

# MTEdit Documentation

updated 19/Nov/2010 by Scott MacInnes

## Introduction

*MTEdit* is a utility program for processing and reviewing magnetotelluric data collected by Zonge receivers. It calculates averaged impedance and apparent resistivity values from unaveraged spectral data. *MTEdit* includes options for both automated processing and interactive quality control editing.

*MTEdit* reads Fourier coefficients for each station from \*.fft files created by *MTFT*, *AMTFFT* or *FFTCOEF*. *MTEdit* saves a copy of the edited spectral data for each station in a file with the extension \*.mtv, so that any skip flags set during sessions of quality control editing are recovered when a data set is reread from a \*.mtv file. *MTEdit* writes averaged apparent resistivity and impedance phase data to *MT*-format \*.avg files. It saves several \*.avg files for each station (where \* represents a station number); \*ga.avg holds generic robust averaged data, \*ps.avg holds values for  $|Z|$  from Phase Slope data, \*dp.avg holds Parker D+ data, while the data version selected by the processor is saved in \*.avg.

## Installation Notes

*MTEdit* requires a computer running Windows NT, XP, Vista or 7.

The following files should be distributed with *MTEdit*:

amtfft.exe	- Fourier transform GDP32-24 *.cac time series to get spectral data *.fft files
mtft.exe	- Fourier transform GDP-32 <sup>II</sup> *.out time series to get spectral data *.fft files
mtft.cfg	- Fourier transform processing preferences
mtedit.exe	- Process spectral data to get impedances and apparent resistivities
mtedit.cfg	- Spectra processing control preferences

*Mtft.exe*, *mtft.cfg*, *MTEdit.exe* and *mtedit.cfg* may be put anywhere on the operating-system path for use in Command Prompt windows. *Mtft.exe* and *MTEdit.exe* may also be run from the start menu or from a Windows shortcut.

After installation, start *MTEdit* by running it from the command line, the Windows Start menu or with a shortcut icon. *MTEdit* first reads default processing control preferences from the file *mtedit.cfg*, if it is present in the same directory as *MTEdit.exe*. *MTEdit* then opens a full size window.

## MT Processing Outline

### Create spectral data from time series

The GDP-32<sup>II</sup> saves time series data in binary \*.out files.  
Use *MTFT* to read \*.out time series data and write \*.fft spectral data.  
Put a required antenna calibrate file amtant.cal in same directory as the \*.out files.  
*MTFT* will read system calibrates from amtbrd.cal if it is present, but amtbrd.cal is not required.  
*MTFT* creates a subdirectory for each station and fills it with a set of \*.fft files.

The GDP32-24 saves time series data in binary \*.cac files.  
Use *AMTFFT* to read \*.cac time series data and write \*.fft spectral data.  
Put a required antenna calibrate file amtant.cal in same directory as the \*.cac files.  
*AMTFFT* creates a subdirectory for each station and fills it with a set of \*.fft files.

### Calculate impedances and apparent resistivities from spectral data

Run *MTEdit*

Check processing options with menu option **Edit Processing Options**.  
Select menu option **Process Spectra**.

Select time-series directory to process multiple stations,  
or a station number subdirectory to process one station.

*MTEdit* will show apparent resistivity versus frequency as its processing data. After finishing spectral processing, *MTEdit* saves the preliminary impedance data in a \*.mtv file for each station.

To review data for each station, select menu option **Read MTV**, navigate to a station number subdirectory in the **Open File** dialog and select a station\_number.mtv file.

Menu option **Phase Slope** can be used to compare generic robust averages,  $|Z|$  from Phase Slope and Parker D+ curves.

Averaged data for a specific frequency and polarization can be skipped with a Ctrl+Left Click on the offending point in the apparent resistivity versus frequency plot. Skip flags can be cleared with a Ctrl+Right Click.

Menu option **QC Data** can be used to set or clear skip flags on unaveraged impedance points shown on plots of Real(Z) versus Imag(Z) and  $|H|$  versus Coherence for a specific polarization and frequency.

Save the data with menu option **Save Data**, which updates the \*.mtv file and saves averaged impedance and apparent resistivity data in \*.avg files.

- \*.avg holds the current active data set, where \* represents a station number.
- \*ga.avg holds generic robust averaged data.
- \*ps.avg holds  $|Z|$  from Phase Smooth data.
- \*dp.avg holds Parker D+ data.

Exit *MTEdit* with menu option **Exit**, or by clicking on the **X** icon in the upper right corner of the *MTEdit* window.

## MTEdit Menu Options

### Edit Processing Options

After starting *MTEdit*, processing control can be configured with the **Edit Processing Options** menu option.

	MinCohXY	MinCohYX	MaxCohXY	MaxCohYX	HxMin (nT)	HyMin (nT)	#FC/Stack
.0007	0.600	0.600	1.000	1.000	0.00	0.00	8
.0010	0.600	0.600	1.000	1.000	0.00	0.00	8
.0015	0.600	0.600	1.000	1.000	0.00	0.00	8
.0019	0.600	0.600	1.000	1.000	0.00	0.00	8
.0029	0.600	0.600	1.000	1.000	0.00	0.00	8
.0039	0.600	0.600	1.000	1.000	0.00	0.00	8
.0059	0.600	0.600	1.000	1.000	0.00	0.00	8
.0078	0.600	0.600	1.000	1.000	0.00	0.00	8
.0117	0.600	0.600	1.000	1.000	0.00	0.00	8
.0156	0.600	0.600	1.000	1.000	0.00	0.00	8
.0234	0.600	0.600	1.000	1.000	0.00	0.00	8
.0313	0.600	0.600	1.000	1.000	0.00	0.00	8
.0469	0.600	0.600	1.000	1.000	0.00	0.00	8
.0625	0.600	0.600	1.000	1.000	0.00	0.00	8
.0938	0.600	0.600	1.000	1.000	0.00	0.00	8
.1250	0.600	0.600	1.000	1.000	0.00	0.00	8
.1875	0.600	0.600	1.000	1.000	0.00	0.00	8
.2500	0.600	0.600	1.000	1.000	0.00	0.00	8
.3750	0.600	0.600	1.000	1.000	0.00	0.00	8
.5	0.600	0.600	1.000	1.000	0.00	0.00	8
.7500	0.600	0.600	1.000	1.000	0.00	0.00	8
1.	0.600	0.600	1.000	1.000	0.00	0.00	8

*MTEdit* automatically reads processing control preferences from an `mteedit.cfg` file that it keeps in the same directory as `mteedit.exe`. If it can't find an `mteedit.cfg` file, *MTEdit* uses internal default processing control values. The **Read MTEdit.cfg** button in the **Processing Control Parameters** dialog pops up an open file dialog that can be used to select an `mteedit.cfg` file with a custom set of processing control values.

If check box **Auto Phase Flip** is selected, *MTEdit* will flip magnetic-field component polarities to make  $\text{phase}(Z_{xy})$  and  $\text{phase}(Z_{yx})$  consistent with the  $(x,y,z)$  EM component orientation specified by *MTEdit* survey configuration. If positive  $E_x$  is ninety degrees clockwise from  $E_y$  in map view, then  $z$  must be positive up to make a self-consistent right-handed  $(x,y,z)$  coordinate system. With  $z$  positive up, then  $\text{phase}(Z_{xy})$  should be in the third quadrant, i.e. between  $-3142$  and  $-1570$  mrad, while  $\text{phase}(Z_{yx})$  should be in the first quadrant, i.e. between  $0$  and  $1570$  mrad. If  $\text{phase}(Z_{xy})$  and  $\text{phase}(Z_{yx})$  are both in the same quadrant, then the E- and H-component polarities used for data acquisition are not self-consistent. *MTEdit* **Auto Phase Flip** attempts to remedy those situations by flipping  $H_x$  and  $H_y$  phase values to get median  $\text{phase}(Z_{xy})$  and  $\text{phase}(Z_{yx})$  values in the expected quadrants.

Some people like to use a  $(x,y,z)$  coordinate system with  $z$  positive down, for which  $E_x$  is ninety degrees counter-clockwise from  $E_y$ . For  $z$  positive down,  $\text{phase}(Z_{xy})$  should be in the first quadrant (between  $0$  and  $1570$  mrad) and  $\text{phase}(Z_{yx})$  should be in the third quadrant (between  $-3142$  and  $-1570$  mrad).

The **Phase Smoothing** field in the **Processing Control Parameters** dialog controls the amount of smoothing in the  $|Z|$  from Phase Slope calculation. Minimal smoothing uses very slight smoothing to help stabilize the calculations used to generate  $|Z|$  from Phase Slope values. Moderate smoothing removes spikes in the impedance phase versus frequency curve before applying minimal smoothing. Robust smoothing is the most tolerant of noisy impedance phase data.

*MTEdit* calculates its initial impedance and apparent resistivity values using a robust averaging procedure that automatically down-weights noisy data points.  $|Z|$  values, and consequently apparent resistivity =  $(0.2/\text{freq}) * |Z|^2$ , are often more noisy than phase( $Z$ ) impedance phase values. With good impedance phase data,  $|Z|$  data quality can be improved with  **$|Z|$  from Phase Slope**, a procedure derived from Sutarno and Vozoff, 1989 (see References section). An alternative approach is to invert the sounding curve to a layered model, and then interpolate the data with the calculated model response. The **Use D+ Curve** option inverts the sounding curves to a best-fitting model described by Parker, 1980.

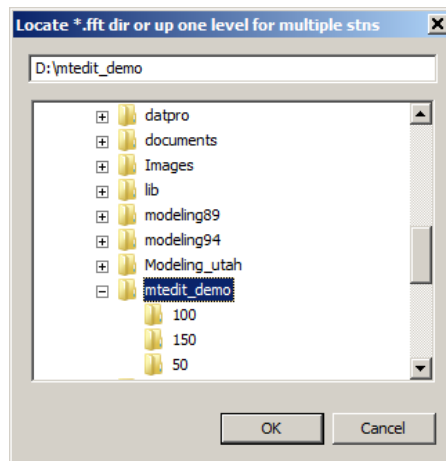
The  **$|Z|$  from Phase Slope** and **Use D+ Curve** options can be turned on and off by checking or unchecking the dialog fields. If  **$|Z|$  from Phase Smooth** is unchecked, then the D+ curve is based on inversion of the generic robust average data. If  **$|Z|$  from Phase Slope** is checked and active, then the D+ curve is based on inversion of the  $|Z|$  from Phase Slope data set.

When *MTEdit* reads spectral data, it rejects points that are likely to be too noisy based on a set of input criteria. The **Input Data Filter** field in the **Processing Control Parameters** dialog allows modification of those input data criteria. Points with a coherence that is too low or too high are rejected. Similarly, points with electric field magnitude, magnetic field magnitude or apparent resistivity values that are too low or too high are dropped. The **Input Data Filter** shows a row for each frequency, and allows modification of the coherence and magnetic field magnitude input filter limits. File *mtedit.cfg* stores a more complete table that also includes electric field and apparent resistivity limits, and is a text file that can be modified with a text editor if it is necessary to change those additional input filter thresholds.

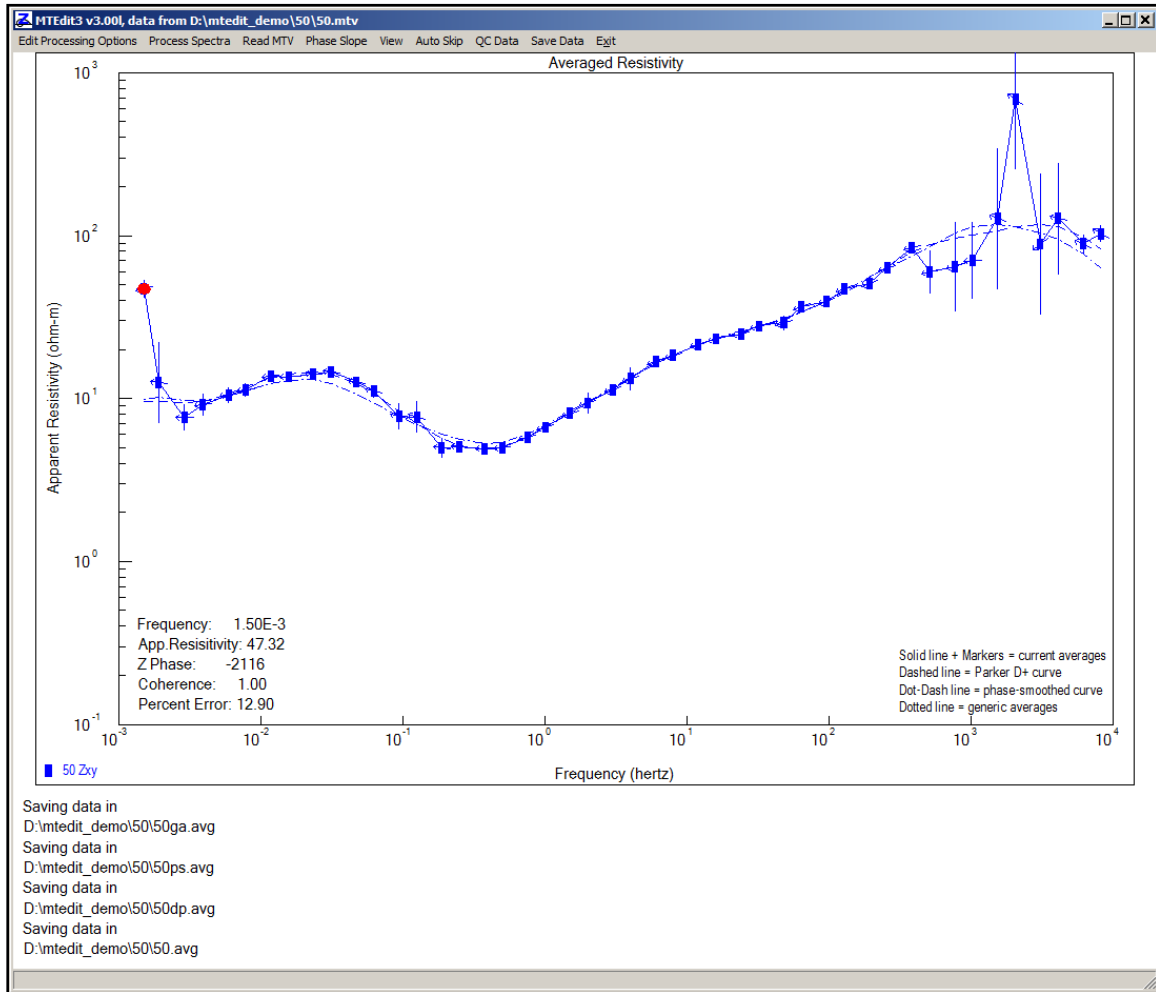
Clicking on the **Processing Control Parameters** dialog **Continue** button saves any changes made to processing control values, and updates the *mtedit.cfg* file before returning *MTEdit* to its main menu. Clicking on the **Cancel** button drops any changes to the processing control parameters and returns *MTEdit* directly back to its main menu.

## Process Spectra

Initial processing of spectral data from \*.fft files is started via the *MTEdit* **Process Spectra** menu option. It first shows a select directory dialog with title text "Locate \*.fft dir or up one level for multiple stns". If you select an individual station number directory, *MTEdit* will process the spectral data for that one station. If you selected a work directory that holds multiple station directories, *MTEdit* will process data for each of the station number subdirectories in turn.



It is usually most efficient to select a directory holding multiple station number subdirectories. In the example above *mtedit\_demo* holds station number subdirectories 100, 150, 50. After selecting directory *mtedit\_demo* and clicking on the **OK** button, *MTEdit* will sequentially process the spectral data in subdirectories 100, 150 and 50. It shows an apparent resistivity versus frequency plot during the spectral processing, with a red circle indicating the current frequency. The apparent resistivity curve is extended as the processing for each new frequency is finished. After processing spectral data in all of the station number subdirectories, *MTEdit* finishes with a plot showing the data for the last station.



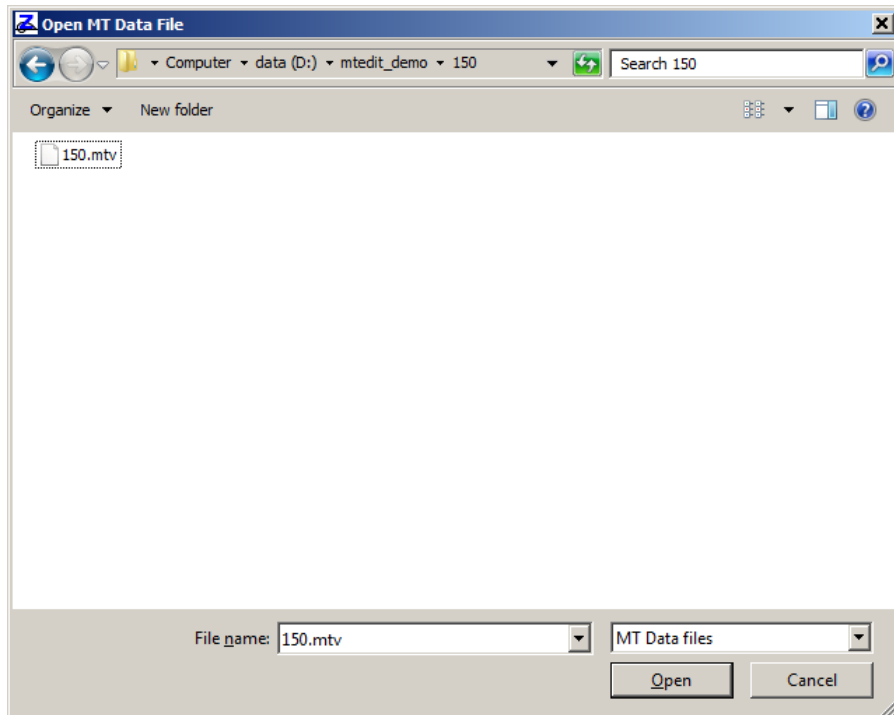
The solid blue line shows the trace of the currently selected apparent resistivity type (generic robust averages,  $|Z|$  from Phase Slope or Parker D+). A dotted line indicates generic robust average data, but in the example above generic averaged data are selected, so the solid line overwrites the dotted line. A dot-dash line indicates the  $|Z|$  from Phase Slope curve and a dashed line indicates the D+ curve.

For good quality data, impedance phase is proportional to the slope of the apparent resistivity curve. A phase value of 0 milliradians corresponds to a -45 degree slope in a plot of  $\log(\text{apparent resistivity})$  versus  $\log(\text{frequency})$ . A phase value of 1570 milliradians corresponds to a + 45 degree slope. Slope from impedance phase is indicated in the *MTEdit* apparent resistivity plot by small arrows. If the arrows point to the right, then the associated impedance phase is in the first quadrant (between 0 and 1570 mrad). If the phase slope arrows point to the left, the associated impedance phase is in the third quadrant (between -3141 and -1570 mrad). An arrow that is nearly perpendicular to the overall trace of the apparent resistivity curve indicates an impedance phase value that is inconsistent with the trend of the apparent resistivity data.

Annotation in the lower left corner of the plot corresponds to the data point indicated by a red dot on the apparent resistivity curve. Clicking on a different apparent resistivity point selects a different frequency and the plot annotation is updated accordingly. A Ctrl+Left Mouse Button click on a point will set a skip flag so that the averaged data point is not used for  $|Z|$  from Phase Slope of  $D+$  calculations. Posted symbols of skipped apparent resistivity points are grayed out. Ctrl+Right Mouse Button click while the mouse cursor is pointing to an apparent resistivity point clears the point's skip flag.

## Read MTV

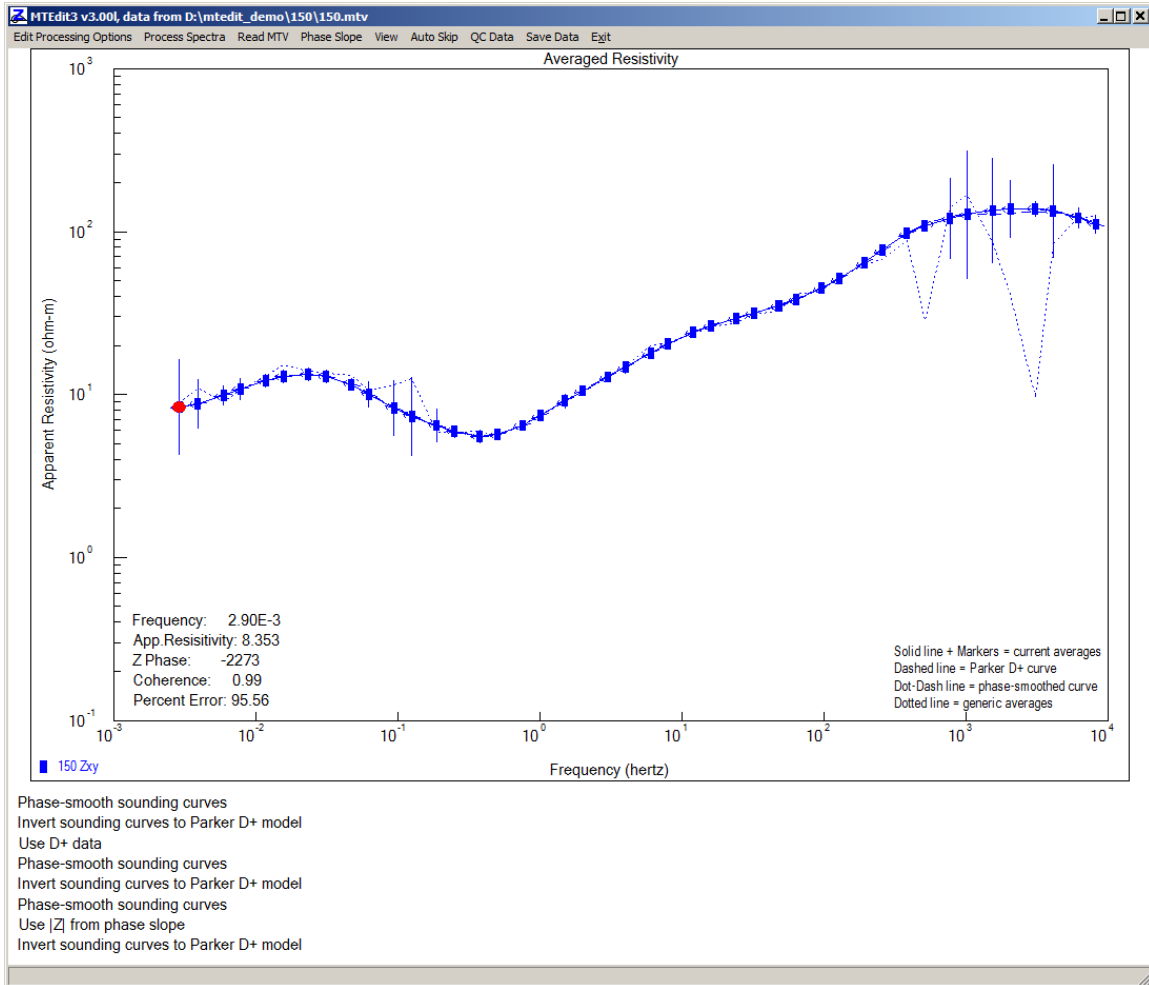
Processed impedance data can be reloaded into *MTEdit* with the **Read MTV** menu option, allowing multiple quality control sessions and station by station review of data originally processed in a multi-station batch. Selecting the **Read MTV** menu option brings up an **Open File** dialog in which you can navigate to a different station number subdirectory and select its \*.mtv file.



Selecting 150.mtv will import impedance data for station 150.

## Phase Slope

The **Phase Slope** menu option pops up a submenu with check box options that can be used to select or deselect  $|Z|$  from Phase Slope and the Parker D+ curve.



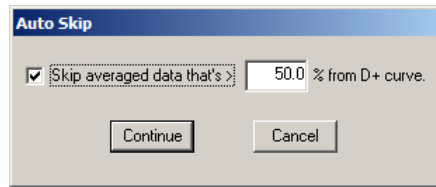
In the example above, the Zxy apparent resistivity for station 150 is loaded from 150.mtv and **Phase Slope** submenu option  **$|Z|$  from Phase Slope** has been selected. The solid blue "active apparent resistivity" curve traces out the  $|Z|$  from Phase Slope curve, while the dotted line indicates the more ragged trace of generic robust averaged data.

## View

The **View** menu option pops up a submenu with check box options that can be used to show or hide generic robust averages,  $|Z|$  from Phase Slope or Parker D+ curve plot lines. Removing unwanted traces from the curve can make the presentation clearer, especially for tensor data where both Zxy and Zyx curves are displayed in the apparent resistivity versus frequency plot.

## Auto Skip

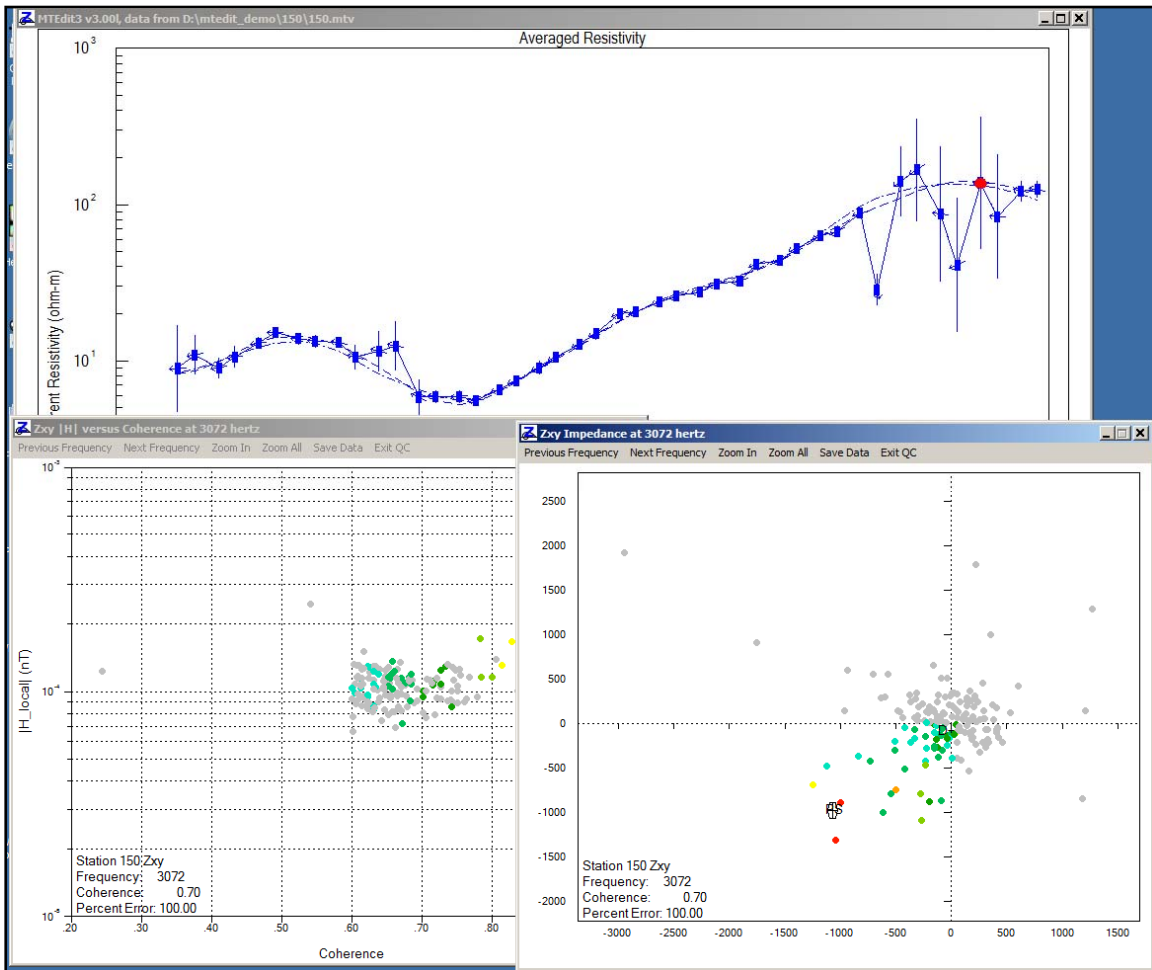
The **Auto Skip** menu option shows a dialog box to with controls for automatically setting or clearing averaged data skip flags.



Clicking on the **Skip averaged data** check box turns the **Auto Skip** test on or off. If the box is checked, then **Auto Skip** flags will be set when you click on the **Continue** button. If the box is unchecked, then all averaged data skip flags will be cleared when you click on the **Continue** button. Clicking on the **Cancel** button exits the **Auto Skip** dialog with no action. The value in **% apparent resistivity deviation** field can be edited to adjust the sensitivity of **Auto Skip**.

## QC Data

**QC Data** is an interactive option for setting or clearing skip flags on individual unaveraged impedance data points. **QC Data** shows the impedance data for an specific frequency and data polarization in two plots, the Real(Z) versus Imag(Z) and |H| versus Coherence.





QC editing is most commonly done using the Real(Z) versus Imag(Z) plot. Impedance points are color coded by coherence, ranging from cyan for low to red for high coherence. A  $\oplus$  symbol indicates the robust average impedance value, while PS indicates  $|Z|$  from Phase Slope and DP shows the D+ value.

Impedance points can be skipped with a left mouse button click-and-drag to surround the offending points with a rubber band box. Set one corner of the box with a left mouse button click while the mouse cursor is in the Real(Z) versus Imag(Z) plot, and then hold down the left mouse button while dragging the mouse cursor to expand and shape the rubber band box. Skipped impedance points are indicated by grayed out dots. A right-click-and-drag can be used to clear impedance point skip flags. Use Ctrl+Left Click to skip all of the impedance points (and the associated averaged data) or Ctrl+Right Click to clear skip flags for all of the plot's impedance points. Skipping all impedance points that are not in the same quadrant as PS and DP is usually a good way to start the QC. It can also be helpful to skip low coherence values in the  $|H|$  versus Coherence plot.

Menu options **Previous Frequency** and **Next Frequency** change the current data frequency. You can also move between frequencies with the mouse scroll wheel, with the left or right arrow keys, with the P (for Previous) or N (for Next) keys, or with the A and D keys to emulate video game control. When editing tensor data, the W key toggles between Zxy and Zyx polarizations. You can also select a frequency and polarization by clicking on a point in the apparent resistivity curve.

For a more detailed view of a QC plot, select the **Zoom In** menu option. The mouse cursor will change to a magnifying glass, which you can click and drag to set a rubber band box around the plot's area of interest. Selecting the **Zoom All** option restores the plot to its default range.

**Save Data** stores the current data values by updating the \*.mtv and \*.avg files.

The **Exit QC** menu option closes both QC plots and returns *MTEdit* to the main window. You can also exit **Data QC** by clicking on the **X** icon in the upper right corner of either **QC Data** plot.

## Save Data

Menu option **Save Data** updates the \*.mtv file and saves averaged impedance and apparent resistivity data in AMT AVG format \*.avg files. Multiple \*.avg files are written for each station to make it easier to compare results from different *MTEdit* processing options. The \*.avg file holds the active data set, where \* represents the station number. \*ga.avg holds generic robust averaged data, \*ps.avg holds  $|Z|$  from Phase Smooth data, and \*dp.avg holds Parker D+ data.

## Exit

The **Exit** main menu option or clicking on the **X** icon in the upper right corner of the main window closes *MTEdit*.

## References

- Beamish and Travassos, 1992, The use of the D+ solution in magnetotelluric interpretation, *Journal of Applied Geophysics*, v29, p1-19.
- Chave and Thomson, 2004, Bounded influence magnetotelluric response function estimation, *Geophysical Journal International*, v157, p988-1006.
- Egbert and Livelybrooks, 1996, Single station magnetotelluric impedance estimation: coherence weighting and the regression M-estimate, *Geophysics*, v61, p964-970.
- Egbert, 1997, Robust multiple-station magnetotelluric data processing, *Geophysical Journal International*, v130, p475-496.
- Jones, Chave, Egbert, Auld and Bahr, 1989, A comparison of techniques for magnetotelluric response function estimation, *Journal of Geophysical Research*, v94, p14201-14213.
- Larsen, Mackie, Manzella, Fiordelisi and Rieven, 1996, Robust smooth magnetotelluric transfer functions, *Geophysical Journal International*, v124, p801-819.
- Parker, 1980, The inverse problem of electromagnetic induction: existence and construction of solutions based on incomplete data, *Journal of Geophysical Research*, v85, p4421-4428.
- Sutarno and Vozoff , 1991, Phase-smoothed robust M-estimation of magnetotelluric impedance functions, *Geophysics*, v56, p1999-2007.

## MTEdit.cfg File Format

*MTEdit* saves processing control preferences in an ASCII file, *mtedit.cfg*, that is placed in the same directory as *mtedit.exe*. If *MTEdit* can't find a *mtedit.cfg* file, it uses internal default processing control values.

*MTEdit.cfg* starts with a block of *\$keyword=value* records followed by a tabular block of comma-separated values holding input-data filter thresholds.

### Partial listing of *mtedit.cfg*

```
$MTEdit3:Version=3.001 applied 2010/11/19
$Auto.PhaseFlip=No
$PhaseSlope.Smooth=Moderate
$PhaseSlope.toZmag=No
$DPlus.Use=No
$AutoSkip.onDPlus=No
$AutoSkip.DPlusDev=50.0
Frequency, AResXYmin, AResXYmax, ZPhzXYmin, ZPhzXYmax, AResYXmin, AResYXmax, ...
7.00000E-4,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
1.00000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
1.50000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
1.90000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
2.90000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
3.90000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
5.90000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
7.80000E-3,0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
. . . . .
. . . . .
. . . . .
8192, 0.1, 9.99999E+5,-3150, 3150, 0.1, 9.99999E+5, ...
```

### **MTEdit.cfg keywords:**

*MTEdit:Version* = string, *MTEdit* version number  
*Auto.PhaseFlip* = boolean, Yes=apply auto phase flip  
*PhaseSlope.Smooth* = enumeration, {Natural,Dipole,Loop}  
*PhaseSlope.toZmag* = boolean, Yes=use |Z| from Phase Slope  
*DPlus.Use* = boolean, Yes=use Parker D+ data  
*AutoSkip.onDPlus* = boolean, auto skip apparent resistivity if too far from D+ curve  
*AutoSkip.DPlusDev* = float, auto skip (apparent\_resistivity-D+) deviation (percent)

### MTEdit input-data filter column definitions:

Frequency	= frequency (hertz)
AResXYmin	= minimum $Z_{xy}$ apparent resistivity (ohm-m)
AResXYmax	= maximum $Z_{xy}$ apparent resistivity (ohm-m)
ZPhzXYmin	= minimum $Z_{xy}$ impedance phase (mrad)
ZPhzXYmax	= maximum $Z_{xy}$ impedance phase (mrad)
AResYXmin	= minimum $Z_{yx}$ apparent resistivity (ohm-m)
AResYXmax	= maximum $Z_{yx}$ apparent resistivity (ohm-m)
ZPhzYXmin	= minimum $Z_{yx}$ impedance phase (mrad)
ZPhzYXmax	= maximum $Z_{yx}$ impedance phase (mrad)
CoherXYmin	= minimum $Z_{xy}$ coherence (0 to 1)
CoherYXmin	= minimum $Z_{yx}$ coherence (0 to 1)
CoherXYmax	= maximum $Z_{xy}$ coherence (0 to 1)
CoherYXmax	= maximum $Z_{yx}$ coherence (0 to 1)
ExMin	= minimum $ E_x $ (mV/km)
ExMax	= maximum $ E_x $ (mV/km)
EyMin	= minimum $ E_y $ (mV/km)
EyMax	= maximum $ E_y $ (mV/km)
HxMin	= minimum $ H_x $ (nT)
HxMax	= maximum $ H_x $ (nT)
HyMin	= minimum $ H_y $ (nT)
HyMax	= maximum $ H_y $ (nT)
NFC/Stack	= number Fourier coefficients/stack

## AVG File Format

*MTEdit* saves averaged impedance and apparent resistivity values in ASCII files with the file name extension \*.avg.

Avg files may have comment lines with a leading “\”, “/”, “!” or “#” character anywhere within the file, although comment lines are normally grouped at the top of the file.

Metadata records with a leading “\$” character are also present and play a large role in recording information that does not fit into a tabular spreadsheet format. Metadata records have a \$program:group.variable=value(s) format. The program name is optional, but if present the metadata record is ignored if the program name is not *MTEdit*. Keyword may have a group.variable structure with the group name unifying keywords with a common theme. An equals sign separates the keyword from one or more comma-separated values. String values which may include commas as part of the text, instead of as a separator, should be enclosed in quotes.

Records with a leading letter are interpreted to column label lines. A line holding column labels must precede numerical data. Column label matching is not case sensitive, but does not allow substring matching. Column order is not fixed and all possible columns may not be present in a particular file.

Numeric data records begin with a leading number. Numerical values are free format with columns separated by either spaces or commas, although comma separated values are preferred. Missing numeric values are flagged by a “\*” symbol or a missing value bracketed by commas.

### Partial listing of file 150.avg

```
$Survey.Type=NSAMT
$Survey.Array=Tensor
$Tx.Type=Natural
$MTEdit3:Version=3.001 applied 2010/11/19
$MTEdit3:Auto.PhaseFlip=No
$MTEdit3:PhaseSlope.Smooth=Moderate
$MTEdit3:PhaseSlope.toZmag=No
$MTEdit3:DPlus.Use=No
$Rx.GdpStn= 150
$Rx.Length=100 M
$Rx.HPR=0,0,0
$Unit.Length=m
Skp Freq Z.mag Z.phz ARes.mag ARes.%err Z.perr Coher
$Rx.Cmp = Zxx
 2 2.9000E-3 2.4389E-1 575.0 4.1023E+00 164.5 965.4 0.99
 2 3.9000E-3 2.6930E-1 735.5 3.7191E+00 87.5 452.8 1.00
 2 5.9000E-3 2.4636E-1 588.0 2.0574E+00 25.0 125.5 0.98
 2 7.8000E-3 3.2524E-1 445.6 2.7123E+00 40.1 201.7 0.98
 2 1.1700E-2 3.5677E-1 345.7 2.1758E+00 27.2 136.3 0.98
 2 1.5600E-2 4.3026E-1 197.5 2.3734E+00 27.1 135.7 0.97
 2 2.3400E-2 4.1419E-1 -65.1 1.4663E+00 20.8 104.4 0.96
 2 3.1300E-2 3.5254E-1 -344.6 7.9413E-01 19.9 99.6 0.97
 2 4.6900E-2 3.6198E-1 -470.3 5.5876E-01 23.1 115.5 0.94
 2 6.2500E-2 4.2978E-1 -768.7 5.9107E-01 62.7 318.7 0.86
 2 9.3800E-2 3.3686E-1 -563.0 2.4195E-01 168.0 998.0 0.49
 2 0.1250 8.1248E-1 -882.2 1.0562E+00 69.0 352.5 0.51
 2 0.1875 4.3825E-1 -383.1 2.0487E-01 85.7 442.8 0.52
 2 0.2500 2.5217E-1 -1188.3 5.0871E-02 70.7 361.2 0.76
 2 0.3750 2.7568E-1 -2138.0 4.0532E-02 69.8 356.5 0.70
 2 0.5000 2.4294E-1 -2097.7 2.3608E-02 54.2 274.5 0.79
 2 0.7500 2.3478E-1 -2545.7 1.4699E-02 36.6 184.0 0.81
 2 1.000 1.7429E-1 -2068.7 6.0756E-03 69.9 357.1 0.82
 2 1.500 3.2197E-1 -2054.3 1.3822E-02 27.3 137.2 0.82
 2 2.000 3.8800E-1 -1968.9 1.5054E-02 23.5 117.7 0.88
 2 3.000 5.0625E-1 -1791.6 1.7086E-02 25.1 125.7 0.98
```

### MTEdit avg file metadata keywords:

Survey.Type = enumeration, {LOTEM, TEM, CSAMT, NSAMT, CR, RPIP, TDIP}  
Survey.Array = enumeration, AMT array {Scalar, Vector, Tensor }  
Tx.Type = enumeration, {Natural, Dipole, Loop}

MTEdit:Version = string, MTEdit version number  
MTEdit:Auto.PhaseFlip = boolean, Yes=apply auto phase flip  
MTEdit:PhaseSlope.Smooth = enumeration, {Natural, Dipole, Loop}  
MTEdit:PhaseSlope.toZmag = boolean, Yes=use |Z| from Phase Slope  
MTEdit:DPlus.Use = boolean, Yes=use Parker D+ data

Rx.GdpStn = float, original GDP Rx station value  
Rx.Length = float, E-field dipole length (ft,m)  
Unit.Length = enumeration, length units {m, ft}  
Rx.Cmp = enumeration, impedance component {Zxx, Zxy, Zyx, Zyy, Tzx, Tzy }  
Rx.HPR = floats, Rx component orientation (heading, pitch, roll deg)

### MT avg file column definitions:

Skp - skip flag, 2 = good data, 1 = bad data, 0 = very bad data.  
Freq - measurement frequency (hertz).  
Z.mag - impedance magnitude (uV/km)/nT  
Z.phz - impedance phase = phase(E/H) (mrad).  
ARes.mag - Cagniard apparent resistivity (ohm-m) .  
ARes.%err - apparent resistivity error (percent).  
Z.perr - impedance phase error (mrad).  
Coher - coherence (0 to 1).