GravNetAdj: A MATALB-based software for gravtiy network ajustment

User Manual

1. Introduction

Gravity measurement is very import for moding the gravity field model and builing a gravity datum for a nation. Even thought there are some software for processing the observations with relative gravity measurement, but a detail error correction are not been given in detail or not a graphical user interface (GUI). Especially, there are no good method to detect multiple outlier in observations or reduce the influence for parameter estimation. Considering the limited number of the alternatives, GravNetAdj was developed to benefit the potential advantages of the robust estimation method. the GravNetAdj is fast, simple, and user-friendly, which makes it easy to carry out the gravity network adjustment when the technicians are not familiar with the gravity data processing Through its user-friendly graphical user interface, GravNetAdj allows users to specify the options, models, and parameters related to gravity data processing and robust estimation for adjustment computation.

2. Installation

GravNetAdj was developed in MATLAB environment since its matrix-based structure and built-in graphics are hight suitable for technical computing, programming, and data visualization. GravNetAdj does not entail any toolbox for function excepte for MATLAB core files and SPOTL for computing ocean tide correction. Two steps should be followed to open the graphical user interface (GUI) of GravNetAdj:

(1) Add the folder containing the source codes of GravNetAdj into MATLAB search path
(2) Type GravNetAdj_English in MATLAB command line

The interface of GravNetAdj was developed using the MATLAB App Designer which is special environment to design and develop visual components of a user interface. For this reason, MATLAB version 2018a or newer is required for running GravNetAdj.

3. GravNetAdj

GravNetAdj is able to perform relative gravity observaitons and gravity network adjustment computation with robust estimation. GravNetAdj allows specifying options , models, and parameters about gravity field processing and adjustment computation through its user-friendly interface. Fundamentally, GravNetAdj consists of four main components which are relative gravity processing, data importing for adjustment computation, observations analysis and adjustment of gravity network.

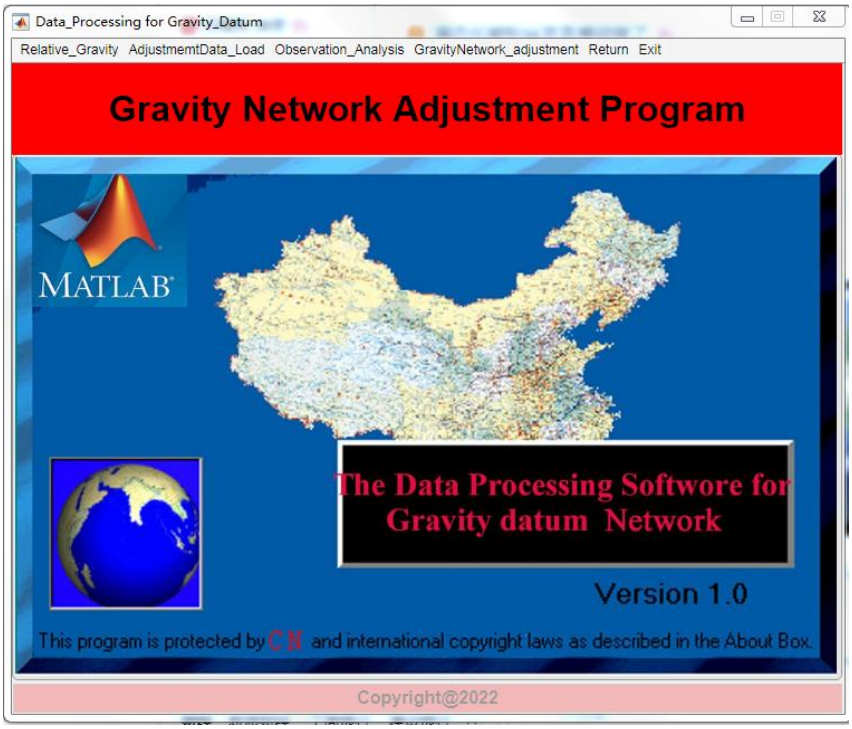


Fig.1 Main components of GravNetAdj

Figure 1 shows the main window of GravNetAdj. Four fundamental tabs representing the components of the software are locaed on the top of the main window. The explanation of each tab along with its preferences is respectively given below.

3.1 Relative gravity data processing

We can relize the function by using the Relavtive_Gravity tabs. There are four tabs . They are parameter setting (para_set), data importing (Input_Data), relative gravity computation (RelGrav_Comp), and Outlier detection (Outlier_detection). Firstly, we must choose the error correction like Solid Tide (earth tide) and Ocean Tide (Figure 2).

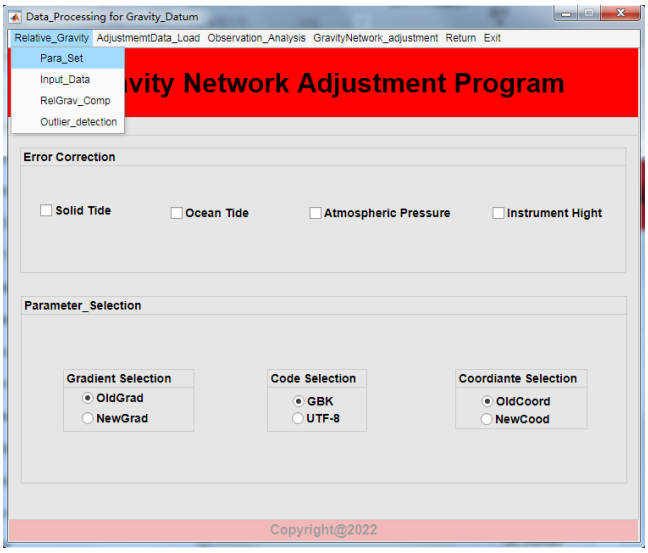


Fig.2 Paramter setting of relative gravity data processing

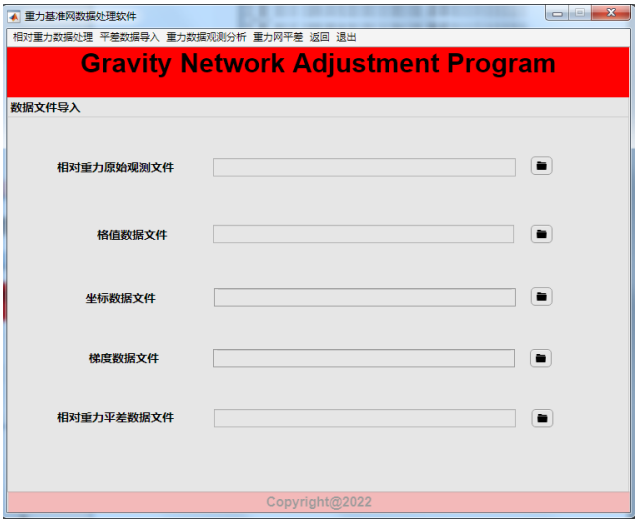


Fig.3 Data import of relative gravity data processing

GravNetAdj requires foundmental data sources to perform relative gravity data processing; original observations of relative gravity, grid value, high precision coodinates, or gradient data. Then The whole necessary files should be introduced to GravNetAdj by clicking the selection box to the related field. Each observation is stored in one file shown in Fig.4, and their detail explanation is expressed in Tab1. All observation file must be placed into the same folder but without any other contents.

```
18
C 063 3 11
B090  Hengshan  2019 9 28  5.433333  2526.545  645.0  345.0  -5.0  3814.0  C063 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.200000  2528.655  642.0  345.0  -5.0  3828.0  C063 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.500000  2567.67   640.0  345.0  -5.0  3814.0  C063 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C 534 3 11
B090  Hengshan  2019 9 28  5.483333  6363.972  643.0  476.0  -5.0  3814.0  C534 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.033333  6367.376  639.0  476.0  -5.0  3823.0  C534 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.533333  6363.039  640.0  476.0  -5.0  3814.0  C534 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C 056 3 11
B090  Hengshan  2019 9 28  5.533333  2510.021  643.0  314.0  -5.0  3814.0  C056 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.100000  6367.376  639.0  314.0  -5.0  3828.0  C056 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.516667  6363.039  640.0  314.0  -5.0  3814.0  C056 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C 1066 3 11
B090  Hengshan  2019 9 28  5.166667  4774.981  643.0  472.0  -5.0  3814.0  C1066 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.066666  6367.419  639.0  472.0  -5.0  3828.0  C1066 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.483333  6363.104  640.0  472.0  -5.0  3814.0  C1066 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C 1064 3 11
B090  Hengshan  2019 9 28  5.500000  4649.614  643.0  474.0  -5.0  3814.0  C1064 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.050000  4654.057  639.0  474.0  -5.0  3828.0  C1064 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.450000  4649.714  640.0  474.0  -5.0  3814.0  C1064 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C 052 3 11
B090  Hengshan  2019 9 28  5.516667  2669.625  643.0  314.0  -5.0  3814.0  C052 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
C076  Hengshan  2019 9 28  6.516667  2674.045  639.0  314.0  -5.0  3828.0  C052 Liuxing Likai 56.0 0 0 77 6 19 36 27 39 3 0
B090  Hengshan  2019 9 28  6.450000  2669.662  640.0  314.0  -5.0  3814.0  C052 Liuxing Likai 56.0 0 0 77 3 12 36 26 52 3 0
```

Fig.4 The data format of relative gravity observations

Tab.1 The explaination of relative gravity observastions

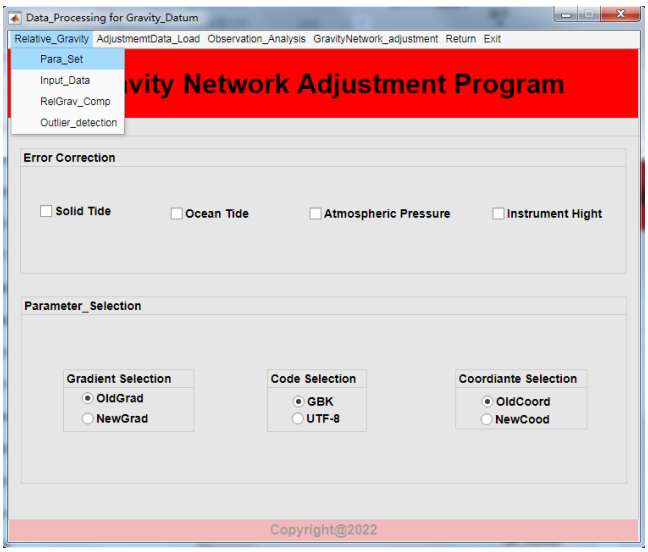
First line	18	Total number of observations
Second line	C	Initial character of the used instrument
	063	Series number of instrument
	3	Number of stations
	11	Measurement type
Third line	B090	Point number
	Hengshan	Name of point
	2019	Years
	9	Month

	29	Day
	5.433333	Mean time
	2526.545	Mean of reading number
	645.0	Atmospheric pressure
	345.0	Instrument height
	-5.0	Overflow
	3814.0	Height
	C063	Name of instrument
	Liuxing	Observer
	Likai	Recorder
	56.0	Inward overflow
	0	Amplitude
	0	Weather
	77	Lontitude(degree)
	3	Lontitude(minute)
	12	Lontitude(second)
	36	latitude (degree)
	26	latitude (minute)
	52	latitude (second)
	3	grade
	0	Vehicle

3.2 The detail step for gravity network adjument

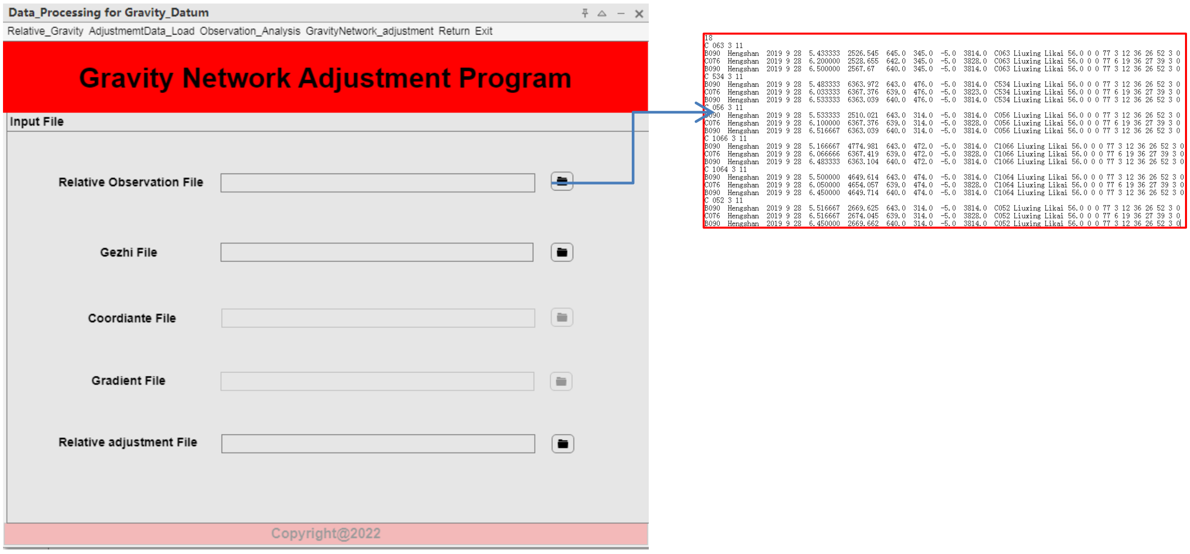
It should be declared that the data and results shown below are not real data. The main function is to perforem the processing of computing.

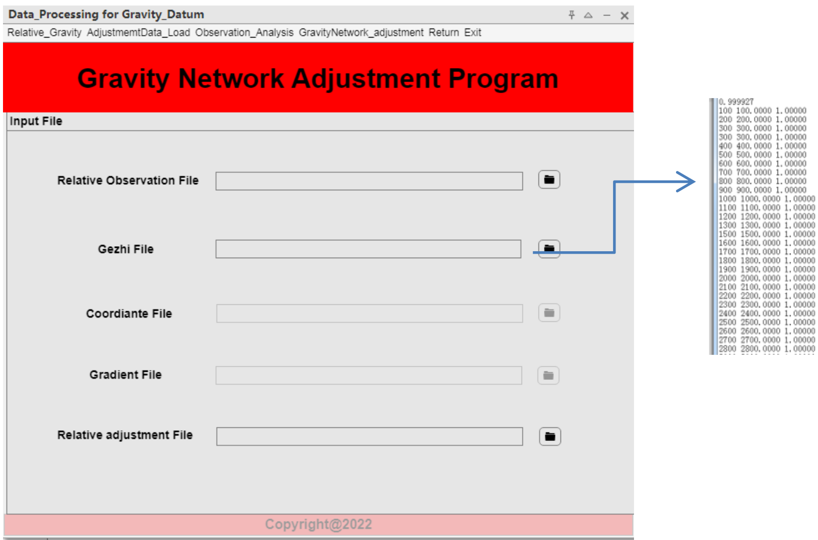
step 1：Click on the menu bar 【 Relative_Gravity- Para_Set 】 to select the corresponding error correction and data selection

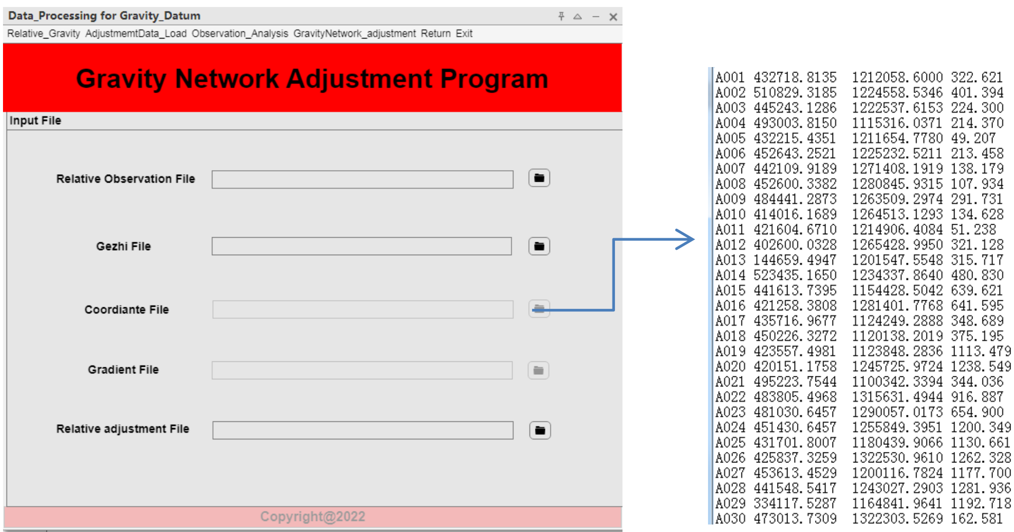


Step 2: Click on the menu bar【Relative_Gravity- Input_Data】to import the required data for data processing. Including the observation data of relative gravity

measurement, grid value data and coordinate data.



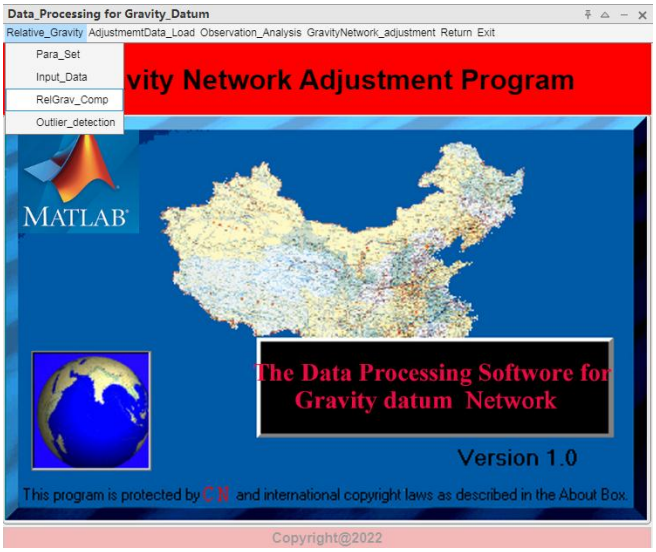




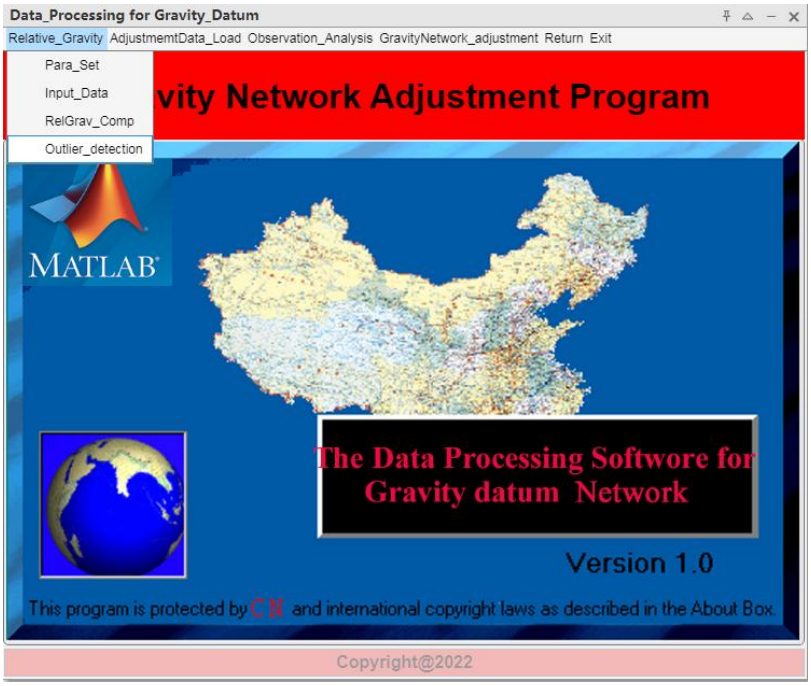
The gradient data is not necessary if there isnot the gradient data. Therefore, we can

using the empiric value. The ending result is stored in file by chooseing click the button in

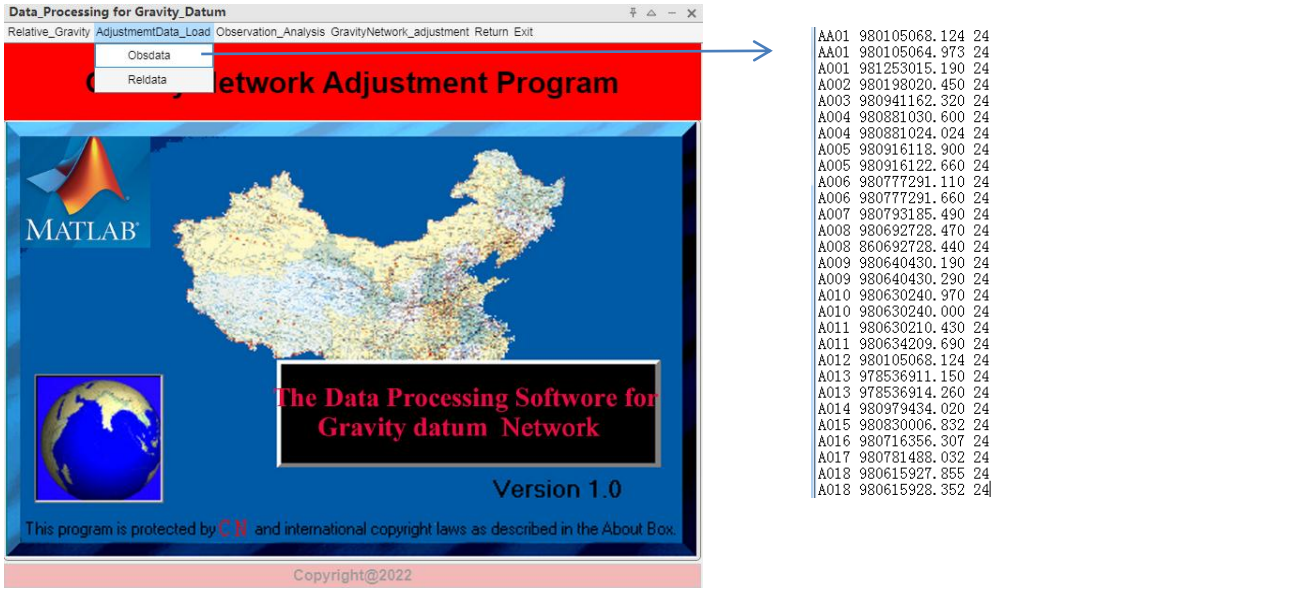
Step 3: Click on the menu bar 【Relative_Gravity- RelGrav_Comp】 to start the preprocessing of relative gravity data.

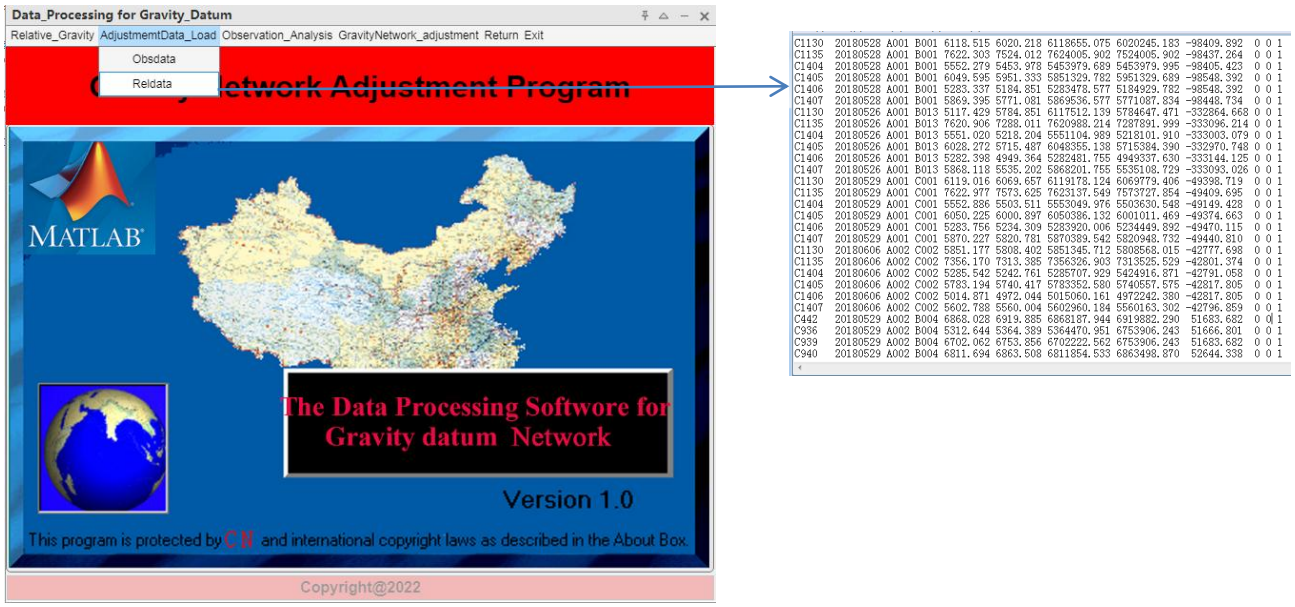


Step 4: Click on the menu bar 【Relative_Gravity- Outlier_detection】 to start gross error detection for the relative gravity data.

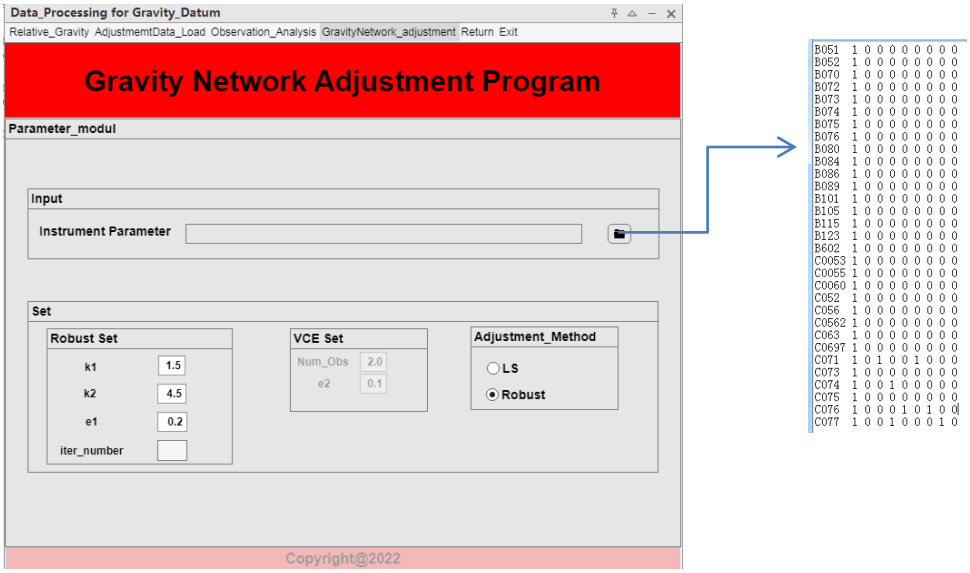


Step 5: Click on the menu bar 【 Adjustmentdata_load - Obsdata】 to start importing absolute gravity adjustment data dand Click on the menu bar 【Adjustmentdata_load - Reldata】to start importing relative gravity adjustment data.

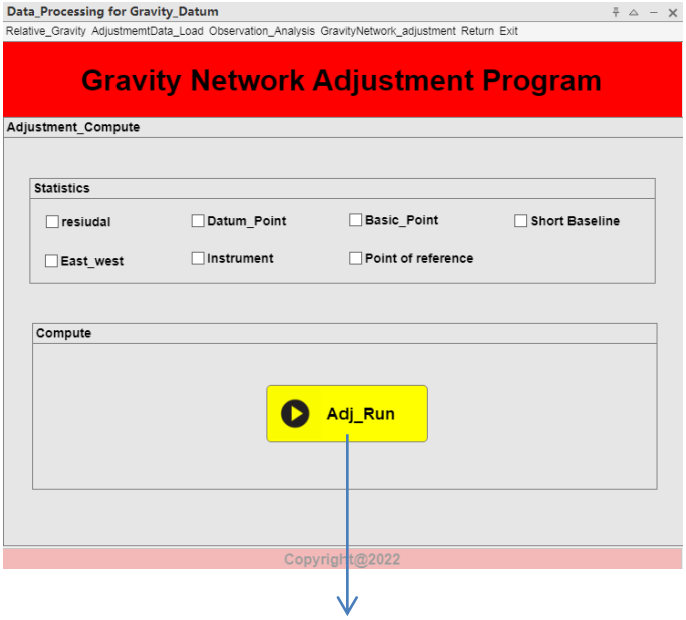




Step 6: Click on the menu bar【 GravityNetwork_Adjustment - Parameter Settings 】to import data, set adjustment parameters, and select adjustment methods. For example, we must give the parameter k1, k2 and e1 for conducting the robust estimation.



Step 7: Click on the menu bar 【GravityNetwork_Adjustment - Parameter Settings】, select the adjustment parameter results statistics, and click on the menu 【adjustment computation



1. number of measurement for adjustment computation: 1357 2. Number of gravity point and instrument:
3. Sigma: 15.199 4. Vaiance of gravity point: 3.487

5. The ending gravity value of observaiton point:

Seriers number of point	Gravity value	Precision
A001	981252015.196	2.540
A002	980980100.853	3.231
A003	980941163.183	4.240
A004	980881028.095	3.640
A005	980777293.116	4.270
A006	980793186.791	3.468
A007	980640429.304	5.236
A008	980634209.004	3.640
A008	980476448.943	5.552
A010	978536910.618	4.359
A011	980979442.482	3.356
A012	980830067.546	4.565
A013	980716358.213	3.115