Grav3D: A high performance GUI based Matlab code for 3D forward and inverse modeling of gravity data

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USER GUIDE

Description

Grav3D is a free computer program, which uses an iterative inversion procedure based on Parker's (1972) forward formula to determine the 3D geometry of a horizontal density interface from observed gravity anomalies. The code is written in MATLAB (version R2013b) with an easy-to-use graphical interface (GUI) allowing the user to customize the inversion/forward modelling configurations and setting of the output export formats. The code also provides additional option to visualize the output data either in 2D maps. Outputs can be exported either numeric data or image format. The flow diagram used to estimation of topography interface is shown in Fig. 1.

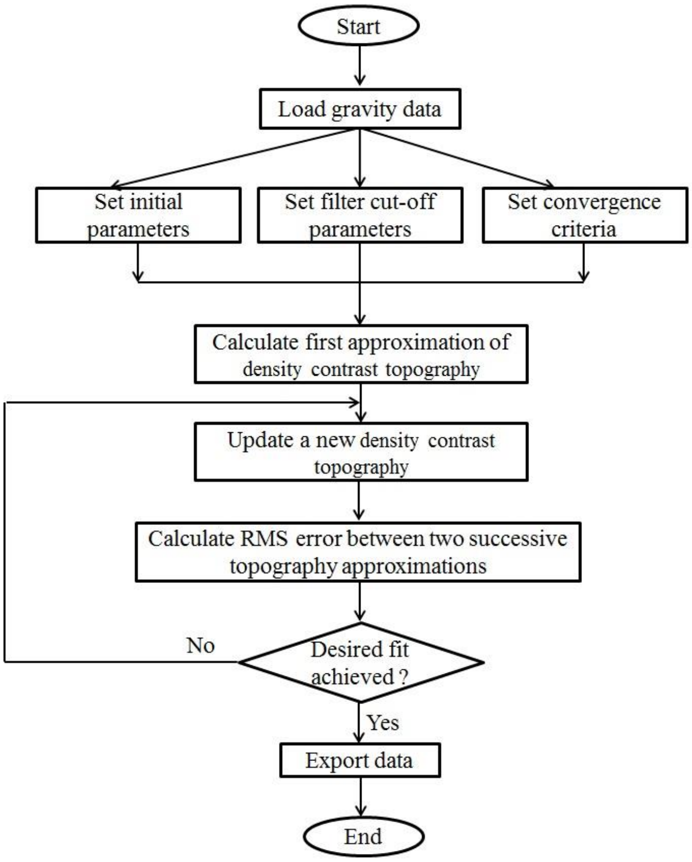

Fig. 1. The flow diagram of Grav3D code for estimating the 3D geometry of a horizontal density interface

Parker, R.L., 1972. The rapid calculation of potential anomalies. Geophys. J. Roy. Astron. Soc. 31, 447–455.

<u>Run the Code</u>: Locate the program code to the working space of Matlab or vice versa the working space of Matlab to the source directory of the code and thereafter type the name of the code to the command window of Matlab.

By running of the Grav3D program, it opens the main graphical interface "Data & Settings" panel covering the entire screen. The configuration of this panel structure is illustrated in Fig. 2. It includes graphical control items for loading of gridded gravity data, editable cells for settings of the field and filtering parameters, the iteration stop criterion, and a confirmation button that initiates the inversion procedure. The remaining part of the panel contains the input map and its spectrum display area.

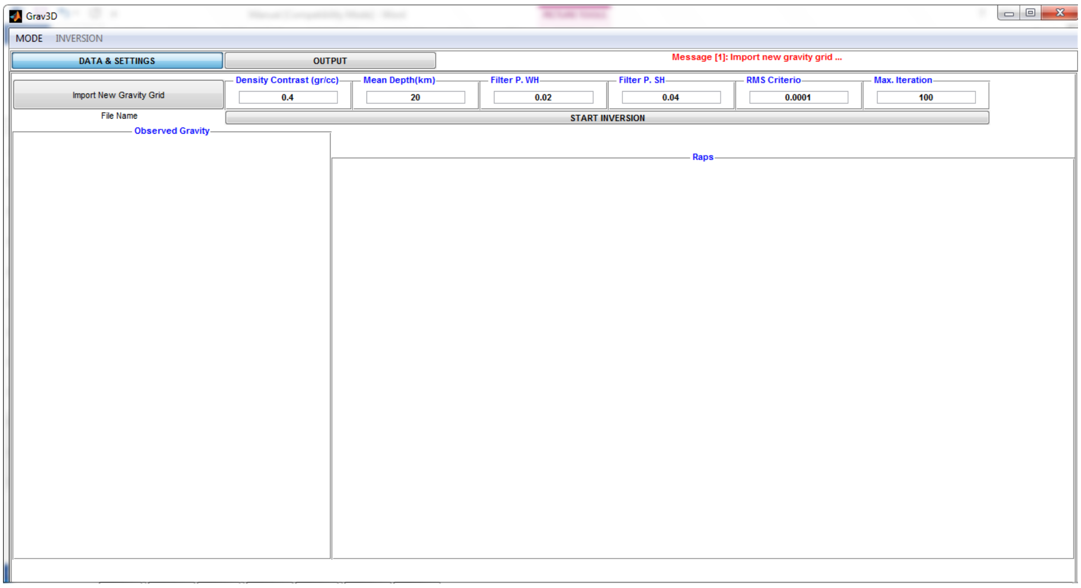

Fig. 2. Screenshot from Grav3D main GUI

After successful data loading, the file name of the input is described below the import menu item, and a contour map and a spectrum graph corresponding to the input data are displayed (Fig. 3).

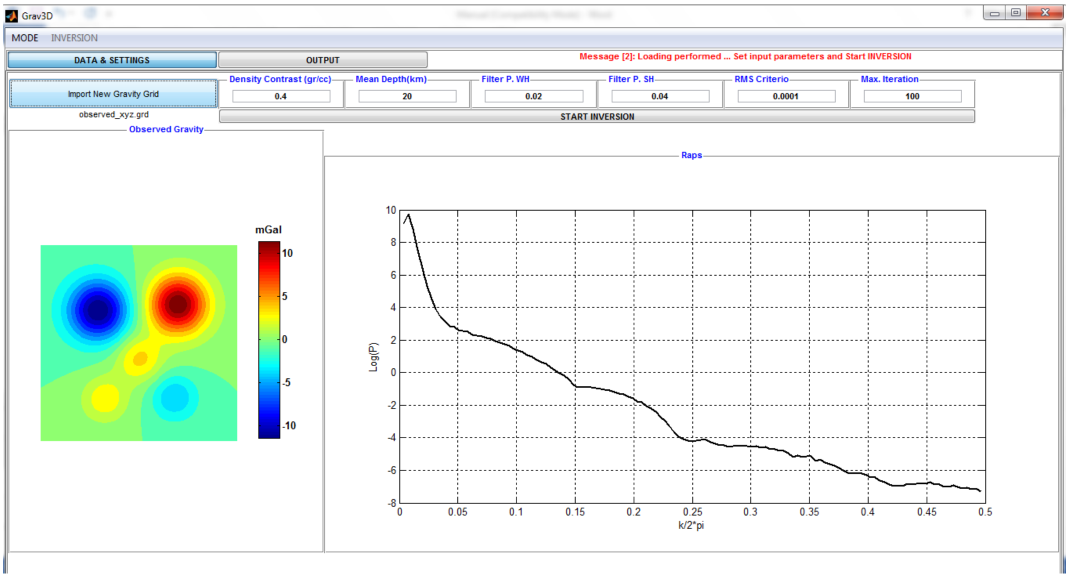

Fig. 3. Screenshot from Grav3D main GUI after a successful data loading.

Required data and formats

Loading the gravity data set is provided by the interactive [Import New Gravity Grid] menu item located at the top left of the panel which allows the user loading either a grid file compatible with Golden Software Surfer formats (*.grd [Surfer 7 Binary grid / Surfer 6 text grid].

The algorithm approves square as well as rectangular input grids. However, the mesh grid intervals to the east and north are required to be equal and any blank in input is not allowed.

Inversion procedure and storing the outputs

To invert gravity data, the set of the density contrast, the mean depth of the density interface, the roll-off frequency parameters of the filtering, and the stopping criterion of the inversion are required (Fig. 4). Distances of the map units are expressed in km, the gravity in mGal and the unit of density contrast in g/cm^3.

Fig. 4. Input parameters (the density contrast and the average depth of the interface) and settings of behaviour of the termination of the iterative procedure.

The set of the SH and WH roll-off frequency values can be done either by entering manually into the correspond edit box or interactively by mouse controls on the spectrum graph.

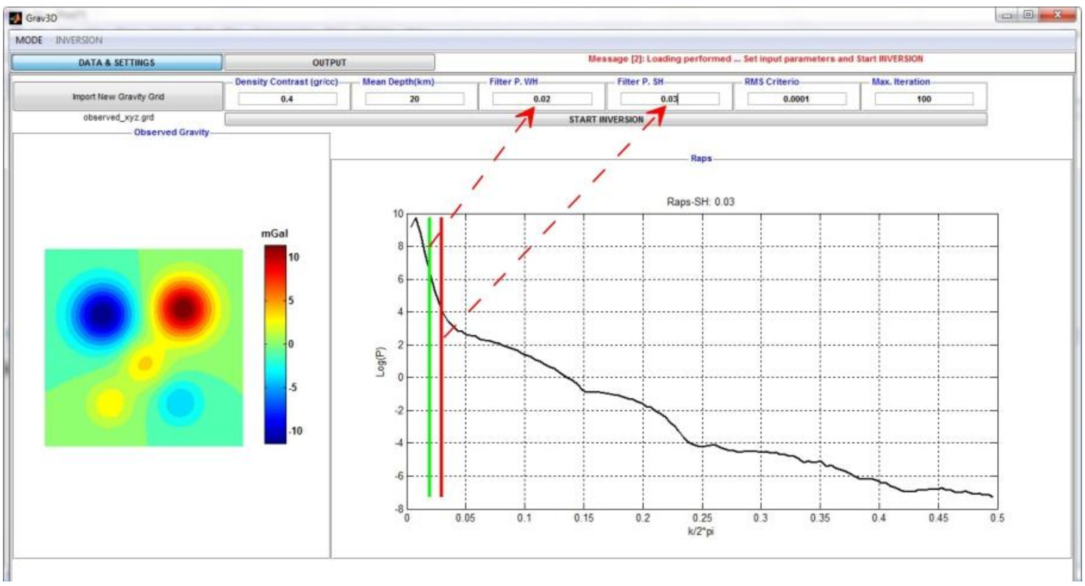

Fig. 5. Setting the roll-off frequency parameters of the high-cut filter.

The iterative procedure stops when the goodness of the fit between two successive depth estimates is below the predefined RMS threshold (default 10^{-4}) or when it completes the preset limit number of iterations.

After validating the entries, the process starts with building the initial depth estimates from Eq. (2) and uses them again in Eq. (2) for their improvement. This operation is continued until the matching criterion between two successive depth estimates is achieved. Finally, the code records the gravity response and the inverted basement depths obtained at the stopping iteration step, the residual between the actual and modelled gravity anomalies and the values of RMS after each iteration. Following, the code auto switches to the "Output" panel that enables the user to display or to export any of the output either numeric or image format (Fig. 6).

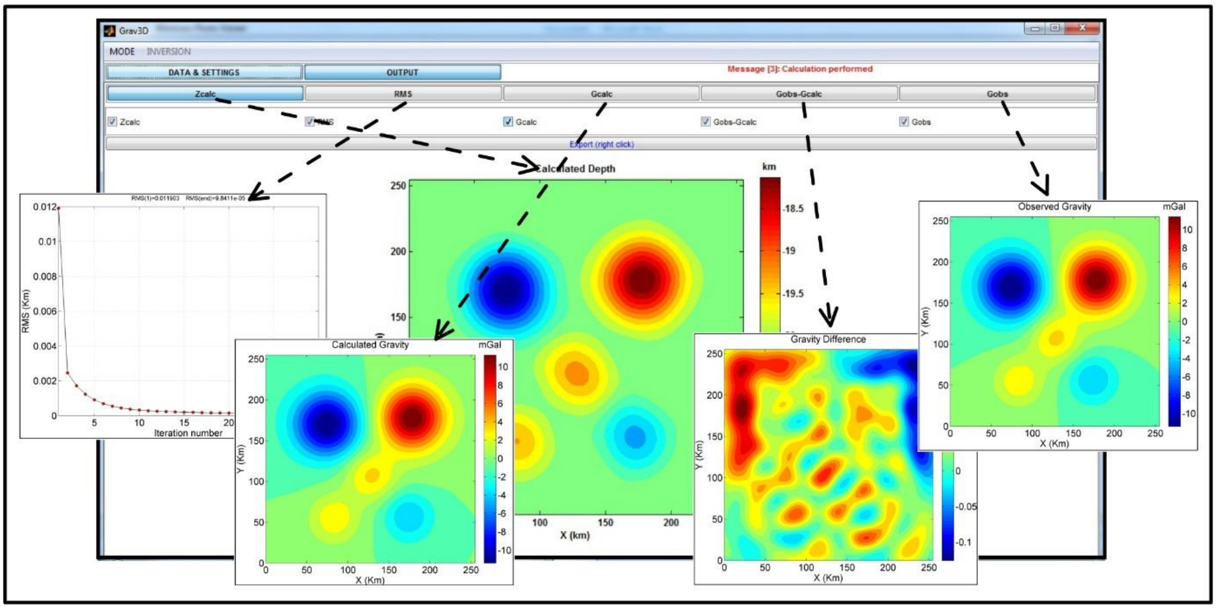

Fig. 6. The output GUI window after the iterative process.

The results can be exported selectively with a user-defined file name common for all the selection. The code automatically adds an informative extension of the available output. Formats for numeric exports (*.grd, *.dat) are compatible with the formats of Golden Software whereas the image exports are supplied with portable network graphic format (*.png) of 300 dpi in resolution (Fig. 7).

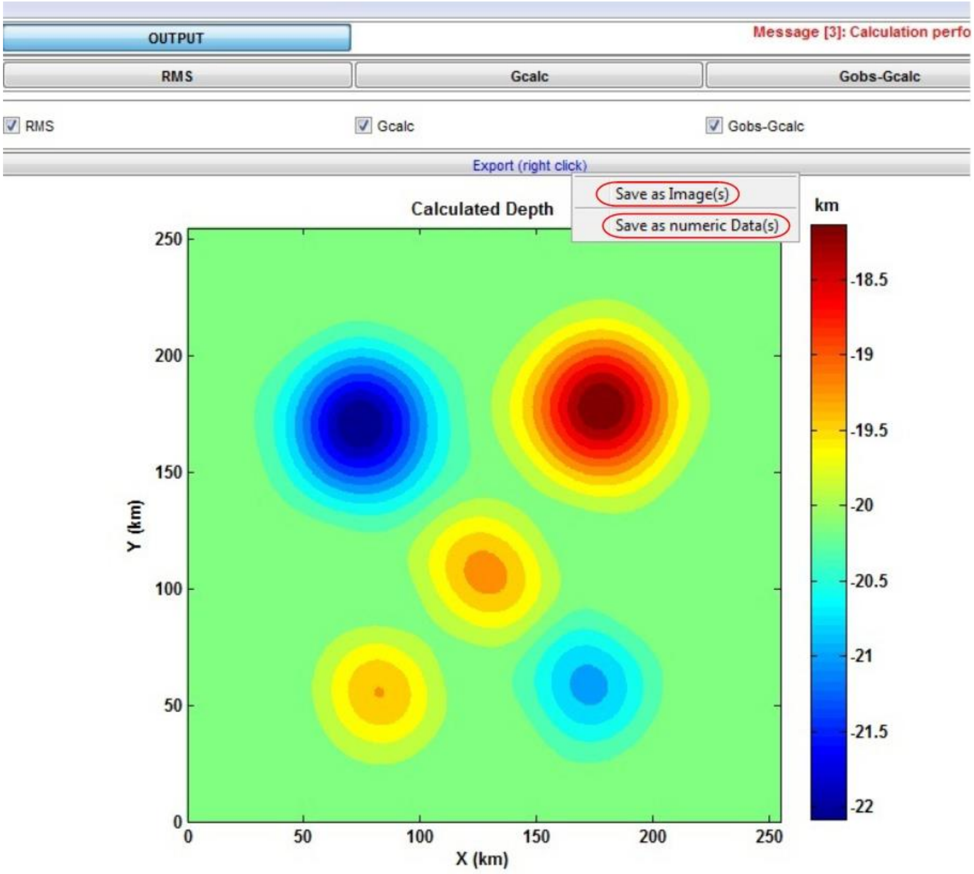

Fig. 7. Export menu items at the output GUI window.

<u>Additional function for forward modelling</u>

Besides the inversion scheme, the Grav3D code also includes a user panel enabled by the [Mode] menu at the topmost left of the main GUI for generating computed gravity anomalies of a certain depth model.

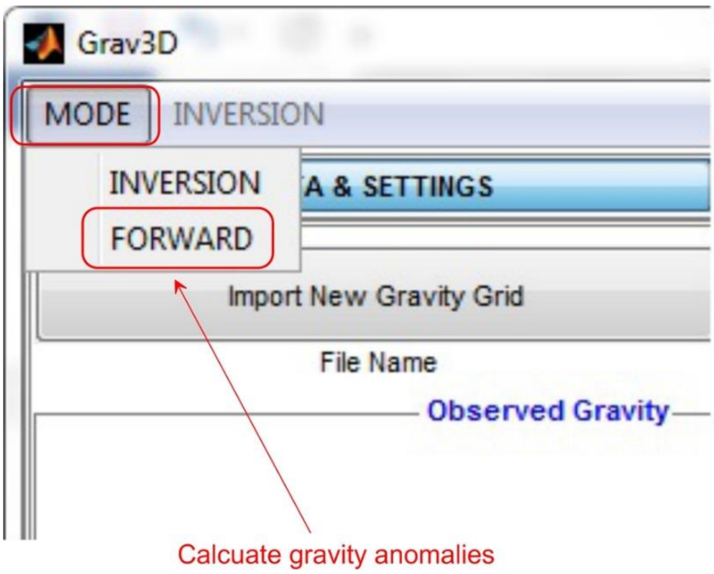

Fig. 8. Additional function for forward modelling.

Loading the depth data set is provided by the interactive [Import New Depth Grid] menu which allows the user loading a grid file compatible with Golden Software Surfer formats (*.grd [Surfer 7 Binary grid / Surfer 6 text grid]) (Fig. 9). After successful data loading, the required input parameters (the density contrast and the average depth of the interface) need to be entered in their related edit boxes (Fig. 9). After confirmation, the code performs the forward calculation of gravity anomalies and maps the result. The user can export the resulted map either as a data file (*.grd) or as an image file (*.png) using [Export (right click)] menu (Fig. 10).

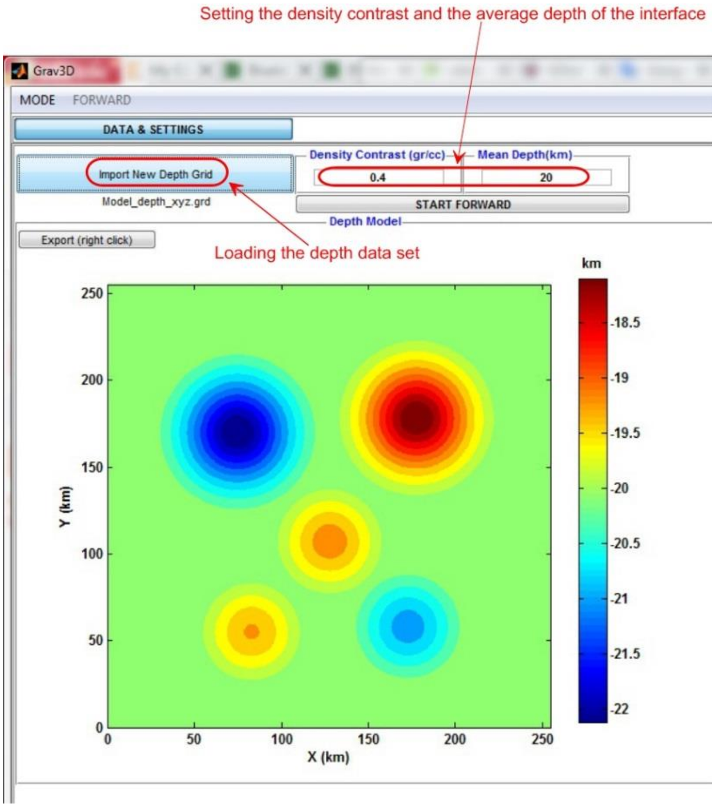

Fig. 9. Loading the depth data set and setting the required input parameters.

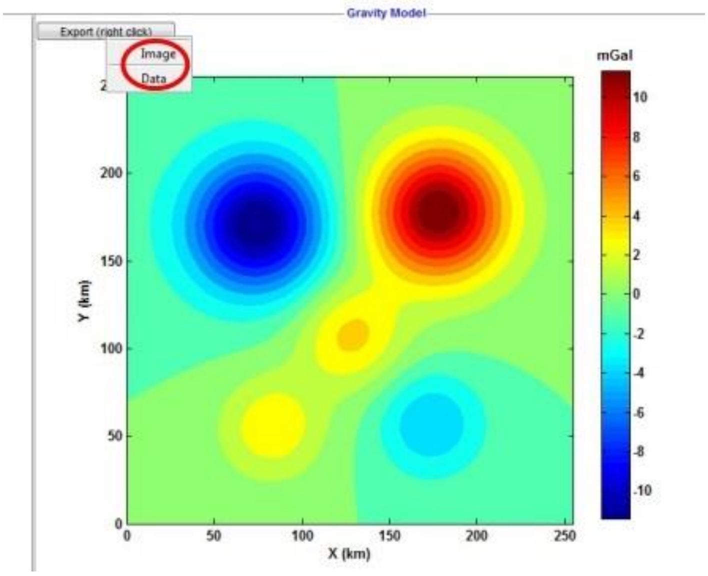

Fig. 10. Exporting gravity anomaly data.