Gravity Data Correction
in
QC-Tool

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1. Importing Data

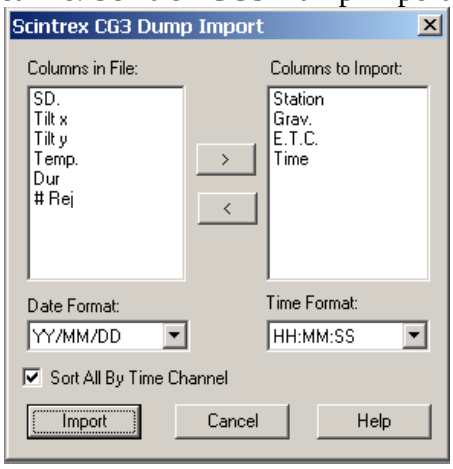
You have to import to QCTOOL measured gravity data from ASCII files. Then you have to import the data from CSV files with base station and location information.

1.1. Importing Gravity Survey Data Files

You can import data from a gravity instrument dump files. Accepted file formats are CG3, CG5 – dump files, any ASCII columnar files.

1.1.1. Importing a gravity instrument dump file from a Scintrex CG3 gravimeter.

- On the *File* menu select *Import File*, and then select *Scintrex CG3 dump* item from a pop up list of Import Formats. Select desired dmp-file to import and specify the output qct-file. Scintrex CG3 Dump Import dialog appears:



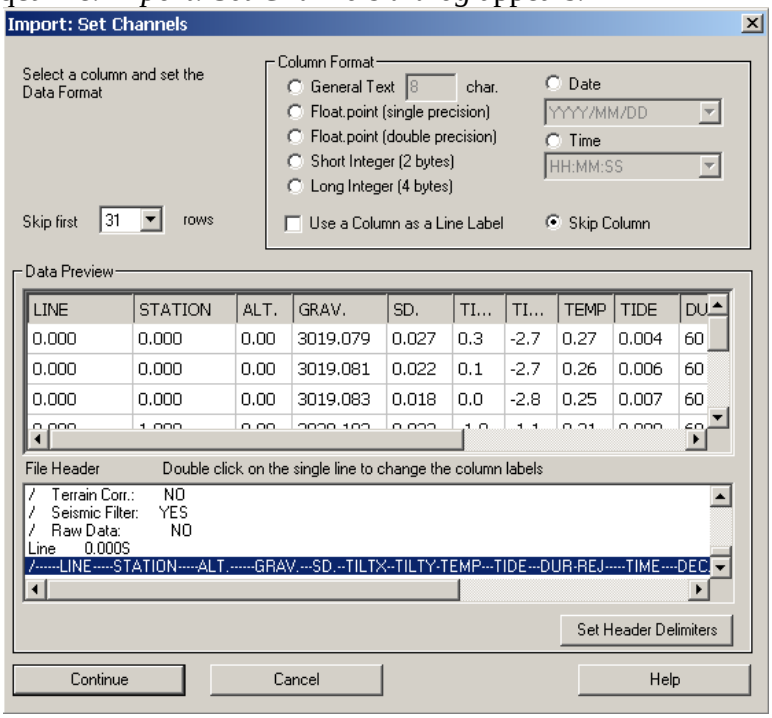
- Specify data columns to be imported. Add or remove columns to the "Columns to Import" list with buttons ">", "<".
- Specify date and time formats in the importing file.
- Leave "Sort All by Time Channel" checked to sort importing records by time automatically.
- Click on Import button.

N	A: Station	B: Grav.	C: E.T.C.	D: Time	E: Date
1	90002.	4604.65	0.01	05:18:29	94/06/15
2	5715.	4603.79	0.01	05:41:14	94/06/15
3	1605.	4600.01	0.01	06:09:13	94/06/15
4	1618.	4606.02	-0.03	09:47:23	94/06/15
5	1616.	4604.38	-0.03	09:58:21	94/06/15
6	1621.	4606.96	-0.03	10:10:44	94/06/15
7	1619.	4607.70	-0.03	10:25:23	94/06/15
8	1614	4603.29	-0.03	10:35:34	94/06/15

1.1.2. Importing a gravity instrument dump file from a Scintrex CG5 gravimeter

- On the *File* menu select *Import File*, and then select *ASCII* item from a pop up list of Import Formats. Select desired dmp-file to import and specify the output

qct-file. *Import: Set Channels dialog* appears.

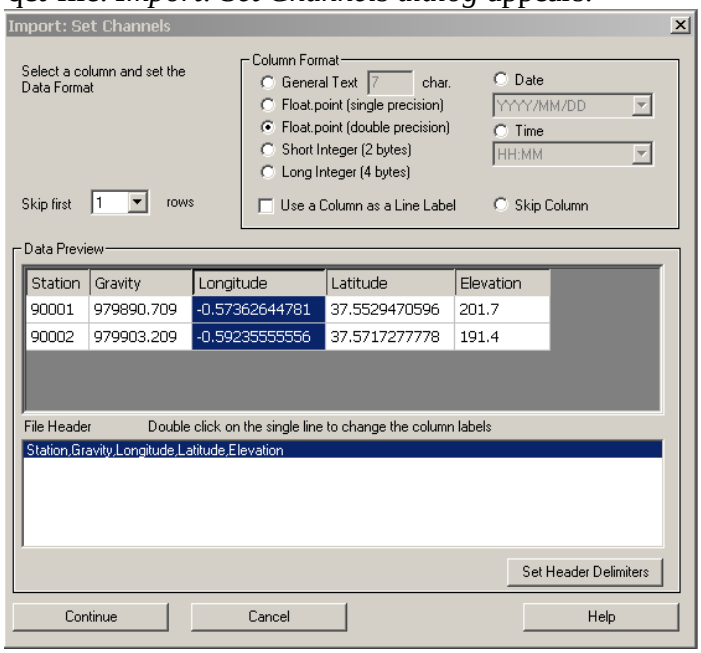


- Specify header line, format of columns and click on continue button.

1.2. Importing Base Station Data.

You can import data from SCV or any ASCII columnar file. File should contain geographical coordinates, elevation and absolute gravity for all base stations.

- On the *File* menu select *Import File*, and then select *ASCII* item from a pop up list of Import Formats. Select desired base station data file to import and specify the output qct-file. *Import: Set Channels dialog* appears.



- Specify header line, format of columns and click on continue button.

1.3. Importing Location Data.

Procedure is similar to the one described in the Importing Base Station Data topic.

2. Merging survey data files with base station and location files.

2.1. Creation of Lat/long coordinates from UTM XY data.

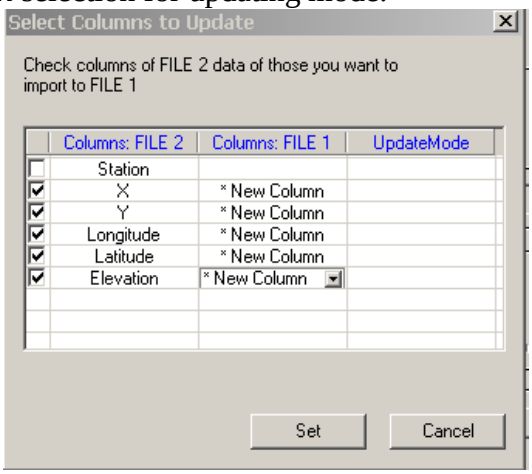
Open qct-file with location information. On the Tools/Coordinates menu select *Transverse Mercator Calculator*. Select "*UTM->Latitude/longitude"* mode. Specify channels for UtmX, UtmY. Set the geographical zone or Central Meridian and Ellipsoid Datum. Create new channels with Lat/long by clicking on *Process* button.

2.2. Creation of UTM XY coordinates from Lat/Long data.

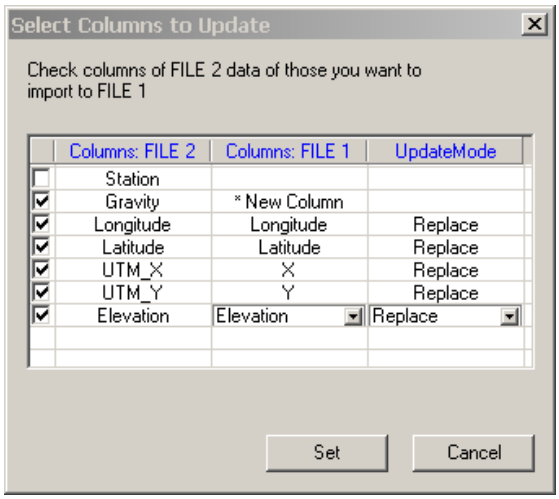
Use *Transverse Mercator Calculator* to create UTM XY coordinates channels in qct-file with base station information.

2.3. Merging survey data files with base station and location files.

- Close all qct-files. Select *Merge Files* from *Tools/Files* menu.
- In the "Merging Mode" dialog select *Update File Channels*. *Merge File* dialog appears.
- Specify survey data file as a File 1. Select Base Channel from Channel list.
- Specify location data file as a File 2. Select Base Channel from Channel list.
- Click on *Set Channels* button and select columns from file 2 data of those you want to import to the File 1. For example, *X, Y, Longitude, Latitude, Elevation*. Leave *New Column* selection for updating mode.



- In Merging File dialog click on Merge button.
- Start another merging process.
- Repeat merging procedure with survey data and base station files. In Select Columns to Update dialog specify columns of file 1 which you want to be updated.



- Open the result file in Read/Write mode.

3. Drift Correction.

Now you have a qct-file with measured gravity data and coordinate information all together.

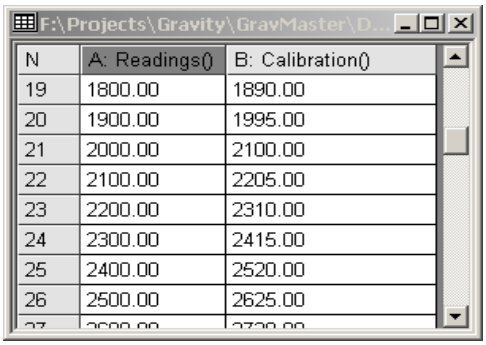
When you calculate Drift Correction you want to eliminate the instrument error. Also you want to correct data for the tide effect. This may involve three steps. First, applying Meter Calibration correction, then, calculating and applying the tide correction, and finally, applying the Meter Drift Correction.

3.1. Meter Calibration Correction.

For many older meters the manufacturers provided a single number for meter calibration. The number was the simple scale factor that converted the meter reading into milliGals by multiplying the reading times the factor. The scale factor was sometimes engraved into the meter nameplate. To apply this correction simply use QCTool calculator and apply instrument scale factor to the readings, which already corrected for tide effect.

Modern meters use a more complete description of the relationship between meter reading (counter units) and milliGals. Over the extended range of these meters the conversion from counter reading to milliGals is not perfectly linear; hence, a table rather than a constant is used. The table for the translation of instrument reading to milliGals is supplied by the manufacture.

- Import this table to the QCTool to have qct-file like this:



N	A: Readings()	B: Calibration()
19	1800.00	1890.00
20	1900.00	1995.00
21	2000.00	2100.00
22	2100.00	2205.00
23	2200.00	2310.00
24	2300.00	2415.00
25	2400.00	2520.00
26	2500.00	2625.00

- To apply Meter Calibration table use the *Merge Files* utility.
- Select your gravity survey file as a File 1. For the Base Station channel select Instrument Readings Data.
- Select Instrument Calibration file as a File 2. For the Base Station channel select Instrument Readings Data.
- In the *Select Columns to Update* dialog select channel with translation data. Leave New Column mode.
- **IMPORTANT**. Check the *Interpolate if Value is not found* check box. The calibrated reading data will be calculated automatically.

3.2. Tide Correction.

Open your gravity survey file and correct data for the tide effect.

- Select *Free Air, Tide, Bouguer Correction* from the *Extended Tools* menu. Specify Latitude, Longitude, Elevation channels in respective combo list boxes. Select *Tidal* algorithm in the correction algorithm list box. Specify Date and Time channels and GMT difference. Set the name of output channel. Click on *Apply* button.
- The new channel with Tide correction will be created in your work file.
- Apply this correction to the channel with instrument readings by using the calculator. (Insert channel, apply formula *new channel = instrument reading + tide correction* (e.g. M = B+L) for all lines, all rows).

3.3. Instrument Drift Correction.

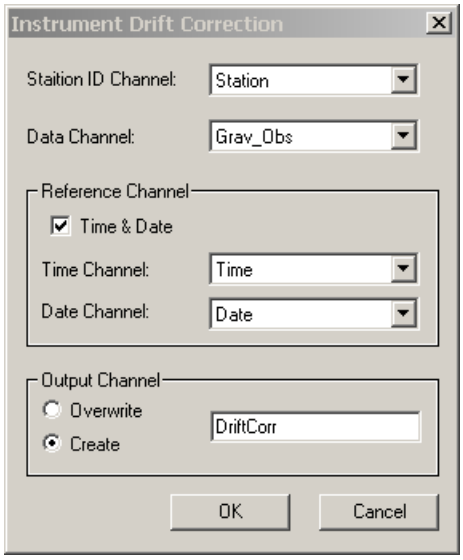
Characterizing the Drift

Meter drift is often assumed to be a linear phenomenon. If it were truly linear, the drift rate could be determined from only two readings. You could take a base station reading at the beginning of the survey and another at the same station at the end of the survey. This is called a loop tie. From this, you could solve for the constant drift rate and use this to compute the drift to remove from any observation as a function of time.

Rather than making a single loop tie, you could make several loop ties as the survey progresses. Within each loop tie, you might assume a linear drift but because you have many different drift segments, you can reasonably approximate a more complex drift. Once the drift curve is established, you can compute what drift to remove from any observation as a function of time.

Select *Tools/Data Channels/Drift Correction* from menu. *Instrument Drift Correction* dialog appears.

Make sure you have selected the Station ID channel (channel with a station label) as well as Data channel, which in our case will be the channel with data already calibrated and corrected for the tide effect. Set the reference channels (Time and Date). Specify the output channel.



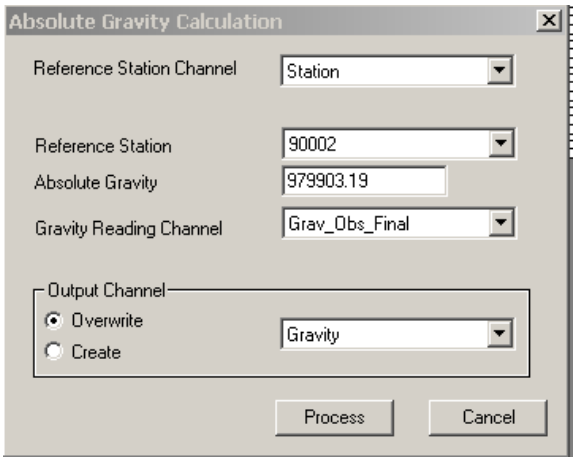
Now apply the drift correction to the data channel by calculator **adding** function. You will get the observation gravity data.

N: Grav_Obs	O: DriftCorr	P: Grav_Ob...
4834.865522	0.000000	4834.865522
4833.965497	-0.000352	4833.965145
4830.036361	-0.000785	4830.035576
4836.409874	-0.004162	4836.405712
4834.682339	-0.004332	4834.678007
4837.377858	-0.004524	4837.373334
4838.154712	-0.004751	4838.149961
4833.529221	-0.004908	4833.524313
4835.854897	-0.005167	4835.849730
4832.816510	-0.005298	4832.811212
4834.872262	-0.006740	4834.865522

4. Absolute Gravity Calculation.

Now the absolute gravity could be calculated for all stations in the survey file.

Select *Absolute Gravity Calculation* from *Extended Tools* menu. The *Absolute Gravity Calculation* dialog appears. Select the *Reference Station Channel* (channel with station label), *Reference Station* (reference station, which absolute gravity data is known) and *Gravity Reading Channel* (your result of 3.3 step channel) from respective combo boxes. Set the *Absolute Gravity* for the specified reference station. Specify output channel.



Click on Process button to get the absolute gravity.

Note: If you have more than one raw files with gravimeter readings import all of them into QCTool first. Then merge all files into one with *Append Files* utility. After you get one file with all measure data apply steps from 2 to 4 described in this manual.

5. Terrain Correction.

You may either build a topography grid from a government DEM file (5.1) or from your own elevation data file (5.2)

5.1. Creating a Regional Topography grid from USGS (GTOPO) or Canadian (CDED) files.

This application has been designed to create a regional topography grid, which can be used in QCTool terrain correction algorithm from the DEM files in GTOPO30 format.

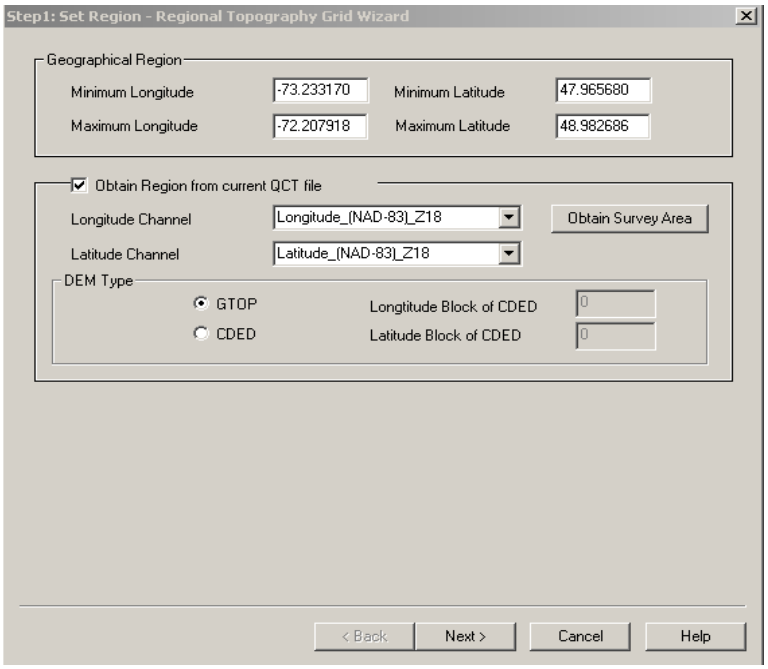
http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html.

As of 2010, CDED files may also be used. These are available from Geobase:
http://www.geobase.ca/geobase/en/data/cded/index.html

On the *Extended Tools* menu select *Create Regional Topography Grid*. The wizard to create such a grid appears.

First Page:

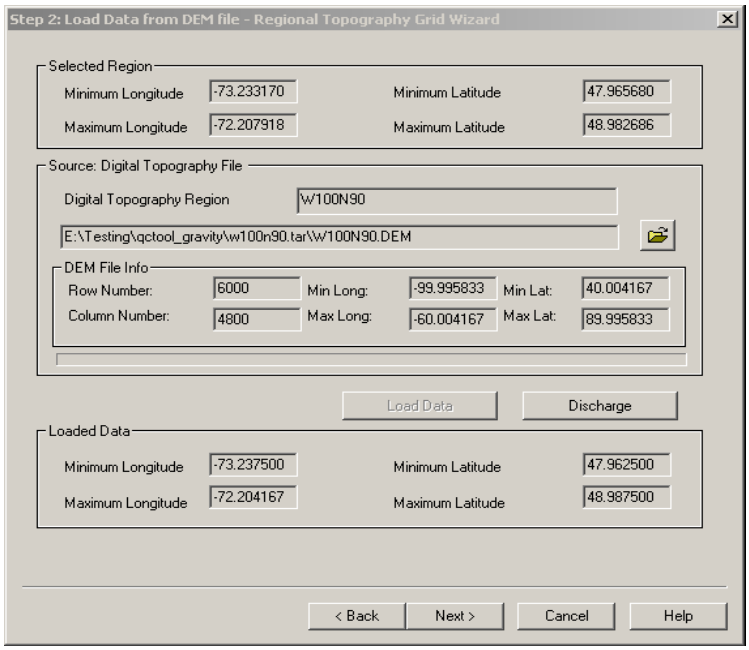
- On the first page of wizard specify Geographical region by setting of minimum and maximum values for the latitude and longitude. If you want to cover the region of your survey data simply check the *Get Region from current QCT file* check box, specify channels for Latitude and Longitude and click on *Get Survey Area* button.
- Select the type of DEM file (GTOPO or CDED) Click *Next*.



Second Page:

For GTOPO Files

- On the second page of wizard specify the appropriate digital topography file. The directory of DEM file should have header file containing size and coordinate information for the DEM. This file is expected to be with the same name as a dem-file and hdr- extension.



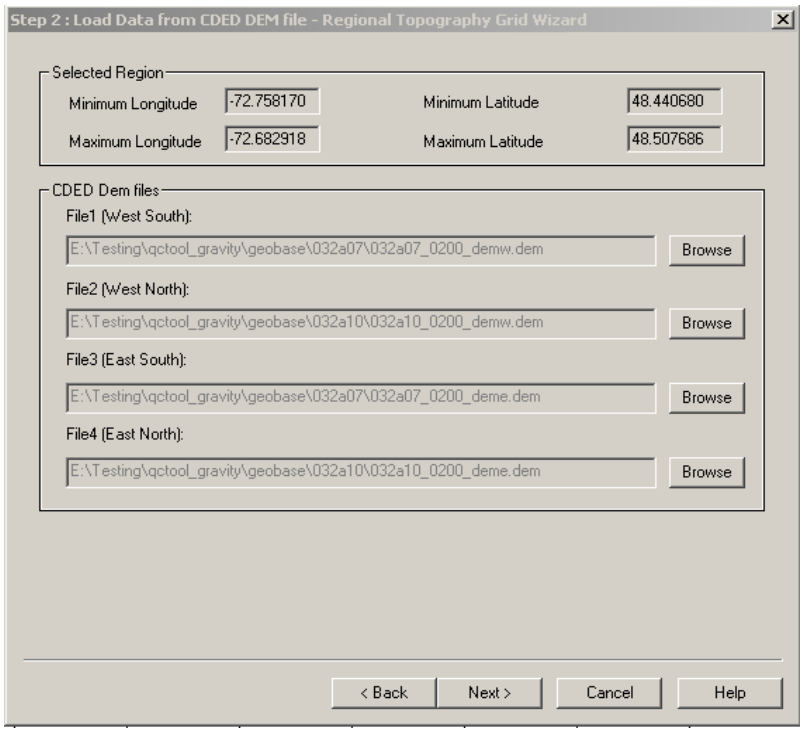
- Click on *Load Data* button to load the elevation data to the qct-file.
- You can append data to the existing topography file if your survey area is covered by more then one dem-file. Select *Add To File* radio button, select another dem file and click on *Load Data* button again.
- Click on *Next*.

Note: If selected area covered more than one geographical zone you will get the warning. The suggestion is to split measured area into parts according to the geographical zone bounds.

- Specify *Output Elevation File* to dump data from the dem-file.

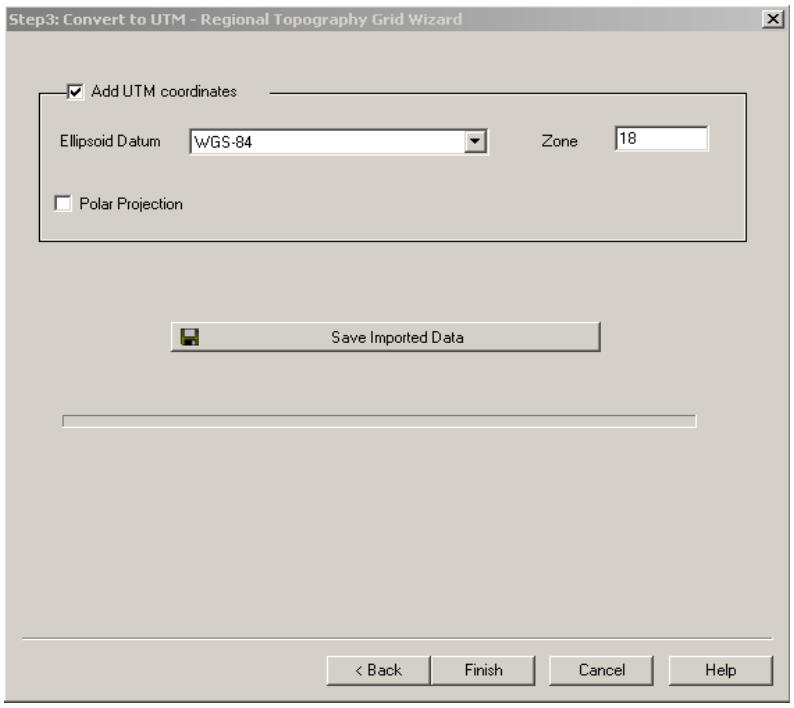
For CDED files:

- Depending on the size of the area you selected in Step 1, you may need to load up to four files. Select the relevant files before clicking *Next*.



Third Page:

- On the third page you will create a grid with topography data file in the QCTool grid format. Two steps will be processed to get such a grid.
- First, the latitude/longitude coordinates are transformed to UTM X and Y. Select desired Ellipsoid Datum to do this. Check out the *Polar Projection* check box if the survey area inside the polar bound.
- Second, the regional grid is created. Click *Save Imported Data* and specify a file name.



5.2. Building a Grid from User Elevation Data

If you have your own elevation data, you may use it to build a grid and use this grid to perform the correction.

- Import your data into QCTool. You must have UTM X and Y channels in addition to elevation data.
- Grid the elevation channel in QCGrid  . When you click QCGrid, a *Set Channels* dialog appears. Ensure that the correct channels are selected for X,Y, and data.
- Interpolate the data using  . You can set an appropriate cell size. Note that the rotation angle must be zero to use the grid for a terrain correction.
- Click the grid mesh button  , then click  to save the grid to an EGR file.

5.3. Regional Terrain Correction.

Select *Regional Terrain Correction* from *Extended Tools* menu. *Terrain Correction* dialog appears.

- Specify the Regional DEM Grid file (qdem file, which you have built with Regional Topography grid wizard) or EGR file.
- Select file columns for UTM X and UTM Y in respective combo boxes.
- Specify *Output Channel.*
- Set *Parameters*: density, inner and outer radiuses.
- Click on *Calculate Correction* button to get the column in file with local terrain correction values.

5.4. Local Terrain Correction.

Select *Local Terrain Correction* from *Extended Tools* menu. *Local Terrain Correction* dialog appears.

- Select file columns for Station ID, UTM X, UTM Y, and Elevation in respective combo boxes.
- Specify qct-file with correctional points. This file should be already created and contained Station ID, UTM X, UTM Y, and Elevation channels. It should be at least 3 correctional station points around each corrected station of original file. The file should look like one below:

N	A: StationID	B: X	C: Y	D: Z
1	A	380669.88	4439796.51	2000.50
2	A	380667.58	4439794.51	2001.00
3	A	380666.88	4439790.00	2000.00
4	A	380670.00	4439795.00	2000.40
5	A	380669.00	4439795.51	2000.30
6	B	374649.08	4436562.84	1900.50
7	B	374648.08	4436560.84	1900.00
8	B	374647.58	4436561.34	1901.00
9	B	374647.28	4436561.24	1900.80

- Select columns for Station ID, UTM X, UTM Y, and Elevation in respective combo boxes for the file with correctional points.
- Specify the output channel and density.

6. Latitude, Free Air, Bouguer correction.

- Select *Free Air, Tide, Bouguer Correction* from the *Extended Tools* menu.
- Specify Latitude, Longitude, Elevation channels in respective combo list boxes.
- Select *Theoretical, Free Air and Bouguer* algorithms from the Correction Algorithm list.
- Set the additional parameters for each algorithm (Theoretical Gravity correction System for Latitude correction, density value for the Simple Bouguer correction.
- Check output channels for each algorithm.
- Click on *Apply* button. The new channels with Theoretical gravity data and free air and simple Bouguer corrections data will be created.
- Use formula *Corrected_Gravity = Gravity_Observation_Final – Gravity_Theoretical - Free Air correction - Bouguer correction* to calculate the reduced gravity value with simple Bouguer correction.
- Use formula *Corrected_Gravity = Gravity_Observation_Final – Gravity_Theoretical - Free Air correction - Bouguer correction + Terrain Corrction+ Local Terrain Correction* to calculate the reduced gravity value with complete Bouguer correction.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