
GPS Filters

- Evaluate VTG and GGA GPS data

- Graphs show transect selected in to table

- Filters are Auto by default be can be manually adjusted
  - Min Diff Quality (GGA)
  - Altitude Change
  - HDOP
  - Smooth

GPS - Minimum Diff Quality (GGA)

- Minimum quality of GPS GGA data required
  - 1 – Autonomous
  - 2 – Differential
    - Default
  - 4+ - RTK

- Does not affect VTG
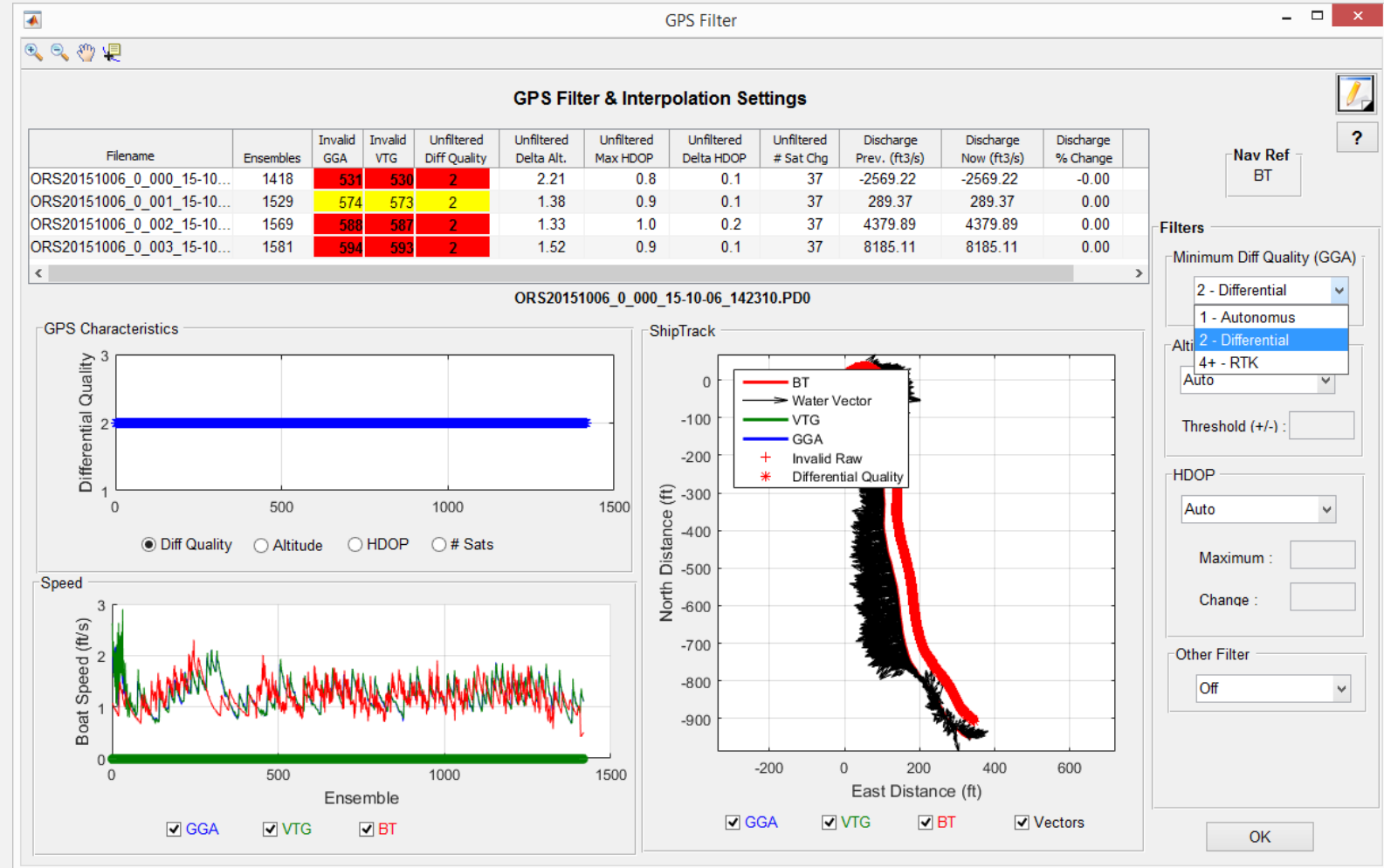
GPS Filters – Altitude Change (GGA)

- Auto
  - Default
  - Set to 3 meters (9.84 ft)
- Manual
  - User specified
- Off
  - No Altitude Filter

GPS Filters - HDOP

- Auto
  - Default
  - Sets maximum HDOP to 4 and maximum change to 3
- Manual
  - User selected
    - Maximum HDOP
    - Change in HDOP
- Off
  - No HDOP Filter
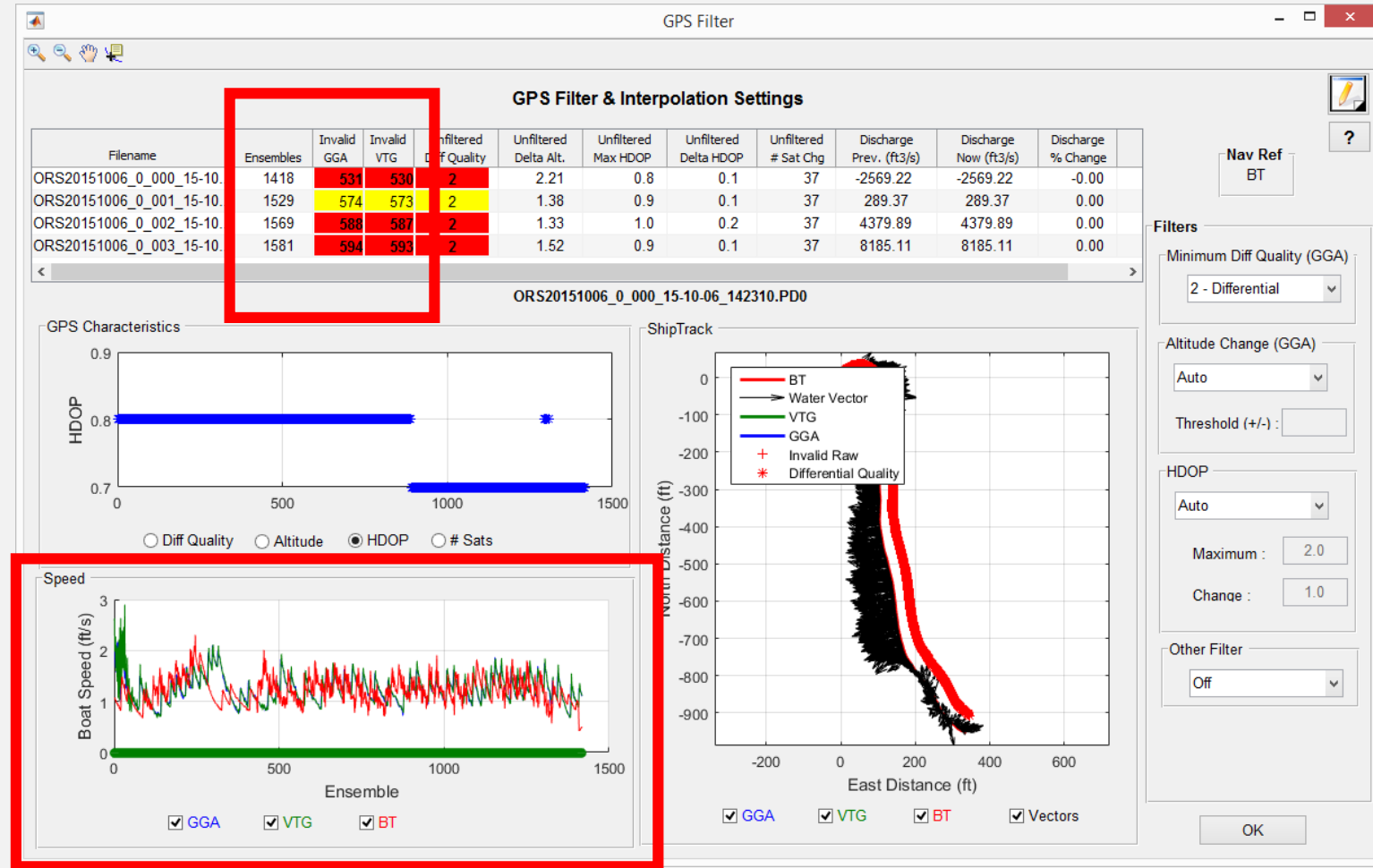
HDOP – Horizontal Dilution of Precision: Measure of possible error (GPS accuracy) due to the geometry of the satellites visible to the GPS receiver (lower is better, < 2 preferred)

Select Reference

Select Reference

- Select reference for navigation
  - BT
  - GGA
  - VTG
- Turn Composite Tracks on or off
  - Substitutes other valid reference is selected reference is invalid
  - Default = Off
- Button is disabled if only BT data available (no GPS)

Depth Filters /Draft

- View and update transducer draft

- Evaluate measured depths from each beam and final mean depth

- Can change primary depth reference when more than one available

- Adjust averaging and filter

Depth Reference Options

- Comp 4-Beam Preferred
  - Default
  - Uses 4-beam average when available, if not uses depth sources
- 4-Beam Avg
  - Will only use the average of the 4-beam bottom track depths
- Vertical
  - Will only use vertical beam depths
- Comp Vertical Preferred
  - Uses vertical beam when available, if not uses other depth sources
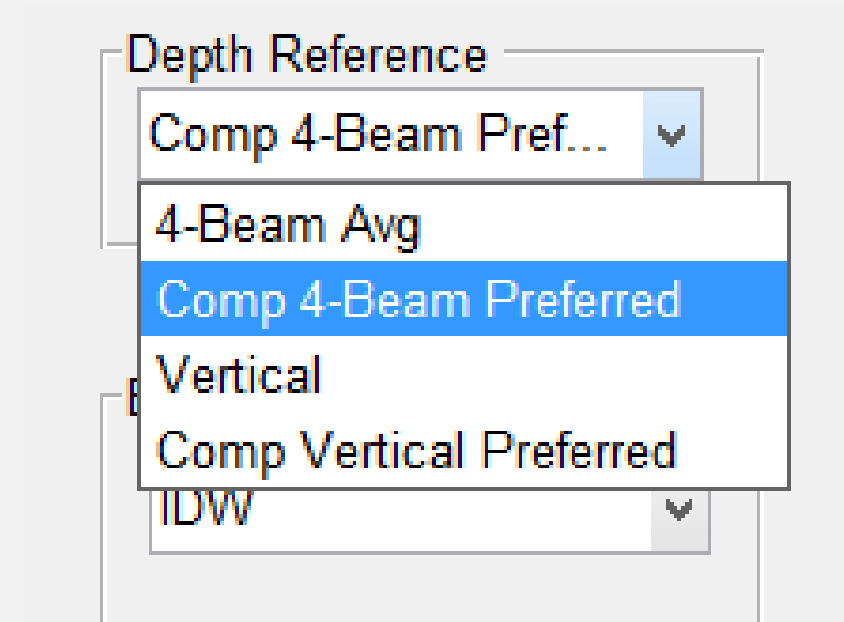
Bottom Track Depth Averaging Options

- IDW – Inverse Depth weighted Average - default
- Simple – Simple average of beam depths
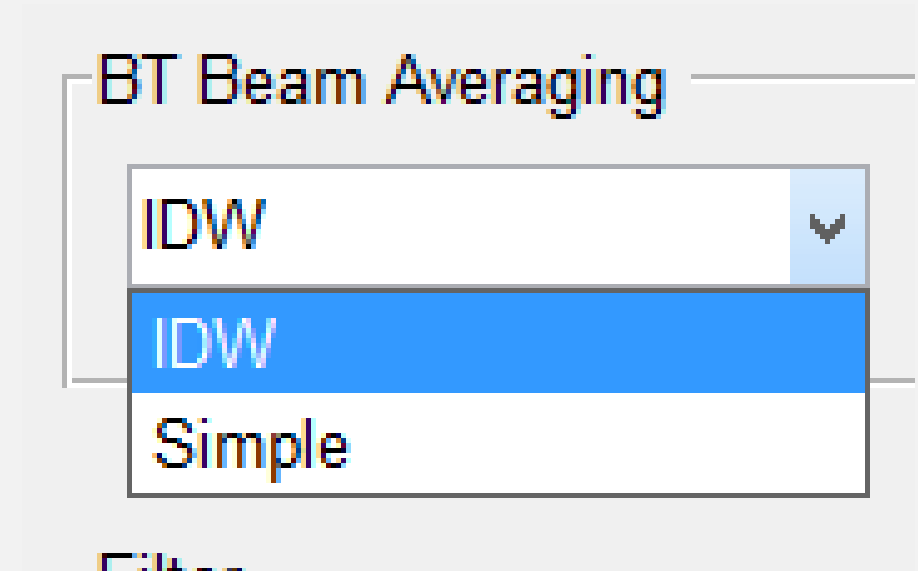
Depth Options to Filter out spikes

- Smooth: uses a LOWESS smooth filter
  - Default
  - Can have issues with large gaps
- TRDI – Filter out a beam depth in an ensemble if it is > 1.75 time other beam depth
- Off – No filtering of depth data
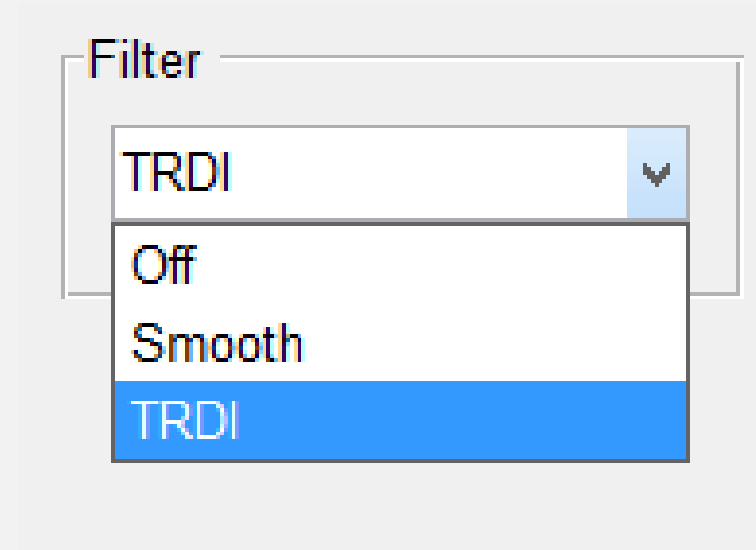
WT Filters

WT Filters

- Evaluate water velocities for each transect

- Graphs show transect selected in to table

- Radio buttons can select the types of graphs displayed

- Filters are Auto by default be can be manually adjusted
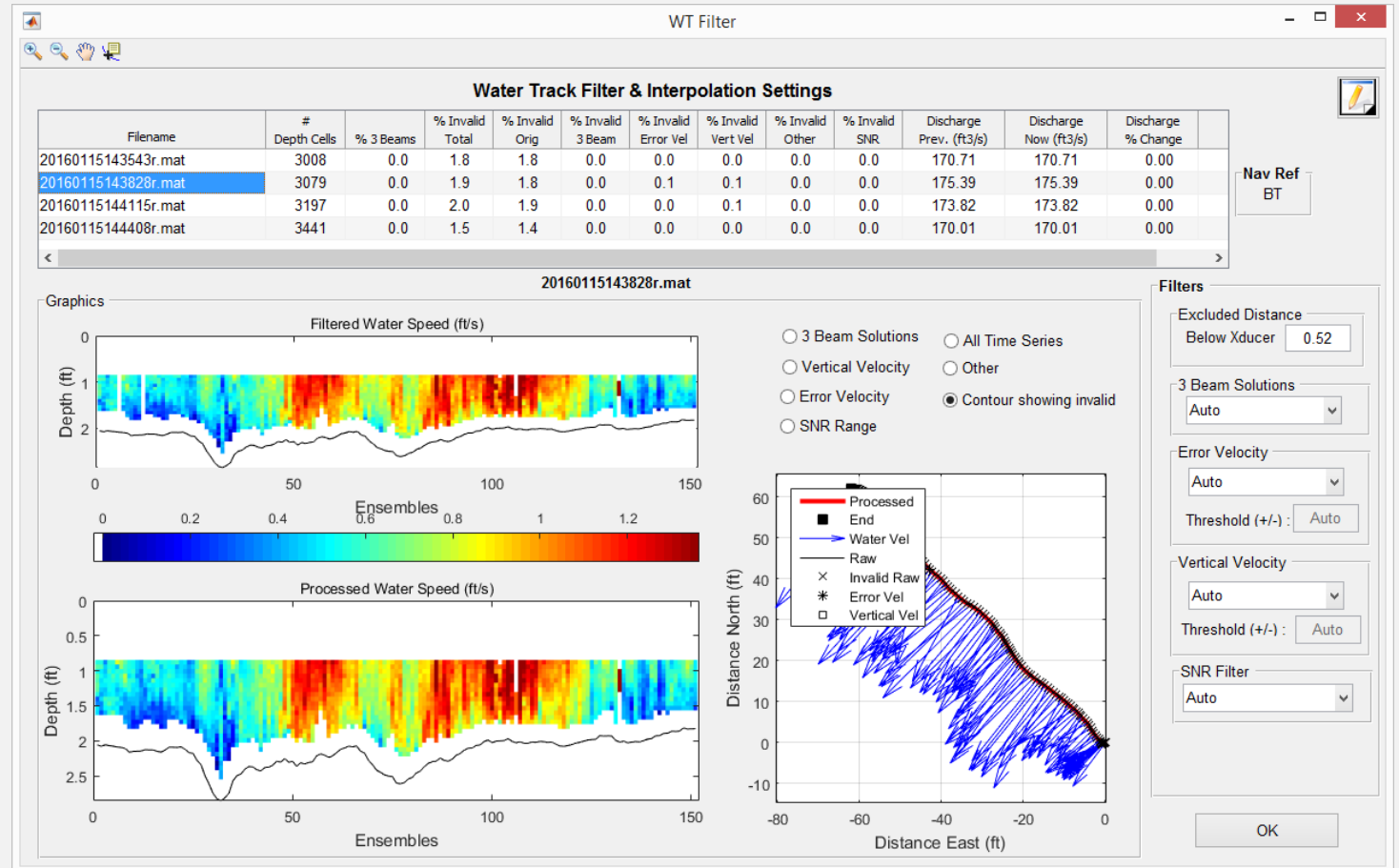
WT Filter – Excluded Distance

- Will exclude any data down to this distance below the ADCP

- For M9 defaults to .52 ft (to screen out water velocities possibly affected by flow disturbance)
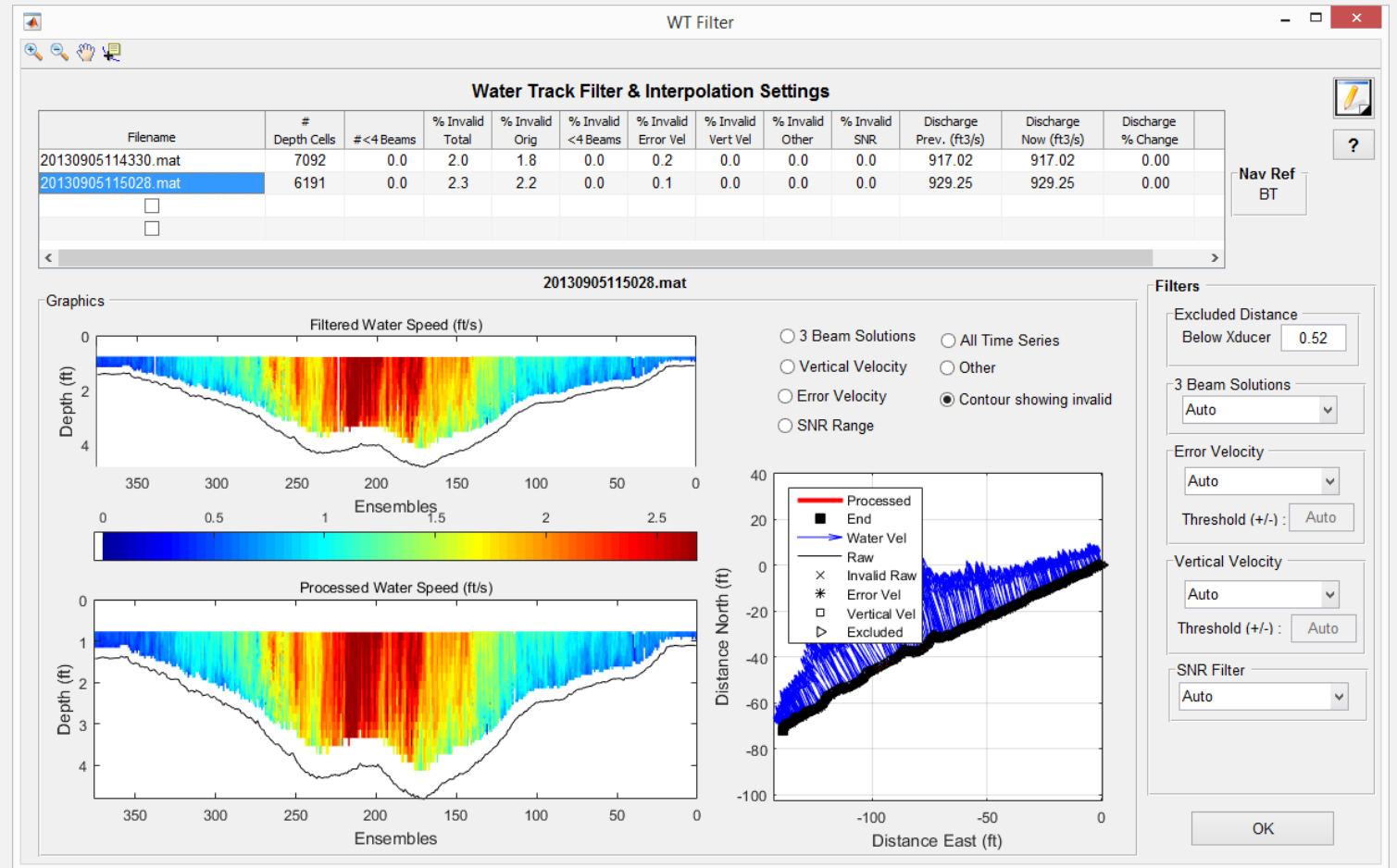
WT Filters – 3-Beam Solutions

- Auto
  - Default
  - Evaluates 3-beam solutions using neighboring data
- Allow - will use 3-beam solutions
- 4-Beam Only – requires all 4 beams to have valid velocity
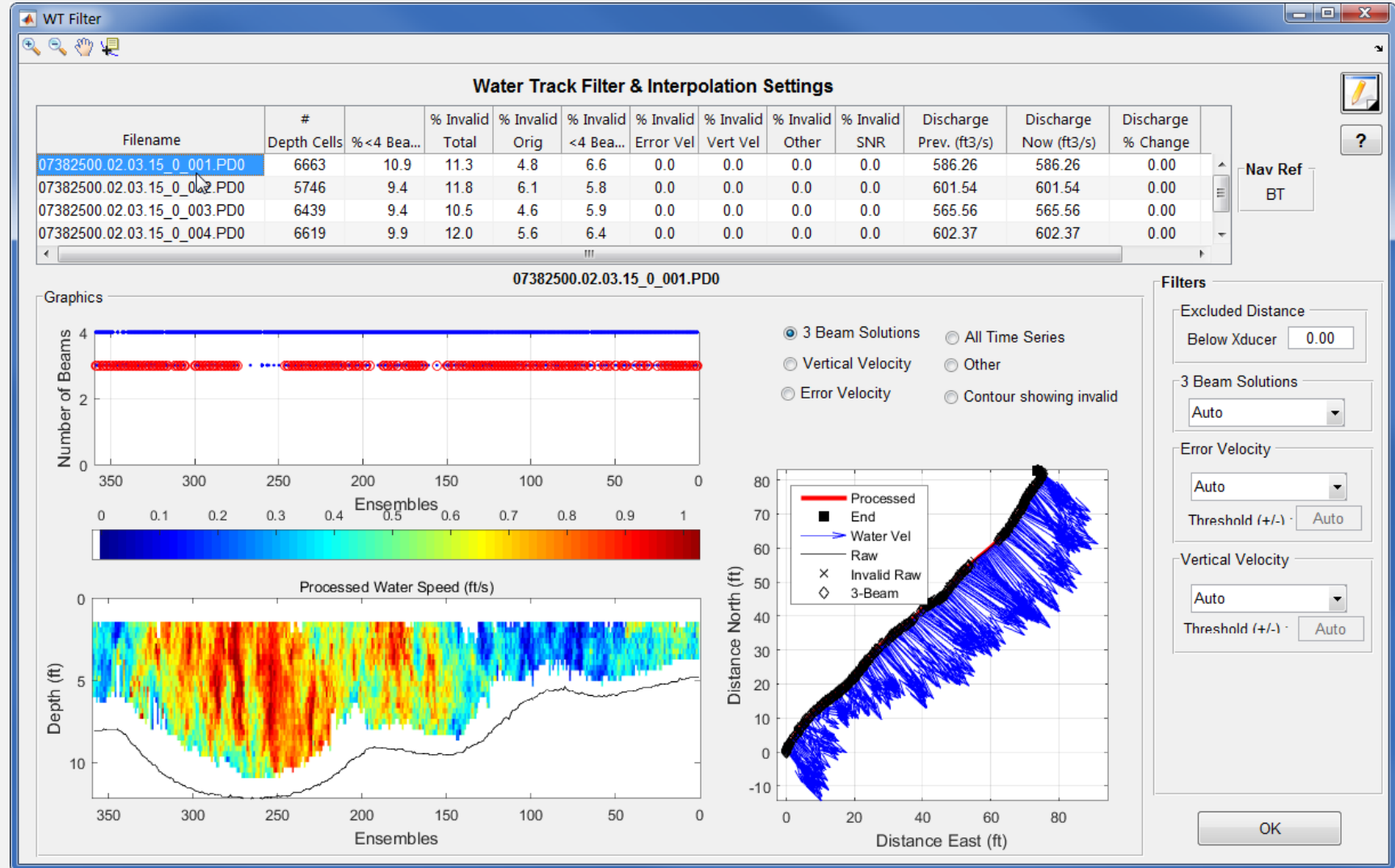
WT Filters – Error Velocity and Vertical Velocity

- Auto
  - Default
  - Use variance of error velocity data to automatically set threshold limits for each transect

- Manual
  - User enters value that is applied to all transects

- Off
  - No error velocity filter applied

- Reminder error velocity is the difference in vertical velocity between two beam pairs. For WT this is for each depth cell.
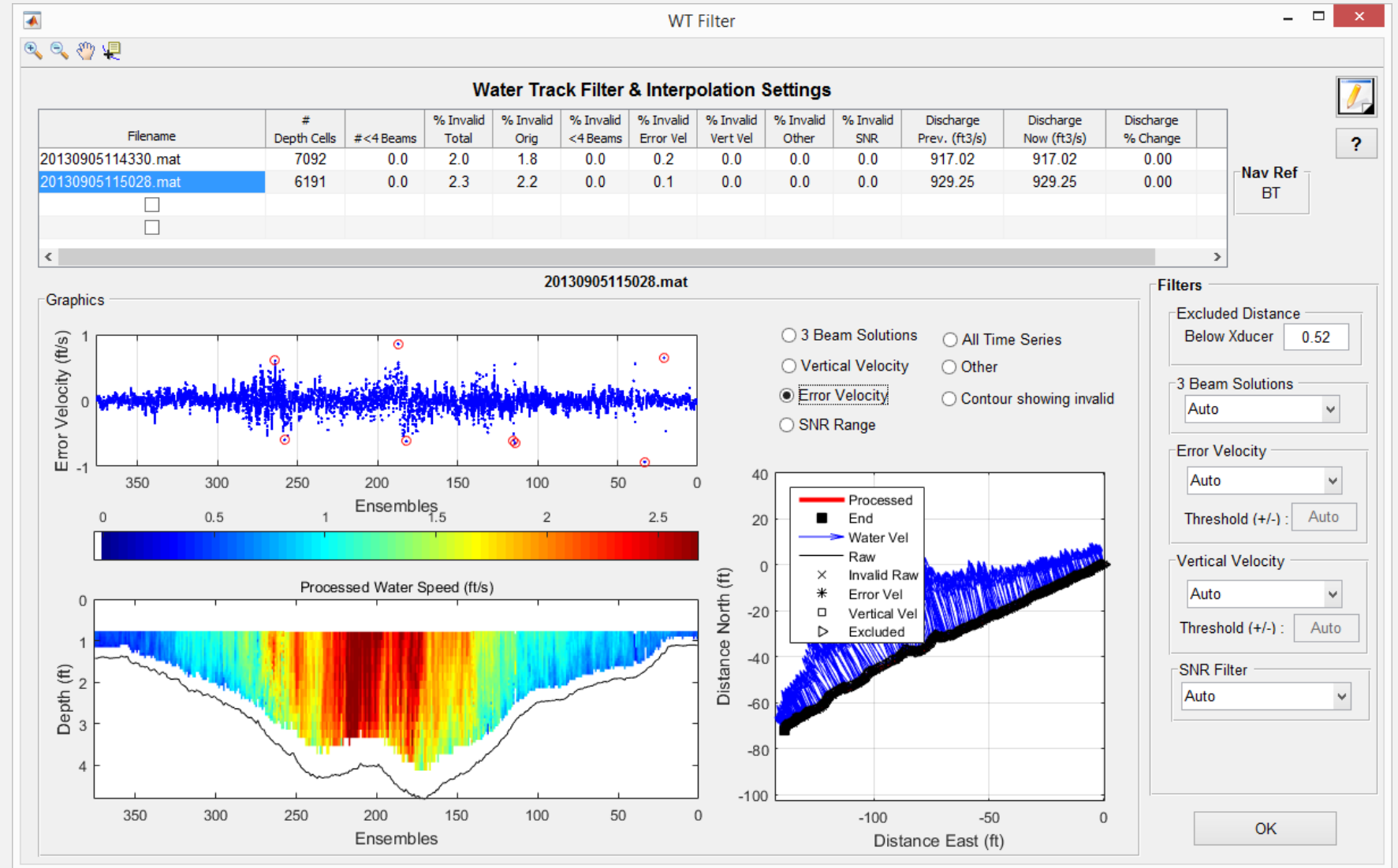
WT Filters – SNR Filter

- Currently can only be applied to SonTek Data

- Looks for differences between beam SNR in an attempt to filter out data that might be affected by air/bubbles in front of transducers

- Defaults on Auto with no Manual setting (SonTek Only)
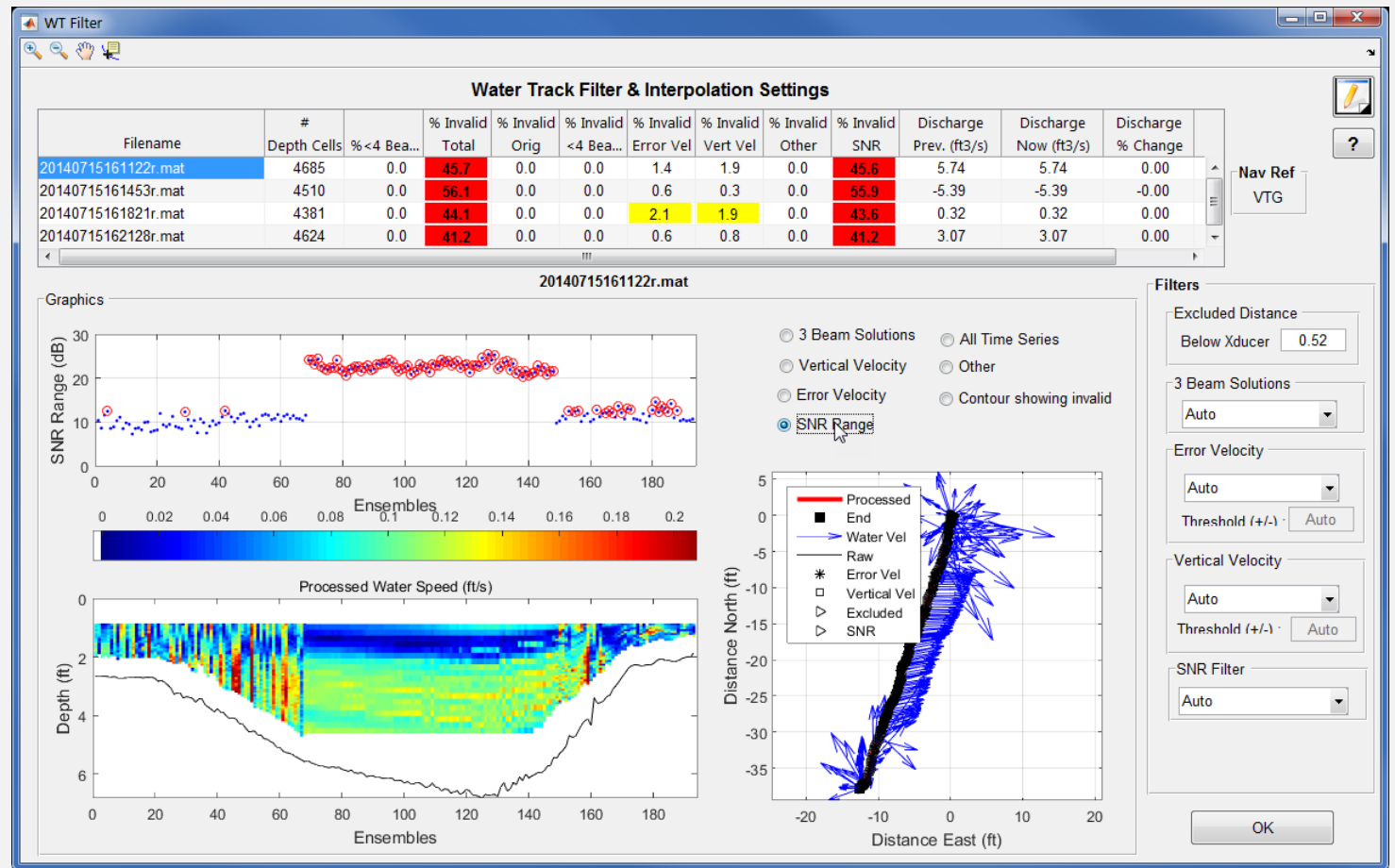
Extrapolation

Extrapolation

- Review and apply changes to top and bottom extrapolation methods

- Graphic display of fits to data

- Discharge sensitivity table displays % difference in discharge for various extrapolations

- "Cancel" button will revert to extrapolation set when Extrapolation window opened (listed in top right as previous extrapolation settings)

- "OK" button applies settings selected to all transects
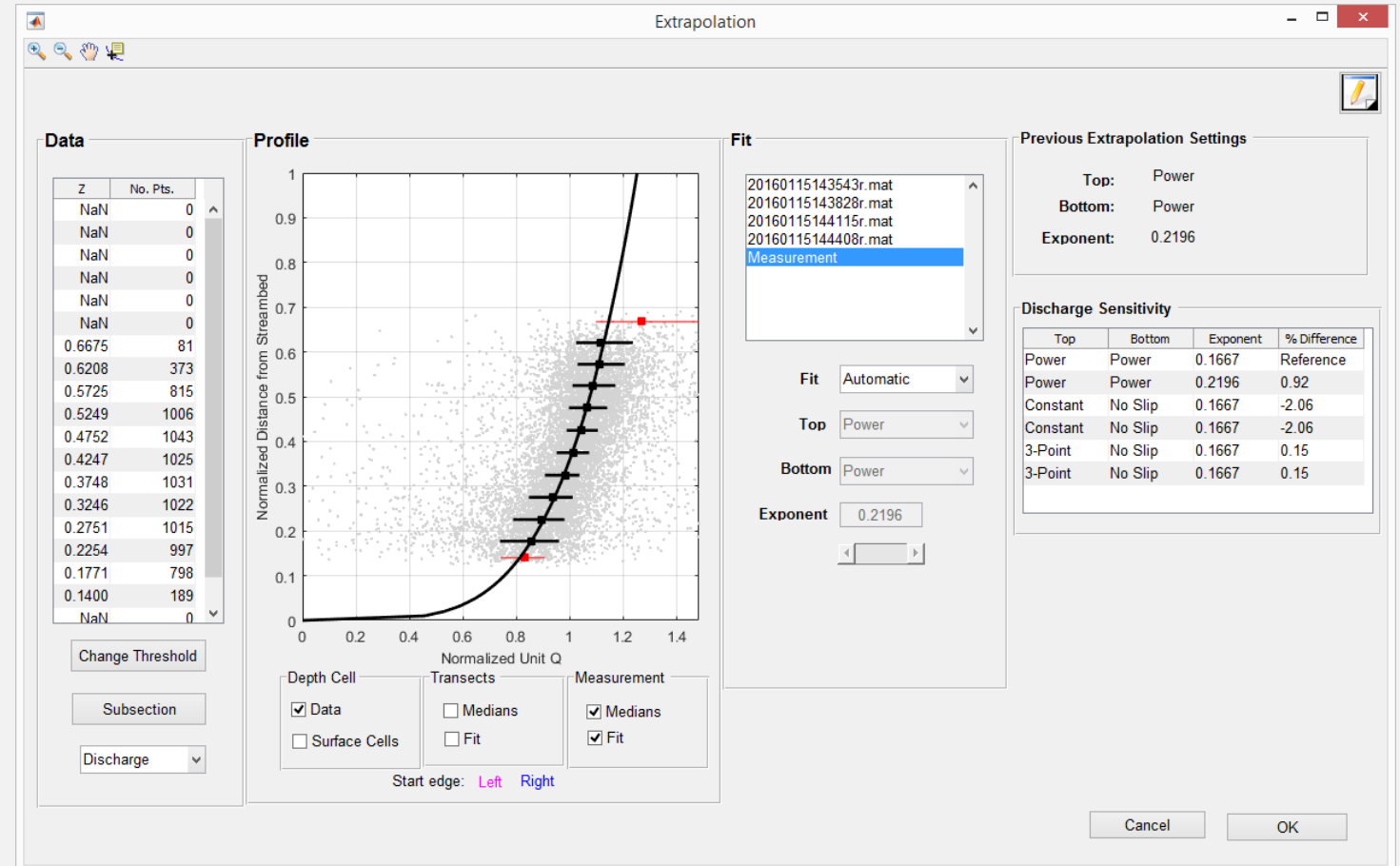
Edges

- Review and adjust settings associated with edge discharge computations
  - Start edge
  - Edge type
  - Edge distances
- Graphs show data in left and right edges for transect selected in table at top
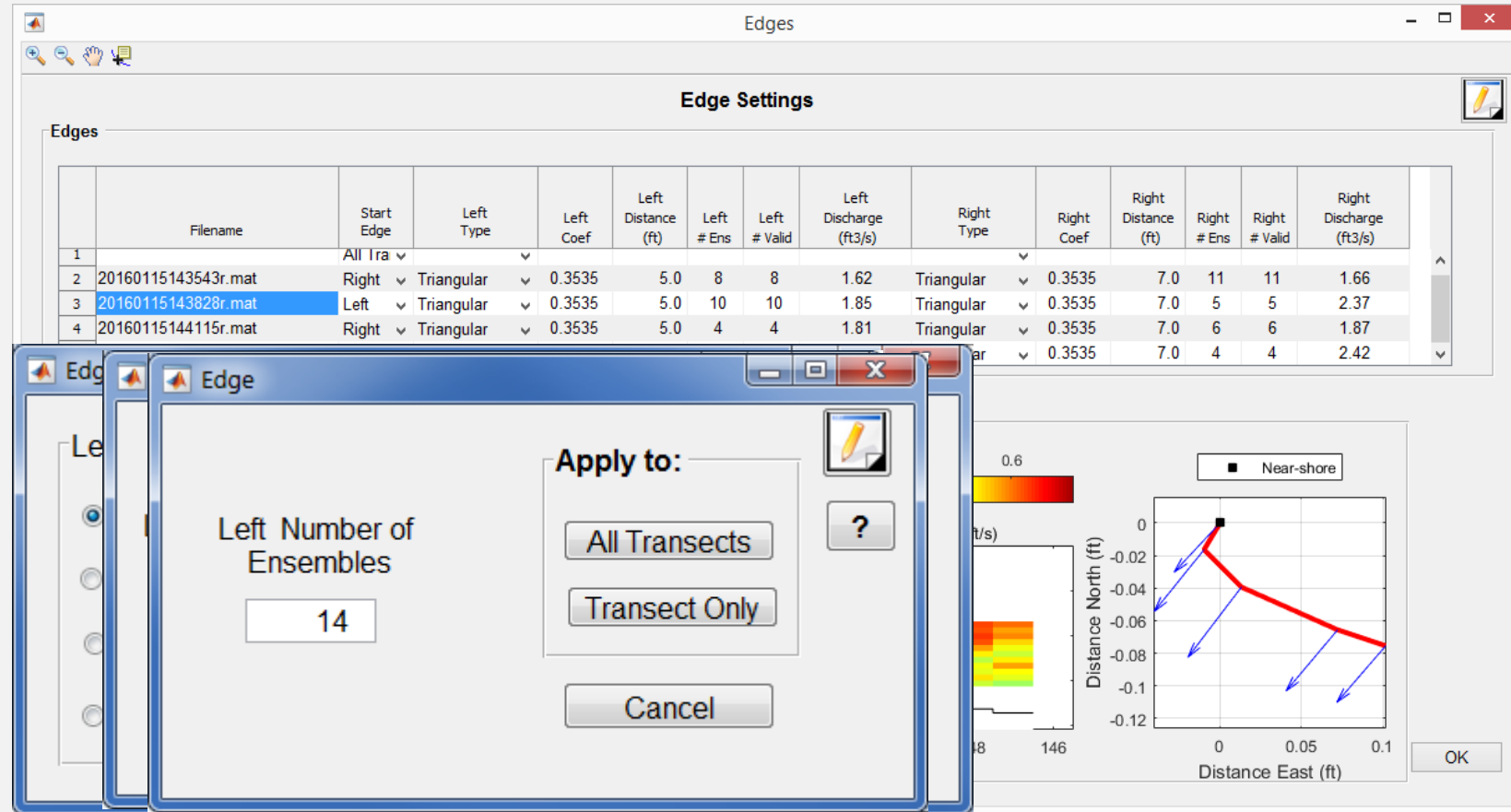
View Comments

- Displays all comments
  - Imported
  - Added with QRev

- FileSave comment added when QRev file saved, includes userid

View Comments

Comments

```
QRev Main 05/24/2016 12:08:25: Do not use firts transect
GPS 05/24/2016 12:11:03: Lost too many sattelites, lost VTG and GGA
in the begining of the measurement. Use bottom track
FileSave 05/24/2016 12:18:16: 20160524121816_QRev by bmason
Q=3621.471 ft3/s
Extrapolation 05/25/2016 08:25:57: Wind blowing downstream, constant
(top) seems to be underestimating. Use power extrapolation.
QRev Main 05/25/2016 08:33:06: If more transects were collected,
measurement could be rated as good.
FileSave 05/25/2016 08:34:10: 20160524121816_QRev by bmason
Q=3621.471 ft3/s
FileSave 05/25/2016 08:53:39: 20160524121816_QRev by bmason
Q=3621.471 ft3/s
```

OK

Save

Save

- Opens Save Dialog box for saving QRev Matlab file (*_QRev.mat)

- Defaults to folder where data was loaded

- Recommend accepting the default QRev naming format which is YYYYMMDDHHMMSS_QRev.mat where date and time is current date and time

- Also creates a .xml summary file for loading into SVMobile

- If data is later reviewed or reprocessed this is the file that should be loaded in QRev

SELECT FILENAME AND LOCATION FOR MATLAB FILE

« Data ▶ 05465500

Search 05465500

Organize ▼ New folder

Favorites
Desktop
Downloads

Name

No items match your search.

File name: 20160127114219_QRev.mat

Save as type: MAT-files (*.mat)

Save   Cancel

Hide Folders

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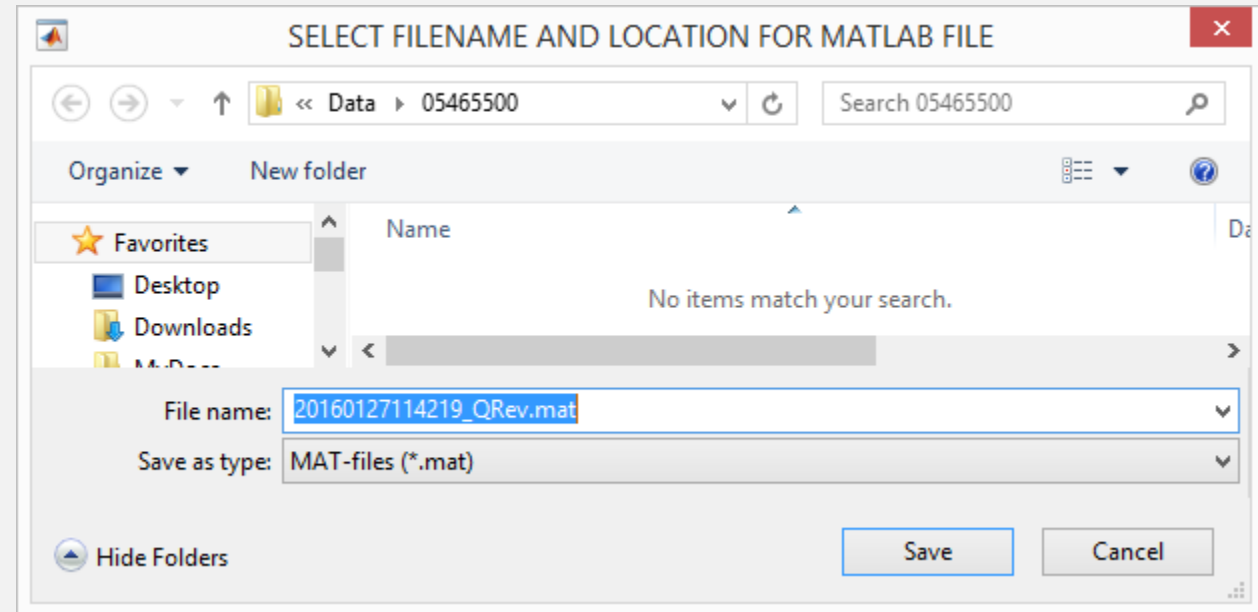
Close

- Exits QRev
- Any changes made that have not saved will be lost
- If you have imported a new measurement from WinRiver II or RSLive and not saved QRev will prompt
- No prompt while closing if
  - If you have already saved an imported Qm in QRev – even if changes made after save
  - If you open a QRev file – even if changes made without save
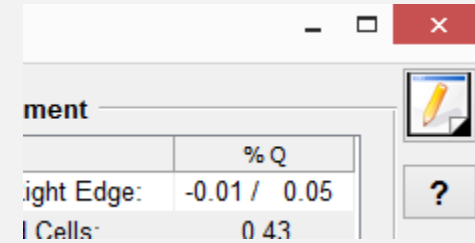
- Pressing the X button on the QRev main window also exits QRev
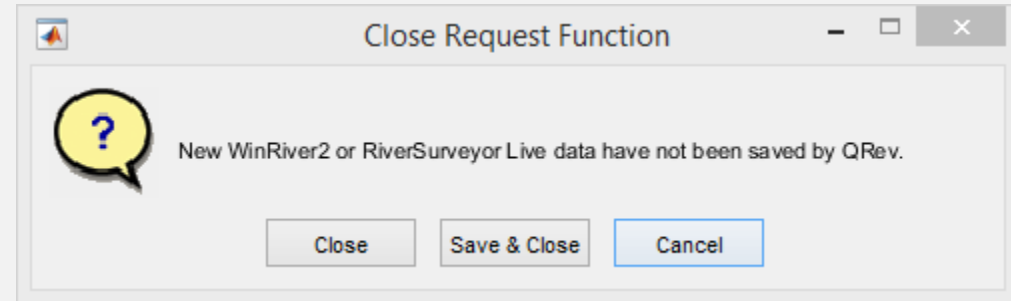
Reprocessing Large Data Sets (such as Tidal Measurements)

- Checking or unchecking a transect in the main window causes QRev to reprocess the entire measurement automatically (can be slow).

- ALT-u with uncheck all transects

- ALT-s changes the save function to save only the data from the check transects (Save button with change to Save Checked)

Suggested Procedure for Tidal (Unsteady Flow) Measurements

1. Load all data
2. ALT-s to set save to save only checked transects
3. ALT-u to uncheck all transects
4. Check the desired transects
5. Address messages and complete processing of those transects
6. Save – may desire to give a descriptive name to the saved file
7. Repeat steps 3-6 as need to process all transects

Google Earth

- If your data were collected with GPS data you can plot the transect lines in Google earth to see their location.
- Click GPS Filters button
- From the GPS Filters window press ALT-g

Demo

Warnings and Errors

- The colors and messages are to alert you to potential problems
- Evaluate the problem, make adjustments to settings is appropriate
- Add comments to support your analysis or changes
- DON'T attempt to make all buttons green

Limitations

- No ability to view intensity or correlations
- No ability to subsection data
- Invalid data at edges are not handled well by interpolation algorithms in QRev
- GPS based data with small errors in compass or magvar will inflate the Uncertainty
- Slow GPS update rate will result in a lot of invalid GPS ensembles and my inflate the Uncertainty

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https://hydroacoustics.usgs.gov/movingboat/QRev.shtml

OSW Hydroacoustics

Training
Classes   Webinars
On Demand

Memos

Hydroacoustic Forums

The HaWG

Known Hydroacoustic Issues

Moving-Boat Deployments
Instruments   Guidance
Software   Deployments
Tech Tips   References

Index Velocity
Instruments   Guidance
Software   Deployments
Tech Tips   References

Mid-Section Measurements
Instruments   Guidance
Software   Deployments
Tech Tips   References

QRev

Description

QRev is a Matlab program developed by OSW to to compute the discharge from a moving-boat ADCP measurement using data collected with any of the Teledyne RD Instrument (TRDI) or SonTek bottom tracking ADCPs. QRev improves the consistency and efficiency of processing streamflow measurements by providing:

- Automated data quality checks with feedback to the user
- Automated data filtering
- Automated application of extrap, LC, and SMBA algorithms
- Consistent processing algorithms independent of the ADCP used to collect the data
- Improved handing of invalid data
- An estimated uncertainty to help guide the user in rating the measurement

Because QRev uses data filters, interpolation algorithms, and computations that may be different from WinRiver II and RiverSurveyor Live, the the discharge computed with QRev using default settings may be different than discharges computed by WinRiver II and RiverSurveyor Live.

Office of Surface Water Technical Memorandum 2016.03 recommends and authorizes the use of QRev for processing discharge measurments made with an ADCP from a moving-boat.

QRev can be used on desktops, laptops, and tablets running either 32- or 64-bit versions[1] of the Windows operating system. QRev should be used in the field to process measurement immediately after data collection and in the office to review measurements. The graphical user interface for QRev was designed to work on tablets, so most controls are buttons, radio buttons, and check boxes that can be easily operated by tapping on the screen. QRev is written and compiled with Matlab and requires the installation of the Matlab runtime libraries.

[1]NOTE: 32-bit operating systems will only be supported through about mid-2017 as Mathworks has announced that the 2015b release of Matlab is the last Matlab version that will support 32-bit operating systems.

Links

Download

Installation Instructions

Updates and Bugs

Integration with SV Mobile and NWIS

Recommended Workflow

Viewing QRev Summary without SV Mobile

User's Manual (Note: This is out of date with current software version, see User's Guide in software.)

Technical Manual

Recorded Webinar

Source Code Repository

Download

USGS Software Users Rights Notice

QRev can be downloaded by clicking on the version number in the table below. *_32 is a 32-bit verison. *_64 is a 64-bit version.

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Questions