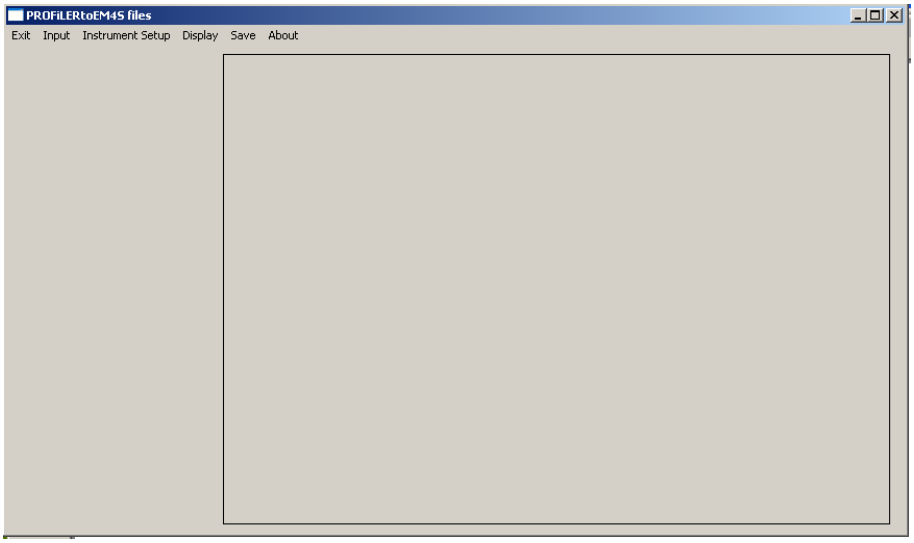
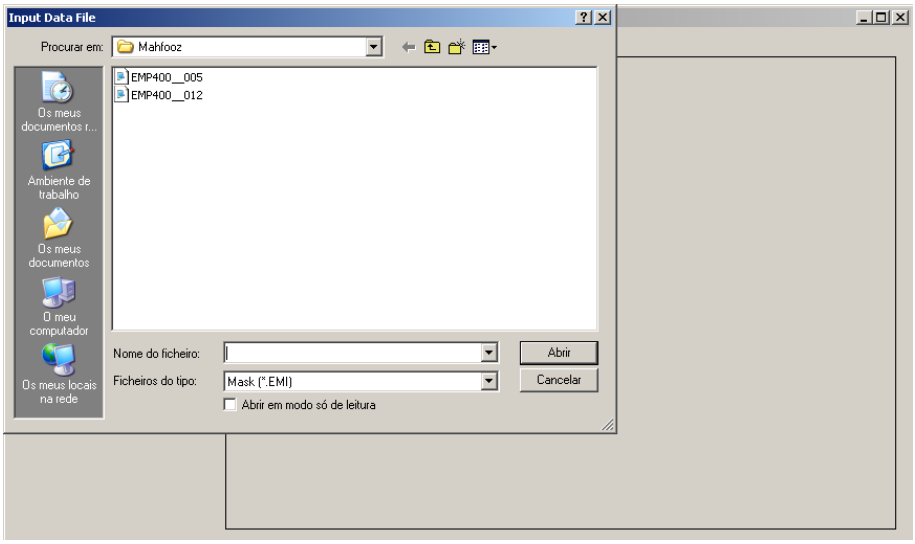
Short Guide for EM4Soil users

A- Preparation of the data

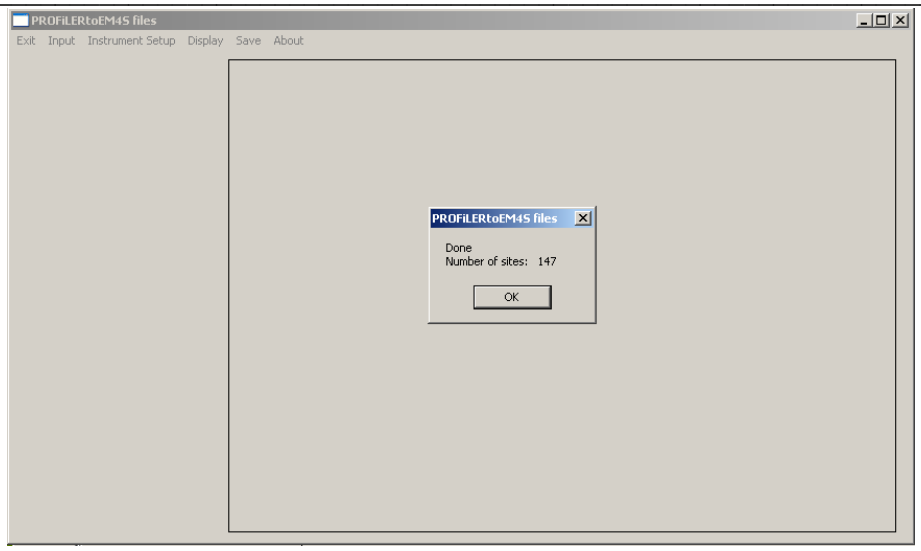
The data from EM400P should be converted in a format readable for EM4Soil. To do that run the program PROFTOEMS (clicking twice in the name of the program). The following screen will appear:



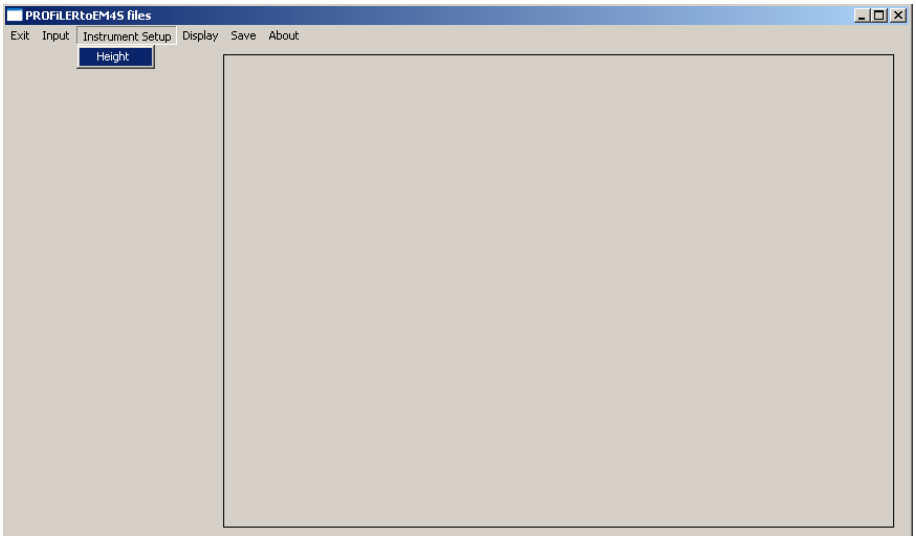
Go to Input and click on Input Profiler file.

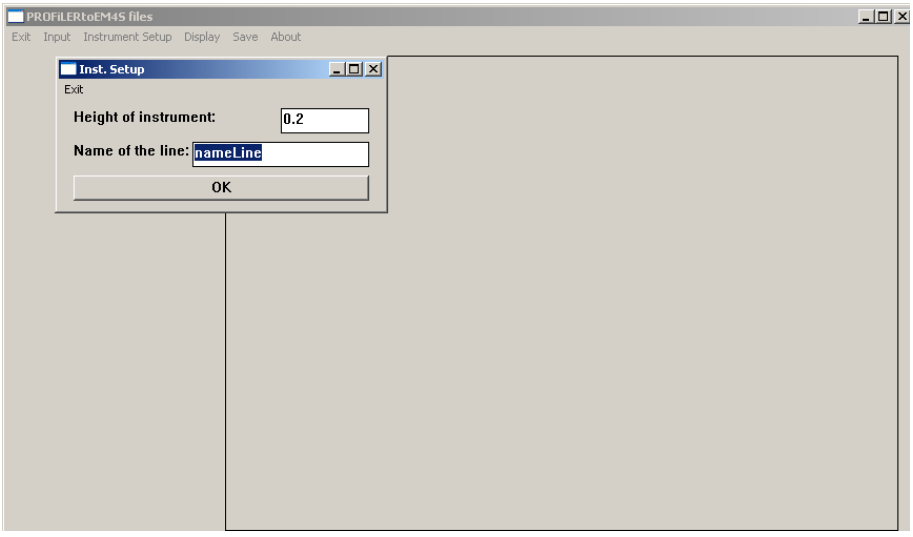


Choose the file (*.EMI) to be converted. Clicking twice in the file name the program will import the data informing you the amount of values.

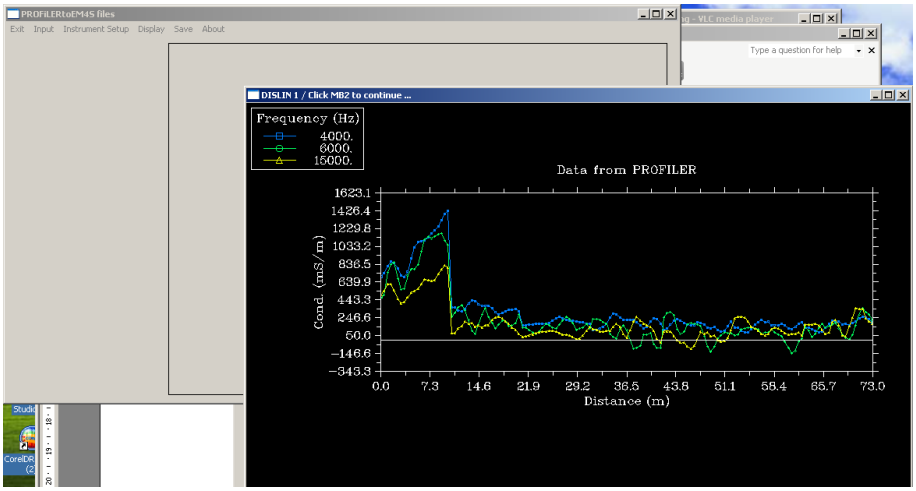


Clicking in OK will finish the importing. Go now to the Instrument Setup to give the height of the equipment during the acquisition and the name of the survey:

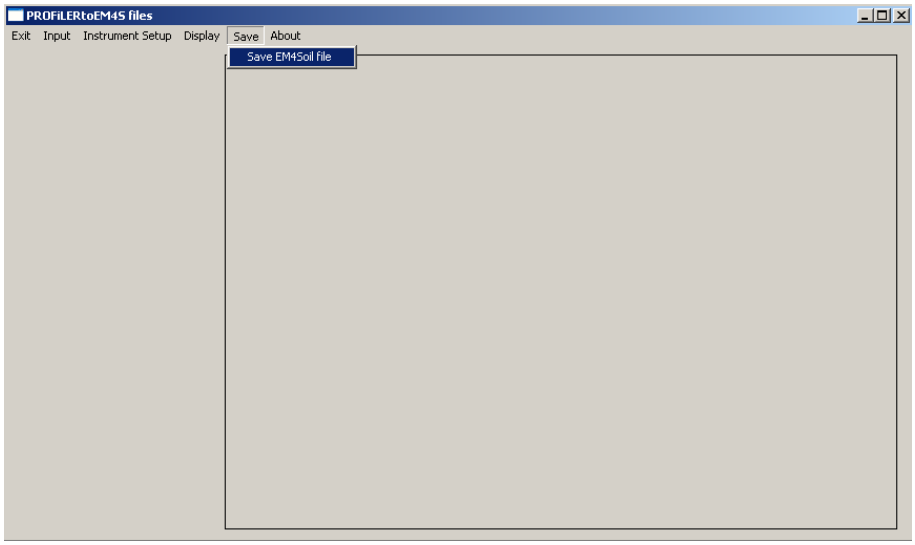




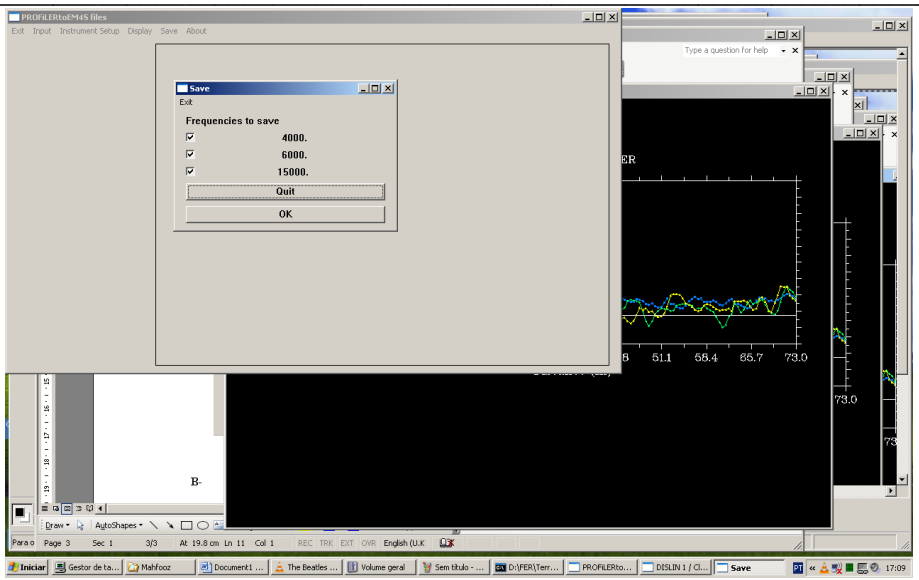
After importing the data you can display a graphic with your data. Go to Display and press the display data:



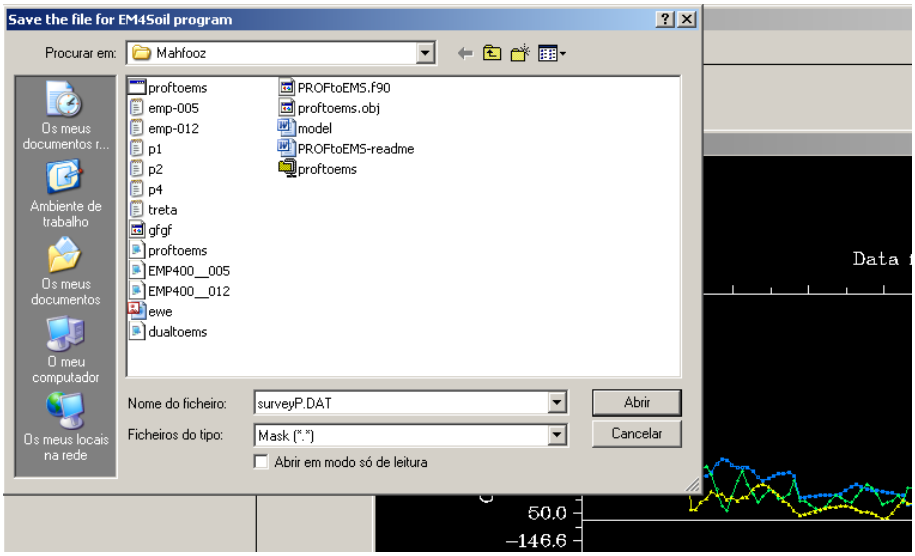
Then you can have an idea about the quality of your data and to decide which frequencies do you want to save for inversion on EMS4Soil. To do that, go to Save:



And choose the frequencies:



And click in OK, and save the file in a folder.



That file will be import by EM4Soil for processing and inversion. The file is an ASCII one and the first rows will be like the example below:

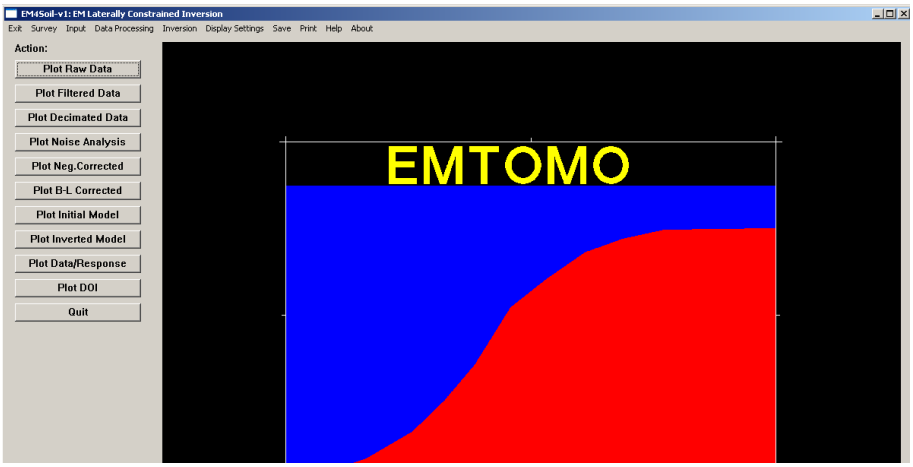
EMP400_012
147 0.2000000 1
3 4000.000 6000.000 15000.00
X Y Z ECa4000 ECa6000 ECa15000 Lat Long time

0.000000	0.000000	0.00	700.95	469.52	500.96	0.00	0.00	0.00
0.000000	0.500000	0.00	738.36	494.87	538.12	0.00	0.00	0.00
0.000000	1.000000	0.00	819.56	748.57	617.46	0.00	0.00	0.00
0.000000	1.500000	0.00	869.47	835.96	617.76	0.00	0.00	0.00
0.000000	2.000000	0.00	848.91	861.21	546.57	0.00	0.00	0.00

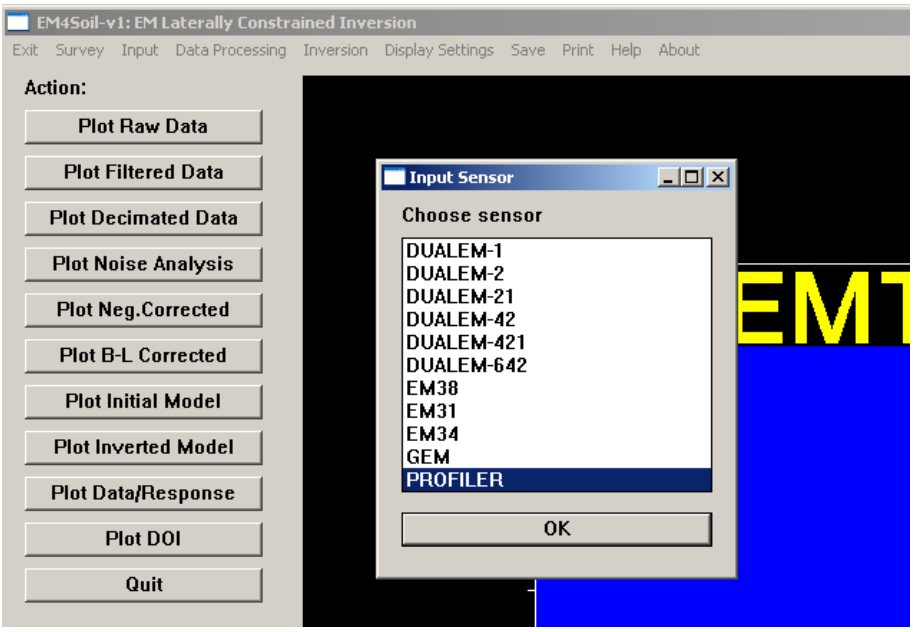
Close the program and start the EM4Soil one, clicking twice in the name.

B- Using the EM4Soil program

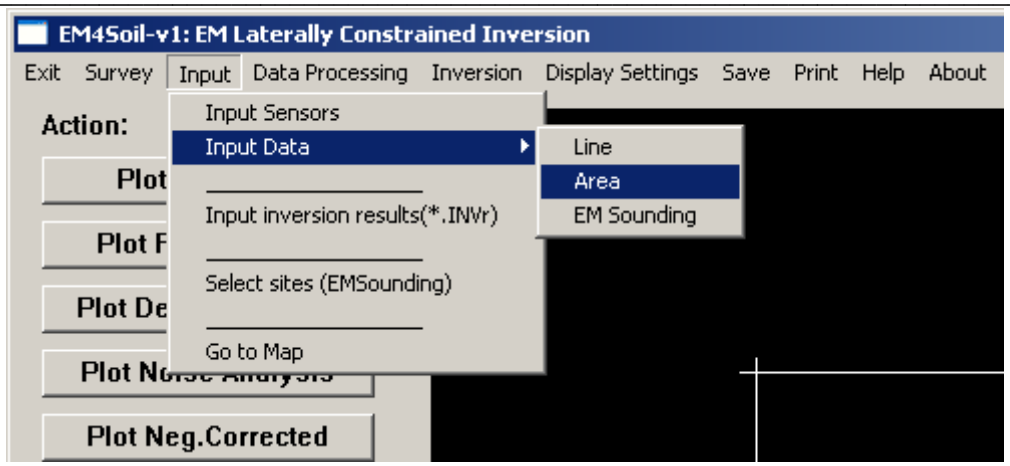
The program will display the following screen:



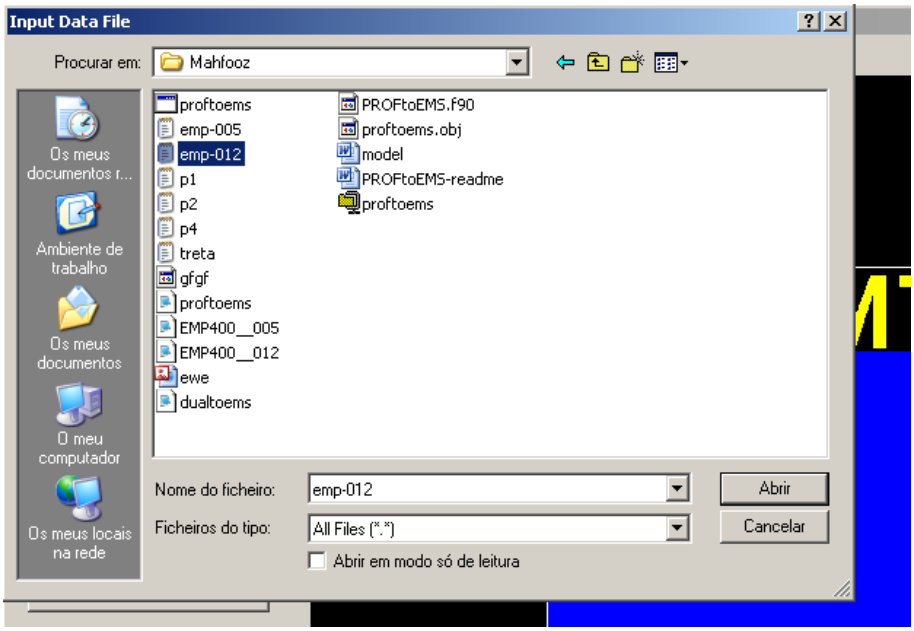
The program needs you select the equipment used for acquisition. Go to Input and Input Sensor and choose the PROFILER. After click OK.



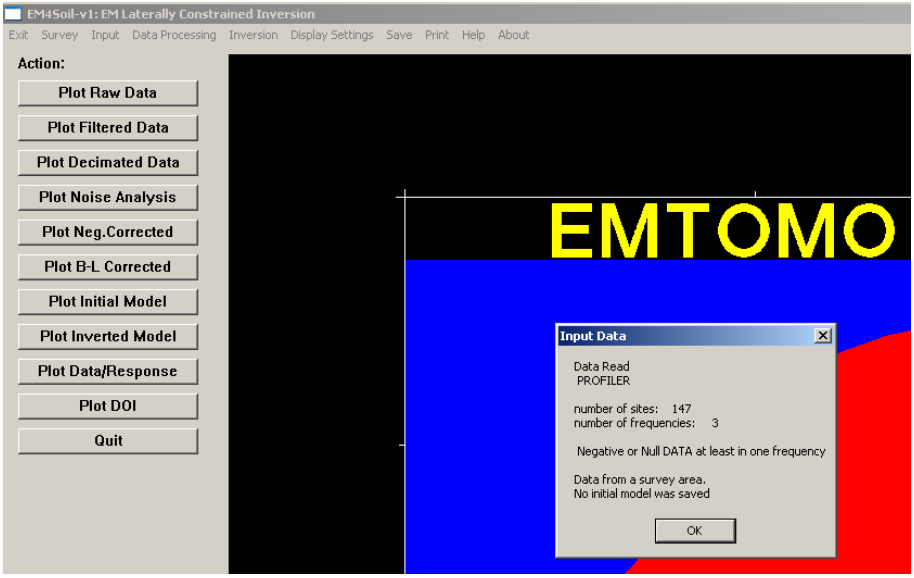
If your data has been collected in several profiles it is considered a Area survey and should be import in Input, Input Data, Area:



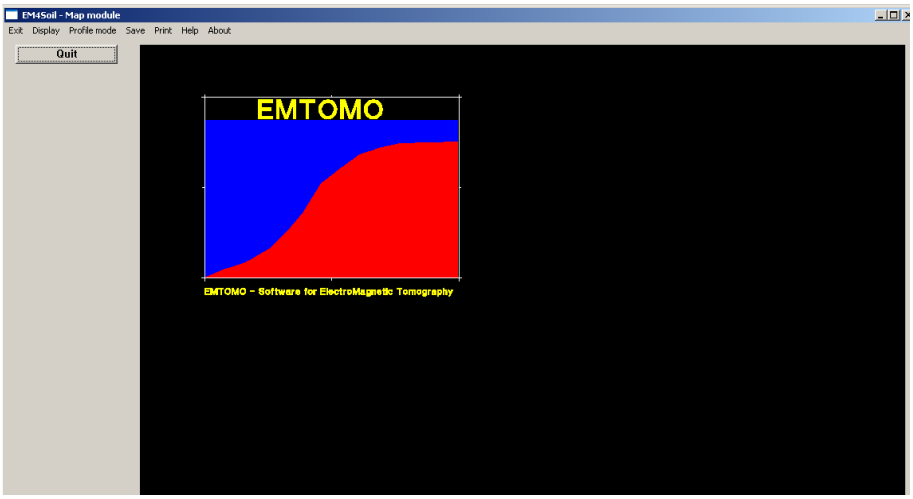
Choose the file to input (probably you need to modify the type of file from DAT to All files):



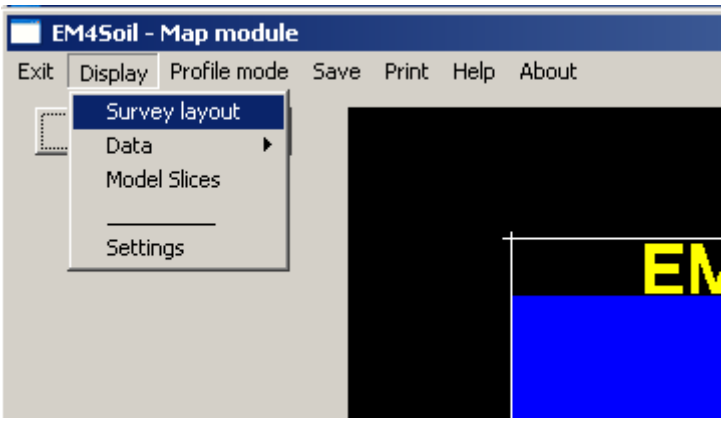
Clicking twice in the file name the program will input the file and you will be informed about the data: Equipment you have chosen; number of values; number of frequencies and if you have negative values. In any case “No initial model will be made”, because you have input a AREA survey NOT a line survey.

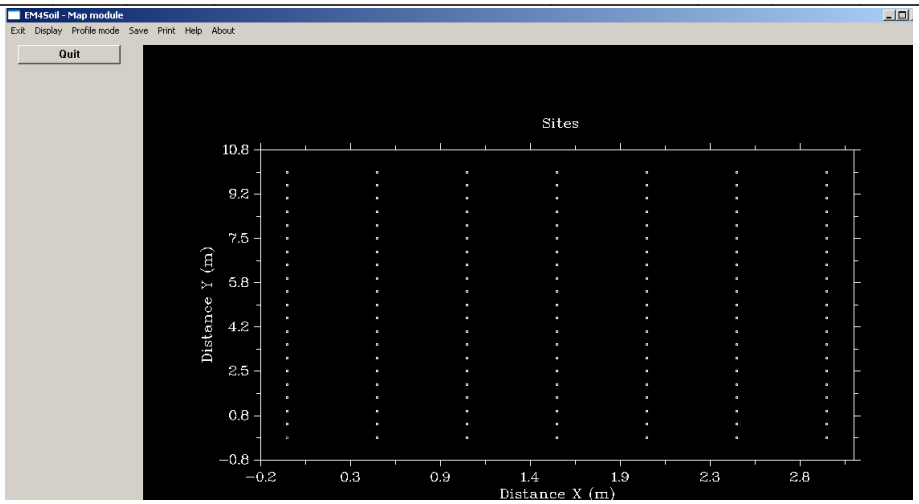


Clicking in OK the program will open the MAP Module where you can see the data and select the profiles to be inverted. The following screen will be displayed:

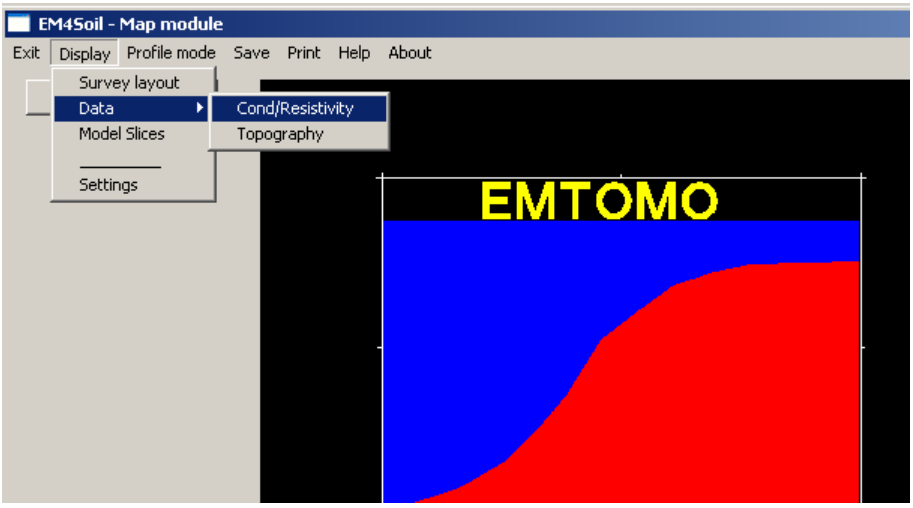


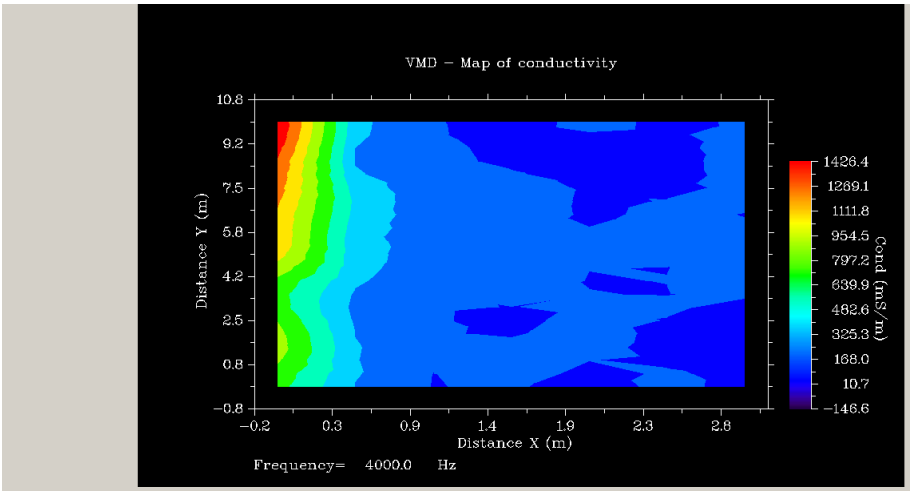
You can go to Display, Survey Layout to see the location of your data:





Or display the Data, Cond/Res and see your data:

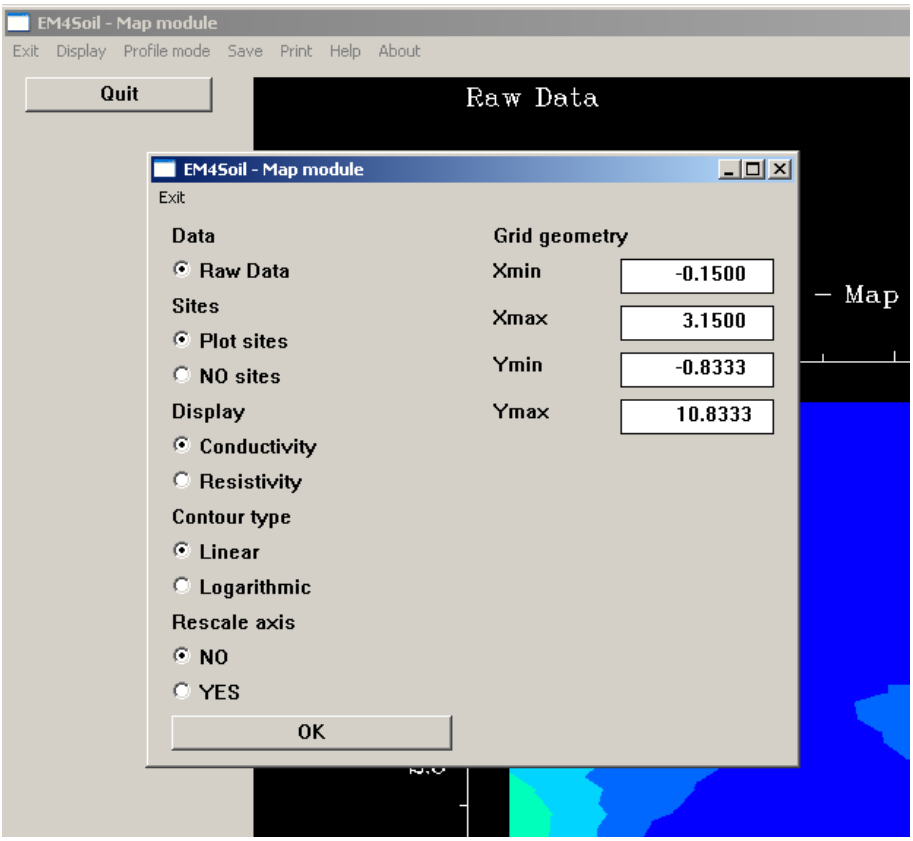




You can see the maps of all frequencies clicking on the right button of the mouse.

The Model slices only can be used after the inversion of the profiles (will see this feature latter).

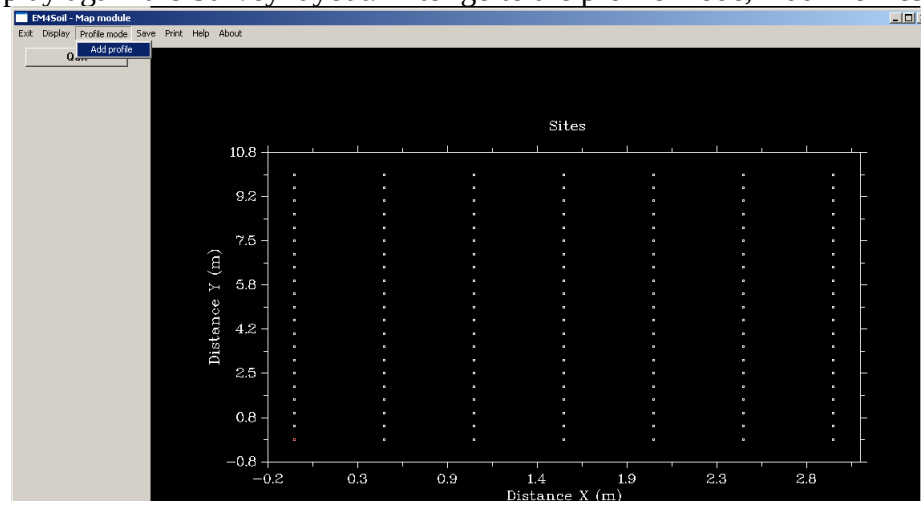
The entrance settings will allow you to do some alteration on the map display:



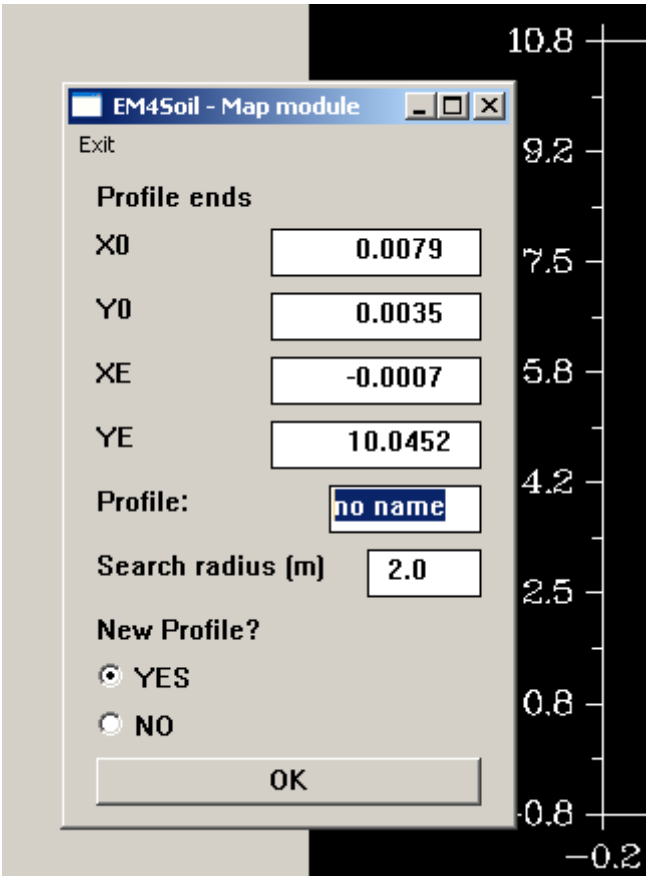
You can print any Map going to the Save menu.

Let's see how to define and export profiles for inversion.

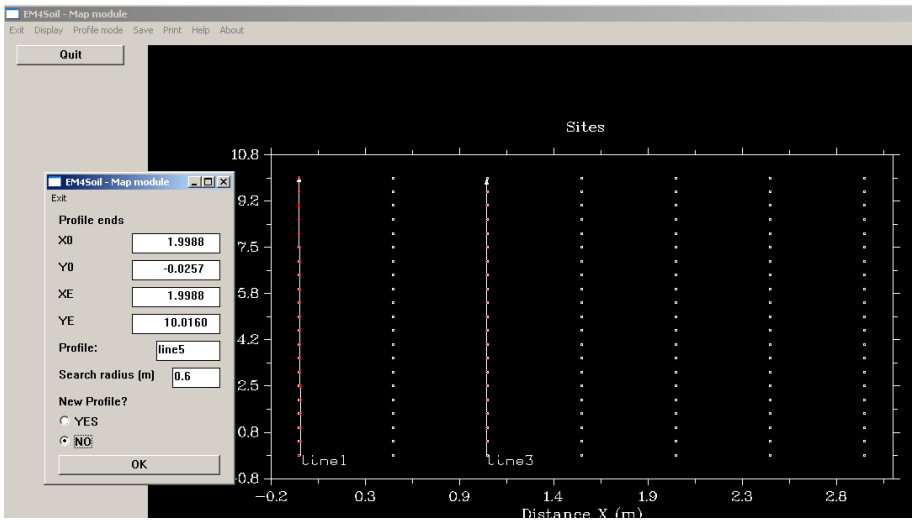
First display again the Survey layout. After go to the profile mode, Add Profiles:



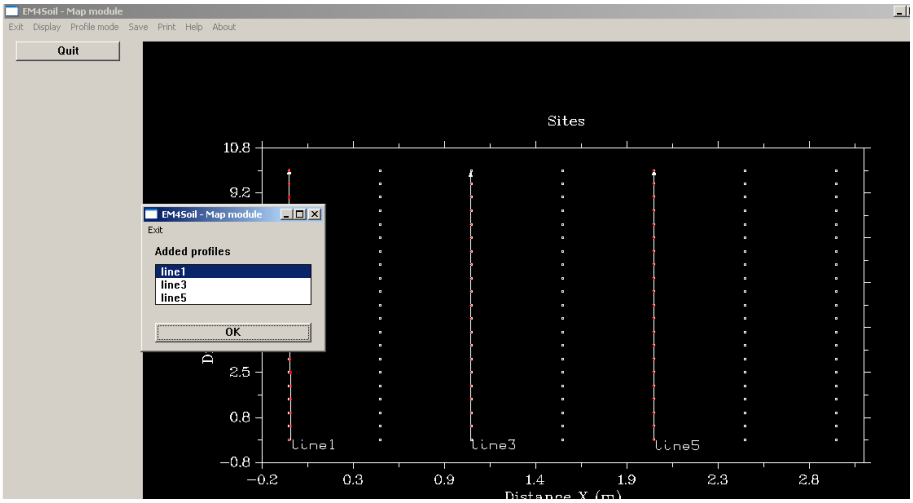
When you click in Add Profile the arrow of the mouse modifies into a cross. Go to the beginning of the profile and click on the left mouse button. After go to the end of the profiles and click on the left mouse button. Without to move, click on the right mouse. This finish the profile selection and open the following screen:



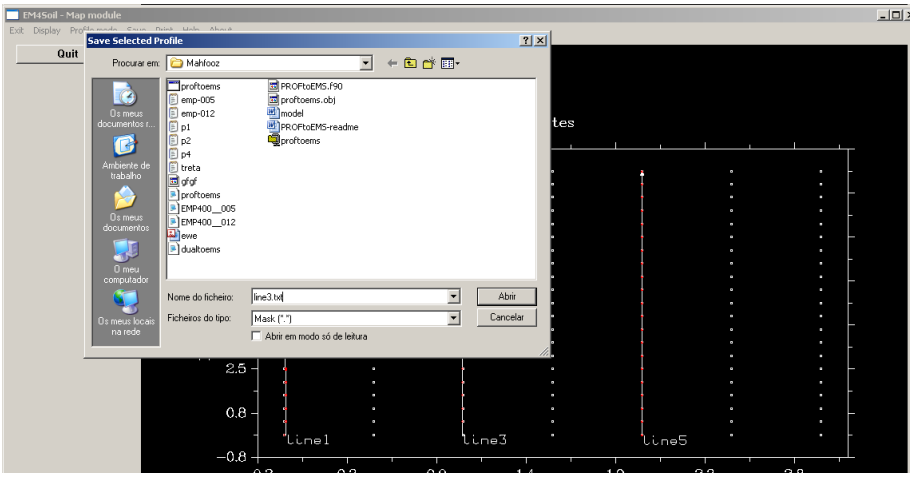
Give a name for the profile and choose the search radius (should be a little smaller than the distance between measured data). If you do not want more profiles select NO.



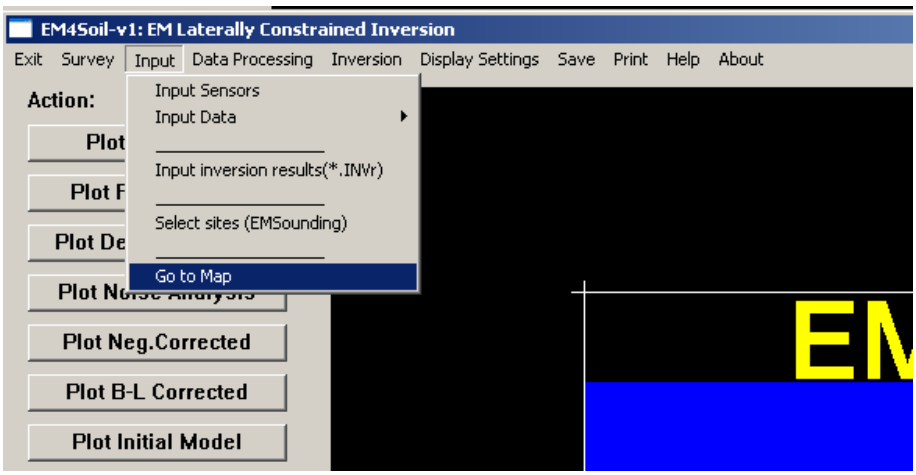
After, the selected profiles should be saved. Go to Save, Save Profiles:



Select the profile you want to save and do that clicking in OK.

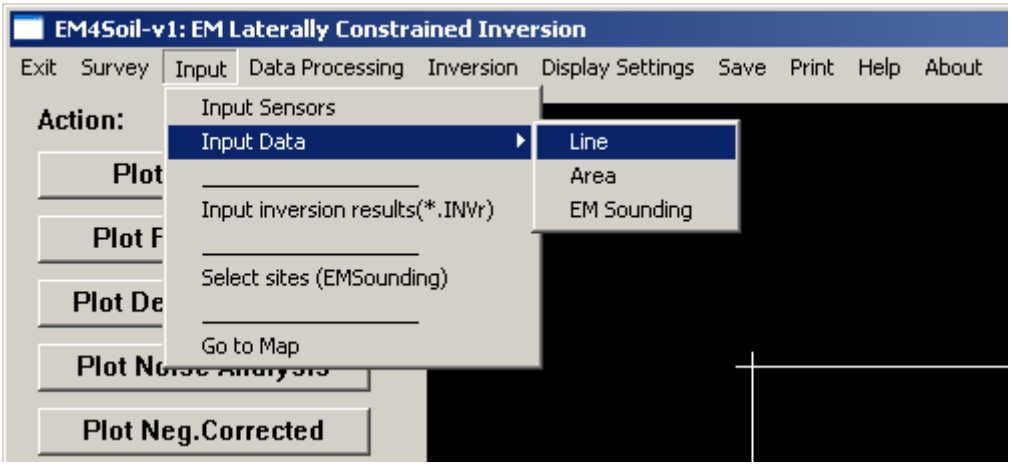


After you have saved the profiles, quit the Map Module clicking in QUIT. You can back to the Map module at any time using the entrance Input, Go to Map of the EM4Soil:

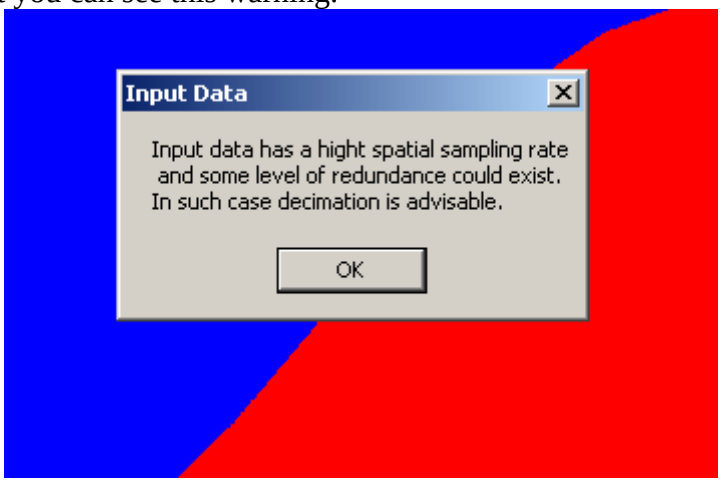


C- Inverting (Q2D) and Displaying results

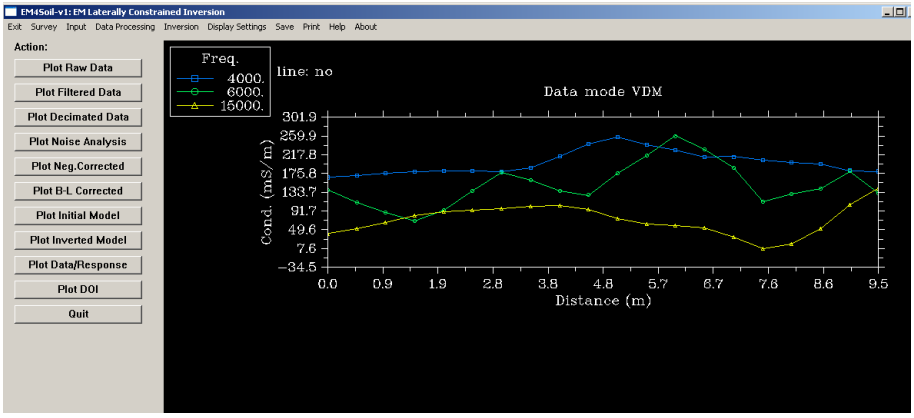
Now you must invert the profiles you have saved. To do that, go to EM4Soil program and input the first profile using the Input, Data, Line option:



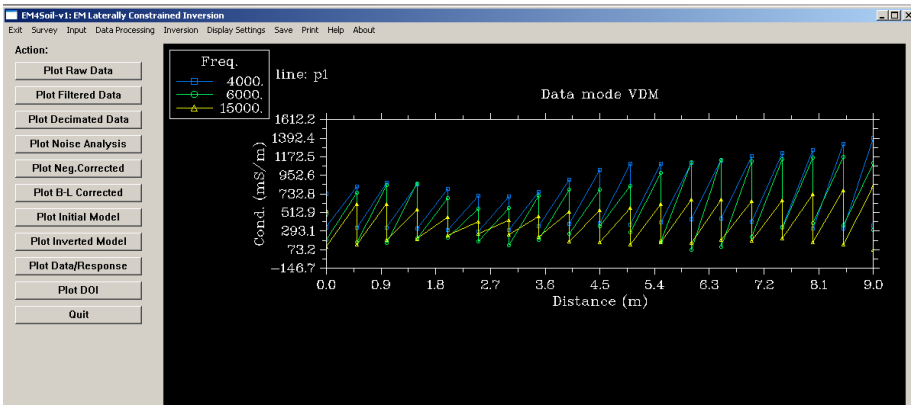
During the input you can see this warning:



In general you do not need to go for decimation (only if you have a significant data redundancy). After input the data will be displayed:

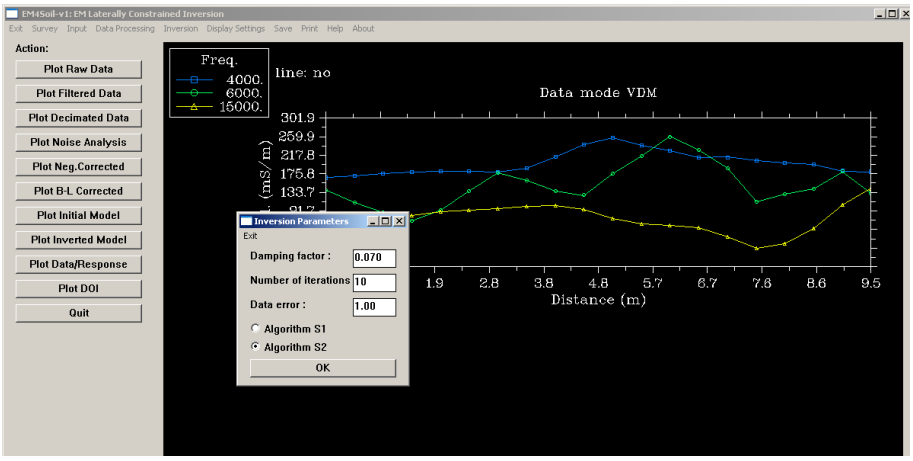


If the display is like the following, it means that your search radius was too large. You must reselect the profile.

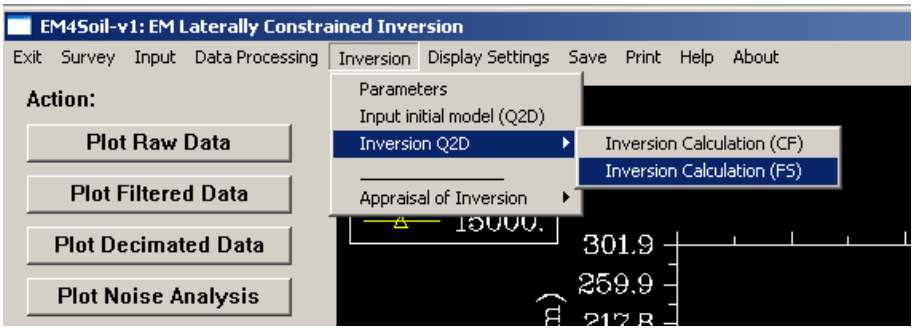


After importing the profile you can filter, try to correct negative values etc…

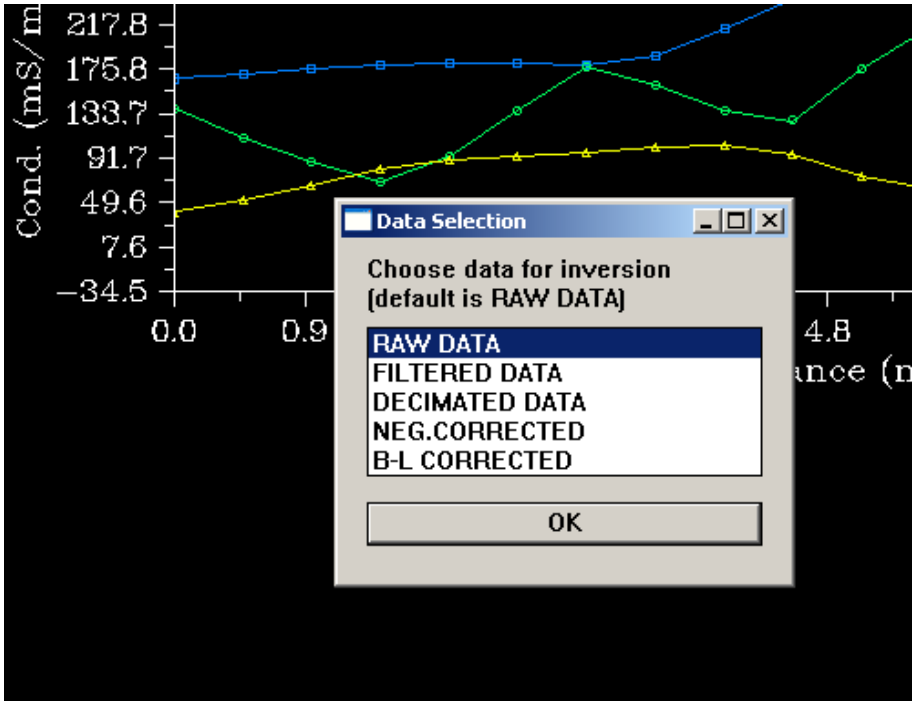
If the data did not have any negative value, an initial model was saved (you have been informed about it during the data input) and you can use it for the inversion.
If it is the case, go to the inversion and select the Inversion Parameters:



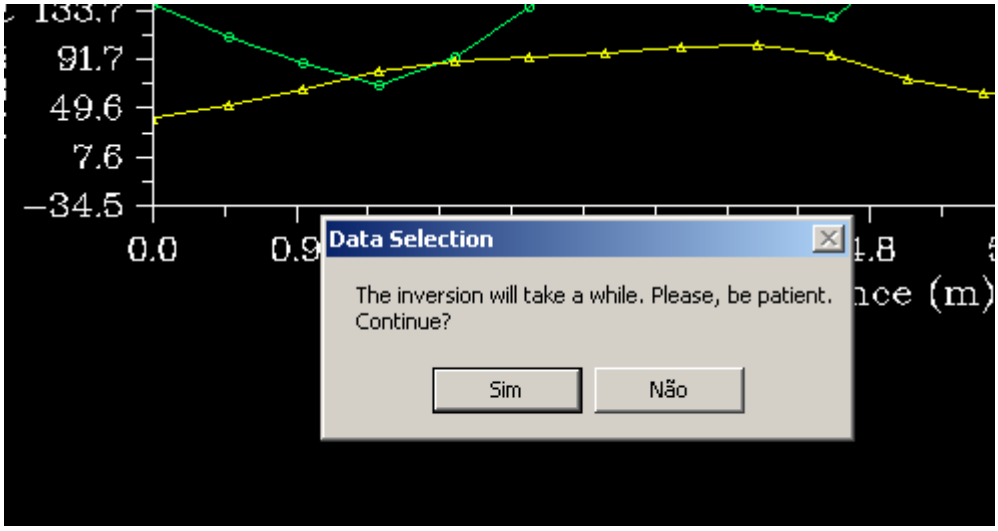
After that, go to the Inversion, Inversion Q2D, Inversion calculation (FS):



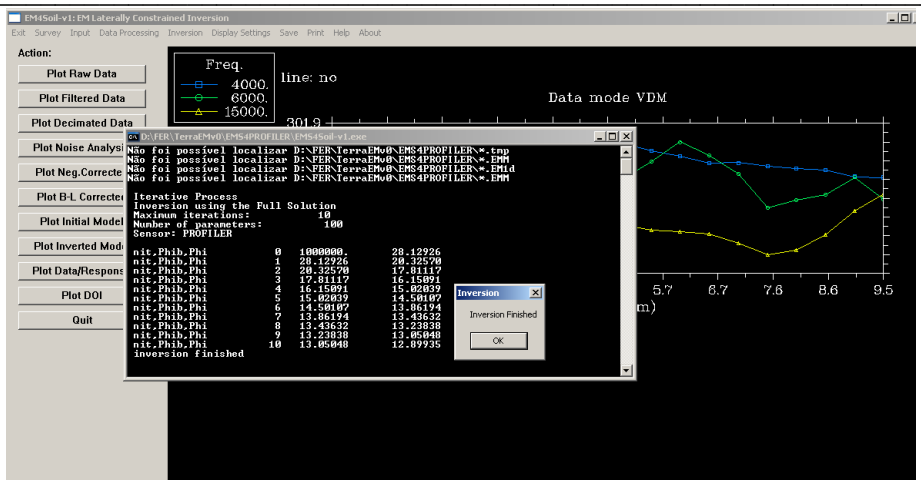
Select the data you want to invert:



The following warning will appear:

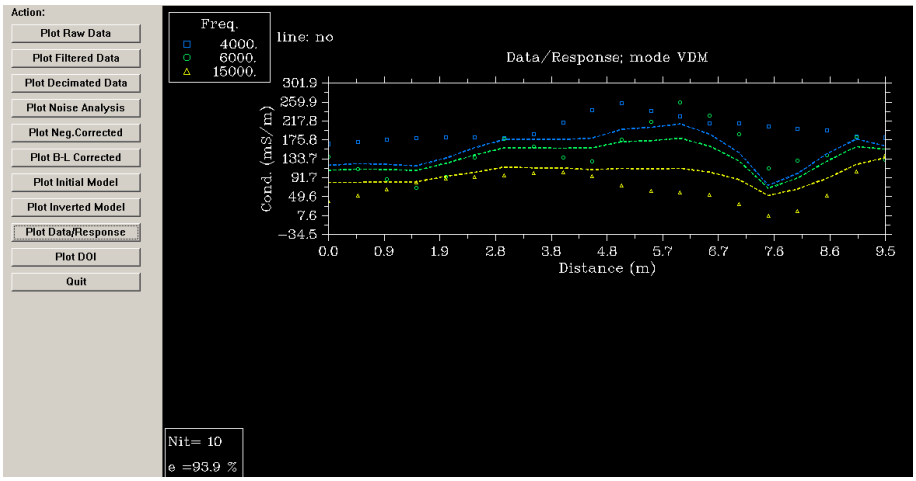


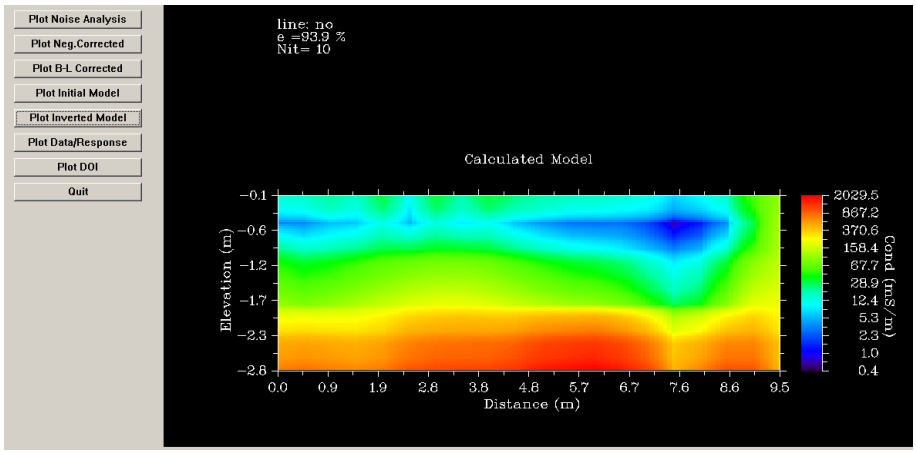
Click on YES (SIM is yes in Portuguese language). The program will start the inversion. You can follow the inversion in the DOS windows opened when the EM4Soil program started.



Clicking in OK the program save all the needed files and you can now see the inversion results and save the model for further processing.

Use the buttons on left of the screen to display the data/results misfit and the model also:

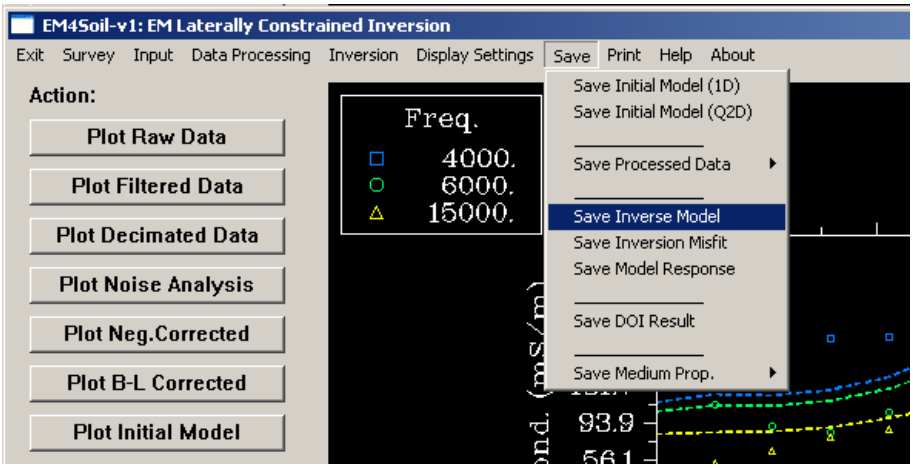




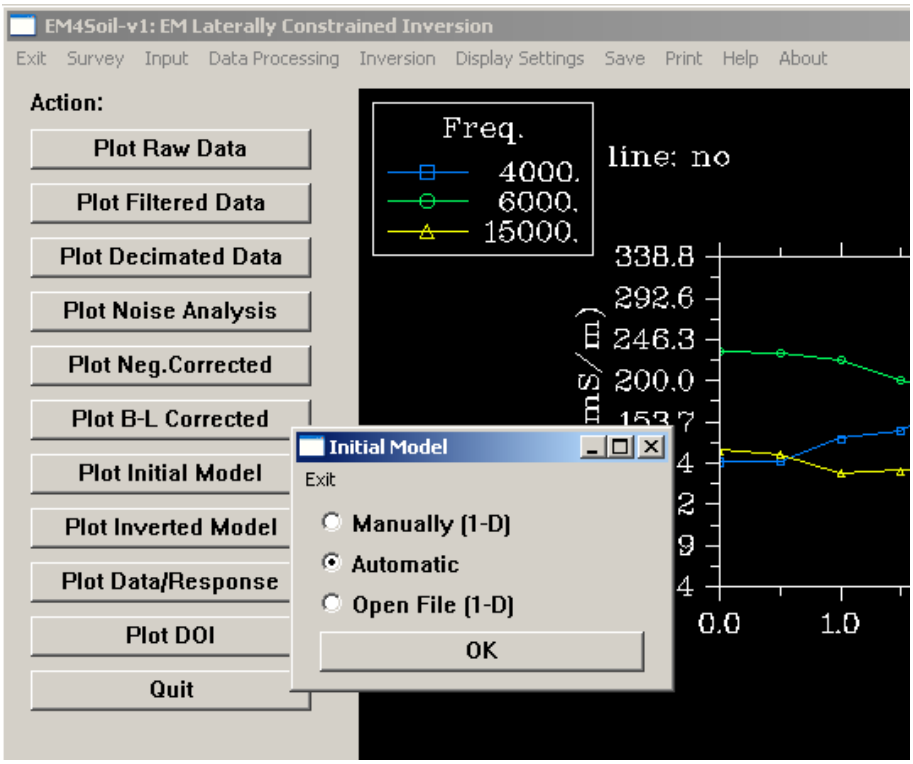
In this particular case the misfit is very high. There are several factors that affect the misfit values: data quality (the most important), initial conductivity, number of

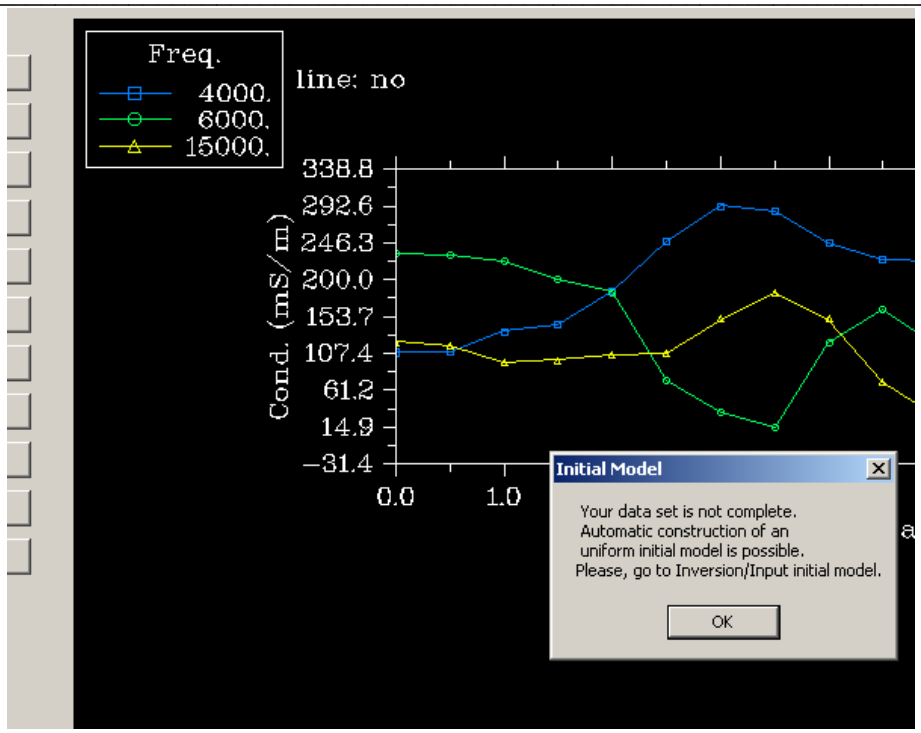
iterations, damping factor…etc. This model was made using the default parameters. A better model can be calculated using a damping of 0.02 and 15 iterations.

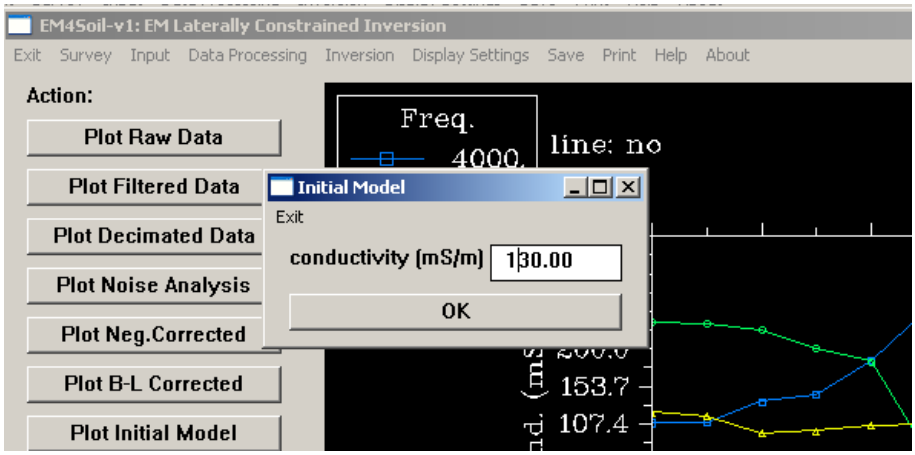
After to calculate a satisfactory model, this should be saved. Go to Save option:



NOTE: if your data have negative values (even if they have been corrected) the program does not do an initial model. In such case before the inversion you must define an initial model. Go to Inversion, define initial model (see the sequence of screens):



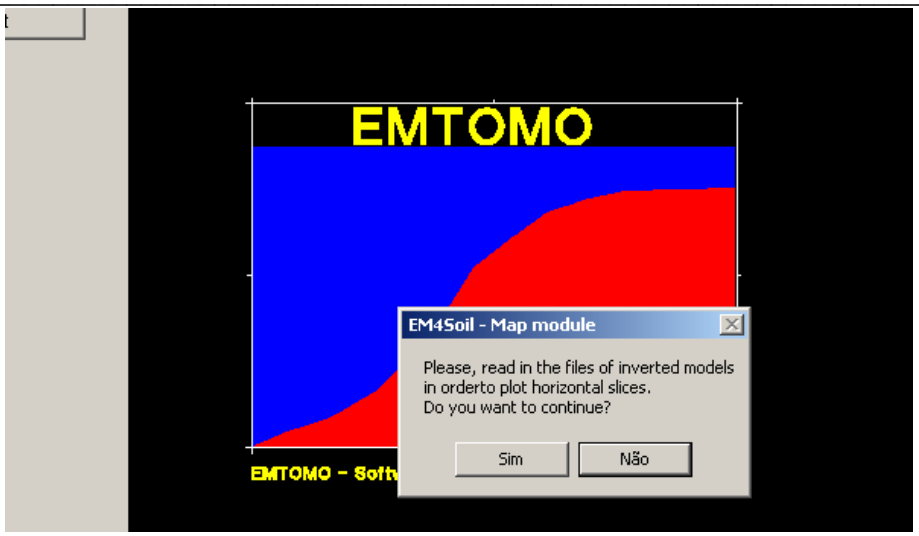




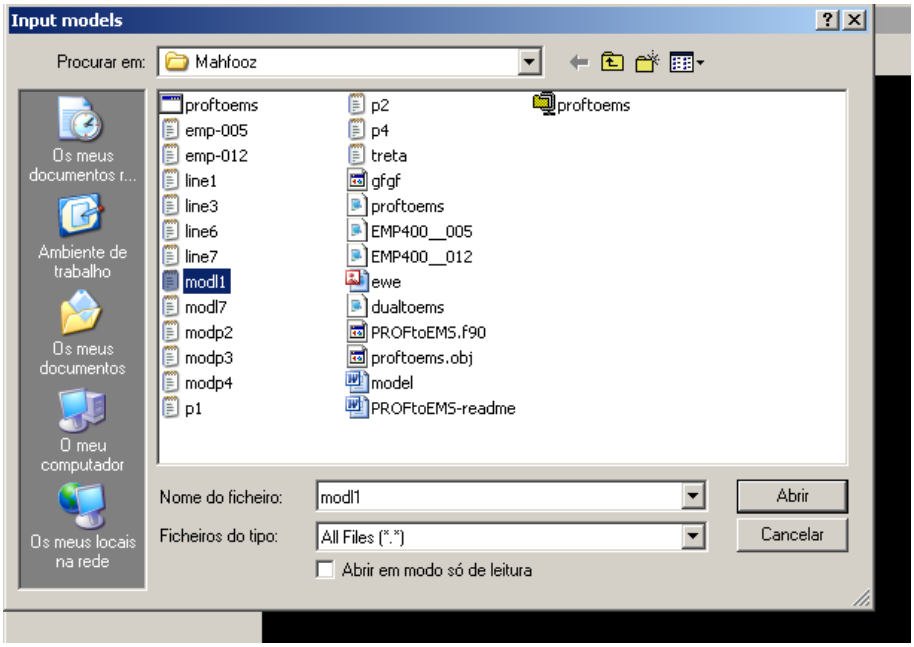
Therefore an initial model of uniform conductivity of 130 mS/m was defined. Now you can do the inversion.

D- Using the Map Module to display the models

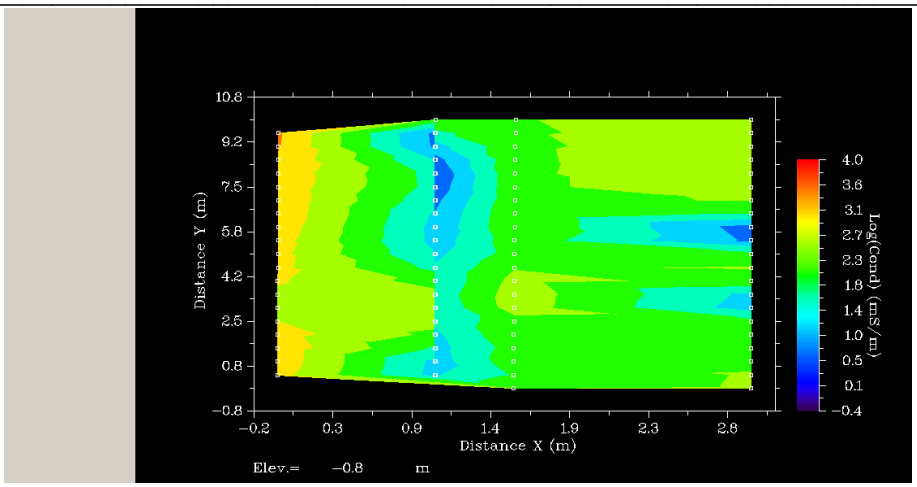
After to have the models calculated you can back to the Map Module going to the Input, Go to Map option. Then go to Display, Models. The following warning appears:



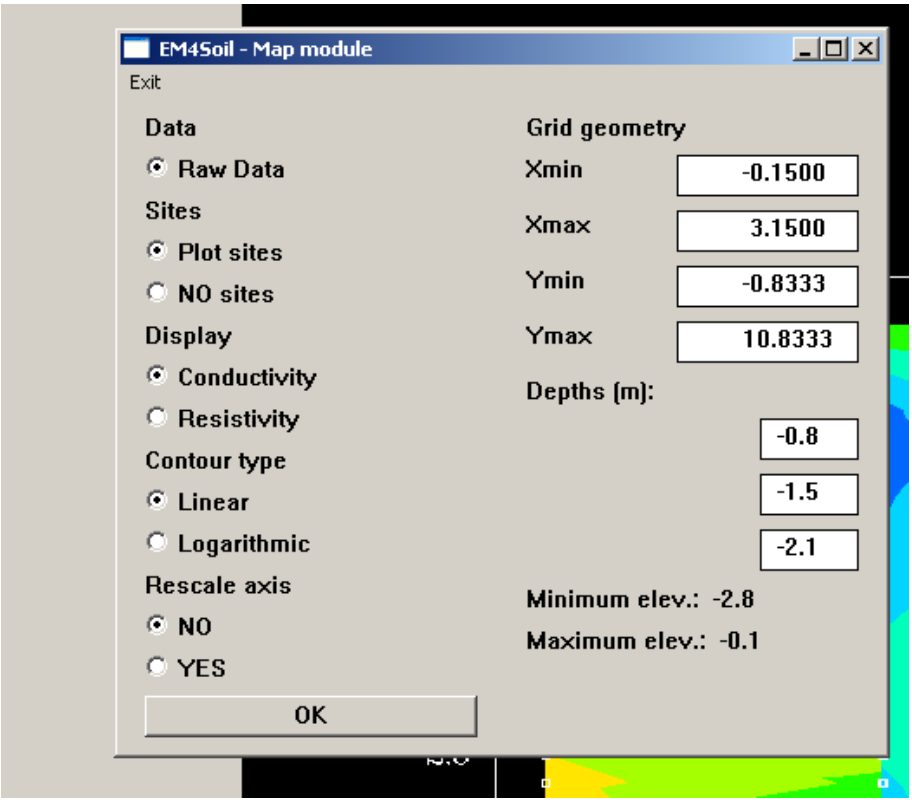
Clicking in Yes you will input the models file:



All the files should be input in sequence. After importing the last model file click in Cancel and the program will display the first level of your models.



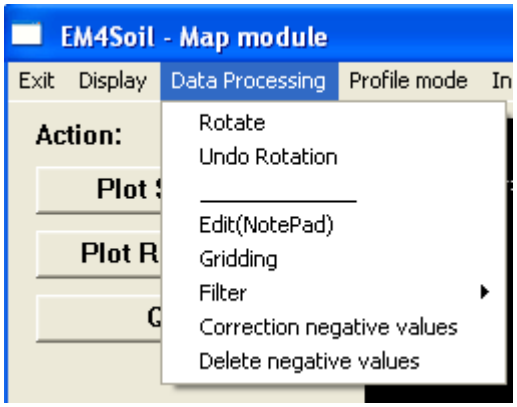
In same cases it is better to display the values in a Log scale. This can be selected in the Settings entrance:



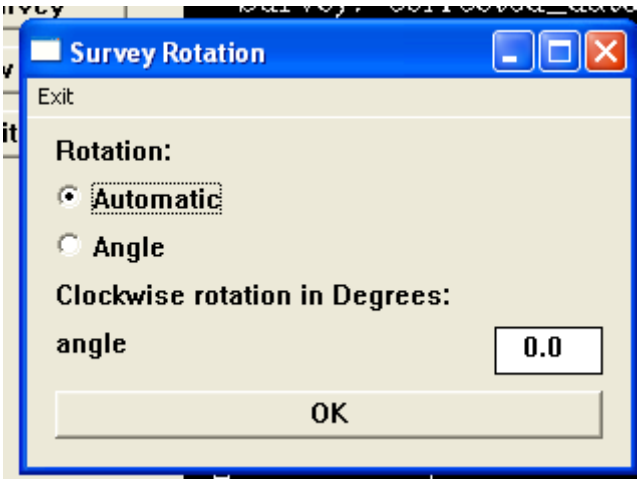
You can also select the depth (elevations) of the slices to be shown. To display the next slice use the right mouse button. Print the correspondent figures using the Print entrance in the menu bar.

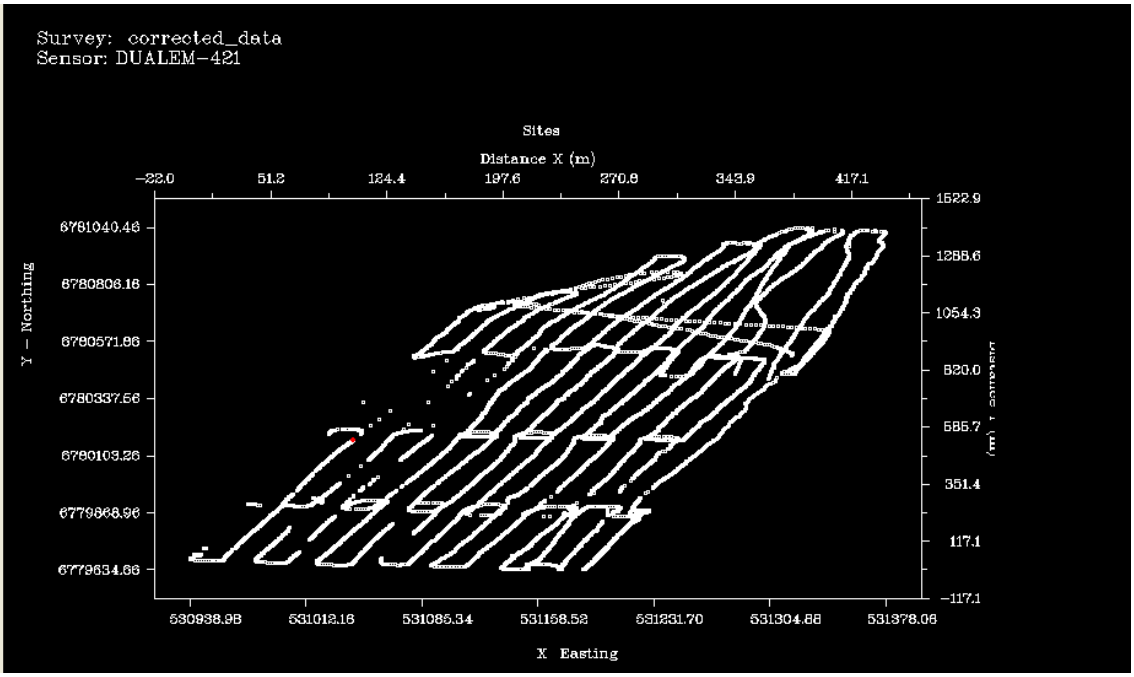
E- Preparing data for the Q3D inversion

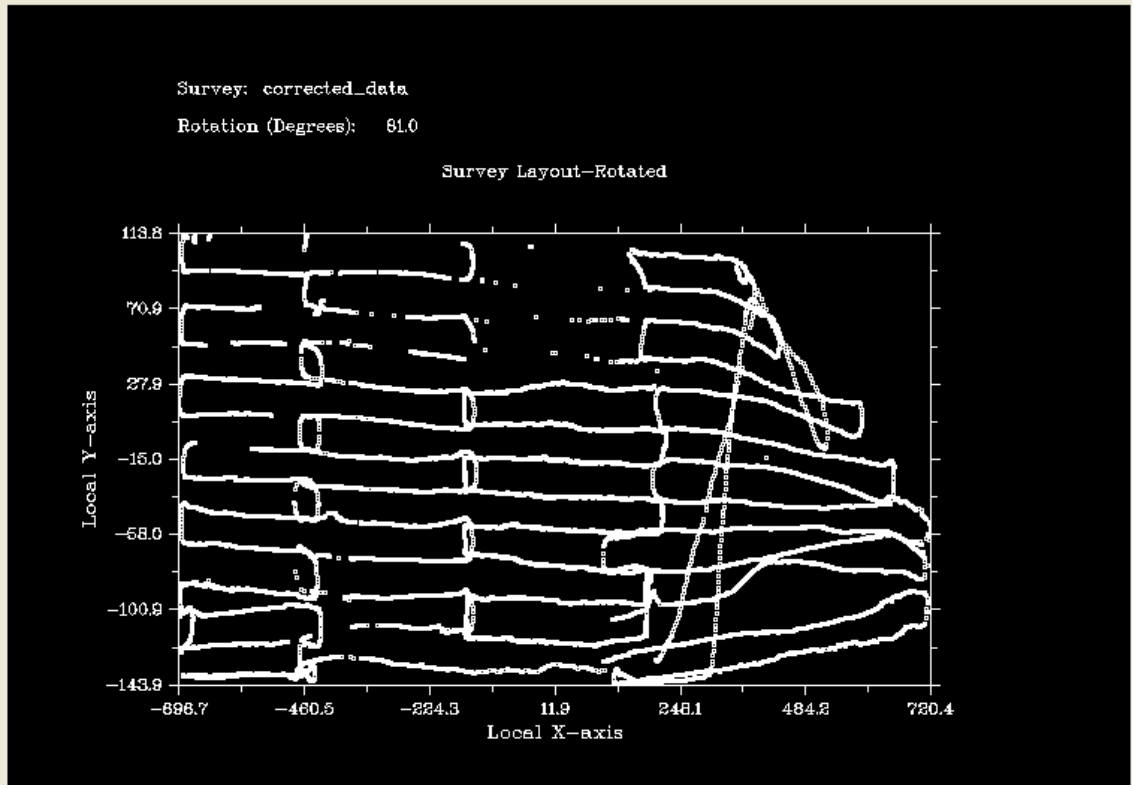
Data from a survey (area) can be inverted using the Q3D algorithm. The data should firstly correct from negative values.



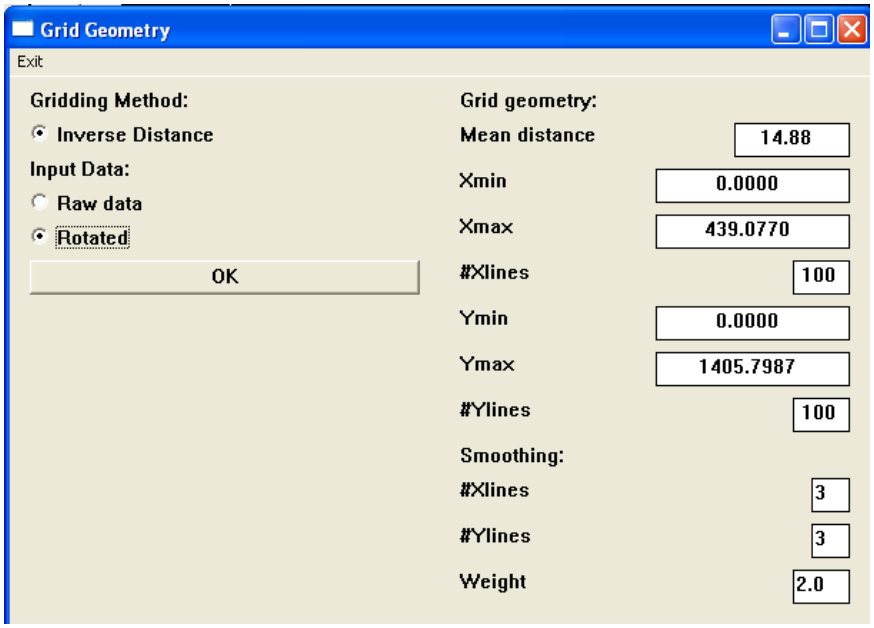
In the next step, before gridding the data, the user should decide about the rotation of the survey in order to optimize the mesh for the inversion.





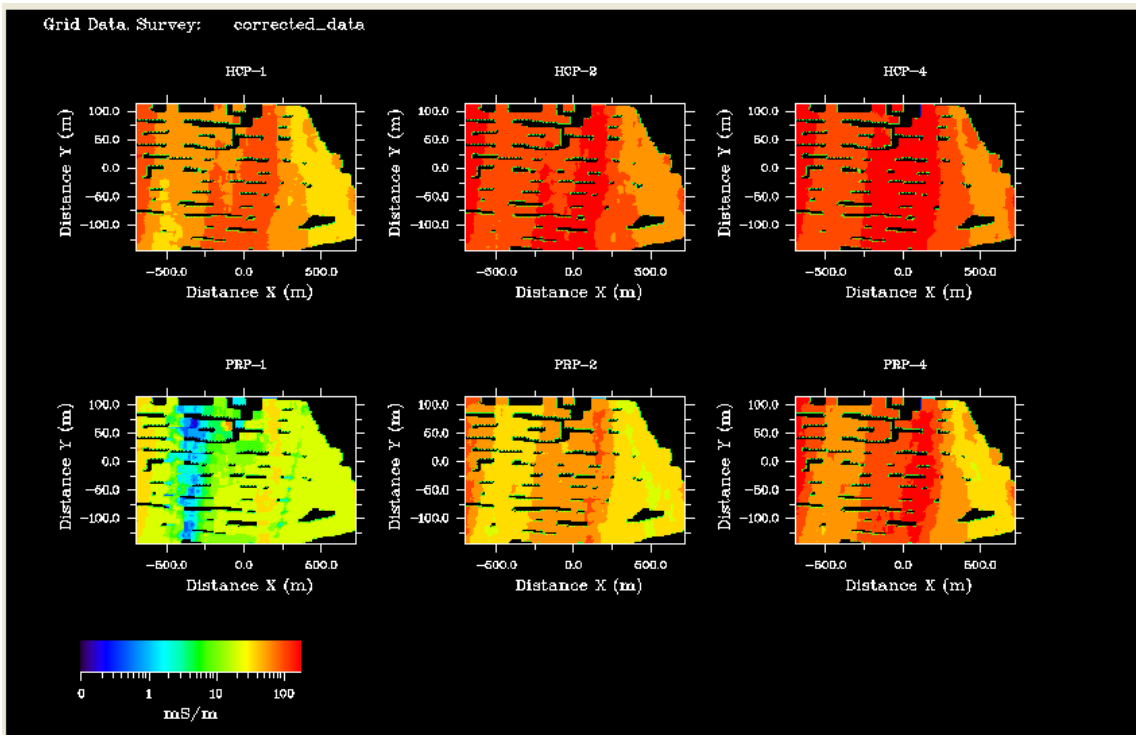


The rotated result can be saved for future use. However, the gridding of a rotated survey can be done immediately the rotation with saving the results.



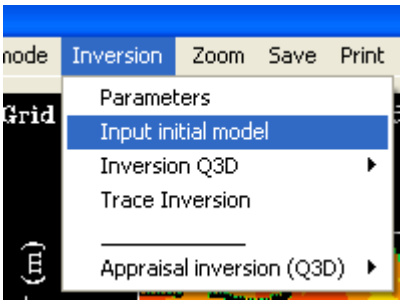
Note: after selection of "rotated" click in OK to accept the selection (this is not necessary selecting "raw data"). Select the number of #Xlines and #Ylines and click OK. The gridding process can take a while for surveys with a high number of measurements. Wait till the program finish. The mean distance value that appears in the screen is an average value of the diagonal of the mesh (sqrt(dx^2 + dy^2)).

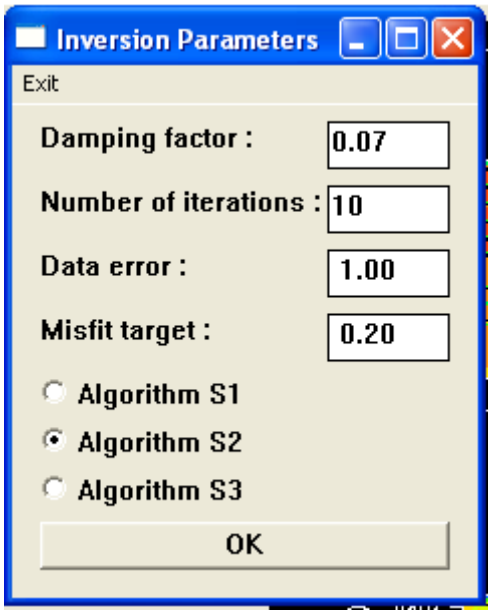
The user should inspect the gridding result using the option Display/Grid/Filtered data. In the example below the #Ylines value of 100 is too high originating several zones without any data with consequences in the inversion results.



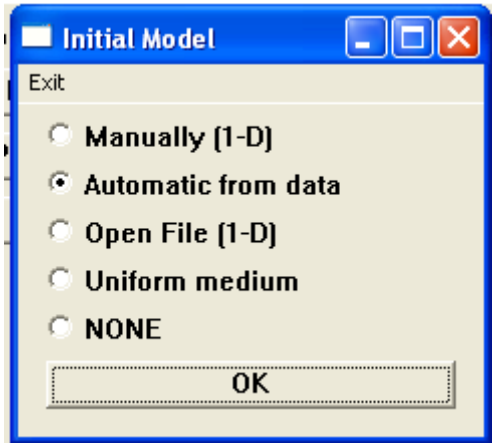
After the gridding the filter of the topography or of the apparent conductivity values can now be applied.

The data are now ready to be inverted. To do that, select the parameters . inversion (number of iterations, damping factor and the algorithm to use.)



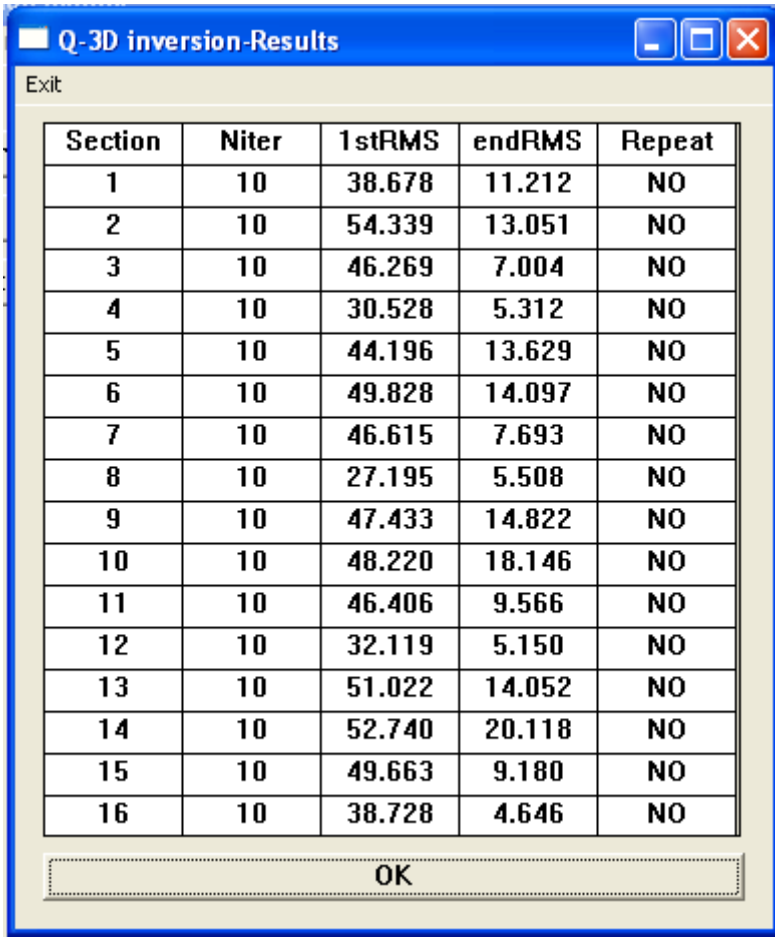


Higher damping factor will smooth the model. Algorithm S1 allows more variability in the model than algorithm S2. Algorithm S3 is for 1D inversion without any spatial constraint (a 1D model of 2 or 3 layers should be selected as initial model for this option).

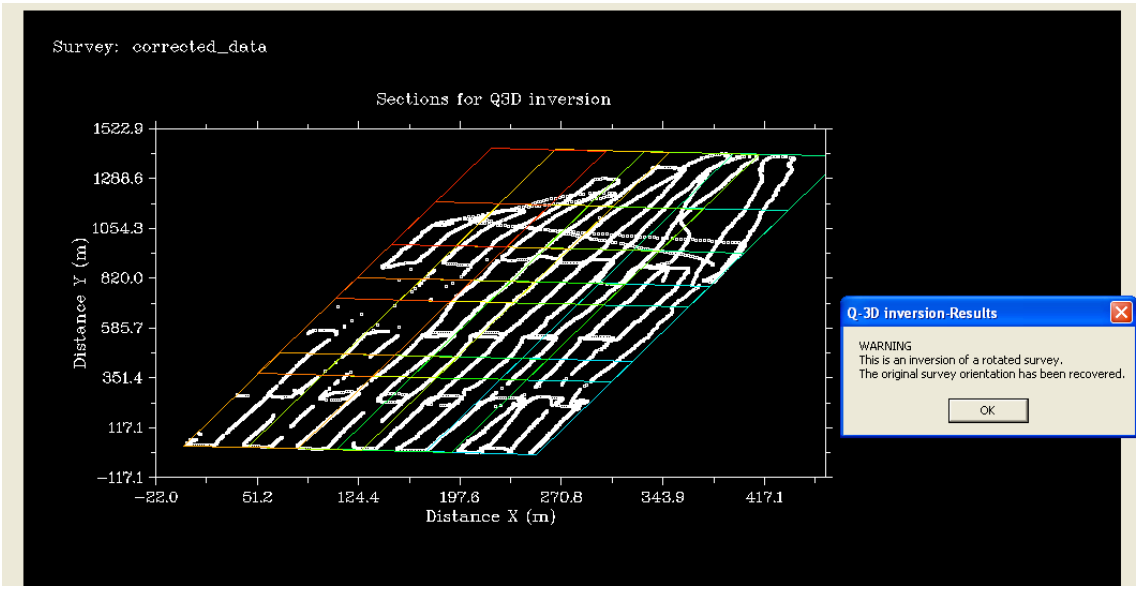


The Manual option is good for algorithm S3. Automatic and Uniform medium are options that use the default layered model and can be used with care. The user should prepare a 1D model file according his experience and input it.

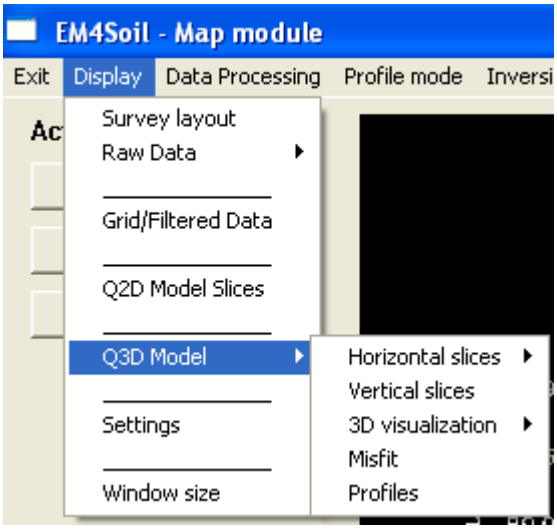
The start and finishing RMS corresponding to each section will be presented in a table for evaluation.

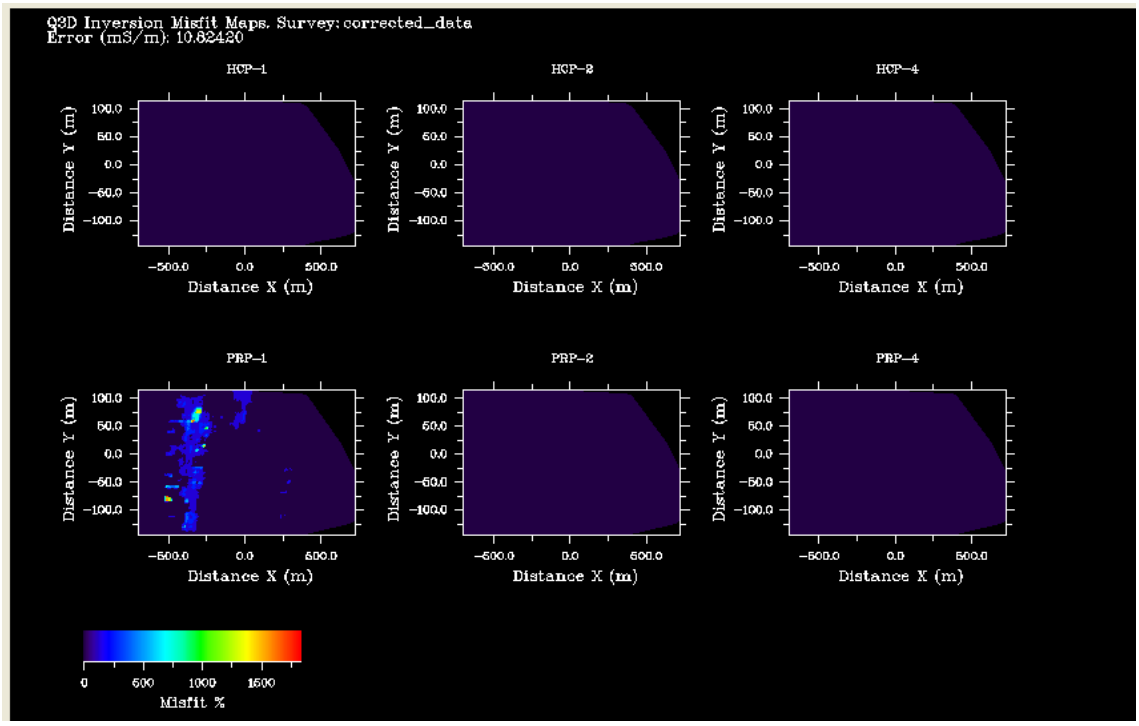


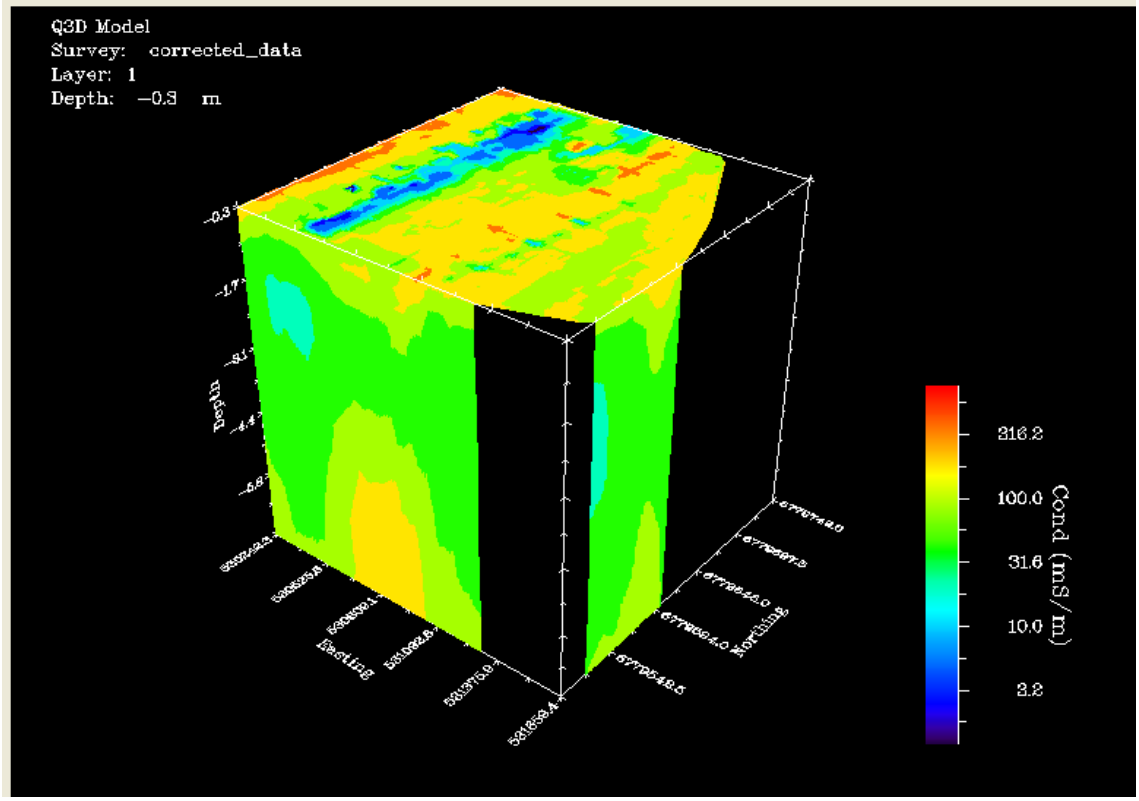
Section	Niter	1stRMS	endRMS	Repeat
1	10	38.678	11.212	NO
2	10	54.339	13.051	NO
3	10	46.269	7.004	NO
4	10	30.528	5.312	NO
5	10	44.196	13.629	NO
6	10	49.828	14.097	NO
7	10	46.615	7.693	NO
8	10	27.195	5.508	NO
9	10	47.433	14.822	NO
10	10	48.220	18.146	NO
11	10	46.406	9.566	NO
12	10	32.119	5.150	NO
13	10	51.022	14.052	NO
14	10	52.740	20.118	NO
15	10	49.663	9.180	NO
16	10	38.728	4.646	NO

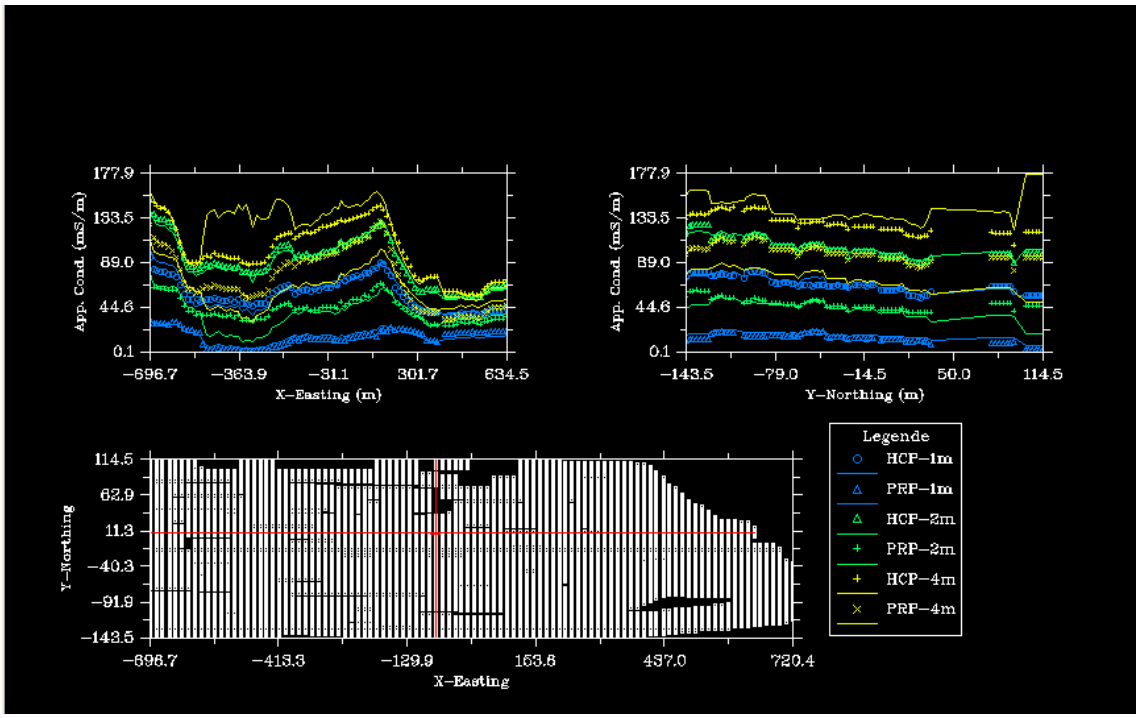


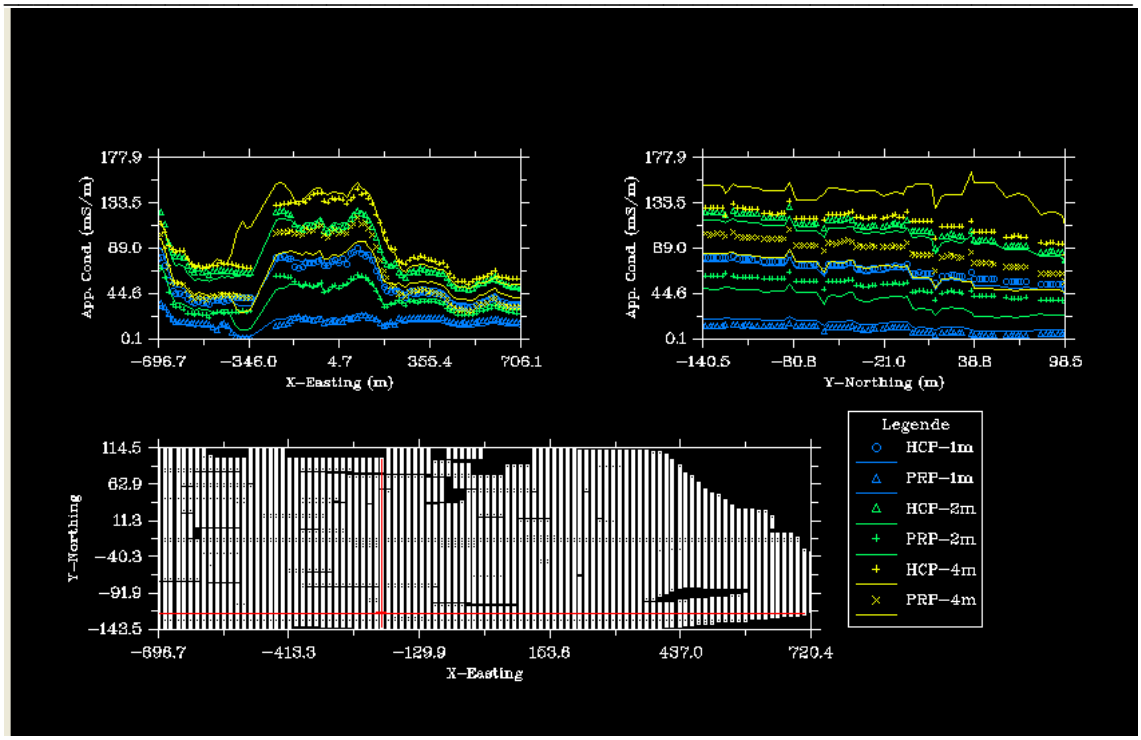
The final model can be displayed in different ways.






Q3D Model
Survey: corrected_data
Layer: 1
Depth: -0.3 m
Depth
Easting
Northing
316.2
100.0
31.6
10.0
3.2
Cond (mS/m)


App. Cond. (mS/m)
177.9
133.5
89.0
44.6
0.1
-696.7
-363.9
-31.1
301.7
634.5
X-Easting (m)
-143.5
-79.0
-14.5
50.0
114.5
Y-Northing (m)
Y-Northing
114.5
62.9
11.3
-40.3
-91.9
-143.5
-696.7
-413.3
-129.9
153.6
437.0
720.4
X-Easting
Legende
HCP-1m
PRP-1m
HCP-2m
PRP-2m
HCP-4m
PRP-4m



The user can save (mainly the MAP file) and print the results using the Save and Print options in the menu bar.