Eikon Technologies Ltd

MAGNETOMETER COMPENSATION SOFTWARE

About QCTool

OK

QCTool 4.0.4
Version
Marine
Gravity
Coefficient

F14F7

Licensed To: ross, petros

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VERSION 5
For Windows OS only

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CONTENTS

NOTICE TO USERS

The magnetic compensation software routines are embedded within **QCTool**. Although the compensation is provided with a variety of additional tools, the user need not be familiar with these other tools. For a basic introduction to the QCTool software, please refer to the "Tutorials" directory as well as our video tutorial available on the website.

It is assumed that the user of this software is familiar with running PC based programs and Microsoft Windows.

REQUIREMENT FOR MAGNETIC COMPENSATION

Modern magnetometers and signal processing boards for magnetic measurements now enable both high sensitivity and high sampling rates to be coupled with a broad bandwidth. The magnetic interference from the airframe and the sensor itself due to attitude changes can be far greater than the inherent resolution of the system. Changing of magnetic parts and the use of coils and permalloy strips can only partially remove the interference effects. Proper magnetic compensation, either in real time or post processing is necessary to remove these effects. The compensation must address all of the interference sources. Magnetic compensation is now one of the limiting factors in the overall useful sensitivity of any airborne magnetic survey whether fix wing, helicopter stinger or towed array or drone systems.

It has been our philosophy to use a graphical approach to magnetic compensation so that the operators can always see down to the noise levels of the system. By this technique, interference effects can often be seen immediately and cured before expensive airtime is wasted.

Additionally we recommend the use of wide bandwidth, which must be matched for the magnetometer, the compensating fluxgate or the IMU units. We recommend the use of at least 10 Hz sampling with a 2 Hz bandwidth to reduce the effects of aliasing.

Our method uses purely software techniques, without the use of varying currents and coils which can distort the field around the sensor. This method records the compensating data and all of the required raw data necessary to re-compensate the magnetometer data in post processing.

The standard application is for many types of aeromagnetic data. However, the same software may be used for compensating marine and ground surveys.

SUMMARY OF PROCEDURES

This is a summary of the basic steps:

1. "Box" flights are first flown at as high altitude as possible away from areas of strong regional ground responses but near enough to the survey area that the Earth's field is very similar at both survey area and box area.
2. Base station data should be collected near the compensation box flights. While it is not important to remove the "diurnal" (internal) field of the earth, reductions must be done to remove atmospheric EM noise. Otherwise compensation coefficients are likely to be contaminated by the atmospheric noise. Two base stations are recommended for these procedures. Coefficients can then be calculated for correlations to the fluxgate and/or the IMU data. Additionally, collection of the box data twice in reverse order (clockwise and counter clockwise is recommended. If these reverse flights are performed, the procedures are easily implemented to remove the gross heading effects prior to calculation the coefficients. This procedure will significantly improve compensation of the survey data.

Heading effects as a function of flight azimuth should be noted for processing of the survey data.
3. If the corrections are to be made in flight the coefficients should be loaded into the acquisition equipment. If the acquisition is so enable either or both sets of coefficients should be loaded.
4. After survey flights, data may be dumped and the processing for removal of diurnal and atmospheric effects should first be removed. If heading effects from reverse compensation flights have been determined, these effects should now be removed from the survey data. Compensation of the data should then be done prior to any additional processing.

SOURCES OF MAGNETIC INTERFERENCE

Magnetic interference in a moving geophysical environment comes from several sources. These include:-

A)   **Permanent magnetism**, mainly from engines and other 'hard iron' magnetic components close to the sensor. This interference is proportional to the coupling with the magnetic field generated by the permanent magnetic materials on or inside the aircraft.

B)   **Induced magnetism**, from 'soft iron' components close to the sensor. This interference is proportional to the coupling with the magnetic field and the magnitude of the magnetic field and is a function of the susceptibility and size of these components.

C)   **Eddy current terms**, from rate of change of movement of conductive surfaces in a magnetic field. This interference is proportional to the coupling with the magnetic field, its magnitude and the rate of change of attitude. Although, these causes are often considered to be the major contributions to "eddy current effects", there are, in principle, many other sources which are not well understood.

D)   **Heading effects** of the magnetometer sensor itself.

E)   **Altitude changes** in a vertical magnetic gradient.

F)   **Attitude effects due** to orientation of the sensor in the magnetic field

G)   Additional effects come from **moving surfaces** and materials, such as trim surfaces and push rods, and distortions of the airframe through flexing.

H)   **Electrical and mechanical interference** in the pass band of the system.

The order of magnitude of these interference effects varies greatly from installation to installation. Typically permanent terms could bring 10 nT of magnetic interference, the induced terms 5 nT and eddy current terms 2 nT. The heading effects of modern magnetometers can be as much as 20 nT and attitude effects of a much as 10 nT. The vertical magnetic gradient at 3000 m. above ground is of the order or 30 pT/m or 10 pT/ft.

On a fairly clean magnetic installation moving surface and electrical and mechanical interference should be better than 1 nT. These can be tested on the ground in a quiet location with the sensor held in a rigid position. As these interference sources are not measured they will affect the residual compensation and should be minimised. In fact the cleaner the installation, with respect to these unmeasured interference effects, the poorer is the overall improvement by this compensation.

The main differences in these terms can be seen in their magnitude and phase relative to a sinusoidal motion.

The permanent interference effect would be in phase with this motion.

The induced component is again in phase with the coupling but with only an increasing effect of the measured field, maximum along the north and south directions where coupling with the magnetic field is greatest at higher latitudes and the reverse at low latitudes.

The eddy current term has a magnitude proportional to the absolute value of the magnetic field coupling and to the rate of change of coupling.
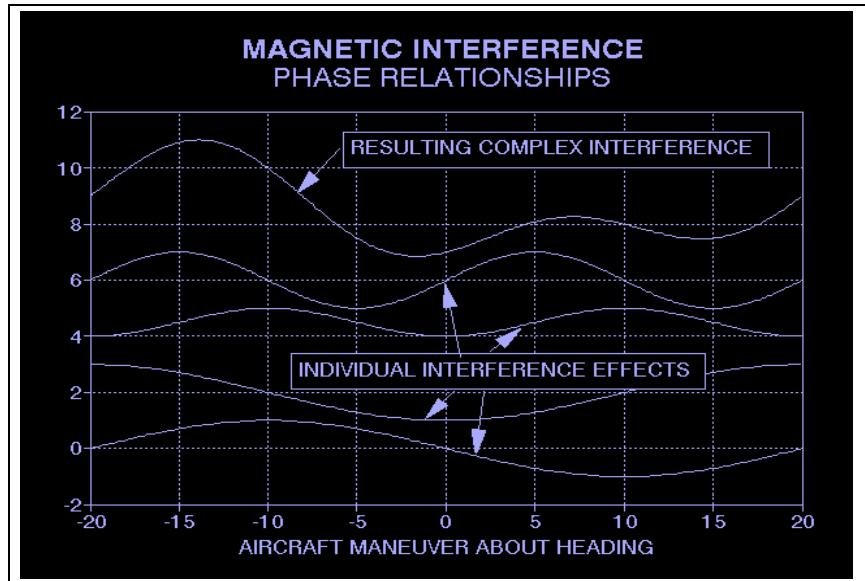

Figure 1

Above we show individual interference effects for a sinusoidal motion. They can be at the frequency of the motion, both in phase and 90 degree phase shifted. They can also have a frequency twice that of the motion, again in or 90 degree phase shifted. The resulting magnetic interference is the vector sum. This can have a complex shape, depending on the magnitudes of the interference.

REALITY IN COMPENSATING A REAL SYSTEM

The residual magnetic interference is somewhat more complex that a simple sine wave manoeuvre. In reality the magnetic interference is in three dimensions, longitudinal, transverse and vertical. Additionally the components in each dimension have different interference effects from pitch, roll and yaw motions. Similar phase shifted responses exist for rolls and pitches. The summed interference is much more complex as the three dimensional attitude and rate of change of attitude of a real aircraft is inter-related.

In a real environment the vehicle is also moving through a changing magnetic field. Even high above ground level there still exists long wavelength gradients and curvature in the magnetic field. By carrying out a box manoeuvre the background magnetic gradient changes at the same time as the heading effect of the aircraft. This makes it extremely difficult to separate the two effects.

BASES OF COMPENSATION

The basis of our compensation is the reduction of motion and orientation induced noise on the selected magnetic elements. These can be individual sensor or various gradient configurations. This motion noise comes from the complex three-dimensional magnetic signature of the airframe as it changes attitude with respect to the magnetic field vector. The noise comes from permanent, induced and eddy effects of the airframe plus additional heading effects of the individual sensors whether optically pumped or fluxgates.

Due to the background magnetic changes experienced in real flying conditions, long wavelength geological interference, it is felt that it is not easy to obtain adequate compensation coefficients which can be used on all survey headings. Only in extremely low gradient areas would this technique give reasonable results. This is due to the fact that these background changes alter with the heading and have the same high frequency components.   They are, therefore, indistinguishable from heading effects due to the airframe alone.   Attempts to use 1 set of coefficients for all headings average these background errors into the compensation coefficients and produce inferior results during compensation. Additionally, the coupling of the earth's magnetic field with the susceptible and conducting materials on the aircraft changes with heading and thus the net effect on the individual sensors varies with aircraft heading and thus this would imply the necessity of heading dependent coefficients.

Our approach has been to use four individual sets of coefficients, one each for the four survey headings and if necessary for the eventual survey, diagonal.   On survey the changes from the nominal line are small, typically within +-20 degrees for pitch, roll and yaw. Note: You may also use diagonal paths in the box data. Be sure, in all cases, when calculating the coefficients to split the box flight into its different flight directions as "lines" or "profiles". This is easily done within QCTOOL prior to calculating the coefficients. Note that if the survey lines are not in the usual cardinal directions, the box data should be calculated from profiles or lines parallel and perpendicular to the survey headings.

We define 4 headings for each survey, even if only 2 are used for surveying. Of course, the other 2 cardinal headings may be used for tie lines. These cardinal headings are normally, but not necessarily, orthogonal. The Main Cardinal Heading is defined as the grid value of the cardinal heading closest to grid north. For example, the main survey direction is on a heading of 100 degrees east of grid north then the cardinal headings are 10, 100, 190 and 280 degrees with the Main Cardinal Heading 10. We then define our 10 degree east heading as 'NORTH'. Similarly the 100 degree heading is defined 'EAST', the 190 deg heading as 'SOUTH' and the 280 degree heading as 'WEST'.   This convention will be carried through from the SURVEY program to post-processing.

The magnetic compensation is carried out in software without the use of active distorting magnetic fields. A magnetic interference model has been constructed with three orthogonal sets of components. This assumes a magnetically rigid magnetic interference model.

A three axis fluxgate or a three axis IMU instrument is used to measure the coupling of the three axes with the background magnetic field. These sensors are very sensitive to attitude changes and are used to accurately monitor the vehicle reference frame. If using IMU data for compensation, accurate synchronization of the IMU channels with the magnetic data should be made. The frequency response and sample rate of the **acquisition system** used to measure the fluxgate/IMU signals should optimally be the same as that of the **magnetometer acquistion system**. This means that there is no phase distortion of these synchronised measurements. This leads to improved compensation throughout the pass band of the system.

A series of pitch, roll and yaw motions are carried out on each survey direction to vary this coupling and gather fluxgate, barometric and measured magnetic field data. In fact, a predefined series of motions is not required. Merely, that there should be sufficient activity along the compensation lines to provide enough data to supply the algorithms. This data is processed using generally either an SVD or a Ridge-Regression technique to find a stable set of coefficients for the model. When the compensation algorithm is run using the model and coefficients, either in real-time or post-processing, a magnetically compensated data set is generated.

We have tried to make this software as production orientated as possible, to supply the operator with either real-time or quick post processing compensated data to view, confirming that it meets company specifications, and continue flying.

The programs supplied should enable the user to achieve software magnetic compensation for total field data or magnetic component data. This can be carried out in real-time using previously calculated compensation coefficients or in post-processing using a selection of compensation coefficients.

NOTE on Box Maneouvers: The coefficient calculation is such that no specific flight maneouvers need be made BUT sufficient maneouvers must be made to characterize the effect of the aircraft and the sensors with regard to attitude and velocity. Both, slow moving manoeuvres and as well as high frequency manoeuvres should be made in all directions during the box flight.

NOTE on Removal of heading effects in Box Manoeuvres': It is optimal to fly the box twice once clockwise and once counter clockwise. The heading effect for each heading can easily be reduced by calculating the mean data of the entire data and then the mean data of each profile for both directions. The bulk heading effect can then be calculated and removed from the box data prior to calculating coefficients. These heading effects can be introduced to the survey data and the survey corrected subsequently.

NOTE on Base Station Corrections: As many external noise effects should be removed prior to calculating the compensation coefficients. Any noise not correlated with the magnetometer and vehicle movements will be introduced to the equations and reduce the accuracy of the compensation calculations. There are several sources of external magnetic noise. The principal sources being the earth's internal field ("diurnal") which varies daily and specifically with the location on the earth, atmospheric magnetic fields often referred to as the magnetotelluric fields and various forms of cultural noise. These noises cannot be removed accurately enough with a single base station as the various noises cannot be separated and processed appropriately from a single data location. Two local base stations or a local base station and a proximate observatory data set can normally accomplish the task. The observatory variation should be removed from the local base station to then process the local variation. The local variation should have a sufficiently high sample rate to properly remove the variation from the survey data whether it be the compensation flights or the survey flights. Optimally, the local base station should sample the base data at the same rate as the moving magnetometer. If this is not possible, then likely the moving magnetometer data should be low passed before processing. Please follow our magnetic base station tutorial found in the /help subdirectory of the QCTool installation folder.

STAGES OF COMPENSATION

The compensation takes four stages:-

A)   Acquisition of motion test data followed by processing to split this test data into separate profiles on each heading. Removal of superfluous data.

B)   Removal of internal (diurnal) and external (atmospheric, cultural) noise

C)   If motion test data flown with reverse headings (recommended), removal of main heading effects

D)   Produce compensation coefficients.

E)   Post processing of the survey data with compensation utilizing the coefficients.

X)   Real Time Processing: the compensation algorithms can be applied in real time if desired by loading compensation coefficients whether calculated vs. fluxgate and/or IMU data.

ACQUISITION of Motion Test data (*Box data*)

The acquisition of motion test data should take approximately 20 minutes for fixed wing or stinger helicopter data or towed instruments from the helicopter. Slightly, longer times are required for drone configurations. Let us consider that we want to fly N-S traverses and E-W tie lines. The test should consist of the following:

1) Have all equipment in normal operating conditions. The magnetic sample rate should be that of the survey. 10 Hz minimum sampling with a 2 Hz bandwidth is recommended for all surveys. All the equipment that would normally be "ON" during a survey flight should on. If the aircraft is equipped with an auto-pilot it should be turned off and the aircraft flown manually. Aircraft systems that consume large amounts of power such as air conditioning should be either turned off and left off or placed in a mode where the compressor and fan systems are continually on and do not cycle. It should be noted that whatever aircraft systems are on during the compensation test flight must be "ON" for all surveys flights. Failure to observe this practice will result in poor compensation results during survey data acquisition.

2) The pilot(s) should be consulted to ensure they understand the following, often somewhat conflicting, ideal requirements.

Ideally, the compensation motion tests should be carried out in a magnetically quiet area at high altitude, away from ground effect, at least 8,000 feet above ground but this depends on the ground response. The motion tests should be flown reasonably proximate to the actual survey such that the earth's inducing field is comparable. The normal data acquisition program should be run with the sample rate the same as that to be used in the survey.   Traditionally, during each of the four lines the aircraft should perform three each complete pitch, roll and yaw motions. These should be smooth and as symmetrical as is possible, of typically 5-10 second period. In addition, if flying any diagonal lines during the survey, diagonal lines should be flown in the motion box test.

For towed sensors from drones, box flights are limited in elevation due to regulations. Thus, every attempt should be made to fly the box flights in quiet magnetic areas. But, the box area must not be so removed from the survey area that the earth's magnetic field is substantially different in the two areas. Controlled pitch, roll and raw motions are difficult for any towed instrument but the software has been optimized such that as long as there is sufficient activity in these three motions,

the compensation will be effective. For drone surveys, it is highly recommended to flight overlapping patterns for the box data (Figure 2). All magnetic sensors have inherent heading effects and these cannot be well dealt with by the compensation software. However, by flying reverse patterns (Figure2), the heading effect for all necessary azimuths can be easily determined within QCTool. These heading calculations are then introduced as corrections for the survey data prior to applying the compensation.

Figure 2: Suggested Box Patterns

Another useful compensation box configuration is shown below (Fig2a). In this case, 8 flight lines are flown E to W, W to E, N to S and S to N all crossing near the same location. In this case, the survey lines were flown E to W or W to E and the tie lines N to S and S to N. This is a very good technique for determining the inherent heading effects of the sensors
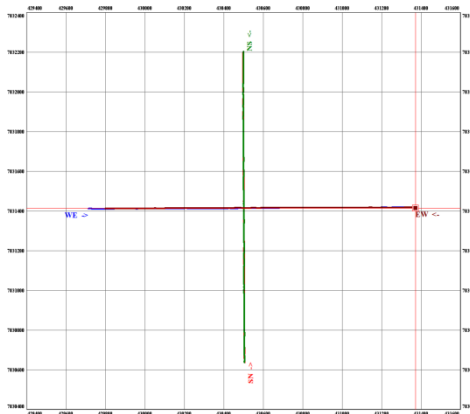

Figure 2a: Another practical box for drones.

Traditionally, the motions should be consistent with normal vehicle motion experienced during survey data acquisition. Roll manoeuvres should be +/-10 degrees peak to peak, pitch manoeuvres should be +/-5 degrees peak to peak and altitude changes should also be minimised, 50 m. or less if possible, and yaw manoeuvres should be +/- 5 degrees peak to peak. Only the aircraft surfaces that are used on line to alter the aircraft attitude should be used, e.g. do not use rudder excessively if this is not normally used as magnetic push rods may complicate the compensation. The order of motions is not critical. It is, however, good procedure and enables us

to view the replot in a more meaningful way. The line should be closed, the vehicle set on a new heading, e.g. west, and the same motions carried out. The motions should then be carried out again on the remaining south and east headings. In order to assist in data analysis the operator should note, if possible, on the flight log the start and end fiducials for each of the 12 manoeuvres

The operator may have several files, one for each direction or one file for the entire flight. The software can manage with either of these cases.

The reduction of the data to calculate the coefficients can be carried out on the aircraft but is easier and more accurate to do it the ground, either on the aircraft system or a similar PC computer. It is recommended that a plot is carried out of the data at the fastest sample rate to view the fluxgate, IMU and the magnetometer signals to ensure that there are no glitches or other problems with the data. The user should also select the fid ranges to use for each heading. There should be from 800 to 20000 data samples for each line.

It is recommended that this test procedure should be carried out at the beginning of each survey and every two weeks or whenever any major magnetic component is changed.

REDUCTION WITH QCTOOL:

QCTOOLS's tool "Magnetic Compensation" calculates the regression of the magnetometer readings individually against the fluxgate or IMU signals. The results may be saved to various formats for import to interpretation software.

LICENSING

Typically, two licenses are provided. One license allows calculations of the coefficients as well as processing of the survey data with the coefficients. The other license allows only processing of the survey data with the coefficients imported for processing. This licensing allows for one license to be in the office for production of the coefficients by an experienced technician and the other for processing of the survey data in the field with the coefficients provided from the home office. If desired, software is provided to allow the survey processing within Oasis (Geosoft).

Getting Started in QCTOOL

A variety of formats for import are provided but typically ascii XYZ, .csv or .gdb formats are utilized but also manufacturers formats.

This example is carried out very traditionally as we will see as we progress. However, there are several pitfalls in the box procedures as well as acquisition processing.

First to import and process the compensation box data:

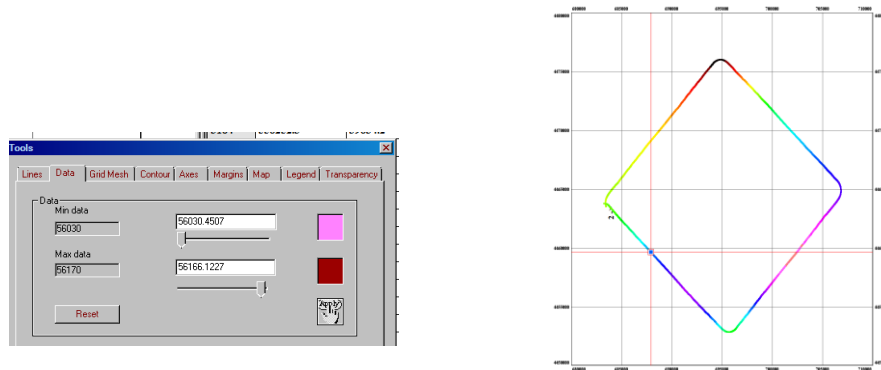**Start -> Programs -> QCTOOL -> QCTOOL-> Import**

Select your format and perform standard QCTOOL import selecting the format of each channel. This import allows the user to create a new .qct file name and store it in the directory of choice. This would usually be the main data processing directory or the directory containing the raw flight data**.** In our example, the box data is contained in ascii columnar format. We are assuming the

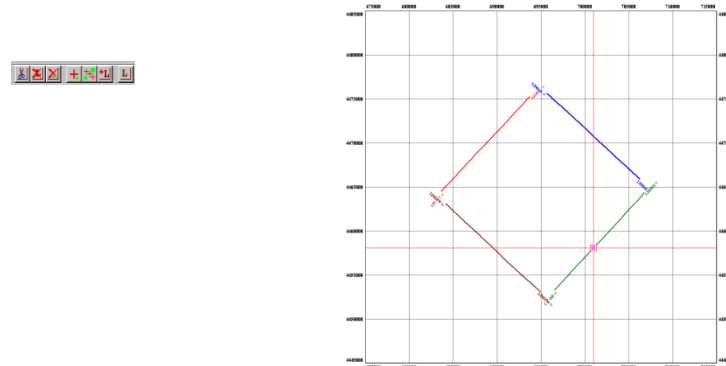user is familiar with this import facility in QCTOOL.

B:SEC	C:GTME	D:GLON	E:GLAT	F:Easting_UTM_Znn(m)	G:Northing_UTM_Znn(m)	H:GALT	I:MAG1	J:MAG2	K:BX	L:BY	M:BZ	N:ROLL	O:PITCH	P:YAW
558775.50	40357.40	95.290782	40.206303	694959.5	4453172.0	5273.2002	56091.9	56089.7	17848.0	15837.3	-48891.7	1.985	0.723	39.993
558775.60	40357.50	95.290732	40.206336	694955.2	4453175.4	5273.2002	56091.8	56089.6	17849.0	15842.9	-48892.0	1.994	0.731	40.032
558775.70	40357.60	95.290682	40.206368	694950.8	4453178.9	5273.2002	56091.7	56089.5	17816.5	15847.6	-48905.0	2.011	0.750	40.073
558775.80	40357.70	95.290632	40.206400	694946.4	4453182.4	5273.2002	56091.6	56089.4	17778.3	15852.5	-48913.4	2.012	0.781	40.113
558775.90	40357.80	95.290582	40.206433	694942.1	4453185.9	5273.2002	56091.5	56089.3	17758.4	15863.5	-48918.3	2.012	0.797	40.149
558776.00	40357.90	95.290532	40.206465	694937.7	4453189.3	5273.2002	56091.5	56089.2	17725.8	15880.4	-48935.7	2.012	0.811	40.187
558776.10	40358.00	95.290482	40.206497	694933.4	4453192.8	5273.2002	56091.4	56089.1	17705.3	15900.5	-48930.6	1.996	0.830	40.217

The channels contained in the file are shown in the QCTOOL header above although the Easting and Northing were computed in QCTOOL from Lat/Long and the channels added. The data contains 2 Cesium magnetometer channels, 3 fluxgate channels as well as the IMU data.

Our first stage is display MAG1 vs. Easting/Northing in a map. *"Right click the channel and select MAP"*
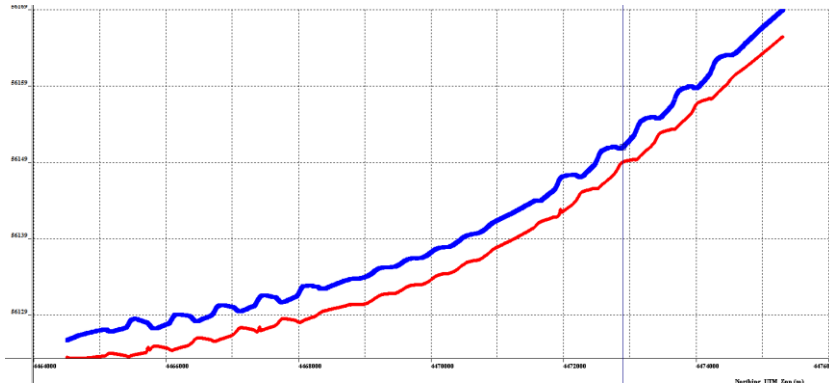

This view tells us a few things. First, there was only one circuit flown clockwise. Second, the data has a range of 140nT. This fact as well as the variation around the flight indicates that there is still a response from the ground in the data. Also, there is a significant variation during the flight, the determination of the raw effect of heading may be problematic using the two opposing flight azimuths. We then use several graphical tools in the GridView to cut and clean the flight line.
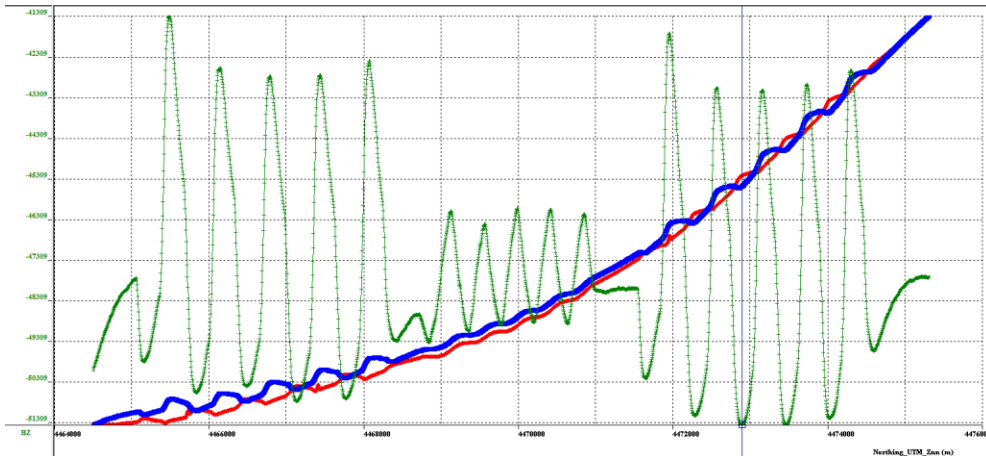

The flight is cut into 4 flight paths/profiles/transects each along a different main heading and these profiles each named appropriately. (E.g. Line SE_NW). This process of cutting the lines places the data now in 4 spreadsheets within the original .qct file [one spreadsheet per profile]. This organization is fundamental to the design construction of QCTOOL.

We can now use the plotter within QCTOOL to view and compare different parts of this data.

The plot above shows the values of the two total field magnetometers along one of these flight paths. The two plots are here plotted to the same scale. This demonstrates an example when two magnetometers have different heading effects.

The plot above shows the data for the two total field magnetometers as well as the vertical component of the fluxgate magnetometer. Here the 3 plots are not to the same scale.
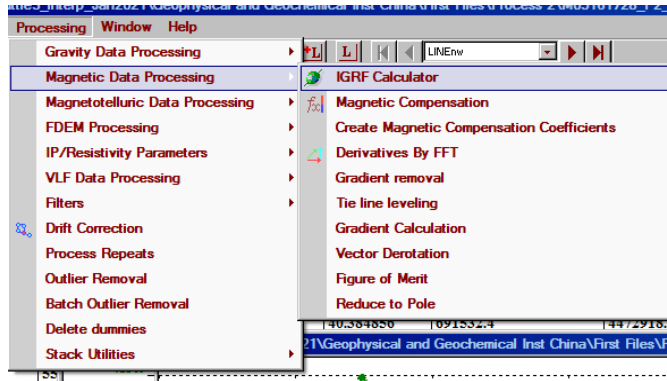
At this stage, it is suggested that both the total field data as well as fluxgate data be edited for removal of atmospheric noise. Base station data can first be reduced by observatory data to remove the long wavelength variations. The resulting data can then be processed for the local variation and removed from the TMI data. Removal of the variations in the fluxgate data can also be performed. This is a more complicated procedure but requires only simple mathematical operations all of which are provided in the QCTOOL calculator tool.
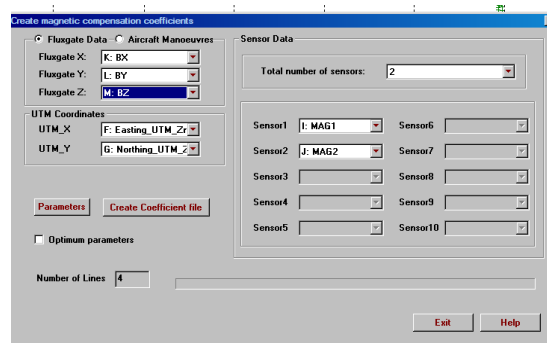
EDITING BOX DATA

All of the data should be examined and edited for outliers and superfluous data. Data points can simply be removed individually or in groups or individual values in channels can be set to NO DATA if the data is to be disregarded.

Coefficient Calculation

When everything is ready, select "*Create Magnetic Compensation Coefficient*s"
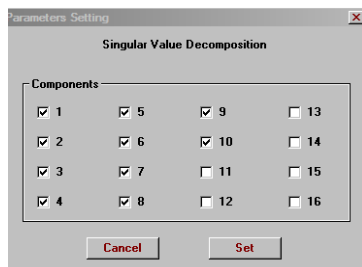
The following screen will appear.

In this instance, we have selected to calculate the coefficients for the two total field magnetometers using their relationship to the three fluxgate channels.
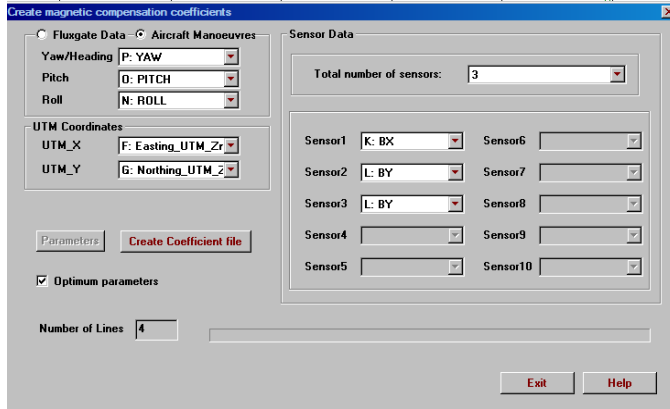
SELECT PARAMETERS OF SOLVER

In QCTOOL, only one algorithm is provided by which the coefficient matrix is solved via our Singular Value Decomposition algorithm. However, the user may select how many components they wish to use. This is presently turn off as the software now automatically determines the best components to use.

This solver (SVD) usually gives the best results in most conditions. In the event that the desired level of compensation is not achieved the user may wish to contact us for further software allowing other solvers. Additionally, we have enabled an optimization process to determine the optimum parameters for a solution. We suggest if you are not very familiar with magnetic compensation to select the "*Optimum parameters*" box.

After selecting everything required, left click the "*Create Coefficient file*". You will be provided an interface to select the name and location of your coefficient file. The length of time required to calculate the coefficients will vary depending on the solver selected, the length of the lines in the compensation data file, the complexity of the data and the speed of your computer. You will be notified when the computations are finished and the file saved. Click *Exit*.

In the example above, we have chosen to calculate the coefficients for the 3 fluxgate channels via the IMU data utilizing the coefficient optimization process. The coefficients are always calculated for each heading in the compensation box and thus the compensation box should include all headings to be utilized in your survey.

EXAMPLE OF TYPICAL SET OF COEFFICIENTS FOR NORTH HEADING

```
_7020.0N  0  Sensors  2  Ang 359
30
50167.310011249967000   50180.191013749980000  M_AV            1
     0.901068421430980     0.901068421430980  X_AV        2
    -0.401071537591340    -0.401071537591340  Y_AV        3
     0.146134477313536     0.146134477313536  Z_AV        4
     0.000000000000000     0.000000000000000  CONO         5
    -6.210427040762355    -8.386201421230732  XS          6
    -2.659618427906260    -4.713554467773923  YS          7
   -14.554975284857377    -6.116321934625224  ZS           8
     0.000000000000000     0.000000000000000  X2          9
     0.000107032104440     0.000074005136053  XY          10
     0.000096677474941     0.000058658344039  XZ          11
    -0.000075504881691     0.000060281667377  YZ          12
     0.000110040961133     0.000029927459216  Z2          13
     0.000202047555711     0.000293907080544  Y2          14
     0.000000000000000     0.000000000000000  DXX          15
     0.000245336329606     0.000014017613258  DXY          16
    -0.000170890976665    -0.000019691175589  DXZ          17
     0.000216231672625     0.000244881930981  DYX          21
    -0.000086717760520    -0.000100416026859  DYY          19
     0.000027911376371     0.000035755524798  DYZ          20
    -0.000152631848576    -0.000099043569107  DZX          21
     0.000057307901985     0.000042494894827  DZY          22
     0.000624456693965     0.000121012690309  DZZ          23
     0.000000000000000     0.000000000000000  BARO          24
 7540.337552083333300  7540.337552083333300  A4_AV          25
     0.000000000000000     0.000000000000000  OFFSET          26
 3044.377387115921900  3044.377387115921900  TOT_AV           27
     0.000000000000000     0.000000000000000  X_DIF          28
     0.000000000000000     0.000000000000000  Y_DIF          29
     0.000000000000000     0.000000000000000  Z_DIF          30
```

Coefficients for all sensors and all selected profiles are stored in one file. These coefficients can now be used by the real-time data acquisition program and any desired post-processing.
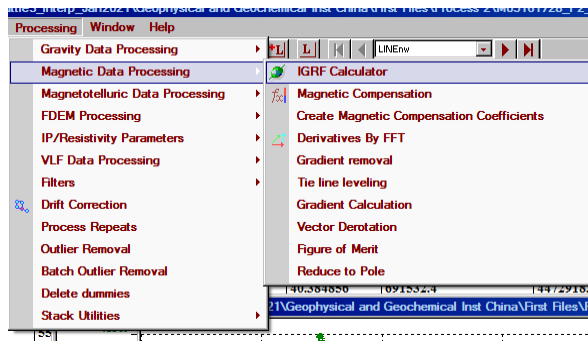
DATA COMPENSATION

Note 1: For users wishing real-time corrections during data acquisition, please contact Eikon Technologies.
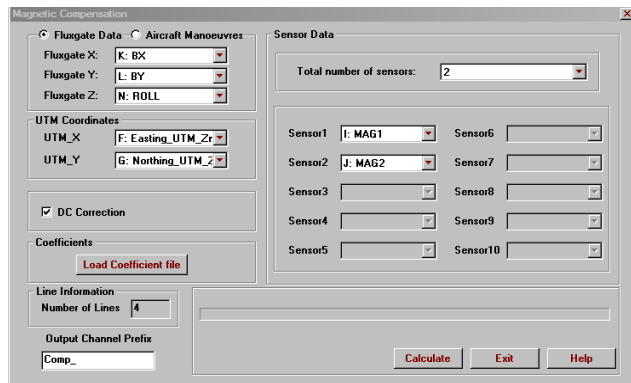
Note 2: The correction of the flight data may now be done in QCTOOL or if you have purchased the corresponding components within Oasis. We suggest QCTOOL as it is more versatile for merging, filtering, removing outliers, etc.

Generally, removal of both the long wavelength diurnal variation and the higher frequency atmospheric and cultural variation should be done prior to utilization of the compensation.
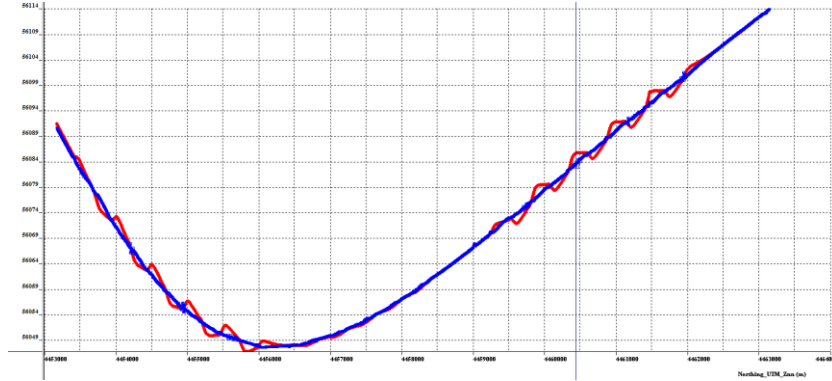
As an example, we will not compensate several of our channels in our box data example and view the comparisons.
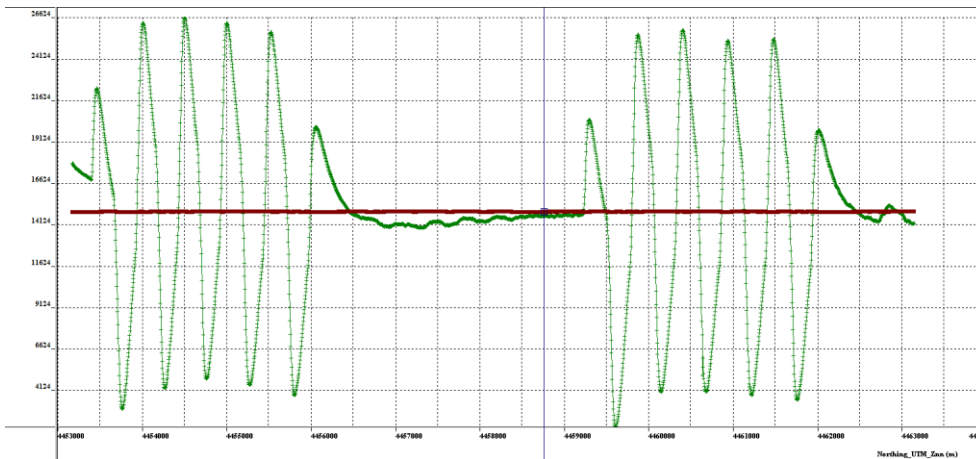

This time, we select the "*Magnetic Compensation*" tool.

In this case, we have chosen to compensate the two total field magnetometers with the fluxgate data. Upon clicking "*Load Coefficient File*" select the coefficient file that was saved when these selections were made - *.cor. The precursor of the Output channels may be chosen and then simply click Calculate. You will be notified when complete and all the compensated channels are now in the QCTOOL file. We may now evaluate the results either by calculating misfit parameters or simply plotting the original and compensated data.

In the above plot, the original data for TMI sensor 1 on the eastern line from SW to NE is shown in red while the blue is the compensated data. Close examination shows some small noise issues in the compensated data. These may be due to the lack of removal of atmospheric noise in the box data or timing issues between the TMI and fluxgate data.

In the above plot, the original data for the Bx fluxgate sensor on the eastern line from SW to NE is shown in green while the brown is the compensated data.

Exporting Compensated Data:

Simply select Save As under file and select the format that you desire and then you will be requested to select which profiles and which channels that you wish to export.