VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF ENVIRONMENTAL ENGINEERING
DEPARTMENT OF GEODESY AND CADASTRE

Ovidija Čepaitė

GRAVIMETRINIŲ MATAVIMŲ REZULTATŲ APDOROJIMO ANALIZĖ

ANALYSIS OF THE GRAVIMETRIC MEASUREMENTS TREATMENT RESULTS

Master Thesis

Program of study: Geodesy and Cartography, State Code 62410T102
Specialization: Geodetic Networks
Field of study: Measurement Engineering

Vilnius, 2011

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

APLINKOS INŽINERIJOS FAKULTETAS

GEODEZIJOS IR KADASTRO KATEDRA

TVIRTINU
Katedros vedėjas

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(Parašas)

Česlovas Aksamitauskas

(Vardas, pavardė)

____

(Data)

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Geodezinių tinklų specializacija

Matavimų inžinerijos studijų kryptis

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BAIGIAMOJO MAGISTRO DARBO
UŽDUOTIS
………........................Nr. ....
Vilnius

Studentei ...……Ovidijai Čepaitei.......................
(Vardas, pavardė)

Baigiamojo darbo tema: Gravimetrinių matavimų rezultatų apdorojimo analizė

patvirtinta 201…m. ………………..…… d. dekano potvarkiu Nr. ………….

Baigiamojo darbo užbaigimo terminas 201…m. ………………..…… d.

BAIGIAMOJO DARBO UŽDUOTIS:

Atlikti antrosios klasės gravimetrinių matavimų duomenų apdorojimo analizę. Įvertinti matavimų duomenis, atlikti jų matematinį apdorojimą ir išlyginimą bei tikslumo įvertinimą.

Baigiamojo darbo rengimo konsultantai: ... prof. Reiner Jäger.........
(Pareigos, vardas, pavardė)

Vadovas ....prof. habil. dr. Petras Petroškevičius......
(Parašas) (Moksl. laipsnis, vardas, pavardė)

Užduotį gavau

…………………………………
(Parašas)

………. Ovidija Čepaitė.....……
(Vardas, pavardė)

………………………………..…..
(Data)

Vilniaus Gedimino technikos universitetas
Aplinkos inžinerijos fakultetas
Geodezijos ir kadastro katedra

ISBN	ISSN
Egz. sk.	
Data ..........-.....-.....	

Antrosios pakopos studijų **Geodezijos ir kartografijos** programos baigiamasis darbas	
Pavadinimas	**Gravimetrinių matavimų rezultatų apdorojimo analizė**
Autorius	**Ovidija Čepaitė**
Vadovas	**prof. habil. dr. Petras Petroškevičius**

Kalba: anglų

Anotacija

Darbe apžvelgtas Lietuvos teritorijos gravimetrinis ištirtumas. Atliktas gravimetrinių antrosios klasės matavimo duomenų apdorojimas ir tikslumo įvertinimas. Sudaryta duomenų bazė, skirta gravimetrinių matavimų duomenų analizei. Išanalizuoti gravimetrų Scintrex CG-5 Nr.183 ir Nr.184 gravimetrinių matavimų duomenys. Nagrinėtos gravimetrų atskaitų paklaidos, posvyrio, temperatūros pataisos. Matavimų duomenys apdoroti GRAVSOFT programų paketo procedūromis. Sudaryti gravimetrų redukuotųjų atskaitų skirtumų grafikai. Darbo pabaigoje pateiktas gautų rezultatų apibendrinimas ir išvados.

Darbą sudaro 6 dalys: įvadas, 3 skyriai, pagrindiniai darbo rezultatai, literatūros sąrašas.

Darbo apimtis – 90 p. be priedų , 70 paveikslų, 58 lentelės, 32 bibliografiniai šaltiniai.

Prasminiai žodžiai

Gravimetras Scintrex CG-5, gravimetriniai matavimai, duomenų bazė, gravimetrinių duomenų analizė, gravimetrinių duomenų apdorojimas ir tikslumo įvertinimas.

Vilnius Gediminas Technical University Faculty of Environmental Engineering Department of Geodesy and Cadastre	ISBN	ISSN
	Copies No.	
	Date ..........-.....-.....	

Master Degree Studies **Geodesy and Cartography** study programme Final Thesis	
Title	**Analysis of the Gravimetric Measurements Treatment Results**
Author	**Ovidija Čepaitė**
Academic supervisor	**Prof Dr Habil Petras Petroškevičius**

Thesis language: English

Annotation

Gravimetric exploration of the Lithuanian territory was described in the finale thesis of master degree. Treatment and accuracy assessment of measurements data of the second gravimetric class network was carried out. Database for the analysis of the gravimetric measurements data was formed. Data of the measurements of gravimeters Scintrex CG-5 No.183 and No.184 were analyzed. Gravity changes, reference corrections, tilt, temperature corrections have been studied. The gravimetric measurements data was processed with the procedures of GRAVSOFT program's package. Graphs of the reduced references differences of two gravimeters were created. At the end of the work there were described main results.
Thesis consists of 6 parts: preface, 3 chapters, main results, list of literature.
The volume of the work: 90 p. text without appendixes, 70 pictures, 58 tables, 32 bibliographical entries.

Keywords

Gravimeter Scintrex CG-5, gravimetric measurements, database, analysis of the gravimetric measurements data, gravimetric data processing and accuracy assessment.

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PREFACE

Lithuanian gravimetric network is an important part of the Lithuanian National geodetic network. During the formation of new Lithuanian National geodetic basis it is necessary to create gravimetric networks, to carry out a detail gravimetric survey, to evaluate its usability.

Gravity measurements give valuable information about the Earth gravity field. This information is usable in the assessment of the heterogeneous gravity field in the geodetic measurements. Gravimetric data are usable to determine the form of geoid, also in the solving problems related with height determination. Moreover, it is needful to solve geophysical, mineral searches, geodynamic, navigation and other tasks.

Zero-class Lithuanian gravimetric network was created in 1994 with the specialists of the Finnish Geodetic Institute. First time a ballistic absolute acceleration of gravity measurements were carried out in three points of this network (Vilnius, Klaipėda and Panevėžys). Measurements were made by the ballistic gravimeter JILAg-5, the acceleration of gravity was measured with 5 μ accuracy. Measurements were repeated in 2002. In this way modern high accuracy IGSN 71 system reference for gravity field research was created.

Lithuanian National gravimetric network of first class is created for a reason to expand IGSN 71 gravimetric system based for the whole territory of Lithuania. There are 51 points in this network. Second Class gravimetric network was established in 2007 – 2009, it thickens zero and first-class networks. Measurements were carried out by new automatical gravimeters Scintrex CG-5. In order to clarify the capabilities, the accuracy of these devices, and in order to improved measurement methods it is necessary to carry out researches and analysis of the measurements.

Subject of master thesis - treatment of the gravimetric measurements results. Measurements were carried out using procedures of GRAVSOFT software package.

The purpose of my masters thesis - is to analyze the gravimetric measurements treatment results. To achieve this purpose it is necessary to carry out these tasks:

- to evaluate the measurement data,
- to carry out mathematical treatment and alignment of the measurements,
- make accurate assessments.

The first chapter describes gravimetric network of the Lithuanian territory, absolute gravity measurements, there are provided information about first and second-class gravimetric networks. Also there are described gravimeter Scintrex CG-5, the main technical parameters, additional tips for Scintrex CG-5 using.

Databases for the gravimetric measurements analysis are described in the second chapter. This chapter presents the main menu, computerized procedures, which were created by the program.

Also here you can find information about the program, which was created for a reason to calculate reduced data.

The third chapter is appointed for the measurements data processing. Analyzed measurements data and the scheme of trips of the second class network measurements are in this chapter. Also here are analysis of the measurement data, data preparation, reduction and adjustment, estimated accuracy, analysis of the results.

At the end of the work there are main results. Practical benefit of the results – obtained results can be used in the treatment of gravimetric measurements.

Report of the Master Thesis topic was read in the Republican Scientific Conference "Civil Engineering and Geodesy". Moreover, master thesis was presented in the Karlsruhe University of Applied Sciences in Germany.

1. MEASUREMENTS OF THE SECOND CLASS GRAVIMETRIC NETWORK

The gravimetric observations give valuable information on detail gravitational field. It is also usable in geoid analysis, in the various surveying tasks: creating geodetic networks, the development of modern height system, the geodynamic and geophysical surveys. For this purpose, there are carried out absolute and relative gravity measurements. National First Order Gravimetric Network was made in 1954-1962 by the static gravimeters (more than 10,000 points).

Absolute gravity measurements, gravimeter Scintrex CG-5, advices how to put it in practice, measurements technique, technical parameters, first and second-class gravimetric networks will be described in this chapter.

1.1. Lithuanian National Gravimetric Network

The first measurements of the gravity acceleration in Lithuania were carried out by Vilnius University professor J. Sniadeckis in XIX century. Later, in 1865-1891, the acceleration of gravity measurements were carried out by Vilnius astronomical observatory director P.Smyslovas. Lithuanian Gravimetric network was created according to Baltic Geodetic Commission program in 1930-1934. It was consisting of 35 points.

Two first-class gravity points 1976-1983 were appointed in Vilnius and Klaipėda. Satellites of these stations were equipped at Vilnius International Airport (it is destroyed now) and at the seaport in Klaipėda. First-class acceleration was the 0.03 mGal accuracy.

Lithuanian Second Class gravimetric network was established in 1968 by a trust "Specgeofizika". Points Vilnius Nr.379 and Klaipėda Nr.383 were the base points in these measurements. Root mean square (rms) of measurements was 0.05 mGal, and the second class of the gravity acceleration according to the first-class values - 0.2 mGal. Second-class network consists of 21 points, the distance average between points from 50 to 70 km.

1.1.1. Absolute Gravity Acceleration Measurements

Measurements of the acceleration due to gravity form one of the geophysical methods for investigating the interior of the earth, and also one of the tools of geodesy for the determination of the earth's shape. Those variations in gravity which are related to the departure of the earth from a spherical form are of particular interest in geodesy, the science of the earth's shape (Garland *et al.* 1965).

One of the most familiar facts about the earth is that a body released near it will fall with increasing velocity. The rate of increase of velocity is called the acceleration due to gravity. In the case of a body on the earth, the force of attraction is determined by the product of the earth's mass and the mass of the body, and the distance between the body and the earth's centre (Garland *et al.* 1965).

Information on detail gravitational field is very important for increasing an accuracy of the geoid models. Precision of these models defines the accuracy of normal heights detection by modern space technologies. Reliable gravimetric observations are necessary in combination with high precision geodetic measurements, performing geodynamic investigations, executing the resources survey and in solving other various geophysical, navigational and cartographical tasks (Obuchovski *et al.* 2008).

To perform the detail research of the gravitational field in any particular territory it is necessary to develop the gravimetric control, which should be based on the gravity system, based on the absolute measurements of the gravity acceleration, and on the precise gravimetric networks. Such gravimetric control could be developed by using modern equipment and nowadays technologies of the gravimetric observations (Obuchovski *et al.* 2008).

For a long time the absolute acceleration of gravity value was determined solely by pendulum method, but now largely restricted is ballistic or free fall method. Thus obtain the maximum accuracy - from 10^{-7} g to 10^{-9} g (g - acceleration of gravity). Gravimetric stations, which are operating continuously, provide the information about the acceleration of gravity of global changes.

A. Sakuma was the first, who started to do the experimental measurements of the gravity acceleration by the ballistic method with the fixed ballistic device in 1967. Accuracy of the gravity acceleration values was 1μGal. Similar continuous gravimetric stations was created in the International Latitude Observatory of Japan (Mizusava) in 1975.

Atmospheric braking effects and micro-seismic ground motion has a significant impact to the accuracy of the ballistic method. The atmospheric resistance depends on body shape, the drop in velocity and atmospheric density. Micro-seismic motion effects can be minimized using a special construction ballistic devices and by carrying out more measurements.

Magnetic and electrostatic field influences affects the ballistic measurements. Non-magnetic material used to reduce magnetic effects. Electrostatic charge can accumulate on the receding body because of the friction. Non-symmetrical parts of the device layout of the vacuum chamber may influence the occurrence of gravitational effects.

Ballistic measurements are influenced by many random and systematic error sources. It depends on the design of the device, point position, measurement and processing methods. If the measurements were made with modern devices, then the random error, if measurements were made many times, can be reduced to 5 μGal. Other errors of the controlled may reach 1μGal, and a general systematic will be close to a random error. All of the absolute acceleration of gravity measurement errors by the ballistic method are close to the 10μGal. Errors could be reduced by using "stations method" or by repeated measurements. During the measurements should always be taken into account the acceleration of gravity changes, which are due to the sweep of the tides, pole movement and atmospheric pressure changes. In these measurements are important not only a short period of gravity acceleration changes, but also a variation of long period.

Lunar and Solar attraction changes Earth gravity field. This has influence for geodetic measurements and determining the gravity acceleration. The biggest change of the acceleration of gravity is then, when the celestial body is in the zenith or nadir, or perpendicular to their positions. Undamaged surface of the Earth maximum acceleration of gravity change is 165 μGal (because of the lunar impact), and 76 μGal (because of the solar). Total maximum exposure of both celestial bodies - 241 μGal. Actually the Earth gravity changes are larger and reachs about 280 μGal. The rate of change - 1 μGal/min. Tidal changes should be adopted according to the International Association of Geodesy requirements. Time to calculate the correction must be known to one minute accuracy. Fix error does not exceed few μGals.

Acceleration of gravity correction because of the Earth pole movement is a long period. Instantaneous pole coordinates are needed to calculate the adjustments, which expresses the deviation from the middle pole CIO.

The gravimeter readings at a given point on the Earth's surface are not constant. Gravity changes with time-dependent processes such as Earth tides, instrumental drifts, changes in air pressure, and groundwater mass. When relative measurements of gravity are performed on field survey, Earth tides and instrumental drift are the most notable effects. Other effects important in absolute measurements and continuous monitoring of gravity changes at a ixed point are negligible in relative gravity (Dias and Escobar 2000).

The gravity changes due to variations in groundwater masses were not taken into account in this work. It is difficult to find proper data sets indicating the true influences of these local effects on relative measurements of gravity (Dias and Escobar 2000).

Acceleration because of the the groundwater level and soil moisture changes can vary up to several tens of μGals. Measurement results should be reduced under normal conditions of point. Reduced gravity acceleration measured error grade level of the item should not exceed 1 μGal.

Since the seventies the U.S.A, Italy, Japan, Russia and France were started to produce non-static ballistic gravimeters. These devices are used to create the gravimetric networks and to ascertain the acceleration of gravity changes.

Observing the body falls, there are measured time t and the path of falling body l. Acceleration of gravity dependence of these values in the indiscrete gravity field is obtained by the following formula:

$$l = l_o + v_o t + g\,\frac{t^2}{2}\ , \tag{1.1}$$

here l_o , $v_o t$ – the path of falling body and speed in the moment t=0 (Makinen *et al.* 2003).

After measuring the time, at which the body goes, and his three points on the road, acceleration of gravity can be determined by the formula:

$$g = 2\,\frac{(l_3 - l_1)(t_2 - t_1) - (l_2 - l_1)(t_3 - t_1)}{(t_3 - t_1)(t_2 - t_1)(t_3 - t_2)}\quad . \tag{1.2}$$

More than three-changing body positions are ascertained with the modern ballistic gravimeters and the results processed by the least squares method (Makinen *et al.* 2003).

The real gravity field is not homogeneous. Acceleration of gravity decreases with increasing altitude, so the measurements must be taken into account the vertical gradient of gravity. The falling body in the heterogeneous field during the same period of time goes a greater distance than by falling in the indiscrete field. The path in the heterogeneous field is obtained by the following formula:

$$t = \frac{g_o}{2}t^2\left(1 + \frac{W_{zz}}{12}t^2 + \ldots\right) \tag{1.3}$$

here: g_o – acceleration of gravity at initial the point(l=0).

W_{zz} – vertical gravity gradient acceleration, which can be determined by measuring with the relative gravimeter.

The falling body in the real field defined distance goes in less time than in the indiscrete field. In this case, the fall time is determined by the formula:

$$t = \left(\frac{2l}{g_0}\right)^{1-2}\left(1 - \frac{W_{zz}}{24}\frac{2l}{g_0} - \ldots\right) \tag{1.4}$$

Body free fall in the real gravity field can be reduced to fall in the indiscrete field, reducing to (1.3) formula or increase the distance measured in accordance with (1.4) formula, the estimated value of time. As a result we will get the acceleration of gravity g_o.

After *n* measurements (using the “stations method”), gravity acceleration value is obtained by the following formula:

$$g = \frac{1}{t_n}\int_0^{t^n}\left(g_0 + \frac{W_{zz}}{2}g_0 t^2\right)dt = g_0\left(1 + \frac{g_z}{6}t_n^2\right) \tag{1.5}$$

Acceleration at a point was set below the baseline (l=0) according to the size ln/3. During the determination of the acceleration of gravity, height of a point is selected above ground, on which device is constructed, and to which the measured value of gravity acceleration is reduced. Often that height is equivalent to 800 mm height. Vertical gravity gradient acceleration is usable to the reductive calculations. It is determined by measuring with the relative gravimeters.

The relative error of the acceleration of gravity is determined by the formula:

$$\frac{dg}{g} = \frac{dl}{l} - 2\frac{dt}{t} \tag{1.6}$$

If the relative error not exceed 10^{-9}, and if the distance is 0,5 m (fall time of 0,3 s), distance and time of measurement error is 0,5 nm and 0,2 ns. This accuracy can be achieved by laser interferometer and electronic equipment (last-mentioned are needed to set the time). With the invention of atomic clocks and developments in laser technique is easier to increase the absolute accuracy of measurements (Makinen *et al.* 2003).

Modern absolute gravity acceleration measurements in the basic points of gravimetric are carried out by few micro-gals (μGal) accuracy. This high accuracy is achieved only with the ballistic devices. It is desirable that the absolute gravity measurements of gravimetric points would be repeated several times.

Absolute measurements of the local points have been selected according to the common Baltic absolute gravity measurement points in the network, possible changes of gravity and high-precision leveling lines in the layout. Satellite gravity points are equipped near the points of the absolute gravity acceleration, which can be used in a variety of gravimetric and geodetic works and for monitoring the stability of the main gravimetric points.

Gravity acceleration of the point satellite is adjusting in regard the measuring point. Groundwater wells, used to determine the level of ground water, are located near the gravimetric points. High-precision gravimetric basis is required for the creation of new gravimetric network.

National Lithuanian Gravity Network, built on three absolute gravity stations, was measured by dr. Jaakko Mäkinen (Finnish Geodetic Institute) in 1994 and 2002. The ballistic gravimeter JILAg-5 was used. Sites for gravimetric points were selected in calm and geologically stable locations. Station VILNIUS – cellar, PANEVĖŽYS – basement and KLAIPĖDA – ground floor. Monuments for the points are reinforced concrete poles, 2 m in depth. There are brass marks fixed into monuments. Elevation of marks was determined by precise levelling. Gravimetric measurements were carried out in day and night. The room was kept at a constant temperature and there always was carried out periodic maintenance of the device. During the measurements there were micro-seismic vibrations - it seared just only at nights. Analysis of the results were carried out after the measurements gravity value was determined with 5 mGal accuracy. In this way modern high accuracy IGSN 71 system for gravity field research was created.

Absolute gravity measurements were organized by series of 25 falls. Time period of each series was 5 minutes, and time between series – 10 minutes. Total number of measurements in 1994 and 2002 is presented in Table 1.1 and 1.2 respectively (Paršeliūnas *et al.* 2008).

Table 1.1. Absolute gravity measurements in 1994 (Paršeliūnas *et al.* 2008)

Station	**Period**	**Height, mm**	**Number of series**	**Number of falls**
VILNIUS	07 15-17	826	168	4200
KLAIPĖDA	07 22-23	835	140	3500
PANEVĖŽYS	07 28-29	832	110	2750

Table 1.2. Absolute gravity measurements in 2002 (Paršeliūnas *et al.* 2008)

Station	**Period**	**Height, mm**	**Number of series**	**Number of falls**
VILNIUS	08 04-05	832	102	2550
KLAIPĖDA	08 07-09	842	142	3550
PANEVĖŽYS	08 11-13	843	144	3600

Treatment of measurements was carried out considering solar and lunar influence, pole movement and atmospheric pressure changes. It was included laser wave length and frequency of standard correction. The maximum recoil correction - 17.8 μGal. After the 1994 and 2002 comparing of the measurements results, it may be noted that after the 2002 measurements, the average recoil correction was significantly higher and have reached 9.8 and -5.5 micro-gals. The correction in 1994 measurements did not exceed 1.1 μGal. The assessment of accuracy has been obtained that acceleration of gravity, which was set at zero grade points gravimetric VILNIUS, KLAIPĖDA, PANEVĖŽYS in 1994 and 2002, error m_g was 5 μGal.

By applying the vertical acceleration of gravity gradients, gravity acceleration value g_h is determined first in the measurements height, later it is reduced to 800 mm and the height of the mark (Table 1.4): Δg_{800} ir Δg_o - the acceleration of gravity reduction g_h from the measurements height to the 800 mm and 0 mm height; g_{800} ir g_o - value of the gravity acceleration in the 800 mm height and the values of the mark level (Makinen *et al.* 2003).

Table 1.4. Reduced measurements data (Makinen *et al.* 2003)

Station name	1994 measurements					2002 measurements				
	g_h, μGal	Δg_{800}, μGal	g_{800}, μGal	Δg_o, μGal	g_o^{94}, μGal	g_h, μGal	Δg_{800}, μGal	g_{800}, μGal	Δg_o, μGal	g_o^{02}, μGal
VILNIUS	981458851.2	7.5	981458858.7	237.8	981459089.0	981458838.7	9.2	981458847.9	239.6	981459078.3
KLAIPĖDA	980547509.5	10.9	980547520.4	259.3	981547768.8	981547502.9	13.0	981547515.9	261.5	981547764.4
PANEVĖŽYS	981526817.1	9.4	981526826.5	245.0	981527062.1	981526809.6	12.7	981526822.3	248.3	981527057.9

Differences between gravity values, which were fixed in 1994 and 2002, are shown in Table 1.5. Differences were calculated in height ($\Delta g_{800}^{02\text{-}94}$) and in the level of markers 800 mm ($\Delta g_o^{02\text{-}94}$). These differences are not large, and do not exceed 10,8 μGal, that is within an observation accuracy. Mean values of gravity g_o^v at the marks level were used for the new adjustment of NATIONAL Lithuanian Gravity Network.

Table 1.5. Average value of gravity acceleration (Makinen *et al.* 2003)

Station name	$\Delta g_{800}^{02\text{-}94}$, μGal	$\Delta g_o^{02\text{-}94}$, μGal	g_o^v, μGal	Marker height, mm	Δg_s, μGal	g_s^v, μGal	m_g, μGal
VILNIUS	-10.8	-10.7	981459083.6	10	2.9	981459086.5	5
KLAIPĖDA	-4.5	-4.4	981547766.6	10	3.1	981547769.7	5
PANEVĖŽYS	-4.2	-4.2	981527060.0	10	2.9	981527062.9	5

Satellite points have been established at the close neighborhood of absolute gravimetric points. Gravity value at the satellite points was determined by relative observations from absolute points using *LaCoste & Romberg* gravimeters. A precise leveling and soil moisture measurements of the points are performed periodically. Ground water level is observed continuously. Lithuanian National Gravimetric Network was related to absolute stations in Poland BOROWA GORA and GDANSK and to gravimetric point GIBY. In these points the calibration of *LaCoste & Romberg* gravimeters *G-1012*, *G-1036*, *G-1078*, *G-1084* was performed.

System IGSN 71 consists according to the 1994 absolute measurements of gravity acceleration in Lithuania. The new system is made by thickening the gravimetric first-class network of Lithuania. The coordinates are adjusting in system LKS 94.

1.1.2. Lithuanian National First Order Gravimetric Network

Lithuanian National First Order Gravimetric Network was established and gravimetric reference was evaluated by support of Danish, Polish and USA specialists in 1998-2001. It based on absolute and relative gravity observations. Absolute gravity observations were performed by Finnish Geodetic Institute (J. MÄKINEN) in 1994 in three points VILNIUS, PANEVĖŽYS and KLAIPĖDA by ballistic gravimeter JILAg–5.

There are the 51 gravity points (including 3 absolute gravity stations) in the final scheme of the Lithuanian National Gravimetric Network (absolute gravity points have been chosen as reference for the network). Points are located at the solid public buildings (mostly – churches), either on the stable fundaments of the buildings. Points are located on the good roads, the average distance between points - 50 km. (Obuchovski *et al.* 2008).

This network is created for a reason to expand IGSN 71 gravimetric system based for the whole territory of Lithuania. Gravimetric points of first-class network are located in the territory of Lithuania evenly. Areas of the points are selected not only to measure the acceleration of gravity, but also for the levelling. Lithuanian National First Order Gravimetric Network scheme is shown in Fig. 1.1. (Obuchovski *et al.* 2008).

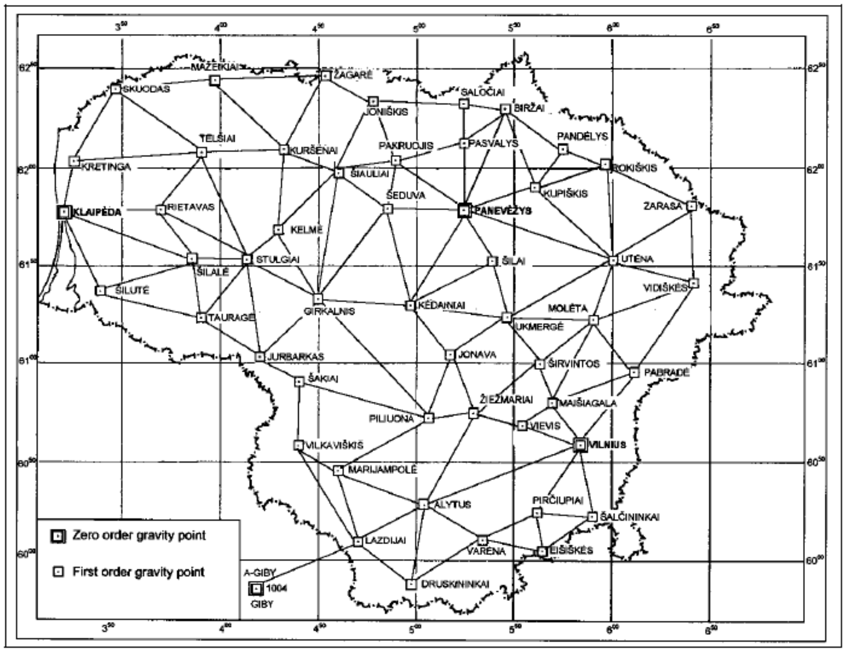


Fig 1.1. Lithuanian National First Order Gravimetric Network (Obuchovski *et al.* 2008).

New points are equipped in combination with high precision geodetic network, which are already existing and designed. GPS station of Šiauliai and the first-class GPS station Piliuona are connected to a network of gravimetric (Jucevičiūtė *et al.* 2000).

The gravity points are very often chosen in churches or other official buildings close to the motor-road system, in order to combine lasting existence with easy access and quick transport. The gravity points were equipted with the metal marks. Information table of the gravimetric point, attached to the walls of the building, indicates the location of the marks (Figure 1.2) (Jucevičiūtė *et al.* 2000).

Fig. 1.2. Information table of the gravimetric point (Jucevičiūtė *et al.* 2000)

A mark is a point whose position is known to a high degree of accuracy and is normally marked in some way. The marker is often a metal disk made for this purpose, but it can also be a church spire, a radio tower, a mark chiseled into stone, or a metal rod driven into the ground. Stations usually have two or more reference marks associated with them. Reference marks are for helping to keep the location of stations from being lost (Benchmark... 2003)

Stability of the control points in the vicinity of the gravimetric, mural installation rappers. Height differences between the rappers and the gravimetric points' marks make second-class leveling accuracy. Normal height of the points coming from rappers leveling, coordinates - according to topographic maps of 1:10000, and the points that coincide with the GPS points obtained by GPS coordinates method. The coordinates are calculated in system LKS 94 (Jucevičiūtė *et al.* 2000).

First-class gravity measurements carried out in 1998-2001 in cooperation with the experts from Warsaw Institute of Geodesy and Cartography. Totally were observed 117 gravity differences. Every difference was measured three times by 3 or even 6 *LaCoste & Romberg* gravimeters: *G-1012*, *G-1036*, *G-1078*, *G-1084* by Polish Institute of Geodesy and Cartography and *G-191, G-192, G-193* by JAV National Imagery and Mapping Agency (NIMA). There are 112 strings, 62 closed figures (48 triangles and 14 quadrangles) in the gravimetric network (Figure 1.1). Maximal closing error was 27 μGal. 60% of closing errors are bellow 10 μGal (Paršeliūnas *et al.* 2008).

Relative gravity measurements were performed by LaCoste & Romberg gravimeters in 1999, 2000 and 2001. Scale factors of the gravimeters *G-191, G-192, G- 193* were detected by intensive measurements on the calibration line VILNIUS–PANEVĖŽYS. The treatment of gravimetric observations was done by software package GRAVSOFT according to the correction of Lunar and Solar attraction's and gravimeters zero-slip. Root mean square of the gravity acceleration differences does not exceed 5 μGal (Obuchovski *et al.* 2008).

Lithuanian National Gravimetric Network was adjusted in six variants:

1. Six initial points – absolute gravity stations (VILNIUS, KLAIPĖDA, PANEVĖŽYS, BOROWA GORA and GDANSK) and station GIBY – and their standard deviations were used. All relative gravity measurements were put in the adjustment procedure.
2. Three initial points – absolute gravity stations (VILNIUS, KLAIPĖDA, PANEVĖŽYS) and their standard deviations were used. Relative gravity measurements of 1998 were not used.
3. Three initial points – absolute gravity stations (VILNIUS, KLAIPĖDA, PANEVĖŽYS), but their standard deviations were not used. All relative gravity measurements were put in the adjustment procedure.
4. As (3), but standard deviations of initial points were used as well.
5. Only one initial point – absolute gravity station VILNIUS – was used.
6. Two initial points – absolute gravity stations VILNIUS and PANEVĖŽYS – were used (Paršeliūnas *et al. 2008)*.

Differences of gravity acceleration values, computed in six variants, do not exceed 8 μGal. Corrections to absolute gravity stations after adjustment are presented in Table 1.3. It is seen, that in all adjustments corrections are slightly bigger to station KLAIPĖDA. It is systematic effect, which probably was called due the station was not included into detection of gravimeters scale factors (Paršeliūnas *et al.* 2008).

Table 1.3. Corrections to absolute gravity stations after adjustments, μGal (Paršeliūnas *et al.* 2008)

Station/Variant	1	2	4	5	6
VILNIUS	-1	-4	-2	0	+1
KLAIPĖDA	-4	-6	-4	-2	-1
PANEVĖŽYS	+4	+10	+6	+9	+10

The gravity observations in the Lithuanian precision gravity network have been adjusted by least squares method based on reduced gravimeter readings and the adopted absolute gravity values. It appears that the absolute values agree very well with the relative observations, and that the general accuracy level of the adjusted gravity values of network points does not exceed 5,3 μGal. The aposteori standard deviation of a single line was estimated to be 4,9 μGal (Jucevičiūtė *et al.* 2000).

1. 2. Measurements by gravimeter Scintrex CG-5

A gravimeter, also called gravity meter, or gravitometer is an instrument used in gravimetry for measuring the local gravitational field of the Earth. A gravimeter is a type of accelerometer, specialized for measuring the constant downward acceleration of gravity, which varies by about 0.5% over the surface of the Earth. Though the essential principle of design is the same as in other accelerometers, gravimeters are typically designed to be much more sensitive in order to measure very tiny fractional changes within the Earth's gravity of 1 *g*, caused by nearby geologic structures or the shape of the Earth and by temporal tidal variations. This sensitivity means that gravimeters are susceptible to extraneous vibrations including noise that tend to cause oscillatory accelerations. In practice this is counteracted by integral vibration isolation and signal processing. The constraints on temporal resolution are usually less for gravimeters, so that resolution can be increased by processing the output with a longer "time constant". Gravimeters display their measurements in units known as gals, instead of ordinary units of acceleration. A gal is defined as 1 centimeter per second squared (Gravimeter... 2010).

There are two types of gravimeters: relative and absolute. Absolute gravimeters measure the local gravity in absolute units, gals. Relative gravimeters compare the value of gravity at one point with another. They must be calibrated at a location where the gravity is known accurately, and then transported to the location where the gravity is to be measured (Gravimeter... 2010).

- **Absolute gravimeters**

Absolute gravimeters, which nowadays are made compact so they too can be used in the field, work by directly measuring the acceleration of a mass during free fall in a vacuum, when the accelerometer is rigidly attached to the ground (Microglacoste… 2011).

A more recent development is a "rise and fall" version that tosses the mass upward and measures both upward and downward motion. This allows cancellation of some measurement errors. Absolute gravimeters are used to calibrate relative gravimeters, and for establishing the vertical control network (Brown at al. 1999).

- **Relative gravimeters**

Most common relative gravimeters are spring-based. They are used in gravity surveys over large areas for establishing the figure of the geoid over those areas (Shokin 1963).

In 1938, M.S. Molodenskil proposed and developed a new gravimeter with a metallic ring spring, which later served as the basis for the construction of several types of gravimeters. Various main parts of the gravimeter were modified and improved many times. The experimental testing of different variants and the evaluation of the advantages and disadvantages of each of them made it possible to clarify many problems (Shokin 1963).

A spring-based relative gravimeter is basically a weight on a spring, and by measuring the amount by which the weight stretches the spring, local gravity can be measured. However, the strength of the spring must be calibrated by placing the instrument in a location with a known gravitational acceleration.

Transportable relative gravimeters also exist; they employ an extremely stable inertial platform to compensate for the masking effects of motion and vibration, a difficult engineering feat. The first transportable relative gravimeters were, reportedly, a secret military technology developed in the 1950-60s as a navigational aid for nuclear submarines. Subsequently in the 1980s, transportable relative gravimeters were reverse engineered by the civilian sector for use on ship, then in air and finally satellite borne gravity surveys (Stelkens-Kobsch 2006).

Types of gravimeters are:

- a wide range (~ 1500 mgal)
- a narrow range (~ 80 mgal)
- universal (80-1000 mgal).

1.2.1. Gravimeter Scintrex CG-5

The Gravimeter Scintrex CG-5 (Fig. 1.3) is an extremely sensitive and precise scientific instrument. The Autograv is a microprocessor-based automated gravity meter that has a measurement range of over 8000 mGals without resetting and a reading resolution of 0.001 mGal. This enables the Autograv to be used for both detailed field investigations and large scale regional or geodetic surveys (Scintrex… 2010).

Accurate measurements are taken by simply pressing a key and under most conditions it takes under one minute to complete the reading. The individual readings are displayed directly in mGals. The data is stored in Flash memory and can be sent to a printer, modem, recorder or PC (Scintrex… 2010).

When setting the Autograv up for a reading, the software-based tilt sensors provide greater accuracy and are easier to operate than the conventional bubble levels. The gravity meter displays the outputs from the sensors on high resolution meters on the ¼ VGA display (Fig. 1.4) (Scintrex… 2010).

Fig. 1.3. Gravimeter Scintrex CG-5 (Scintrex… 2010)

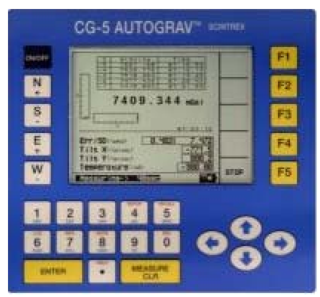


Fig. 1.4. Display of the Gravimeter Scintrex CG-5 (Scintrex… 2010)

The sensing element of the Autograv is based on a fused quartz elastic system. The gravitational force on the proof mass is balanced by a spring and a relatively small electrostatic restoring force. The position of the mass, which is sensed by a capacitive displacement transducer, is altered by a change in gravity (Scintrex… 2010).

Excellent protection from changes in ambient temperature and atmospheric pressure is achieved by sealing the Autograv sensing element in a temperature stabilized vacuum chamber. The wide operating temperature enables the operator to use the Autograv in many environments. Since the sensor is made from non-magnetic fused quartz, the Autograv is not affected by magnetic field variations (as long as they are less than ten times the Earth's magnetic field, i.e. ± 0.5mT) (Scintrex… 2010).

Low drift is a result of the extremely stable operating environment of the quartz elastic system. It allows the long term drift of the sensor to be accurately predicted and a real time software correction reduces it to less than 0.02 mGals per day.

Scintrex gravimeter CG-5 AutoGrav may be used:

- mineral exploration;
- volcanology;
- oil and gas exploration;
- regional gravity surveys;
- measurements of the oceans and on land;
- detailed field research;
- geological mapping;
- civil engineering works.
- metrology.

All Gravimeter Scintrex CG-5 technical parameters are described below (Table 1.6).

Table 1.6. CG-5 SPECIFICATIONS (Survey instruments…2011)

No.	Parameter	Value of parameter
1	Sensor Type	Fused Quartz using electrostatic nulling
2	Reading Resolution	1 microGal
3	Standard Field Repeatability	<5 microGal
4	Operating Range	8,000 mGal without resetting
5	Residual Long-Term Drift	Less than 0.02 mGal/day (static)
6	Automatic Tilt Compensation	±200 arc sec
7	Tares	Typically less than 5 microGals for shocks up to 20 G
8	Automated Corrections	Tide, Instrument Tilt, Temperature, Drift, Near Terrain, Noisy Sample, Seismic Noise Filter.
9	Operating Temperature	-40°C to +45°C (-40°F to 113°F)
10	Ambient Temperature Coefficient	0.2 microGal/°C (typical)
11	Pressure Coefficient	0.15 microGal/kPa (typical)
12	Magnetic Field Coefficient	1 microGal/Gauss (typical)
13	Memory	Flash Technology (data security)
14	Dimensions	30 cm (H) x 22 cm x 21 cm (12" (H) x 8.5" x 8")
15	Weight (including batteries)	8 kg (17.5 lbs)
16	Battery Capacity	2 x 6.6 Ah (11.1 V) rechargeable Lithium-Ion Smart Batteries. Full day operation in normal survey conditions with two fully charged batteries
17	Power Consumption	4.5 W at +25°C (77°F)
18	Standard System	CG-5 Console, Tripod base, 2 rechargeable batteries, Battery Charger 110/240 V, External Power Supply 110/240 V, RS-232 and USB Cables, Carrying Bag, Data dump and utilities software, Operating Manual (CD), Transit Case

1.2.2. Additional tips for Scintrex CG-5 using

In order to operate your CG-5 effectively, you should be aware of additional tips specifically related to:

- Tips for Better Results

a) Whenever the CG-5 is not being actively transported between stations by hand, vehicle or aircraft, even for 15 minutes or less, place it on its tripod and level it, within the range of the tilt meters until you are ready to make a measurement.

b) When necessary to replace the battery during the course of a long day, and then take a reading with the original battery, replace the original battery, wait 5 to 10 minutes, and then repeat the previous reading. This will help determine if there has been a level shift (however small).

c) Where it is possible, select station locations that are on solid ground and away from trees, bridges, poles or other potential sources of vibration.

- Transporting and Handling

a) Avoiding shocks and jolts caused by hitting the instrument against rocks and trees, etc. when taking the instrument out of vehicles and placing it on the tripod.

b) When transporting the instrument in a vehicle, place it on a compliant surface, either a padded seat or a pad made from other shock absorbing rubber-based cord).

c) To obtain the highest accuracy after unavoidable rough transport, allow the Autograv to settle for a few minutes after being leveled on its tripod before starting a reading. If rough handling has occurred, there may be a slight (but noticeable) drift for only a few minutes after leveling.

- Minimizing Motion Noise

a) *Poor ground conditions* - Soft ground, tree root movement and settling of the tripod. These are improved by the Tilt Correction (continuous or not).

b) *Microseismic noise* - This is due to the motion of the continental crust as an effective wave guide for seismic surface waves of (usually) a 4 to 8 second period. These effects may be caused by long-period ocean wave striking coast lines.

c) *Earthquake shock waves* - The shock waves from an earthquake may affect measurements so much that they cannot be carried on while the shock waves last. The effect of smaller tremors could be quite effectively reduced by selection of the Seismic Filter.

d) *Industrial traffic noise* - Vibration due to industrial activity and/or the nearby movement of heavy vehicles generally introduces higher frequency seismic noise (e.g. 4 to 100Hz).

- Minimizing Wind Noise

Wind striking a gravity meter can cause both vibration noise and reduction in gravity by tilting the meter out of verticality. Tilting the meter so that it is not vertical tends to reduce the apparent gravity value, despite the statistical averaging of the gravity measurements and the automatic tilt correction. A windbreak should be devised to protect the meter from the effect of wind. The effect of wind noise may also be reduced by selecting the Seismic Filter.

- Selecting Base Stations

Repeated gravity measurements at a base station can be used to determine the residual drift. In any survey area, try to select base stations that:

a) are easily accessible to the other stations to be surveyed
b) have low vibration noise (e.g. away from industrial, vehicular or natural vibration sources)
c) have a hard, level surface where the precise tripod location may be repeated, and the level of the gravity meter maintained.

- Operating in Cold Weather

a) increased battery drain required to maintain the temperature of the sensor and to heat the display
b) reduced capacity of the battery because the battery becomes cold

An external battery belt and extender cable (optional) can reduce the effect of a cold battery as the external battery is kept warm by the heat of the operator (Scintrex… 2010).

Using the device for the first time (or if the device is switched off for more than 48 hours) there are some following waiting periods, which must be observed:

1. Powering up the Autograv - Use the charger to power up the instrument as well as the battery.

2. Warm-up period – When the power adapter is connected to the gravimeter, it is necessary to wait four hours for the device to warm up and to reach the measuring temperature.

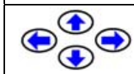
3. Stabilization period - After inserting the battery into the device, it is need to wait 48 hours to stabilize the device and to warm up of the sensor. It is a suggestion to try initializing the software by resetting the time and date, erasing the memory and setting up the Autograv instrument parameters.

4. Checking and adjusting the drift correction - This process involves running the Autograv for approximately 24 hours in the auto-repeat mode.

5. Setting up the instrument for field operations - After completing the previous steps, device is ready for field measurements (Scintrex… 2010).

The basic keys to navigate, select options and enter data are shown in the Table 1.7:

Table 1.7. Basic keys of gravimeter Scintrex CG -5 (Scintrex… 2010).

	- The ON / OFF key turns the microprocessor and display on or off
	- The Enter key is used to acknowledge a particular keystroke sequence
	- The MEASURE/CLR key is a dual function key. The MEASURE function is used to start measurements and the CLR function to move to the previous character field during data entry in alphanumeric fields. It also erases all values in certain fields, enabling entry of an entirely new set of values
	- The arrow keys move the cursor either right, left, up or down
	- The F1 to F5 function keys access the adjacent option on the display. These options will vary according to the current menu. For instance, in the SURVEY PARAMETER SETUP screen, the F1 key allows you to access the second parameters submenu

1.2.3. Calibration of the gravimeters

Calibration is a comparison between measurements – one of known magnitude or correctness made or set with one device and another measurement made in as similar a way as possible with a second device (Calibration… 2011).

Calibration can be called for:

- with a new instrument,
- when a specified time period is elapsed,
- when a specified usage (operating hours) has elapsed,
- when an instrument has had a shock or vibration which potentially may have put it out of calibration,
- sudden changes in weather,
- whenever observations appear questionable.

In general use, calibration is often regarded as including the process of adjusting the output or indication on a measurement instrument to agree with value of the applied standard, within a specified accuracy (Achilli *et al.*1994).

The calibration of the gravimeters Scintrex CG-5 was carried out before and after field survey. For this purpose, the chosen calibration base was Eišiškės – Saločiai, because it passes the meridian direction. This calibration base is connecting the absolute gravimetric measurements stations VILNIUS, PANEVĖŽYS, also it is connecting first-class network stations EIŠIŠKĖS and SALOČIAI. The calibration measurements were carried out in trip VILNIUS, PANEVĖŽYS, SALOČIAI, PANEVĖŽYS, VILNIUS, EIŠIŠKĖS, VILNIUS. Voyage duration was 12 hours. One-time calibration was carried out two runs.

The difference of the gravity acceleration bases is 202 mGal, and two zero order and two first order points are in it. Results of calibrations are presented in Table 1.8 (Paršeliūnas *et al.* 2010).

Table 1.8. The calibration coefficients of the gravimeters (Paršeliūnas *et al.* 2010)

Year	182	183	184	185
2007	1,013470	0,999524	1,000386	0,999914
2008	1,013300	0,999377	1,000312	0,999819
2009	1,013115	0,999151	1,000210	0,999708

The standart deviation of the linear scale coefficients of 0.00006 was received. The maximal change of the linear scale coefficients during all time of field campaign was 0,000159 (gravimeter No 183). During the three months of period of investigations the zero drift of the gravimeters was changed from 17 till 197 µGal/day (Paršeliūnas *et al.* 2010).

1.3. Second class gravimetric network

Second Class gravimetric network was established in 2007 – 2009, it thickens the zero and first-class network. Good road network, suitable locations of points are important for the gravimetric and geodetic measurements. Most of the stations, as well as first-class network, equipped in the church and establish by the same technique.

The gravimetric observations of the second order gravimetric network were done by four gravimeters Scintrex CG-5 (No 182, 183, 184, 185). Average distance between points is 10 km. (Obuchovski *et al.* 2008).

In 2007 the gravimetric observations were performed at 200 points (Fig. 1.5). The measurement campaign was organized in "loops" of 8 to 12 points, and the initial and final point was the same (more often – absolute gravity station or first order point). Totally the 30 loops were performed. The performance of the each loop observations took about 10-12 hours (Obuchovski *et al.* 2008).

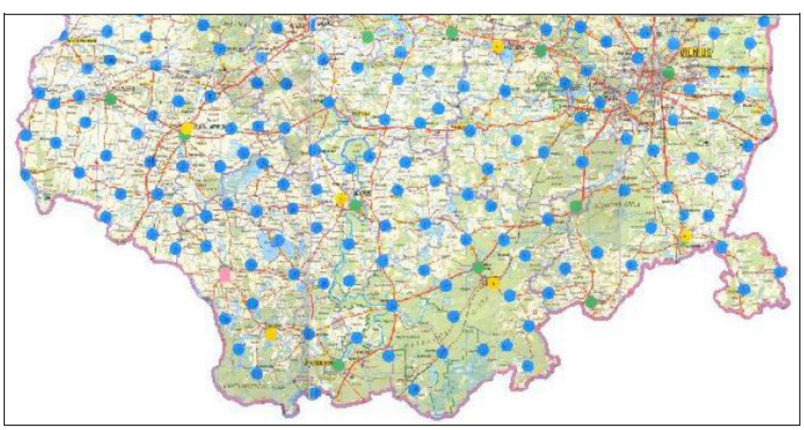


Fig 1.5. Scheme of Lithuanian National Gravity Second Order Network 2007 (southern part; green circles – first order gravimetric points, blue circles – second order gravimetric points) (Obuchovski *et al.* 2008)

Gravimeters were organized in two groups: 183 and 184; 182 and 185. It was performed 23 loops by the first pair of gravimeters, and 7 – by second. It was performed 10 cycles of observations at each point. Duration of single cycle was 55*s*. Observations were performed in the period from 2007 09 25 until 2007 12 03. The meteorological conditions for observations were worse in the second part of this period. The strong wind, rain and wet snow were heavy obstucles for making measurements. The air temperature was about 0° C, sometimes falling below zero, that caused the faster run down of batteries, therefore their capacity was enough even for the longest loop (Obuchovski *et al.* 2008).

The gravimetric network of Lithuania consists from the three absolute gravity points and the first order gravimetric network, consisting of 48 points, and second order gravimetric network, consisting of 636 points (Fig. 1.6) (Paršeliūnas *et al.* 2010).

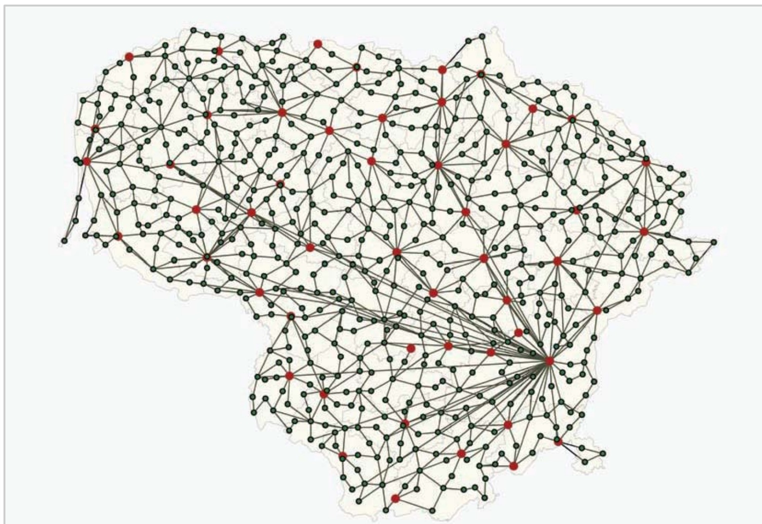


Fig. 1.6. Scheme of the Gravimetric network points (zero-and first-class points – red colour, second-class points – green, lines marks differences of the measured gravity acceleration) (Paršeliūnas *et al.* 2010)

A new second-class network points equipped in accordance with the requirements of gravimetric points. For the points there are selected geologically stable locations, away from major land or water mass changes. Tried to choose how much to quieter places, remote from railways, highways, where the intense movement of factories, plants and other sources of vibration. Eschewed a high-voltage power lines and other sources of electromagnetic fields to create (Obuchovski *et al.* 2008).

Gravity points, involved to the network, equipped near the 25 GPS stations, which are operate continuously. GPS method was using to coordinate points. This method is based on LITPOS network of the permanent stations. Lithuanian territory quasi-geoids' model is used to calculate the normal height of stations. Network measurements are made with four Scintrex CG-5 gravimeters. These devices are currently one of the most accurate gravimeters.

2. DATABASES OF GRAVIMETRIC DATA ANALYSIS

One of the master thesis tasks is to create databases. I had created databases for gravimetric data analysis. Here you can find information about references of gravimetric data, measurement's durations, dates, localities, some information about the workers and instruments. Three tables of databases was created for analysing gravimetric data: initial.dbf, stations.dbf and workers.dbf.

You can do various procedures in this database: data accumulation, entering, editing, searching, erasing, reviewing, you can work a sum of geodetic. Also here you can find helping information about the program. This database was created by *FoxPro* program‘s package, which is generally usable to create and to control relational databases.

Full programmable package is compose of:

- controlling center (usable to edit databases);
- algorithmic language (usable to create application programs);
- compiler, which can create executive *.exe programmes;
- helping programme‘s package, which can facilitate creating of database.

Structure of databases, of databases management, main menu, some computer procedures will be described in this chapter.

2.1. Structure of database

Visual Foxpro is a dynamic object oriented language that supports multiple class libraries, a class browser. It provides programmable dynamic (run-time) subclassing, and data dictionary capabilities. Visual FoxPro operates on dynamic inheritance. It instantiates classes from a library or from base classes. It can also modify and save classes - including contained objects into the class library at run time (Visual FoxPro… 2010).

Visual Foxpro is one of several OO 4GLs, languages that combine OOP and inheritance with native SQL and other relational database capabilities. These languages tend to treat simple variables, object properties, and table fields similarly, allowing operations that include all three. In addition to VFP, three languages: Visual dBase, Alpha 5 Pro, and Visual Objects were also "xBase" languages, meaning they evolved from dBase II/III. Visual dBase 7, from Borland International, now an object oriented language is the direct descendant of dBase (Visual FoxPro… 2010).

Data base management system (DBMS) is a program that serves as an interface between the functional application programs and a set of coordinated and integrated files called a data base. There are many opportunities for these systems to share the same data. For instance, the deforestation application could share data with the land use information system. The DBMS allows the various functional systems to access the same data. The DBMS can pool together related data from deferent files. DBMS is perhaps the most important tool in decision making for sustainable development (Visual FoxPro… 2010).

Each table is kept in a database file with the extension name .DBF. The main data format of DBF (Data Base Format), so that FoxPro can be used by other programs such as ArcView. Database is consists of two stages:

- Creation of a structure;
- Completion of data.

Data contains tabular form in database and the database creation starts with the filling data of structure and databases. All movements did by FoxPro are shown in the control center screen. Structure of the initial database was created in the working environment of the control center and the data collected using the generated applications (Visual FoxPro… 2010).

Basic commands in creating a database file:

CREATE: Create a new database file

BROWSE: Edit and append in a similar manner to worksheet

MODIFY STRUCTURE: Change the database structure

USE: Open a database file

CLOSE DATABASE: Close all database files

CLEAR: Erase the screen

QUIT: Exit the program

Structure of the database created the following: *CREATE <filename>*

The database structure created by *File → New → Table/DBF* (Fig. 2.1).

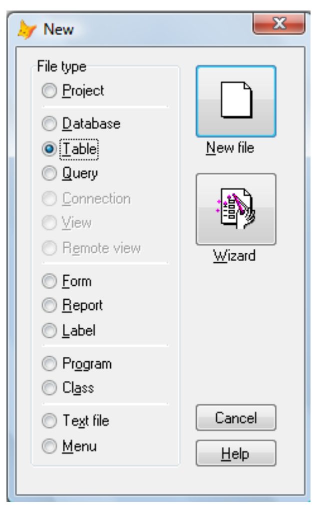


Fig 2.1. New database creation

The display creates a special box and a list of commands, which help specify field names, data type and size. Forming a graph we need to specify what type they are (cell type). There are 6 types:

- Character: A combination of letters, numbers, spaces, and/or punctuation marks that are treated as a text string.
- Numeric: A number consisting of a number, a decimal point, and, if it exists, the decimal part of the number. For example, the number 9999.99 requires a field with of 7.
- Float: A floating field especially is just a special case of the numeric field type.
- Date: An 8 character wide field having the format mm/dd/yy.
- Logical: A 1 character wide field containing a .T.(true or yes) or .F.(false or no).
- Memo: A memo field contains ASCII text.
- General: This field type stores data like pictures and graphs.

The project uses two types of fields: symbolic - Character (254 characters) and a healthy type - Numeric (up to 20 digits) (Fig. 2.2).

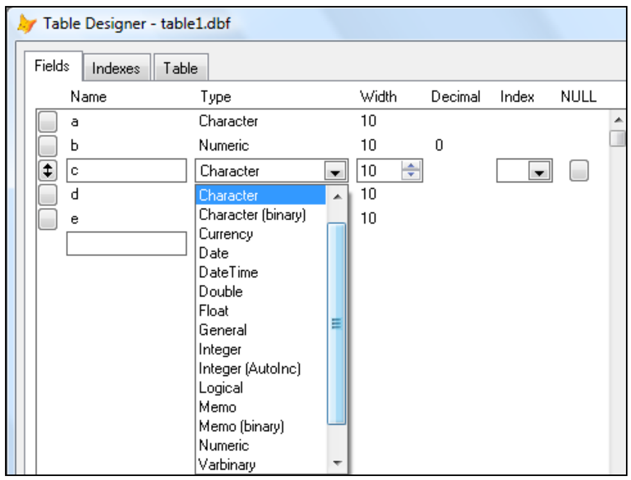


Fig. 2.2. Structuring of the database fields

Structure of databases could be recorded to disk using command Ctrl + End or Ctrl + W. Recorded file type is DBF. By pressing ESC key, recordering can be refused. In addition, structure of the database can be modified by sentence MODIFY STRUCTURE, whose work environment identical to work environment of sentence CREATE.

Three tables of databases was created for analysing gravimetric data: initial.dbf (Fig. 2.4), stations.dbf (Fig 2.6) and workers.dbf (Fig 2.8). Here you can find information about references of gravimetric data, measurement's durations, dates, localities, some information about the workers and instruments.

Below is a chart of data tables (Fig. 2.3 and 2.5 and 2.7) in which is specifying the field names, types, quantity symbols, the number of decimal positions.

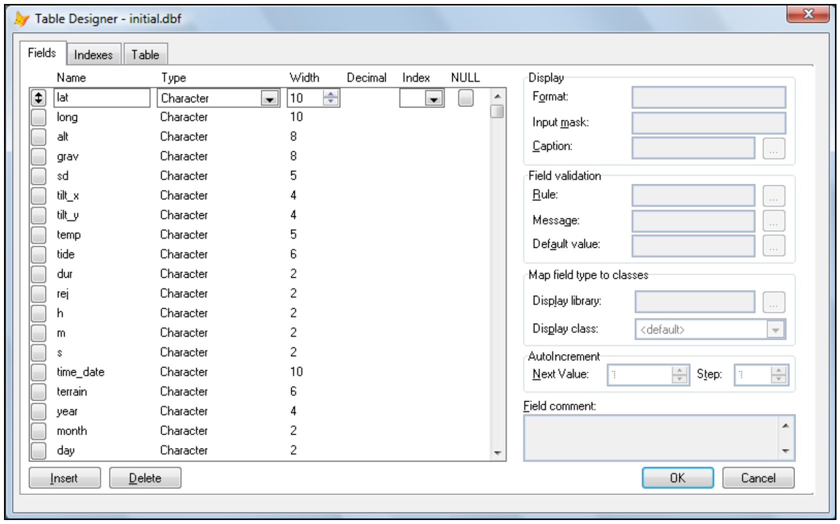
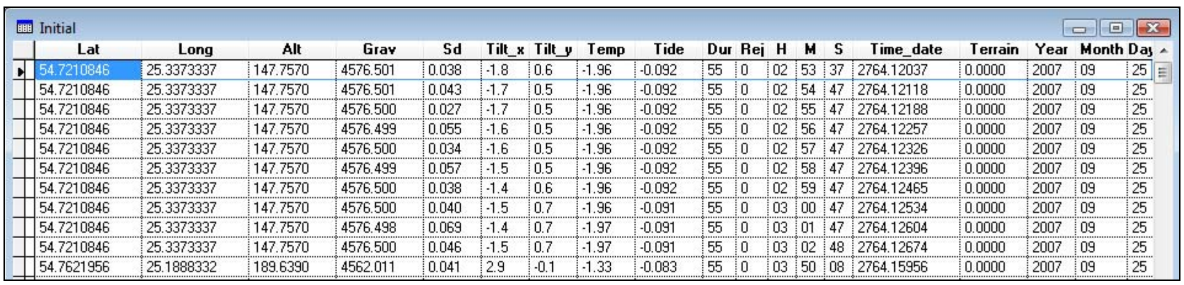


Table Designer - initial.dbf

Name	Type	Width
lat	Character	10
long	Character	10
alt	Character	8
grav	Character	8
sd	Character	5
tilt_x	Character	4
tilt_y	Character	4
temp	Character	5
tide	Character	6
dur	Character	2
rej	Character	2
h	Character	2
m	Character	2
s	Character	2
time_date	Character	10
terrain	Character	6
year	Character	4
month	Character	2
day	Character	2

Fig. 2.3. Initial.DBF table structure



Initial

Lat	Long	Alt	Grav	Sd	Tilt_x	Tilt_y	Temp	Tide	Dur	Rej	H	M	S	Time_date	Terrain	Year	Month	Day
54.7210846	25.3373337	147.7570	4576.501	0.038	-1.8	0.6	-1.96	-0.092	55	0	02	53	37	2764.12037	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.501	0.043	-1.7	0.5	-1.96	-0.092	55	0	02	54	47	2764.12118	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.500	0.027	-1.7	0.5	-1.96	-0.092	55	0	02	55	47	2764.12188	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.499	0.055	-1.6	0.5	-1.96	-0.092	55	0	02	56	47	2764.12257	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.500	0.034	-1.6	0.5	-1.96	-0.092	55	0	02	57	47	2764.12326	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.499	0.057	-1.5	0.5	-1.96	-0.092	55	0	02	58	47	2764.12396	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.500	0.038	-1.4	0.6	-1.96	-0.092	55	0	02	59	47	2764.12465	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.500	0.040	-1.5	0.7	-1.96	-0.091	55	0	03	00	47	2764.12534	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.498	0.069	-1.4	0.7	-1.97	-0.091	55	0	03	01	47	2764.12604	0.0000	2007	09	25
54.7210846	25.3373337	147.7570	4576.500	0.046	-1.5	0.7	-1.97	-0.091	55	0	03	02	48	2764.12674	0.0000	2007	09	25
54.7621956	25.1888332	189.6390	4562.011	0.041	2.9	-0.1	-1.33	-0.083	55	0	03	50	08	2764.15956	0.0000	2007	09	25

Fig. 2.4. Initial.DBF database table

In Fig. 2.3 and 2.4 is gravity data:

LAT - latitude, degrees;
LONG - longitude, degrees;
ALT - altitude, m;
GRAV - Reference of gravimeter, mGal;
SD - Correction, mGal;
TILT_X, TILT_Y - Correction of X and Y axes tilt, µGal;
TEMP - Correction of temperature's differences, µGal;
TIDE - Correction of Lunar and Solar attraction's, mGal;
DUR - Measurement's duration, s;
REJ - Number of rejected measurements;
H - Measurement's time, hours;
M- Measurement's time , minutes;
S- Measurement's time, seconds;
TIME_DATE - Measurement's time by days;
TERRAIN - Correction of terrain;
Year - Measurement's DATE, year;
Month - Measurement's DATE, month;
Day - Measurement's DATE, day.

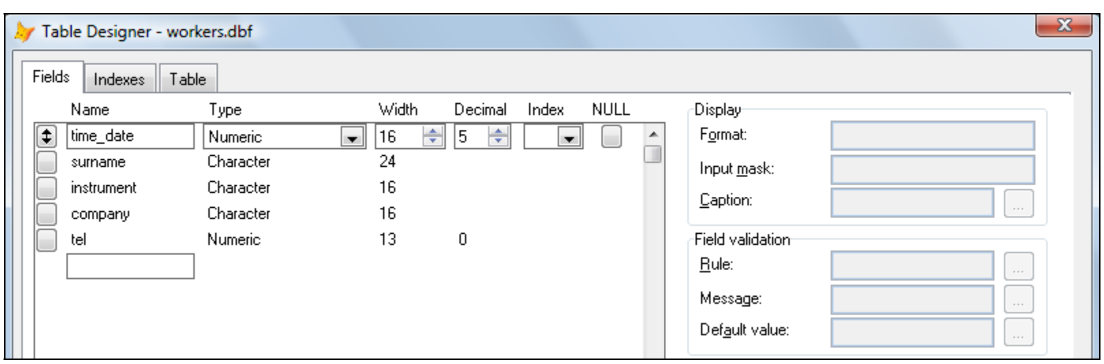


Table Designer - workers.dbf

Name	Type	Width	Decimal
time_date	Numeric	16	5
surname	Character	24	
instrument	Character	16	
company	Character	16	
tel	Numeric	13	0

Fig. 2.5. Workers.DBF table structure

Time_date	Surname	Instrument	Company	Tel
2764.12037	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12118	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12188	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12257	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12326	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12396	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12465	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12534	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12604	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.12674	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.15956	Aleknavičius	ScintrexCG-5	Cometa	867563268
2764.16037	Bajoraitis	CIRES93	Šešupė	864709527

Fig. 2.6. Workers.DBF database table

Fig. 2.5 and 2.6 provides information about the workers. Here:

Time_date - Measurement's time by days;
Surname – surname of workers;
Instrument – type/ title of gravimeter;
Company - job title of the person, who made measurements;
Tel - phone number of the person, who made measurements.

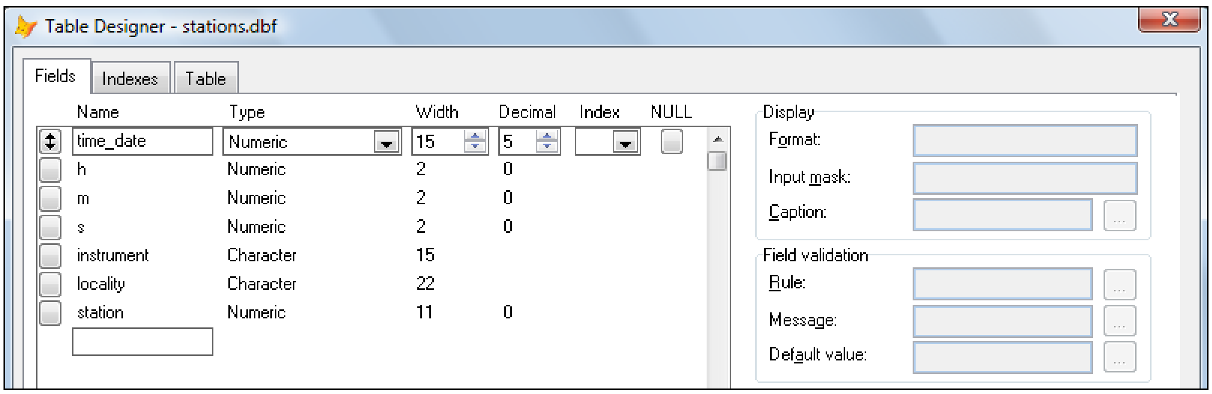


Fig. 2.7. Stations.DBF table structure

Time_date	H	M	S	Instrument	Locality	Station
2764.12037	2	53	37	ScintrexCG-5	VILNIUS	73001
2764.12118	2	54	47	ScintrexCG-5	VILNIUS	73001
2764.12188	2	55	47	ScintrexCG-5	VILNIUS	73001
2764.12257	2	56	47	ScintrexCG-5	VILNIUS	73001
2764.12326	2	57	47	ScintrexCG-5	VILNIUS	73001
2764.12396	2	58	47	ScintrexCG-5	VILNIUS	73001
2764.12465	2	59	47	ScintrexCG-5	VILNIUS	73001
2764.12534	3	0	47	ScintrexCG-5	VILNIUS	73001
2764.12604	3	1	47	ScintrexCG-5	VILNIUS	73001
2764.12674	3	2	48	ScintrexCG-5	VILNIUS	73001
2764.15956	3	50	8	ScintrexCG-5	Avižieniai	73032
2764.16037	3	51	18	CIRES93	Avižieniai	73032

Fig. 2.8. Stations.DBF database table

Fig. 2.7 and 2.8 provides information about the stations. Here:

Time_date - Measurement's time by days;
H,m,s – Measurement's time, h.m.s.;
Instrument – type/ title of gravimeter;
Locality – locality of station;
Station – number of station.

In this way database was made and filled with data. These data was stored in tabular form in the database and presented in a convenient format for users. Collected data were put into the following data formats: 1table.FMT, 2table.FMT, 3table.FMT, together.FMT, together2.FMT.

2.2. Database management structure

Management program for gravimetric data collection consists of several different software modules (Fig. 2.9).

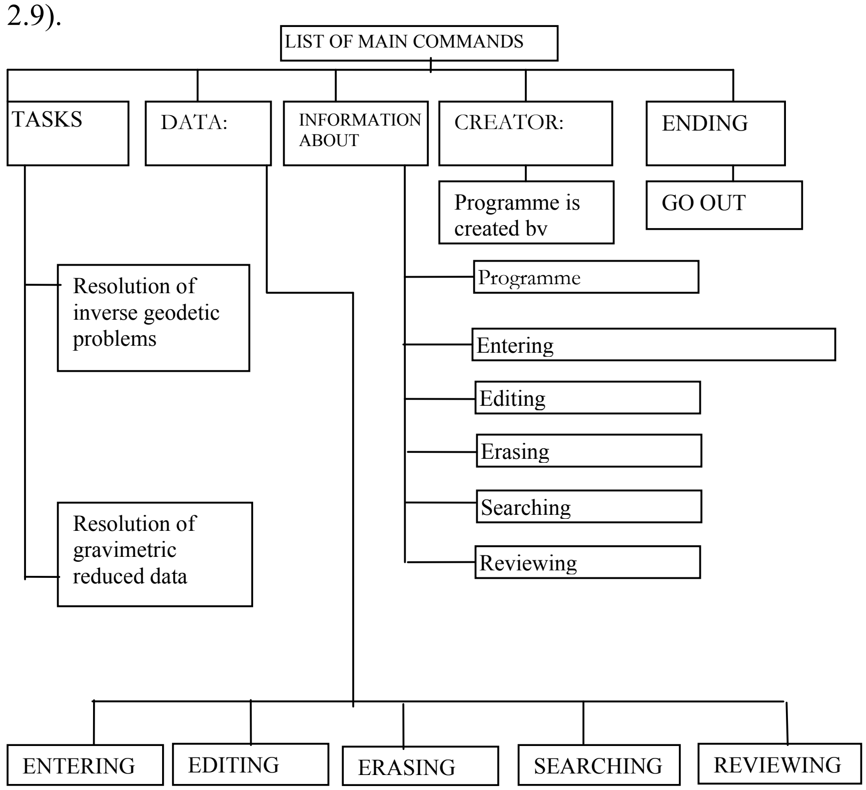


Fig. 2.9. Principal scheme

Main programme – meniu.prg;

Tasks:

Resolution of inverse geodetic problems– inverse_task.prg;

Resolution of gravimetric reduced data– Ovidijos_programme.prg;

Data programme:

Entering programme – ENTERING.prg;

Editing programme – EDITING.prg;

Erasing programme – ERASING.prg;

Searching programme – SEARCHING.prg;

Reviewing programme – REVIEWING.prg;

2.3. Description of computer procedures

When you run the program, primarily opens main window, where you can see the name of the project and the name of person, who made this project (Fig. 2.10).

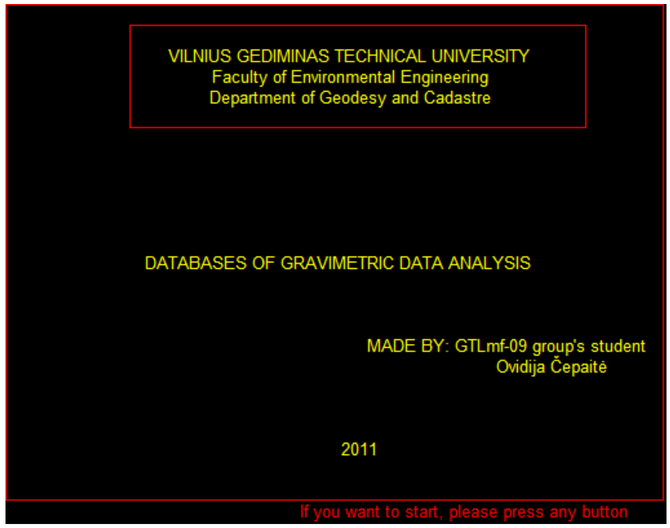


Fig. 2.10. Main project window

2.3.1. Main menu

Main menu includes these procedures: data collection, entering, editing, searching, deleting, reviewing geodetic tasks, aid of database menus and closing procedures. In this project I used information of the gravimetric data. There are horizontal menu in database for the gravimetric data analysis (1st Annex). Main menu of the program is formed from these menus: „TASKS"', „DATA", „INFORMATION ABOUT", „CREATOR", „ENDING". Each of these has its own vertical meniu (Figure 2.11).

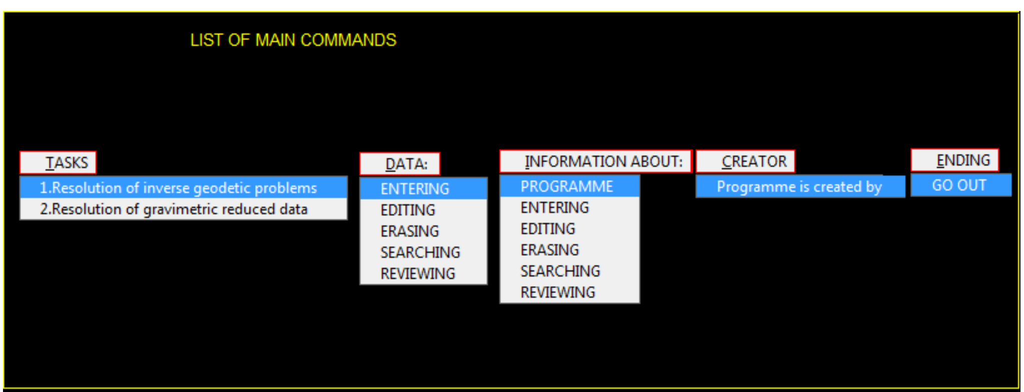


Fig. 2.11. FoxPro main command list

2.4. Geodetic tasks

One of the advantages of this program - an opportunity to work a sum of geodetic. When the program is already created, i.e. when the horizontal and vertical menus are programmed, all programs have to be tested. First from horizontal menu you have to select command “TASKS” and then from the vertical list (Fig. 2.12) you can choose one from two tasks:

1. Resolution of inverse geodetic problems ;
2. Resolution of gravimetric reduced data.

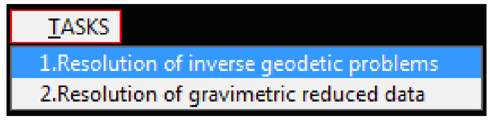


Fig. 2.12. Choice of geodetic tasks

Task “Resolution of gravimetric reduced data”will be described in following chapter.

2.4.1. Resolution of gravimetric reduced data

From the vertical list (Fig. 2.12) we have to choose “Resolution of gravimetric reduced data”. Program opens by clicking on it with the mouse button. Checks are carried out whether the program works and whether there are any errors. Objective of this program – to prepare computerized gravimetric procedures to calculate reduced data (2nd Annex).

Program was implemented using the Visual FoxPro programming language. The graphical environment was created by Visual FoxPro aid, that allows the user to input data, display the result in the screen with established mathematical operations.

When you run the program, there you can see an interactive window, where the user is asksed to enter initial data (Fig. 2.13):

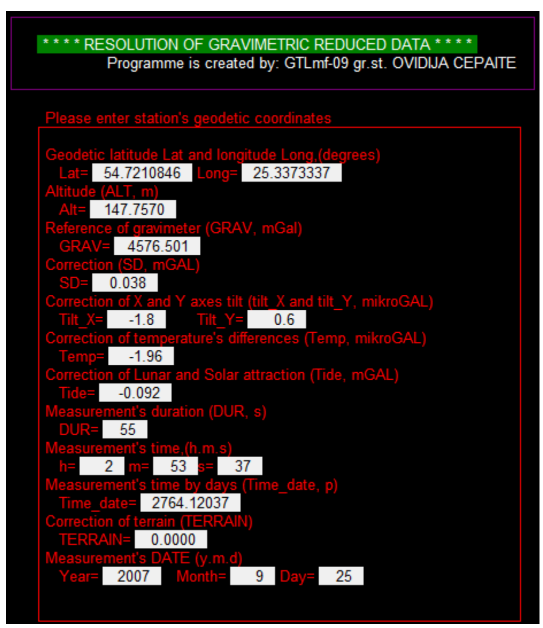


Fig. 2.13. Initial data of the second task

After setting up the initial query result data, there is a possibility to change / correct data (Fig. 2.14).

Fig. 2.14. Data correction request

If entered data is correct and if the user wish to further 'solve the problem', he have to press "N", in the query "Correct data?" and then he can continue this work. After setting up the correct initial data results are obtained (Fig. 2.15).

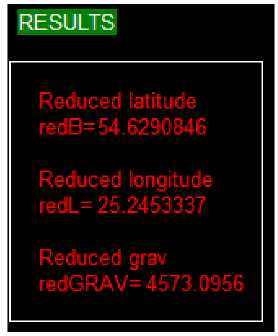


Fig. 2.15. Results of the second task

After the getting results, program provides the opportunity to save data in a database (Fig. 2.16).

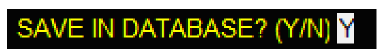


Fig. 2.16. Data saving request

Results could be saved to new database, or to the database, which is already exists (Fig. 2.17).

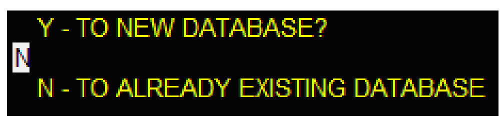


Fig. 2.17. Two data saving opportunities

After saving the data it is possible to continue counting or to complete the program (Fig. 2.18).

Fig. 2.18. End of first task

2.5. The main procedures of program

There are six menus in this program: introduce, editing, searching, reviewing and removal menu. Each of these has its own vertical menu (2.19 - Figure 2.23). Procedures could be choosen by mouse or keyboard.

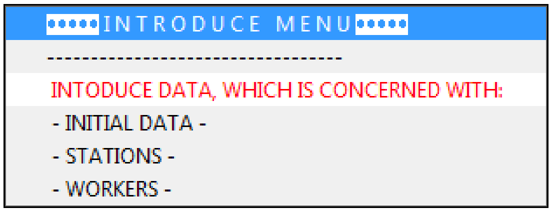


Fig. 2.19. Introduce menu

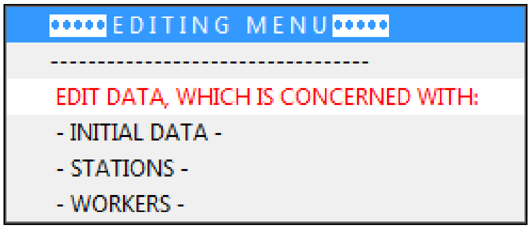


Fig. 2.20. Editing menu

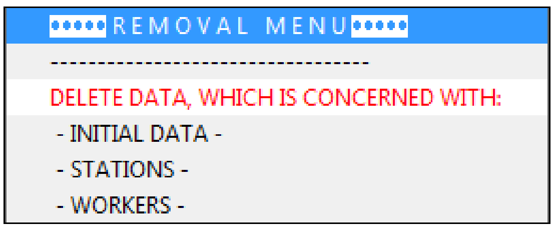


Fig. 2.21. Removal menu

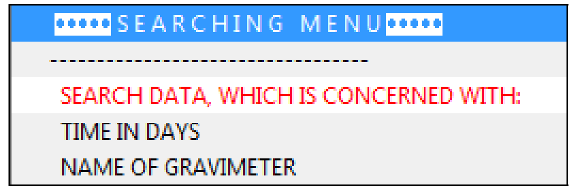


Fig. 2.22. Searching menu

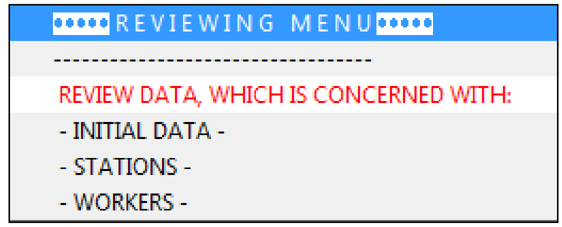


Fig. 2.23. Reviewing menu

2.5.1. Computerized procedure for data collection and entering

The data may be added to the database tables by entering program. Here you can enter data about the stations, altitudes and other data. Data in data tables may be stored in the control center support. There are data input procedure in database model (3rd Annex). Newly entered data complemented databases, which are already established.

Five files for data collection were creatred in this program: 1table.FMT, 2table.FMT, 3table.FMT, together.FMT, together2.FMT and database tables INITIAL.DBF, STATION.DBF, WORKERS.DBF. You choose the data that you want to enter in Input menu: information about the initial data, stations or workers.

After the entering one data, you can enter next data by selecting answer YES to the question "Enter more data?", or you can cancel data entering by choosing answer NO (Fig. 2.24).

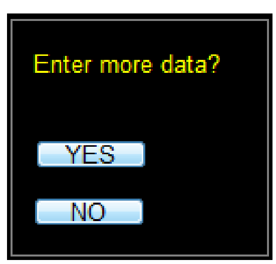


Fig. 2.24. Request for re-entry

“Entering Menu” allow you to select what data you want to enter:

• about initial data (Data are entered into a database table INITIAL.DBF (Figure 2.25));

• about stations (Data are entered into a database table STATIONS.DBF (Figure 2.26));

• about workers (Data are entered into a database table WORKERS.DBF (Figure 2.27)).

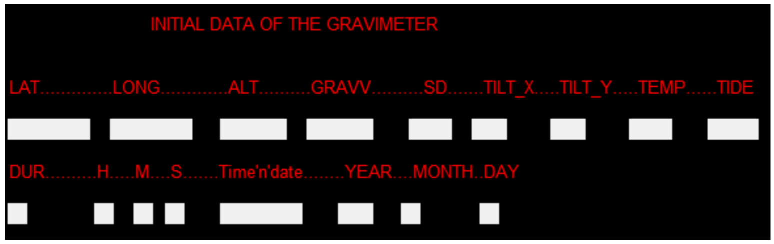


Fig. 2.25. Database table INITIAL.DBF

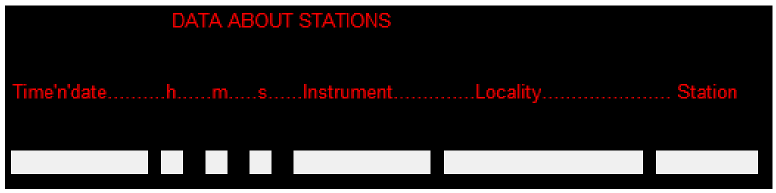


Fig. 2.26. Database table STATIONS.DBF

Fig. 2.27. Database table WORKERS.DBF

2.5.2. Computerized procedure for data editing

Editing lets you check and edit all data in database. Text of editing programme procedure is shown in 4th Annex. You can edit the data, which is related with initial data, stations and workers.

If you want to edit data about the workers, you can do it by entering surname of worker or by entering the time by days. For example, I want to edit data by entering surname of worker (Fig. 2.28):

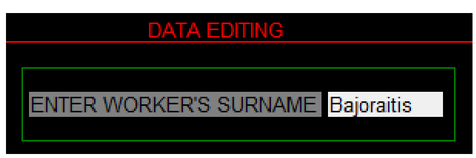


Fig. 2.28. Table of data editing

After the enetering worker's surname you can see new table with that surname that you just enetered. Here you can edit data (Fig. 2.29):

Fig. 2.29. Table of data editing about the workers

If there is no information about this surname in database, then on the screen appears the inscription “This surname does not exist” (Fig. 2.30).

Fig. 2.30. Inscription about that have not been found

If user clicks Enter button, the program is waiting for the entering other names.

2.5.3. Computerized procedure for data searching and presentment

„Search menu“ is used to search for some information, which is already stored in database tables. Search procedures of the program text is in the 5th Annex. Search menu opens after entered the main menu screen and selected “Search menu” (Fig. 2.31).

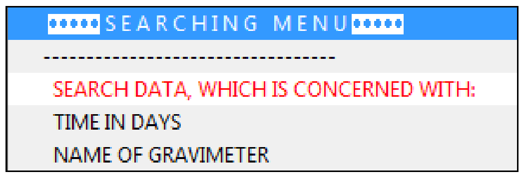


Fig. 2.31. Searching menu

According to available data the program finds the information in these data tables: initial.dbf, stations.dbf, workers.dbf (depending on the selected type of searching). It is also possible to conduct a general search, i.e. if you are working with multiple databases, it could be related. For example, I want to choose a general search for the gravimeter number (Fig. 2.32):

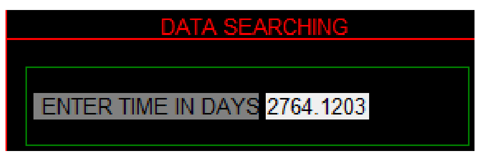


Fig. 2.32. Table of data searching

After introduction of gravimeter number, database table with existing data is appear on the screen (Fig. 2.33).

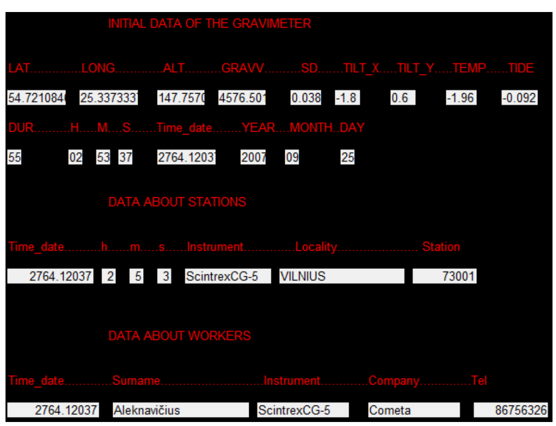


Fig. 2.33. Table of general data searching

Searches can be continuing by pressing again the Enter key.

2.5.4. Computerized procedure for data erasing and reviewing

The data erasing procedure – is the data removing procedure from the chosen database. Removal menu is shown in Fig. 2.34. Program text of erasing procedures is in the 6th Annex.

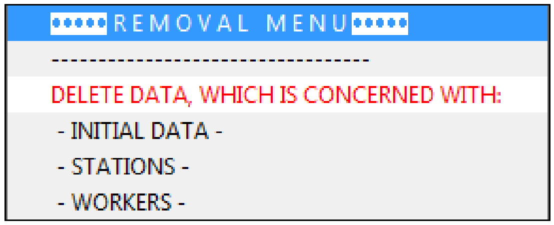


Fig. 2.34. Romoval menu

If you will choose that you want to remove information about the stations, you will see the request to enter the stattion number, which you want to remove (Fig. 2.35):

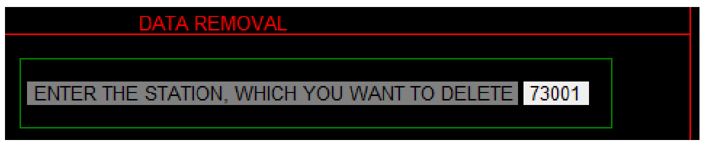
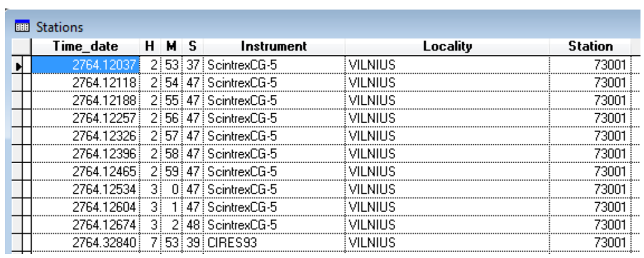


Fig. 2.35. Table of data erasing

After the introduction of the station number, the database contains a table with data that we want to remove (Fig. 2.36).



Stations

Time_date	H	M	S	Instrument	Locality	Station
2764.12037	2	53	37	ScintrexCG-5	VILNIUS	73001
2764.12118	2	54	47	ScintrexCG-5	VILNIUS	73001
2764.12188	2	55	47	ScintrexCG-5	VILNIUS	73001
2764.12257	2	56	47	ScintrexCG-5	VILNIUS	73001
2764.12326	2	57	47	ScintrexCG-5	VILNIUS	73001
2764.12396	2	58	47	ScintrexCG-5	VILNIUS	73001
2764.12465	2	59	47	ScintrexCG-5	VILNIUS	73001
2764.12534	3	0	47	ScintrexCG-5	VILNIUS	73001
2764.12604	3	1	47	ScintrexCG-5	VILNIUS	73001
2764.12674	3	2	48	ScintrexCG-5	VILNIUS	73001
2764.32840	7	53	39	CIRES93	VILNIUS	73001

Fig. 2.36. Removal of data about stations

If you will press ESC, you will see the question about the deleting procedure (Fig.2.37):

Fig. 2.37. Question about data erasing

By clicking “N” - data will be deleted, by clicking “Yes” - data will be removed from the database. Later, program is asking if you want to continue data disposal (Fig. 2.38):

Fig. 2.38. Question about more data erasing

By clicking “Y” - data removal will be continue, by clicking “N” - data removal will be stoped.

„Reviewing menu“ is usable for viewing information from data tables (Fig. 2.39). The program text of the review procedures is in 7th Annex.

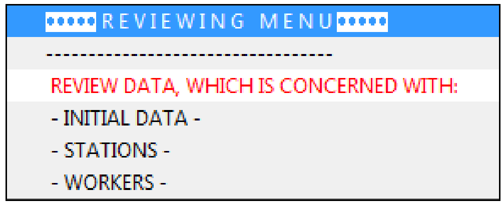


Fig. 2.39. Reviewing menu

According to available data, the program finds the information in these data tables: initial.dbf, stations.dbf, workers.dbf (depending on the selected type of searches). For example, I want to review information about the locality VILNIUS (Fig. 2.40):

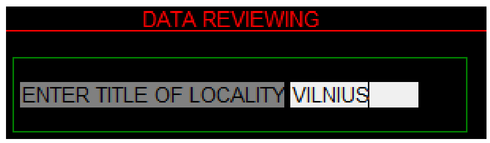


Fig. 2.40. Table of data reviewing

Data with the needed information is shown on the screen (Fig. 2.41).

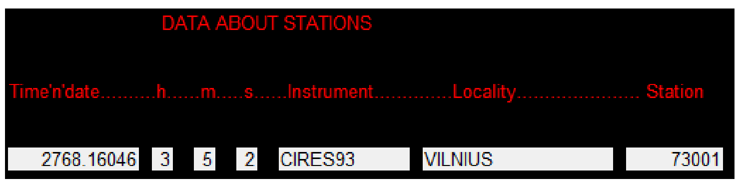
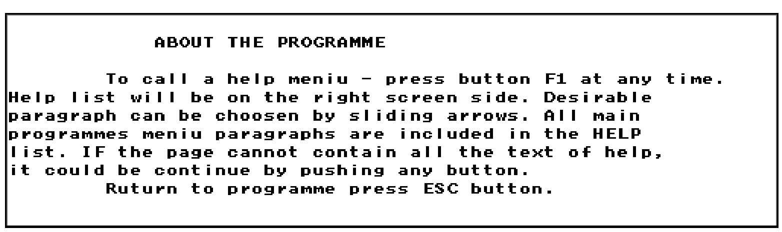
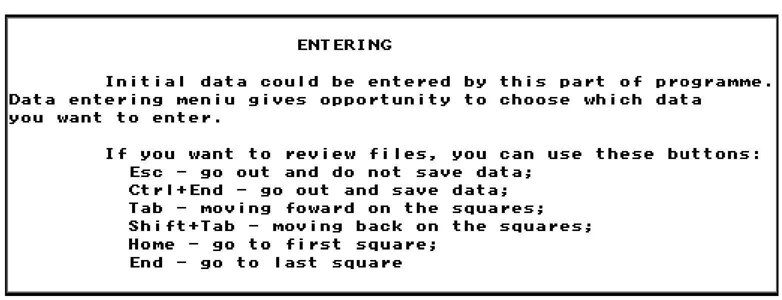


Fig. 2.41. Table of data reviewing about locality VILNIUS

2.6. Computerized procedure “information about” („aid“)

„Aid” menu provides the most comprehensive information about FoxPro program and computer procedures that we are using. In order to introduce and explain the structure, functions and features of project to the user, there are developing explanations of the usable programs. All of them are in horizantal menu "INFORMATION ABOUT" (Fig. 2.42).





```
                    EDITING

        Initial data could be edited in this part of programme.
Programme gives you editing meniu, in which you could edit
file's contents in turn or by your choice.

        To edit initial data you can use these buttons:
          Esc - go out and do not save data;
          Ctrl+End - go out and save data;
          Tab - moving foward by the squares;
          Shift+Tab - moving back by the squares;
          Home - go to first square;
          End - go to last square
          PgUp - return to last editing item;
          PgDn - go to the next item.
```

```
                    SEARCHING

        This part of programme let you search some data.
Data searching meniu gives opportunity to choose what data
you want to search.
        Go out from searching meniu press the button Esc.
```

```
                    REVIEWING

        This part of programme let you review some data,
which were entered or edited previously in data bases.

        To review data you can use these buttons:
          Esc - return to previous list;
          PgUp - review foward;
          PgDn - review back.
```

Fig. 2.42. „Aid“ of programme

2.7. Computerized procedure “Creator” and „Ending“

You can also find information about the person who has created this program. First you have to select “Creator” in horizontal menu (Fig. 2.43).

Fig. 2.43. Information about the creator

Here you can find the name, surname, date of birth, recidence and another information about the creator (Fig. 2.44).

```
NAME: Ovidija
SURNAME: Cepaite
DATE OF BIRTH: 1987.02.24
RECIDENCE : Vilnius
EDUCATION INSTITUTION: VGTU
COURSE: 2 (master)
GROUP: GTLmf-09
```

Fig. 2.44. Information about the creator

Command „Ending” - command from horizontal menu, which closes the program work. If you choose this command, all database tables will be closed, i.e. thus ending the work with program FoxPro (Fig. 2.45).

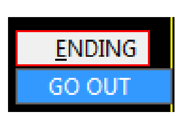


Fig. 2.45 Ending of the programme

3. ANALYSIS OF THE MEASUREMENTS DATA

I analyzed the second-class network measurements in this part of master thesis. Measurements were made in 2007 September 25, 29 and October 01 days in the following points:

September 25 - Vilniuje, Avižieniuose, Sudervėje, Dūkštose, Maišiagaloje, Karvyje, Didžiojoje Riešėje, Paberžėje, Maseliškėse, Giedraičiuose, Bijutiškyje, Molėtuose, Žemaitėliuose, Eitminiškėse ir Europos centre (Fig. 3.1);

September 29 - Vilniuje, Dūkštose, Kernavėje, Musninkuose, Čiobiškyje, Gelvonuose, Bagaslaviškyje, Krikštėnuose, Širvintose (Fig. 3.1);

October 01 – Vilniuje, Širvintose, Sudervėje, Želvoje, Videniškiuose, Molėtuose, Pusnėje, Kiaukliuose, Šešuolėliuose, Alionyse 1, Giedraičiuose, Dubingiuose, Sužionyse, Pabradėje (Fig. 3.1);

All measurements were measured with two devices at the same time: all points measured 10 times in 55 seconds.

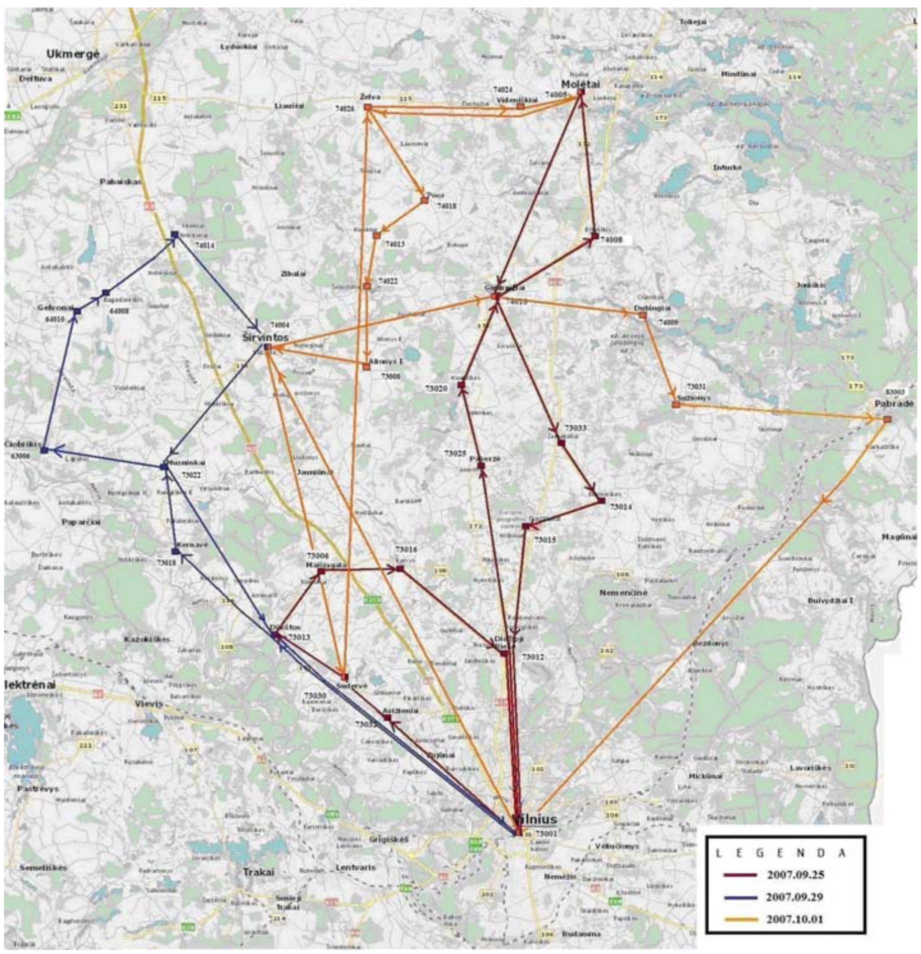


Fig. 3.1. Trips of gravimetric measurements

Measurements data, data preparation, reduction and adjustment, estimated accuracy, analysis of the results will be desrived in this chapter.

3.1. Measurements data

At the beginning of the measurements, first you must fill out the information about the station, in which measurements will be carried out. We have to tap in the name of the measurements, the operator, the measurements time (date and number of the device occurs automatically). Universal Time GMT is used for these measurements. Research data is entered in the “CG-5 parameter / setup”. Zero-slip is entered 0. If you will enter zero-slip resulting from the research, the device will automatically calculate corrections of the slider. Temperature coefficients of sensor devices are different. Tide (Lunar and Solar attraction’s) correction is turn off in „Options" meniu. Correction of terrain is turning off too. Auto rejection and seismic filtre is turn on. All this is illustrated in Fig. 3.2. Part of the gravimetric measurements data you can see in Table 3.1.

/	CG-5 SURVEY	
/	Survey name:	GRAV1
/	Instrument S/N:	183
/	Client:	Bandymai
/	Operator:	Petras
/	Date:	2007/ 9/25
/	Time:	02:46:45
/	LONG:	0.0000000 W
/	LAT:	0.0000000 S
/	ZONE:	0
/	GMT DIFF.:	0.0
/	CG-5 SETUP PARAMETERS	
/	Gref:	
	0.000	
/	Gcal1:	
	7940.012	

/	TiltxS:	610.627
/	TiltyS:	654.881
/	TiltxO:	21.529
/	TiltyO:	12.646
/	Tempco:	-0.146
/	Drift:	0.427
/	DriftTime Start:	08:42:16
/	DriftDate Start:	2007/09/24
/	CG-5 OPTIONS	
/	Tide Correction:	NO
/	Cont. Tilt:	YES
/	Auto Rejection:	YES
/	Terrain Corr.:	NO
/	Seismic Filter:	YES
/	Raw Data:	NO

Fig. 3.2. Gravimeter G -183 data, sets prior to the measurement

Explanations of the data, which is entered into the measuring device:

„SURVEY“ screen shows information about the item:
CG-5 SURVEY.......- This entry shows that all of this information has been completed in the "Survey " menu screen,
Survey name:...........- measured point identifier
Instrument S/N:.......- gravimeter number
Client:......................- client name,
Operator:..................- operator name,
Date:........................- measurement date,
Time:.......................- measurement time,
LONG:....................- longitude,
LAT:........................- latitude,
ZONE:.....................- zone,
GMT DIFF.:............- GMT time difference.

„SETUP“ window shows information about the device settings:

**CG-5 SETUP PARAMETERS:* - This statement indicates that all of this information has been filled with "SETUP PARAMETERS menu window
**Gref:* - Constant offset subtracted from gravity readings
**Gcal1:* - Instrument scale factor.
**TiltxS:* - X tilt sensor sensitivity.
**TiltyS:* - Y tilt sensor sensitivity.
**TiltxO:* - Aligns the X tilt sensor with the gravity sensor.
**TiltyO:* - Aligns the Y tilt sensor with the gravity sensor.
**Tempco:* - Temperature coefficient of the gravity sensor in
mGal/degrees MK.
**Drift:* - Long term instrument drift due to stress relaxation in
the elastic (quartz) system. Units are in mGal/day.
**Drift Start TM/DT:* - The drift start time is the initial time from which the linear calculation is started. The drift start time changes automatically to the current time when the memory is cleared.

Explanations of the results obtained by measuring
LAT - latitude, degrees;
LONG - longitude, degrees;
ALT - altitude, m;
GRAV - Reference of gravimeter, mGal;
SD – Standart Deviation, mGal;
TILTX, TILTY - Correction of X and Y axes tilt, μGal;
TEMP - Correction of temperature's differences, μGal;
TIDE - Correction of Lunar and Solar attraction's, mGal;
DUR - Measurement's duration, s;
REJ - Number of rejected measurements,
TIME - Measurement's time, h.m.s.;
DEC.TIME+DATE - Measurement's time by days;
TERRAIN - Correction of terrain;
DATE - Measurement's DATE y.m.d

Table 3.1. Part of the gravimetric measurement data

LAT	LONG	ALT	GRAV.		SD		TILTX		TILTY		TEMP		TIDE		DUR	REJ	TIME	DEC.TIME+ DATE	TERRAIN	DATE
183-184 grav.	**183-184 grav.**	**183-184 grav.**	**183 grav.**	**184 grav.**	**183 grav.**	**184 grav.**	**183 grav.**	**184 grav.**	**183 grav.**	**184 grav.**	**183 grav.**	**184 grav.**	**183 grav.**	**184 grav.**	**183-184 grav.**	**183-184 grav.**	**183-184 grav.**	**183-184 grav.**	**183-184 grav.**	**183-184 grav.**
54,7210846	25,3373337	147,757	4576,501	5017,222	0,038	0,039	-1,8	1,4	0,6	-1,4	-1,96	-1,83	-0,092	-0,092	55	0	02:53:37	2764,12037	0	2007.09.25
54,7210846	25,3373337	147,757	4576,501	5017,222	0,043	0,042	-1,7	1,5	0,5	-1,3	-1,96	-1,83	-0,092	-0,092	55	0	02:54:47	2764,12118	0	2007.09.25
54,7210846	25,3373337	147,757	4576,500	5017,222	0,027	0,028	-1,7	1,5	0,5	-1,3	-1,96	-1,83	-0,092	-0,092	55	0	02:55:47	2764,12188	0	2007.09.25
54,7210846	25,3373337	147,757	4576,499	5017,221	0,055	0,056	-1,6	1,6	0,5	-1,2	-1,96	-1,83	-0,092	-0,092	55	0	02:56:47	2764,12257	0	2007.09.25
54,7210846	25,3373337	147,757	4576,500	5017,223	0,034	0,037	-1,6	1,7	0,5	-1,3	-1,96	-1,83	-0,092	-0,092	55	0	02:57:47	2764,12326	0	2007.09.25
54,7210846	25,3373337	147,757	4576,499	5017,222	0,057	0,053	-1,5	1,7	0,5	-1,3	-1,96	-1,83	-0,092	-0,092	55	0	02:58:47	2764,12396	0	2007.09.25
54,7210846	25,3373337	147,757	4576,500	5017,223	0,038	0,042	-1,4	1,8	0,6	-1,2	-1,96	-1,83	-0,092	-0,092	55	0	02:59:47	2764,12465	0	2007.09.25
54,7210846	25,3373337	147,757	4576,500	5017,223	0,04	0,038	-1,5	1,9	0,7	-1,1	-1,96	-1,83	-0,091	-0,091	55	0	03:00:47	2764,12534	0	2007.09.25
54,7210846	25,3373337	147,757	4576,498	5017,222	0,069	0,070	-1,4	1,9	0,7	-1,0	-1,97	-1,83	-0,091	-0,091	55	0	03:01:47	2764,12604	0	2007.09.25
54,7210846	25,3373337	147,757	4576,500	5017,223	0,046	0,045	-1,5	2,0	0,7	-0,9	-1,97	-1,83	-0,091	-0,091	55	0	03:02:48	2764,12674	0	2007.09.25
....																				
54,7210846	25,3373337	147,757	4578,365	5017,874	0,024	0,023	1,7	0,9	0,9	-0,6	-1,96	-1,83	-0,031	-0,031	55	0	03:42:15	2768,15409	0	2007.09.29
54,7210846	25,3373337	147,757	4578,365	5017,873	0,017	0,017	1,6	0,9	0,9	-0,5	-1,96	-1,83	-0,031	-0,031	55	0	03:43:25	2768,1549	0	2007.09.29
54,7210846	25,3373337	147,757	4578,365	5017,874	0,023	0,024	1,6	1,0	0,9	-0,4	-1,96	-1,82	-0,032	-0,032	55	0	03:44:25	2768,1556	0	2007.09.29
54,7210846	25,3373337	147,757	4578,364	5017,875	0,017	0,017	1,8	1,1	1,0	0	-1,96	-1,82	-0,032	-0,032	55	0	03:45:25	2768,15629	0	2007.09.29
54,7210846	25,3373337	147,757	4578,367	5017,875	0,020	0,020	1,8	1,0	1,0	0	-1,96	-1,82	-0,033	-0,033	55	0	03:46:25	2768,15698	0	2007.09.29
54,7210846	25,3373337	147,757	4578,366	5017,875	0,022	0,022	1,7	1,0	1,0	0	-1,95	-1,82	-0,033	-0,033	55	0	03:47:25	2768,15768	0	2007.09.29
54,7210846	25,3373337	147,757	4578,367	5017,877	0,026	0,026	1,6	1,0,	1,0	0	-1,95	-1,82	-0,034	-0,034	55	0	03:48:25	2768,15837	0	2007.09.29
54,7210846	25,3373337	147,757	4578,368	5017,878	0,021	0,021	1,5	0,9	1,0	0	-1,96	-1,82	-0,035	-0,035	55	0	03:49:25	2768,15906	0	2007.09.29
54,7210846	25,3373337	147,757	4578,368	5017,878	0,020	0,019	1,5	1,0	1,1	0	-1,95	-1,82	-0,035	-0,035	55	0	03:50:25	2768,15976	0	2007.09.29
54,7210846	25,3373337	147,757	4578,369	5017,879	0,022	0,022	1,5	1,0	1,1	0	-1,96	-1,82	-0,036	-0,036	55	0	03:51:26	2768,16046	0	2007.09.29
....																				
54,7210846	25,3373337	147,757	4578,35	147,757	0,015	0,017	0	0,1	3	-1,3	-1,97	-1,84	0,051	0,051	55	0	03:41:10	2771,15334	0	2007.10.01
54,7210846	25,3373337	147,757	4578,35	147,757	0,015	0,016	0,1	0,2	3,2	-1,3	-1,97	-1,84	0,051	0,051	55	0	03:42:20	2771,15415	0	2007.10.01
54,7210846	25,3373337	147,757	4578,352	147,757	0,02	0,019	0,2	0,5	3,6	-1,1	-1,97	-1,84	0,05	0,05	55	0	03:43:20	2771,15484	0	2007.10.01
54,7210846	25,3373337	147,757	4578,352	147,757	0,017	0,018	0,3	0,6	3,7	-1	-1,97	-1,84	0,05	0,05	55	0	03:44:20	2771,15554	0	2007.10.01
54,7210846	25,3373337	147,757	4578,354	147,757	0,015	0,015	0,2	0,6	3,8	-1	-1,97	-1,84	0,049	0,049	55	0	03:45:20	2771,15623	0	2007.10.01
54,7210846	25,3373337	147,757	4578,352	147,757	0,014	0,015	0,2	0,7	3,9	-1	-1,97	-1,84	0,049	0,049	55	0	03:46:20	2771,15692	0	2007.10.01
54,7210846	25,3373337	147,757	4578,354	147,757	0,016	0,016	0,2	0,7	4	-1	-1,97	-1,84	0,049	0,049	55	0	03:47:20	2771,15762	0	2007.10.01
54,7210846	25,3373337	147,757	4578,354	147,757	0,015	0,015	0	0,7	4,1	-0,9	-1,97	-1,84	0,048	0,048	55	0	03:48:20	2771,15831	0	2007.10.01
54,7210846	25,3373337	147,757	4578,354	147,757	0,016	0,017	0	0,8	4,2	-0,9	-1,97	-1,84	0,048	0,048	55	0	03:49:20	2771,159	0	2007.10.01
54,7210846	25,3373337	147,757	4578,354	147,757	0,02	0,019	0,2	1	4,3	-0,8	-1,97	-1,84	0,047	0,047	55	0	03:50:21	2771,15971	0	2007.10.01

3.2. Analysis of measurements data

The treatment of gravimetric observations was done by software package GRAVSOFT. Gravimeter references, corrections of X and Y axes tilt, corrections of temperature's differences, corrections of Lunar and Solar attraction's, gravity acceleration values for each date (09/25/2007, 09/29/2007 and 01/10/2007) will be analyzed.

GRAVSOFT is a package of FORTRAN programs for gravity field modelling. The specific use of the programs for the determination of the empirical covariance function and its analytic modelling and geoid determination using least-squares collocation is described (Gravsoft... 1992).

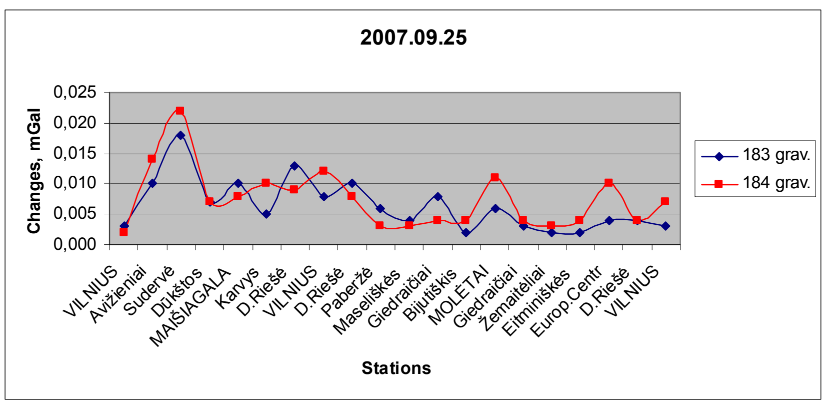
The analysis of the measurements can be performed for a reason to see how references are changing depending on the time. The calculation and results will be shown graphically.

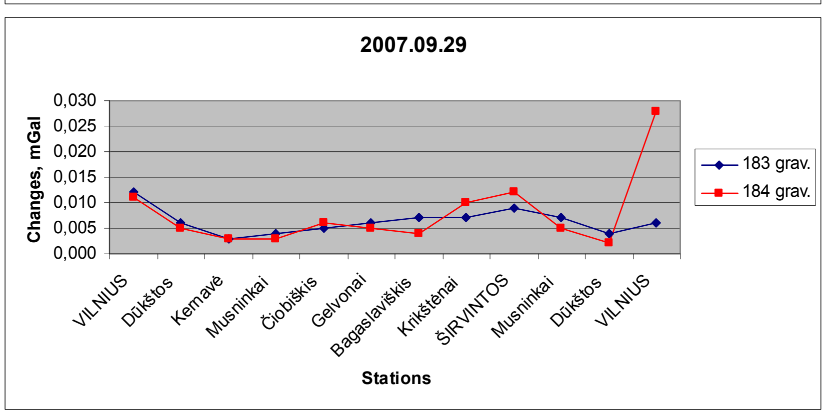
First of all, I will deliver the maximum references for each date of alterations in each point (Fig. 3.3) and the first and last references differences (Fig. 3.4). The data presented in Table 3.2.

Table 3.2. Changes of gravimetric references in the stations

2007.09.25					
Nr.	Station	Maximum change of references		First and last references differences	
		183 grav.	184 grav.	183 grav.	184 grav.
1	VILNIUS	0,003	0,002	-0,001	0,001
2	Avižieniai	0,010	0,014	-0,010	-0,005
3	Sudervė	0,018	0,022	-0,008	-0,005
4	Dūkštos	0,007	0,007	-0,007	-0,007
5	MAIŠIAGALA	0,010	0,008	-0,008	-0,008
6	Karvys	0,005	0,010	-0,004	-0,009
7	D.Riešė	0,013	0,009	-0,013	-0,009
8	VILNIUS	0,008	0,012	-0,008	-0,012
9	D.Riešė	0,010	0,008	-0,010	-0,008
10	Paberžė	0,006	0,003	-0,005	-0,003
11	Maseliškės	0,004	0,003	-0,003	0,000
12	Giedraičiai	0,008	0,004	-0,007	0,003
13	Bijutiškis	0,002	0,004	0,000	-0,003
14	MOLĖTAI	0,006	0,011	0,003	0,008
15	Giedraičiai	0,003	0,004	0,001	0,002
16	Žemaitėliai	0,002	0,003	-0,002	-0,002
17	Eitminiškės	0,002	0,004	-0,002	-0,003
18	Europ.Centr	0,004	0,010	-0,002	0,010
19	D.Riešė	0,004	0,004	-0,003	0,002
20	VILNIUS	0,003	0,007	0,003	-0,007
2007.09.29					
Nr.	Station	Maximum change of references		First and last references differences	
		183 grav.	184 grav.	183 grav.	184 grav.
1	VILNIUS	0,012	0,011	0,011	0,01
2	Dūkštos	0,006	0,005	-0,005	-0,005
3	Kernavė	0,003	0,003	-0,002	0
4	Musninkai	0,004	0,003	-0,002	0
5	Čiobiškis	0,005	0,006	-0,001	-0,006
6	Gelvonai	0,006	0,005	-0,006	-0,004
7	Bagaslaviškis	0,007	0,004	-0,003	-0,002

8	Krikštėnai	0,007	0,01	-0,007	-0,009
9	ŠIRVINTOS	0,009	0,012	-0,009	-0,012
10	Musninkai	0,007	0,005	-0,007	-0,005
11	Dūkštos	0,004	0,002	-0,004	-0,002
12	VILNIUS	0,006	0,028	-0,003	-0,028
2007.10.01					
Nr.	Station	Maximum change of references		First and last references differences	
		183 grav.	184 grav.	183 grav.	184 grav.
1	VILNIUS	0,010	0,009	0,010	0,005
2	ŠIRVINTOS	0,005	0,005	-0,002	-0,003
3	Sudervė	0,003	0,003	-0,003	-0,002
4	Želva	0,003	0,007	-0,002	-0,004
5	Videniškiai	0,005	0,006	-0,002	-0,005
6	MOLĖTAI	0,005	0,002	-0,005	-0,001
7	Želva	0,004	0,005	-0,004	-0,005
8	Pusnė	0,003	0,005	-0,002	-0,004
9	Kiaukliai	0,003	0,010	-0,001	-0,010
10	Šešuolėliai	0,004	0,007	-0,003	-0,005
11	Alionys 1	0,005	0,006	-0,002	0,006
12	ŠIRVINTOS	0,007	0,003	-0,007	-0,002
13	Giedraičiai	0,005	0,005	-0,004	0,000
14	Dubingiai	0,005	0,007	-0,004	-0,005
15	Sužionys	0,006	0,012	-0,006	-0,012
16	PABRADĖ	0,007	0,004	-0,005	-0,002
17	VILNIUS	0,006	0,003	-0,001	-0,001





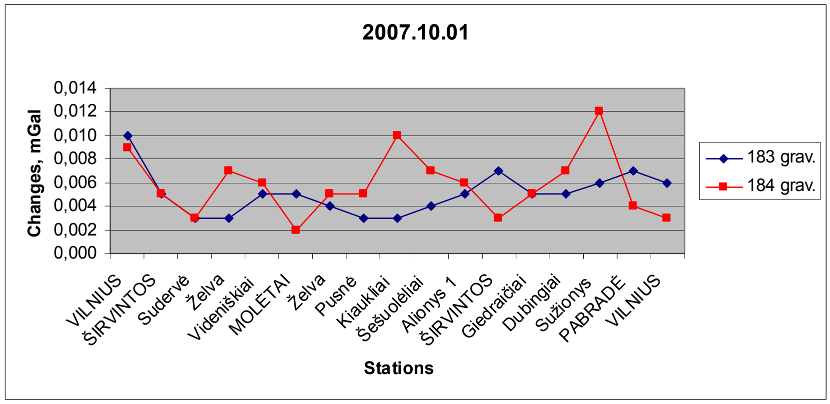


Fig. 3.3. Maximum changes of references

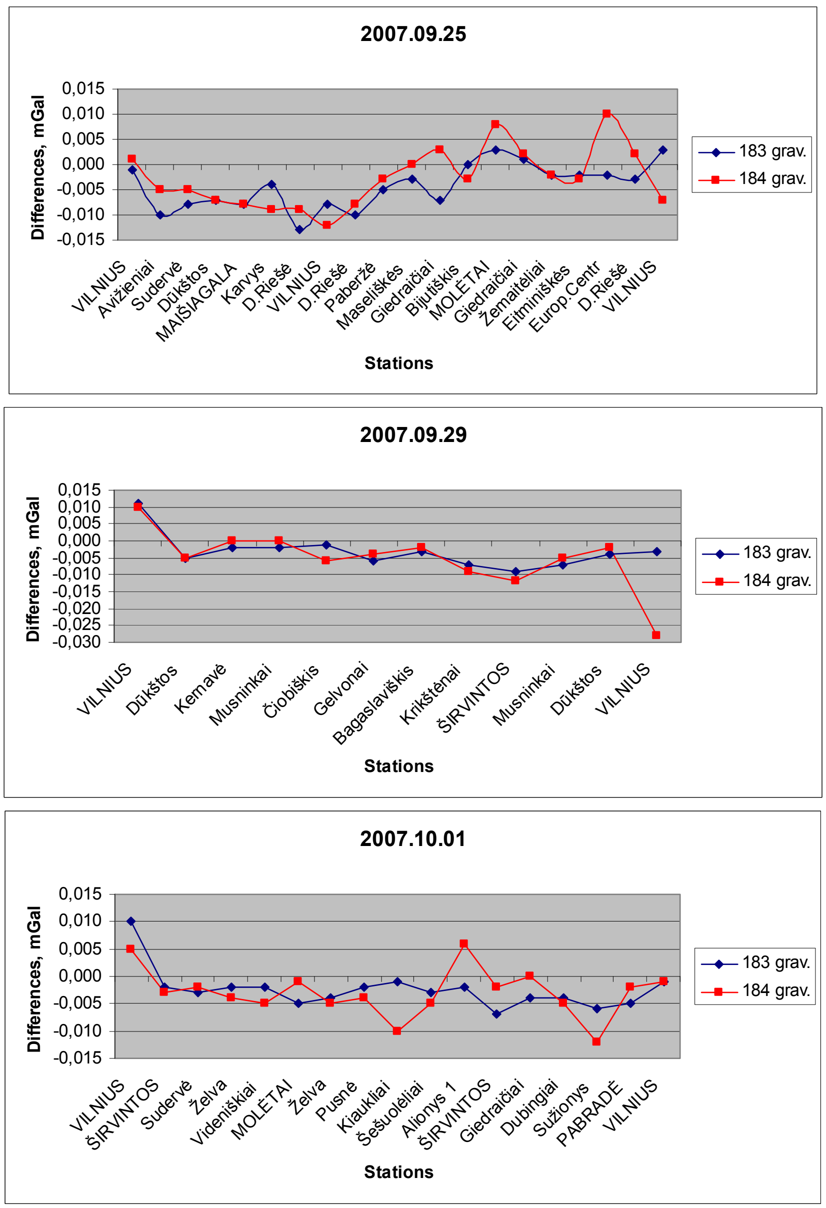


Fig. 3.4. First and last references differences

In Fig. 3.3 and 3.4 we can see that references are always varies irregularly in every station during the measurements with two devices - variation of ranges are quite large.

The most accurate measurements were made in the 10/01/2007 day. After the gravimetric measurements we get gravimeter's references at some moments. All references have standart deviations. These standart deviations are relate to the imperfection of measuring instruments, test conditions and the evolution of the measurement object, the theoretical model and the parallelism of the method of measurement, etc.

Other reasons can be due to random and uncontrollable disturbances during the experiment, which directly affect the measurement result. It can not be estimated because of the big number of disruption, diverse nature and different effects.

Standart deviations of references are presented in Fig. 3.5.

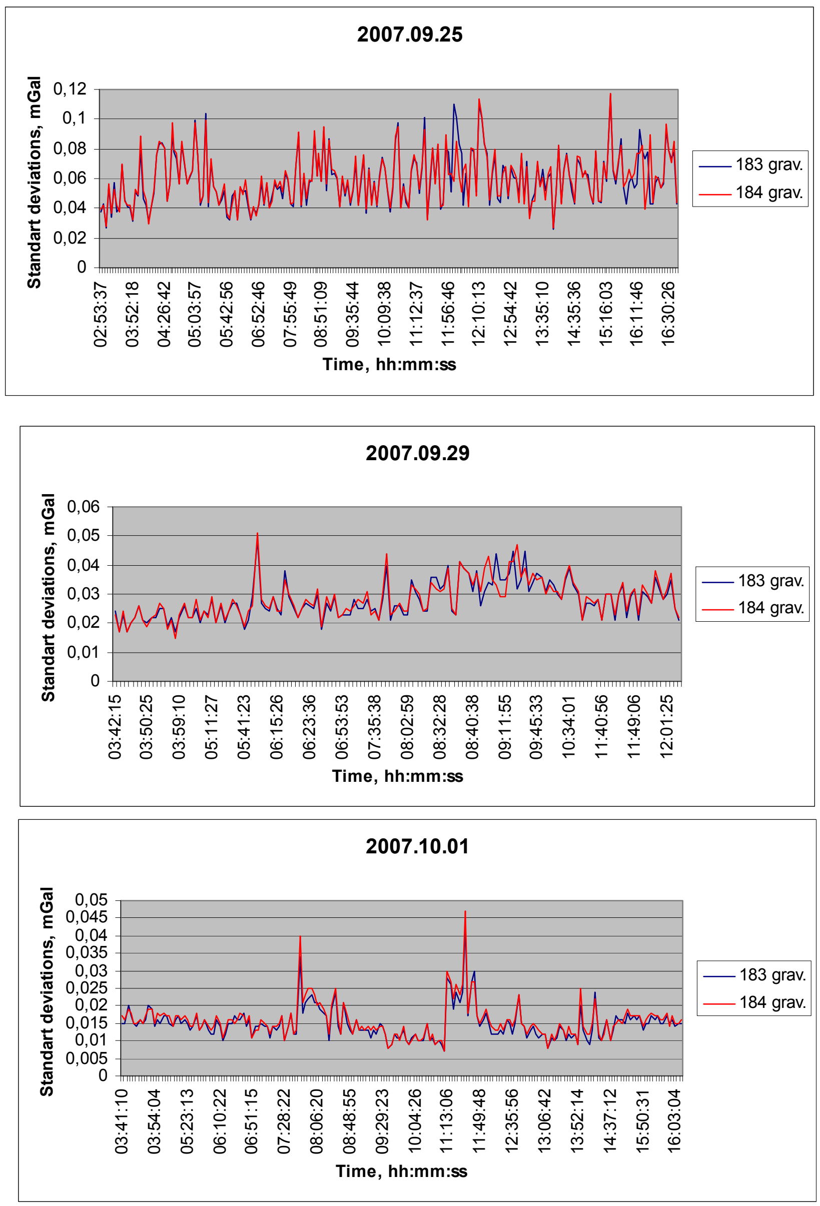


Fig. 3.5. Changes of standart deviations of the gravimeter references

In Fig. 3.5 we can see that during the measurements with two devices in the same time references changes equally, but the range is quite large.

The biggest fluctuations started on 25/09/2007 at 12 o'clock in station Vilnius, on 29/09/2007 - between 5 a.m. and 6 a.m. in station Kernavė, on 01/10/2007 the largest fluctuations were at 8 a.m. in station Molėtai and at 12 a.m. in station Širvintos.

Gravimeter's references may change according to the X and Y axes. These changes are presented in Fig. 3.6 - 3.7.

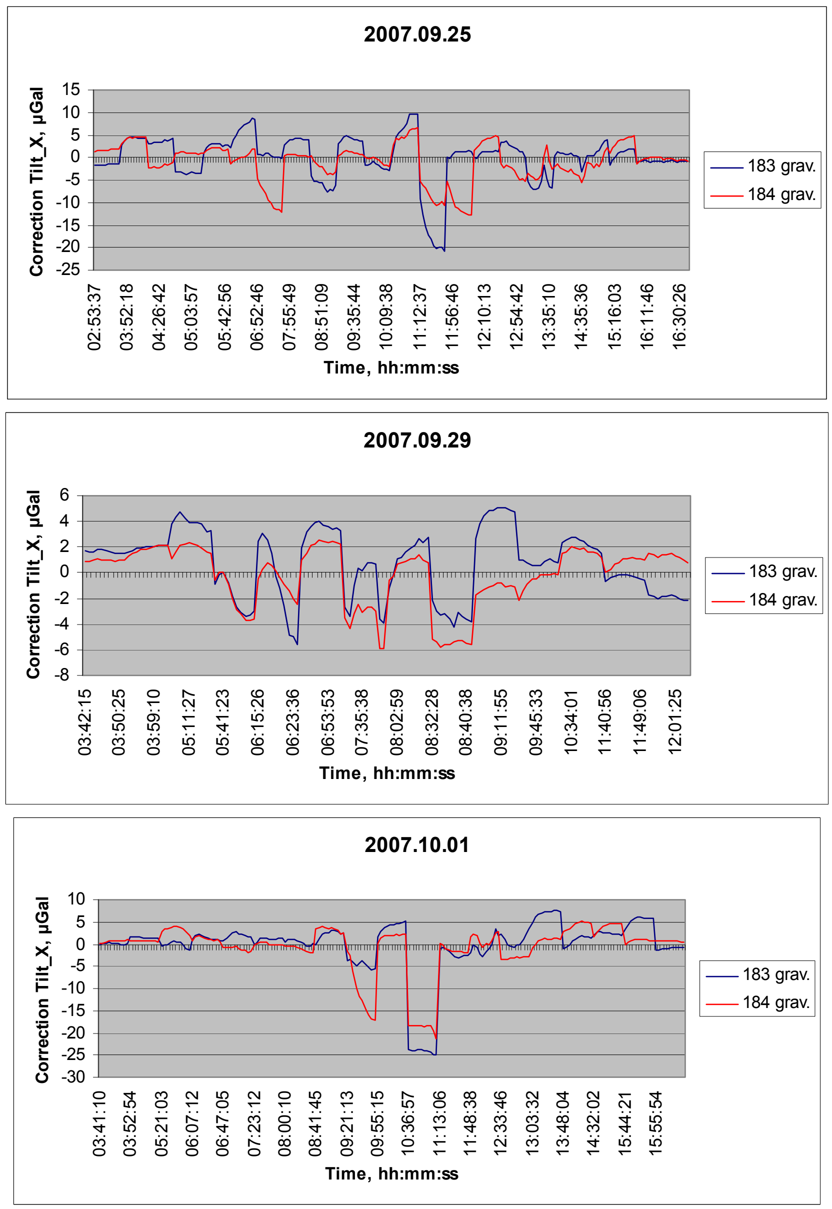


Fig. 3.6. Correction of X axes tilt

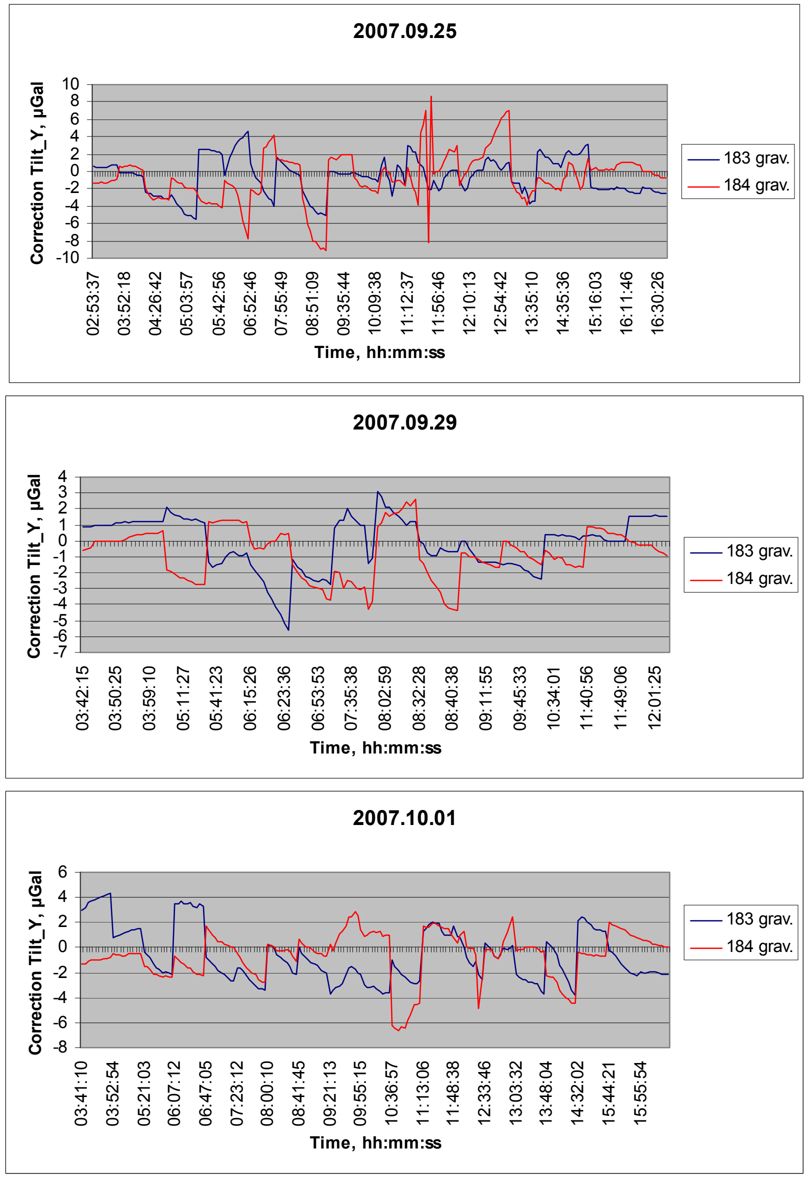


Fig. 3.7. Correction of Y axes tilt

In these figures we can see references changes according to the correction of X and Y axes tilt. Tilt is quite large and if we will compare both gravimeters – very different. The largest variations in the X-axis and Y axis were in the same day - 25/09/2007. These results could be influenced by direct solar radiation.

Internal temperature of the gravimeters is also affected gravimetric measurements. Pendulum measurements made at variuos temperatures must be reduced to the same temperature. If the temperature only changes by a few degrees and if the ate of change is not too high during the observations, it is sufficient to compute the temperature correction. If the pendula are of invar of quartz, it is sufficient to determine the temperature to ± 0.1 ^{o}C (Pick *et al.* 1973).

Correction of temperature's differences are presented in Fig. 3.8.

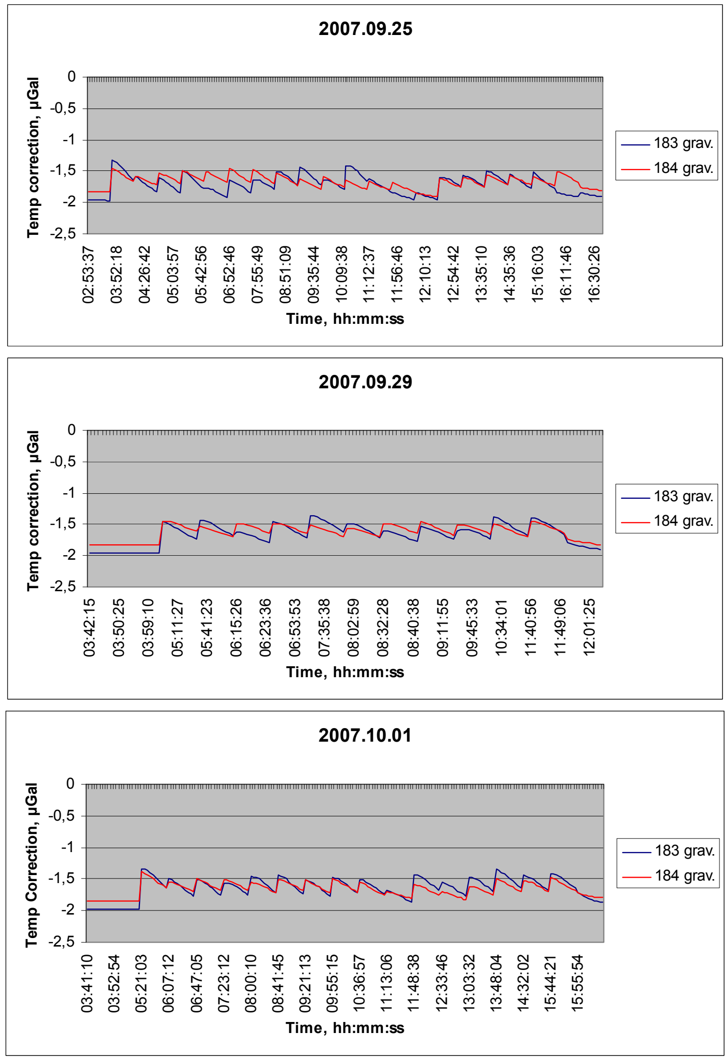


Fig. 3.8. Correction of temperature's differences

These figures show that the temperature’s fluctuations of both gravimeters are quite different, but all time they evolved gradually.

Among the results, obtained by measuring, is the number of rejections. The rejection is needful to eliminate noise spikes and not the microseismic noise. In addition, it is worth noting that the seismic filter very effectively reduces measurement errors due to noise spikes which occur during the first 5 seconds after the start of a measurement, as weighting factors of early samples are relatively small (Scintrex… 2010).

The rejection threshold has been increased from 4 x SD to 6 x SD. The value of a rejected sample is replaced by the value of the previous sample. The reason for increasing the rejection threshold is that, during microseisms, the seismic noise level varies greatly. If the measurement starts during occasional low noise intervals the rejection threshold is set too low, and subsequent higher level seismic noise is rejected, resulting in numerous rejections (Scintrex… 2010).

The effect of ground vibrations upon gravity observations is one of the largest noise we must remove. The vibrations which affect the gravity observations are divided into three classes according to frequency bands and origins; we call them microseisms, cultural noises and mechanical vibrations. The microseisms mainly originate from ocean waves and give periods ranging from about 2 to 10 seconds according to the geology under ground, the cultural noises are from human activities such as traffic and have periods from about 0,05 to 0,2 seconds, and the mechanical vibrations are from instruments themselves and give periods shorter than about 0,05 seconds. The effects of the vibrations may exceed 10^{-5} ms^{-2} (1 mGal) if the gravity observations are made on bad conditions. Vibration reduction is essential in order to improve the accuracy of the gravity measurements even if the amount of the effect is not so large (Kakuta *et al.* 2002).

Rejections are shown in Fig. 3.9.

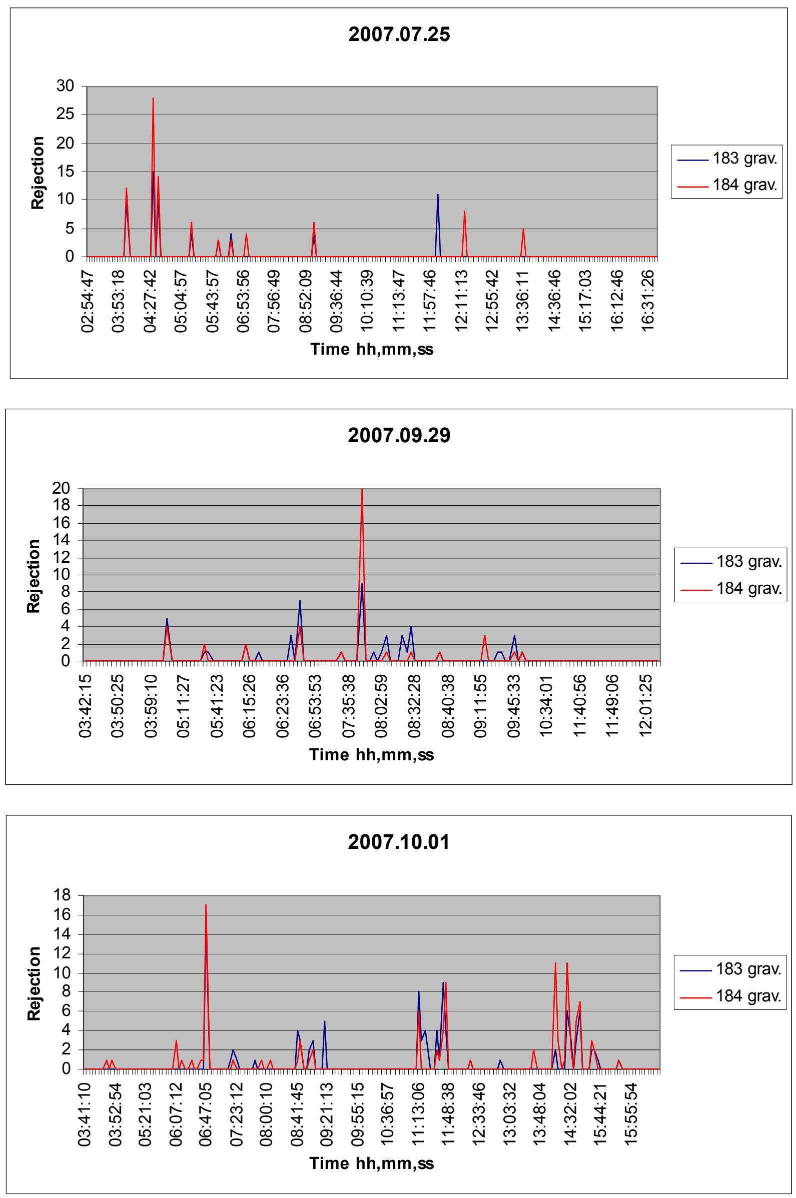


Fig. 3.9 Auto rejection

From these graphs we can see that measurements were most rejected on 10.01 day, the least – on 09.29. According to the results, we can conclude that gravity is in good condition, because the corrections, which we get, are not very high.

3.3. Measurement data processing

Data, unloaded from the device, are not ready to processing. Data has to be set to the rights before the calculations. Only prepared data for further calculations can be entered to the program (Fig. 3.10).

```
1953Sep252007.txt - Notepad
File  Edit  Format  View  Help
/-------LAT--------LONG-----ALT.------GRAV.---SD.--TILTX--TILTY-TEMP---TIDE---DUR-REJ-----TIME----DEC.TIME+DATE--TERRAIN---DATE
54.7210846  25.3373337  147.7570  4576.501 0.038  -1.8   0.6 -1.96 -0.092  55   0 02:53:37    2764.12037   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.501 0.043  -1.7   0.5 -1.96 -0.092  55   0 02:54:47    2764.12118   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.500 0.027  -1.7   0.5 -1.96 -0.092  55   0 02:55:47    2764.12188   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.499 0.055  -1.6   0.5 -1.96 -0.092  55   0 02:56:47    2764.12257   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.500 0.034  -1.6   0.5 -1.96 -0.092  55   0 02:57:47    2764.12326   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.499 0.057  -1.5   0.5 -1.96 -0.092  55   0 02:58:47    2764.12396   0.0000  2007/09/25
54.7210846  25.3373337  147.7570  4576.500 0.038  -1.4   0.6 -1.96 -0.092  55   0 02:59:47    2764.12465   0.0000  2007/09/25
```

Fig. 3.10. Data, unloaded from the device

To make data prepared for the calculations you have to leave only one space between the numbers - there can‘t be any colons or slashes. Prepared data for calculations are shown in Fig. 3.11.

```
3-0925.txt - Notepad
File  Edit  Format  View  Help
# G-183
22
73001,73032,73030,73013,73006,73016,73012,73001,73012,73025,73020,74010,74008,74005,74005,74010,73033,73014,73015,73012,73001,73001
54.7210846 25.3373337 147.7570 4576.501 0.038 -1.8 0.6 -1.96 -0.092 55 0 02 53 37 2764.12037 0.0000 2007 09 25
54.7210846 25.3373337 147.7570 4576.501 0.043 -1.7 0.5 -1.96 -0.092 55 0 02 54 47 2764.12118 0.0000 2007 09 25
54.7210846 25.3373337 147.7570 4576.500 0.027 -1.7 0.5 -1.96 -0.092 55 0 02 55 47 2764.12188 0.0000 2007 09 25
54.7210846 25.3373337 147.7570 4576.499 0.055 -1.6 0.5 -1.96 -0.092 55 0 02 56 47 2764.12257 0.0000 2007 09 25
54.7210846 25.3373337 147.7570 4576.500 0.034 -1.6 0.5 -1.96 -0.092 55 0 02 57 47 2764.12326 0.0000 2007 09 25
54.7210846 25.3373337 147.7570 4576.499 0.057 -1.5 0.5 -1.96 -0.092 55 0 02 58 47 2764.12396 0.0000 2007 09 25
```

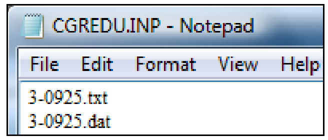
Fig. 3.11. Prepared data for calculations

When data arrays are already prepared, for further calculating we will use program CG2RED B.EXE. First we have to create an array of usable stations (Fig. 3.12). There must included information about the stations codes, longitudes, latitudes, references and the names of the stations.

We also have to create CGREDU.INP data array (Fig. 3.13). In first line of this array is shown data, from which we took data for further calculation, in the second row - an array of data that we will receive after the applet launcher.

```
koord8.dat - Notepad
File  Edit  Format  View  Help
42005 54.53563193 22.71737368 159.481 Girenai
42009 54.52826829 22.82995679 178.901 Pajevonys
42011 54.45483736 22.73057854 178.818 Vistytis
42002 54.41373594 23.09012082 187.379 Akmenynai
42003 54.50126145 23.02610806 115.894 Bartininkai
42004 54.46716298 22.89981287 188.537 Graziskiai
```

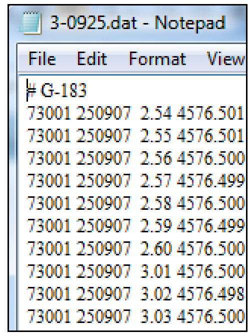
Fig. 3.12. An array of usable stations



```
CGREDU.INP - Notepad
File Edit Format View Help
3-0925.txt
3-0925.dat
```

Fig. 3.13. CGREDU.INP data array

By clicking on the program CGREDU.BAT, we will get 3-0925.dat data array (Fig. 3.14.), which was named in a second row of CGREDU.INP data array.



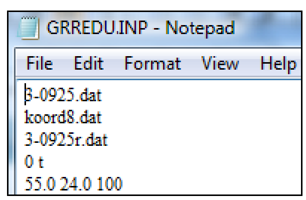
```
3-0925.dat - Notepad
File Edit Format View
# G-183
73001 250907  2.54 4576.501
73001 250907  2.55 4576.501
73001 250907  2.56 4576.500
73001 250907  2.57 4576.499
73001 250907  2.58 4576.500
73001 250907  2.59 4576.499
73001 250907  2.60 4576.500
73001 250907  3.01 4576.500
73001 250907  3.02 4576.498
73001 250907  3.03 4576.500
```

Fig 3.14. 3-0925.dat data array

Fig. 3.14 columns include: station's number, measurement's date, world time and references of gravimeter. Data preparation is completed.

3.3.1. Reduction of gravimetric references

Prepared data are usable in a second stage of the program, when the references of gravimeter are reduced and expressed in mgal by taking the lunar and solar attraction evaluation. This is done by the program's gred2008g2.exe aid. Instructions to the program are drawn up in the GRREDU.INP data array (Fig. 3.15).

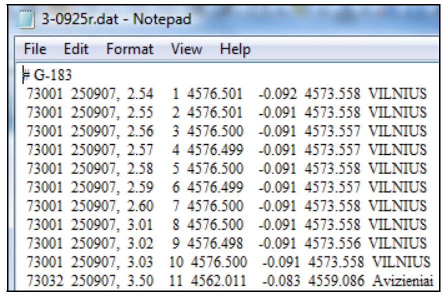


```
GRREDU.INP - Notepad
File Edit Format View Help
3-0925.dat
koord8.dat
3-0925r.dat
0 t
55.0 24.0 100
```

Fig. 3.15. GRREDU.INP data array

In the first and second rows of GRREDU.INP data array there are indicate the names of data sets, which are usable for calculations, in the third row – name of new file, where results should be stored. REDU.BAT program is usable for the data reduction.

The result is 3-0925r.dat data array, in which we can find: code, date, world time, serial number, reference of gravimeter (mgal), correction of lunar and solar attraction, reduced data and the name of station (Fig. 3.16).


3-0925r.dat - Notepad
File Edit Format View Help
```
# G-183
73001 250907, 2.54   1 4576.501  -0.092 4573.558 VILNIUS
73001 250907, 2.55   2 4576.501  -0.091 4573.558 VILNIUS
73001 250907, 2.56   3 4576.500  -0.091 4573.557 VILNIUS
73001 250907, 2.57   4 4576.499  -0.091 4573.557 VILNIUS
73001 250907, 2.58   5 4576.500  -0.091 4573.558 VILNIUS
73001 250907, 2.59   6 4576.499  -0.091 4573.557 VILNIUS
73001 250907, 2.60   7 4576.500  -0.091 4573.558 VILNIUS
73001 250907, 3.01   8 4576.500  -0.091 4573.558 VILNIUS
73001 250907, 3.02   9 4576.498  -0.091 4573.556 VILNIUS
73001 250907, 3.03  10 4576.500  -0.091 4573.558 VILNIUS
73032 250907, 3.50  11 4562.011  -0.083 4559.086 Avizieniai
```
Fig. 3.16. 3-0925r.dat data array

Little part of reduced data of each day is shown in tables 3.3 – 3.5, all reduced data is in 8th Anexes.

Table 3.3. Reduced references 2007.09.25

Locality	References of grav.183	References of grav.184
VILNIUS	4573,558	5018,696
	4573,558	5018,696
	4573,557	5018,696
	4573,557	5018,695
	4573,558	5018,697
…………………………………………………………………		
VILNIUS	4573,576	5018,720
	4573,576	5018,720
	4573,575	5018,720
	4573,575	5018,720
	4573,576	5018,719

Table 3.4. Reduced references 2007.09.29

Locality	References of grav.183	References of grav.184
VILNIUS	4575,482	5019,409
	4575,482	5019,407
	4575,481	5019,408
	4575,480	5019,408
	4575,482	5019,408
…………………………………………………………………		
VILNIUS	4575,501	5019,426
	4575,500	5019,426
	4575,502	5019,426
	4575,500	5019,426
	4575,500	5019,423

Table 3.5. Reduced references 2007.10.01

Locality	References of grav.183	References of grav.184
VILNIUS	4575,548	5019,471
	4575,547	5019,469
	4575,549	5019,469
	4575,549	5019,469
	4575,550	5019,470
…………………………………………………………………		
VILNIUS	4575,556	5019,488
	4575,556	5019,488
	4575,557	5019,488
	4575,556	5019,488
	4575,557	5019,488

3.3.2. Variation of the reduced differences of references

Gravity g measured on the physical surface of the earth must be distinguished from normal gravity γ referring to the surface of the ellipsoid. Gravity reduction serves as a tool for three main purposes:

- determination of the geoid,
- interpolation and extrapolation of gravity,
- investigation of the earth's crust (Wellenhof and Moritz 2010).

Only the first two purposes are of a direct geodetic nature. The third is of interest to theoretical geophysicists and geologists, who study the general structure of the crust, and to exploration geophysicists (Wellenhof and Moritz 2010).

Differences of the reduced references are very imporant for the measrements. During the approximation of calculations we can see whether the reference is changing gradually and how much they differ from the average of allreferences. Reduced analysis is in Fig. 3.17.

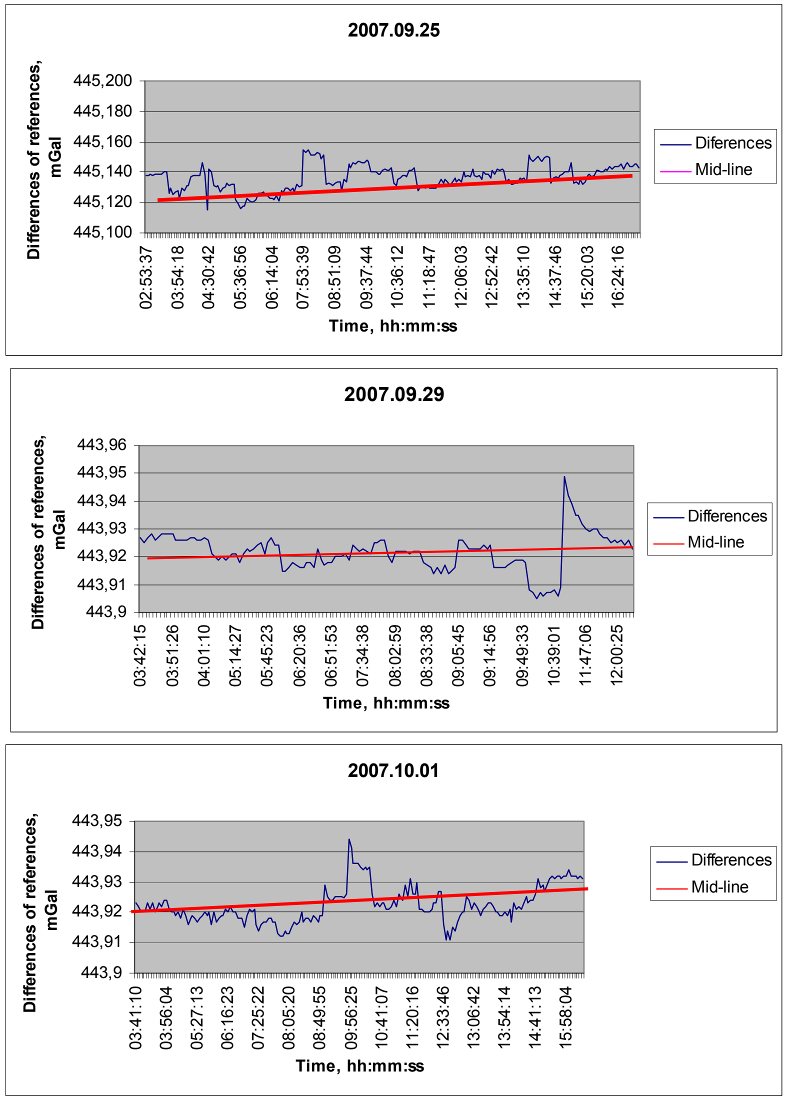


Fig.3.17. Reduced references differences of two gravimeter

After data processing and reduced references receiving, I had compared the differences between two gravimeter references. Measurements result is quite good, because differences of references are close to the straight line.

3.3.3. The adjustment of gravimetric measurements

Network alignment is performed after the reduction with program's GRADJ.EXE aid. Reduced data and acceleration of gravity values of supporting stations with corrections are usable here. During the counting there are evaluating gravimeter zero-slip and correction of one gravimetric reference.

For data alignment must be run ADJ.BAT program. Alignment of measurement data was processed for each indivudual gravimeters, and later, because the observations were done by two gravimeters and because it is possible to compare results, measurement data was alignmented combining reduced references of two gravimeters. There are three data arrays obtained in the end: *.RES (Table 3.6 – 3.8), *.TIE (Table 3.9 – 3.11), *.TYN (Table 3.12 – 3.14). The first one (*.RES) contains the corrected reference and corrections.

Table 3.6. Part of 3-0925.RES data array combining two gravimeters

=== Reading residuals with tares and drift === (excl. single measurements not in adjustment)							
statno	**t**	**seqno**		**obs**	**v**	**plot**	
# G- 183 DRIFT parameter: 0.037 mgal/day BIAS parameter: 4114.466							
73001	250907	2,54	1	4573,558	-0,001	*	VILNIUS
73001	250907	2,55	2	4573,558	-0,001	*	VILNIUS
73001	250907	2,56	3	4573,557	-0,002	*	VILNIUS
....							
73001	250907	16,31	218	4573,575	-0,005	*	VILNIUS
73001	250907	16,32	219	4573,575	-0,005	*	VILNIUS
73001	250907	16,33	220	4573,576	-0,004	*	VILNIUS
r,m,s, residuals: 0,004							
# G- 184 DRIFT parameter: 0.037 mgal/day BIAS parameter: 4114.466							
73001	250907	2,54	1	5018,696	0,007	*	VILNIUS
73001	250907	2,55	2	5018,696	0,007	*	VILNIUS
73001	250907	2,56	3	5018,696	0,007	*	VILNIUS
....							
73001	250907	16,31	218	5018,720	-0,001	*	VILNIUS
73001	250907	16,32	219	5018,720	-0,001	*	VILNIUS
73001	250907	16,33	220	5018,719	-0,003	*	VILNIUS
r.m.s, residuals: 0,004							

Table 3.7. 3-0929.RES data array combining two gravimeters

=== Reading residuals with tares and drift === (excl. single measurements not in adjustment)							
statno	**t**	**seqno**		**obs**	**v**	**plot**	
# G- 183 DRIFT parameter: 0.052 mgal/day BIAS parameter: 4116.395							
73001	290907	3,42	1	4575,482	-0,002	*	VILNIUS
73001	290907	3,43	2	4575,482	-0,002	*	VILNIUS
73001	290907	3,44	3	4575,481	-0,003	*	VILNIUS
....							
73001	290907	12,02	138	4575,502	0,000	*	VILNIUS
73001	290907	12,03	139	4575,500	-0,003	*	VILNIUS
73001	290907	12,04	140	4575,500	-0,003	*	VILNIUS
r.m.s. residuals: 0.003							
# G- 184 DRIFT parameter: 0.051 mgal/day BIAS parameter: 4560.318							
73001	290907	3,42	1	5019,409	0,002	*	VILNIUS
73001	290907	3,43	2	5019,407	0,000	*	VILNIUS
73001	290907	3,44	3	5019,408	0,001	*	VILNIUS
....							
73001	290907	12,02	138	5019,426	0,002	*	VILNIUS
73001	290907	12,03	139	5019,426	0,002	*	VILNIUS
73001	290907	12,04	140	5019,423	-0,001	*	VILNIUS
r.m.s. residuals: 0.003							

Table 3.8. 3-1001.RES data array combining two gravimeters

=== Reading residuals with tares and drift === (excl. single measurements not in adjustment)							
statno	**t**	**seqno**		**obs**	**v**	**plot**	
# G- 183 DRIFT parameter: 0.015 mgal/day BIAS parameter: 4116.462							
73001	11007	3,41	1	4575,548	-0,003	*	VILNIUS
73001	11007	3,42	2	4575,547	-0,004	*	VILNIUS
73001	11007	3,43	3	4575,549	-0,002	*	VILNIUS
....							
73001	11007	16,03	188	4575,557	-0,001	*	VILNIUS
73001	11007	16,04	189	4575,556	-0,002	*	VILNIUS
73001	11007	16,05	190	4575,557	-0,001	*	VILNIUS
r.m.s. residuals: 0.003							
# G- 184 DRIFT parameter: 0.030 mgal/day BIAS parameter: 4560.380							
73001	11007	3,41	1	5019,471	0,002	*	VILNIUS
73001	11007	3,42	2	5019,469	0,000	*	VILNIUS
73001	11007	3,43	3	5019,469	0,000	*	VILNIUS
....							
73001	11007	16,03	188	5019,488	0,003	*	VILNIUS
73001	11007	16,04	189	5019,488	0,003	*	VILNIUS
73001	11007	16,05	190	5019,488	0,003	*	VILNIUS
r.m.s. residuals: 0.003							

Drift elimination in field work is done using repeated measurements. The principal deficiency of present drift determinations lies in the fact that the drift depends on circumstances of transport, temperature variations and other environmental effects (Groten 1995).

Data of the string of measurements accuracy is shown in *.3-0925.TIE data array (Table 3.9 – 3.11).

Table 3.9. 3-0925.TIE data array combining two gravimeters

from	to	inst	date	time	dif	v
73001	73032	G-183	250907	3,50	-14,472	0,006
73030	73032	G-183	250907	4,23	3,625	-0,003
73013	73030	G-183	250907	4,58	-8,792	-0,008
73006	73013	G-183	250907	5,35	-2,020	-0,009
73006	73016	G-183	250907	6,08	5,307	0,000
73012	73016	G-183	250907	6,53	-3,199	-0,001
73001	73012	G-183	250907	7,54	1,185	-0,002
73001	73012	G-183	250907	8,47	1,202	0,013
73012	73025	G-183	250907	9,30	10,228	0,003
73020	73025	G-183	250907	10,01	1,173	-0,004
73020	74010	G-183	250907	10,34	4,398	0,005
74008	74010	G-183	250907	11,13	4,160	-0,012
74005	74008	G-183	250907	11,55	-8,044	-0,003
74005	74010	G-183	250907	12,49	-3,865	0,001
73033	74010	G-183	250907	13,27	6,329	-0,007
73014	73033	G-183	250907	14,02	-13,691	0,002
73014	73015	G-183	250907	14,36	-6,909	0,012
73012	73015	G-183	250907	15,14	13,862	-0,009
73001	73012	G-183	250907	16,08	1,189	0,002
73001	73032	G-184	250907	3,50	-14,486	-0,008
73030	73032	G-184	250907	4,23	3,619	-0,009
73013	73030	G-184	250907	4,58	-8,783	0,001
73006	73013	G-184	250907	5,35	-2,010	0,001
73006	73016	G-184	250907	6,08	5,311	0,004
73012	73016	G-184	250907	6,53	-3,206	-0,008

73001	73012	G-184	250907	7,59	1,170	-0,016
73001	73012	G-184	250907	8,47	1,183	-0,007
73012	73025	G-184	250907	9,30	10,239	0,013
73020	73025	G-184	250907	10,01	1,180	0,003
73020	74010	G-184	250907	10,34	4,388	-0,005
74008	74010	G-184	250907	11,13	4,170	-0,002
74005	74008	G-184	250907	11,55	-8,047	-0,005
74005	74010	G-184	250907	12,49	-3,860	0,006
73033	74010	G-184	250907	13,27	6,336	0,000
73014	73033	G-184	250907	14,02	-13,708	-0,015
73014	73015	G-184	250907	14,36	-6,926	-0,005
73012	73015	G-184	250907	15,14	13,875	0,004
73001	73012	G-184	250907	16,08	1,186	0,000

Table 3.10. 3-0929.TIE data array combining two gravimeters

from	to	inst	date	time	dif	v
73001	73013	G-183	290907	5,08	-9,318	0,007
73013	73018	G-183	290907	5,39	20,870	0,004
73018	73022	G-183	290907	6,15	5,345	0,010
63006	73022	G-183	290907	6,48	-19,184	0,002
63006	64010	G-183	290907	7,31	-4,025	0,003
64008	64010	G-183	290907	8,01	3,322	-0,007
64008	74014	G-183	290907	8,32	-8,405	0,008
74004	74014	G-183	290907	9,06	7,197	-0,003
73022	74004	G-183	290907	9,41	-3,798	-0,009
73013	73022	G-183	290907	10,32	26,198	0,000
73001	73013	G-183	290907	11,41	-9,336	-0,007
73001	73013	G-184	290907	5,07	-9,321	0,004
73013	73018	G-184	290907	5,39	20,872	0,006
73018	73022	G-184	290907	6,15	5,336	0,001
63006	73022	G-184	290907	6,48	-19,191	-0,005
63006	64010	G-184	290907	7,32	-4,020	0,008
64008	64010	G-184	290907	8,01	3,328	-0,001
64008	74014	G-184	290907	8,32	-8,409	0,004
74004	74014	G-184	290907	9,07	7,187	-0,013
73022	74004	G-184	290907	9,41	-3,790	-0,001
73001	73022	G-184	290907	11,46	16,854	-0,015

Table 3.11. 3-1001.TIE data array combining two gravimeters

from	to	inst	date	time	dif	v
73001	74004	G-183	11007	5,21	13,104	0,008
73030	74004	G-183	11007	6,07	-0,364	-0,004
73030	74026	G-183	11007	6,47	6,979	0,006
74024	74026	G-183	11007	7,23	-0,637	-0,006
74005	74024	G-183	11007	8,00	2,549	-0,007
74005	74026	G-183	11007	8,42	1,930	0,004
74018	74026	G-183	11007	9,21	5,644	-0,002
74013	74018	G-183	11007	9,55	1,062	0,002
74013	74022	G-183	11007	10,37	-0,945	0,009
73008	74022	G-183	11007	11,13	8,198	-0,003
73008	74004	G-183	11007	11,49	8,534	0,003
74004	74010	G-183	11007	12,34	1,548	0,013
74009	74010	G-183	11007	13,04	-1,871	-0,002
73031	74009	G-183	11007	13,48	-8,275	-0,008
73031	83003	G-183	11007	14,32	5,099	0,005
73001	83003	G-183	11007	15,44	29,856	-0,003
73001	74004	G-184	11007	5,21	13,107	0,010
73030	74004	G-184	11007	6,07	-0,363	-0,003
73030	74026	G-184	11007	6,47	6,981	0,008
74024	74026	G-184	11007	7,23	-0,638	-0,006
74005	74024	G-184	11007	8,00	2,553	-0,003
74005	74026	G-184	11007	8,42	1,933	0,007
74018	74026	G-184	11007	9,21	5,634	-0,011
74013	74018	G-184	11007	9,57	1,050	-0,009
74013	74022	G-184	11007	10,37	-0,954	0,000
73008	74022	G-184	11007	11,13	8,200	-0,001

73008	74004	G-184	11007	11,49	8,525	-0,006
74004	74010	G-184	11007	12,34	1,537	0,002
74009	74010	G-184	11007	13,04	-1,876	-0,007
73031	74009	G-184	11007	13,48	-8,275	-0,007
73031	83003	G-184	11007	14,32	5,105	0,010
73001	83003	G-184	11007	15,44	29,851	-0,007

There are acceleration values of gravimeter network stations and their accuracy in the last *.TYN data array (Table 3.12 – 3.14).

Table 3.12. 3-0925.TYN data array combining two gravimeters

#== Fixed stations and adjustment residuals ===					
stat	Fix g	sigma	adj g	v	
73001	981459,086	0,005	981459,093	-0,007	VILNIUS
73006	981451,793	0,01	981451,778	0,015	MAISIAGALA
74005	981477,599	0,01	981477,587	0,012	MOLETAI
#== Adjusted new gravity values and standard deviations ===					
73012	981460,281	0,004	Didžioji Riešė		
73013	981449,768	0,004	Dukstos		
73014	981481,075	0,004	Eitminiskes		
73015	981474,153	0,004	Europos centras		
73016	981457,084	0,004	Karvys		
73020	981469,327	0,004	Maseliskes		
73025	981470,505	0,004	Paberze		
73030	981440,985	0,004	Suderve		
73032	981444,613	0,004	Avizieniai		
73033	981467,383	0,004	Zemaiteliai		
74008	981469,547	0,004	Bijutiskis		
74010	981473,720	0,004	Giedraiciai		
=== Statistics of adjustment === Adjustment observations: 433 Stations: 15, total unknowns: 19 SIGMA (single reading at apriori weighting): 0.004					

Table 3.13. 3-0929.TYN data array combining two gravimeters

#== Fixed stations and adjustment residuals ===					
stat	Fix g	sigma	adj g	v	
73001	981459,086	0,005	981459,089	-0,003	VILNIUS
74004	981472,185	0,01	981472,174	0,011	SIRVINTOS
#== Adjusted new gravity values and standard deviations ===					
63006	981495,147	0,005	Ciobiskis		
64008	981487,788	0,005	Bagaslaviski		
64010	981491,118	0,005	Gelvonai		
73013	981449,762	0,005	Dukstos		
73018	981470,627	0,005	Kernave		
73022	981475,962	0,005	Musninkai		
74014	981479,375	0,005	Krikstenai		
=== Statistics of adjustment === Adjustment observations: 266 Stations: 9, total unknowns: 13 SIGMA (single reading at apriori weighting): 0.003					

Table 3.14. 3-1001.TYN data array combining two gravimeters

#== Fixed stations and adjustment residuals ===					
stat	Fix g	sigma	adj g	v	
73001	981459,086	0,005	981459,089	-0,003	VILNIUS

74005	981477,599	0,01	981477,591	0,008	MOLETAI
74004	981472,185	0,01	981472,184	0,001	SIRVINTOS
83003	981488,951	0,01	981488,949	0,002	PABRADE
#== Adjusted new gravity values and standard deviations ===					
73008	981463,654	0,004	Alionys I		
73030	981472,544	0,004	Suderve		
73031	981483,855	0,004	Suzionys		
74009	981475,588	0,004	Dubingiai		
74010	981473,719	0,004	Giedraiciai		
74013	981472,810	0,004	Kiaukliai		
74018	981473,870	0,004	Pusne		
74022	981471,855	0,004	Sesuoleliai		
74024	981480,147	0,004	Videniskiai		
74026	981479,516	0,004	Zelva		
=== Statistics of adjustment === Adjustment observations: 382 Stations: 14, total unknowns: 18 SIGMA (single reading at apriori weighting): 0.003					

Measurements of the acceleration due to gravity form one of the geophysical methods for investigating the interior of the earth, and also one of the tools of geodesy for the determination of the earth's shape (Garland *et al.* 1965).

According to the *.RES data arrays, we see that the corrections that we gave from results, is below in 09.29 and 1.10 days. On the 09.25 day the results were also not bad, but worse than the results of other days.

Maximum string measurement accuracy, which we can see in *.TIE data arrays, was on the 9.29 day, the lowest – on the 09.25 day.

According to the *.TYN data arrays with acceleration of gravity values in gravimeter network points, we can see again that the best results were on the 09.29 and 10.01 days.

Hence we may conclude, that if we will compare the results of three days, we will see that the most accurate measurements were on the 09.29 and 10.01 days, because there were obtained the lowest corrections and the minimum acceleration of gravity deviations.

3.3.4. Data Disposal

During the processing of the measurements there is the possibility to dispose the data from the data arrays. Here a comparison was carried out - what results can be obtained by leaving all the data and what results can be obtained by disposing the worst data of the data arrays. These comparisons, which have been made when two gravimeters were compared, are shown in Table 3.15 – 3.17.

Table 3.15. *.RES data array (2007.09.25) using data disposal

2007.09.25	Using all the data		Some data disposed	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.036	0.056	0.037	0.058

BIAS parameter	4114.467	4559.598	4114.466	4559.596
r.m.s. residuals	0.004	0.004	0.004	0.004

Table 3.16. *.RES data array (2007.09.29) using data disposal

2007.09.29	Using all the data		Some data disposed	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.052	0.049	0.052	0.051
BIAS parameter	4116.397	4560.319	4116.395	4560.318
r.m.s. residuals	0.004	0.006	0.003	0.003

Table 3.17. *.RES data array (2007.10.01) using data disposal

2007.10.01	Using all the data		Some data disposed	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.015	0.030	0.015	0.030
BIAS parameter	4116.462	4560.380	4116.462	4560.380
r.m.s. residuals	0.003	0.003	0.003	0.003

As we can see from the results, if you delete certain data, or if you leave them all – you will received the same accuracy of results, excluding the day of 09.29, because here results were more accurate without some data.

Data of the string of measurement accuracy is shown in *.TIE data arrays in Table 3.18 - 3.20.

Table 3.18. *.TIE data array (2007.09.25) using data disposal

from	to	inst	date	time	dif		v	
					Using all the data	Some data disposed	Using all the data	Some data disposed
73001	73032	G-183	250907	3,5	-14,472	-14,472	0,008	0,006
73030	73032	G-183	250907	4,23	3,625	3,625	-0,001	-0,003
73013	73030	G-183	250907	4,58	-8,792	-8,792	-0,009	-0,008
73006	73013	G-183	250907	5,35	-2,02	-2,020	-0,009	-0,009
73006	73016	G-183	250907	6,08	5,307	5,307	0,001	0,000
73012	73016	G-183	250907	6,53	-3,199	-3,199	-0,001	-0,001
73001	73012	G-183	250907	7,54	1,185	1,185	-0,001	-0,002
73001	73012	G-183	250907	8,47	1,202	1,202	0,014	0,013
73012	73025	G-183	250907	9,3	10,228	10,228	0,003	0,003
73020	73025	G-183	250907	10,01	1,173	1,173	-0,004	-0,004
73020	74010	G-183	250907	10,34	4,398	4,398	0,005	0,005
74008	74010	G-183	250907	11,13	4,16	4,160	-0,012	-0,012
74005	74008	G-183	250907	11,55	-8,044	-8,044	-0,003	-0,003
74005	74010	G-183	250907	12,49	-3,865	-3,865	0,002	0,001
73033	74010	G-183	250907	13,27	6,329	6,329	-0,007	-0,007
73014	73033	G-183	250907	14,02	-13,691	-13,691	0,002	0,002
73014	73015	G-183	250907	14,36	-6,909	-6,909	0,012	0,012
73012	73015	G-183	250907	15,14	13,862	13,862	-0,010	-0,009
73001	73012	G-183	250907	16,08	1,189	1,189	0,003	0,002
73001	73032	G-184	250907	3,5	-14,486	-14,486	-0,006	-0,008
73030	73032	G-184	250907	4,23	3,619	3,619	-0,007	-0,009
73013	73030	G-184	250907	4,58	-8,783	-8,783	0,000	0,001
73006	73013	G-184	250907	5,35	-2,01	-2,010	0,002	0,001
73006	73016	G-184	250907	6,08	5,311	5,311	0,005	0,004
73012	73016	G-184	250907	6,53	-3,206	-3,206	-0,007	-0,008

73001	73012	G-184	250907	7,54	1,161	1,170	-0,024	-0,016
73001	73012	G-184	250907	8,47	1,183	1,183	-0,006	-0,007
73012	73025	G-184	250907	9,3	10,239	10,239	0,014	0,013
73020	73025	G-184	250907	10,01	1,18	1,180	0,003	0,003
73020	74010	G-184	250907	10,34	4,388	4,388	-0,005	-0,005
74008	74010	G-184	250907	11,13	4,17	4,170	-0,002	-0,002
74005	74008	G-184	250907	11,55	-8,047	-8,047	-0,005	-0,005
74005	74010	G-184	250907	12,49	-3,86	-3,860	0,006	0,006
73033	74010	G-184	250907	13,27	6,336	6,336	0,000	0,000
73014	73033	G-184	250907	14,02	-13,708	-13,708	-0,015	-0,015
73014	73015	G-184	250907	14,36	-6,926	-6,926	-0,005	-0,005
73012	73015	G-184	250907	15,14	13,875	13,875	0,004	0,004
73001	73012	G-184	250907	16,08	1,186	1,186	0,001	0,000

Table 3.19. *.TIE data array (2007.09.29) using data disposal

from	to	inst	date	time	dif		v	
					Using all the data	Some data disposed	Using all the data	Some data disposed
73001	73013	G-183	290907	5,07	-9,316	-9,318	0,014	0,007
73013	73018	G-183	290907	5,39	20,87	20,87	0,000	0,004
73018	73022	G-183	290907	6,15	5,345	5,345	0,010	0,010
63006	73022	G-183	290907	6,48	-19,184	-19,184	0,002	0,002
63006	64010	G-183	290907	7,31	-4,025	-4,025	0,003	0,003
64008	64010	G-183	290907	8,01	3,322	3,322	-0,007	-0,007
64008	74014	G-183	290907	8,32	-8,405	-8,405	0,008	0,008
74004	74014	G-183	290907	9,06	7,197	7,197	-0,003	-0,003
73022	74004	G-183	290907	9,41	-3,798	-3,798	-0,010	-0,009
73013	73022	G-183	290907	10,32	26,198	26,198	-0,004	0,000
73001	73013	G-183	290907	11,41	-9,336	-9,336	-0,002	-0,007
73001	73013	G-184	290907	5,07	-9,321	-9,321	0,009	0,004
73013	73018	G-184	290907	5,39	20,872	20,872	0,002	0,006
73018	73022	G-184	290907	6,15	5,336	5,336	0,001	0,001
63006	73022	G-184	290907	6,48	-19,191	-19,191	-0,005	-0,005
63006	64010	G-184	290907	7,32	-4,02	-4,02	0,008	0,008
64008	64010	G-184	290907	8,01	3,328	3,328	-0,001	-0,001
64008	74014	G-184	290907	8,32	-8,409	-8,409	0,004	0,004
74004	74014	G-184	290907	9,07	7,187	7,187	-0,013	-0,013
73022	74004	G-184	290907	9,41	-3,79	-3,79	-0,002	-0,001
73001	73022	G-184	290907	10,32	26,208	16,854	0,005	-0,015

Table 3.20. *.TIE data array (2007.10.01) using data disposal

from	to	inst	date	time	dif		v	
					Using all the data	Some data disposed	Using all the data	Some data disposed
73001	74004	G-183	11007	5,21	13,104	13,104	0,008	0,008
73030	74004	G-183	11007	6,07	-0,364	-0,364	-0,004	-0,004
73030	74026	G-183	11007	6,47	6,979	6,979	0,006	0,006
74024	74026	G-183	11007	7,23	-0,637	-0,637	-0,006	-0,006
74005	74024	G-183	11007	8,00	2,549	2,549	-0,007	-0,007
74005	74026	G-183	11007	8,42	1,930	1,93	0,004	0,004
74018	74026	G-183	11007	9,21	5,644	5,644	-0,002	-0,002
74013	74018	G-183	11007	9,55	1,062	1,062	0,004	0,002
74013	74022	G-183	11007	10,37	-0,945	-0,945	0,011	0,009

73008	74022	G-183	11007	11,13	8,198	8,198	-0,003	-0,003
73008	74004	G-183	11007	11,49	8,534	8,534	0,003	0,003
74004	74010	G-183	11007	12,34	1,548	1,548	0,013	0,013
74009	74010	G-183	11007	13,04	-1,871	-1,871	-0,002	-0,002
73031	74009	G-183	11007	13,48	-8,275	-8,275	-0,008	-0,008
73031	83003	G-183	11007	14,32	5,099	5,099	0,005	0,005
73001	83003	G-183	11007	15,44	29,856	29,856	-0,003	-0,003
73001	74004	G-184	11007	5,21	13,107	13,107	0,010	0,010
73030	74004	G-184	11007	6,07	-0,363	-0,363	-0,003	-0,003
73030	74026	G-184	11007	6,47	6,981	6,981	0,008	0,008
74024	74026	G-184	11007	7,23	-0,638	-0,638	-0,006	-0,006
74005	74024	G-184	11007	8,00	2,553	2,553	-0,003	-0,003
74005	74026	G-184	11007	8,42	1,933	1,933	0,007	0,007
74018	74026	G-184	11007	9,21	5,634	5,634	-0,011	-0,011
74013	74018	G-184	11007	9,55	1,044	1,05	-0,014	-0,009
74013	74022	G-184	11007	10,37	-0,954	-0,954	0,002	0,000
73008	74022	G-184	11007	11,13	8,200	8,2	-0,001	-0,001
73008	74004	G-184	11007	11,49	8,525	8,525	-0,006	-0,006
74004	74010	G-184	11007	12,34	1,537	1,537	0,002	0,002
74009	74010	G-184	11007	13,04	-1,876	-1,876	-0,007	-0,007
73031	74009	G-184	11007	13,48	-8,275	-8,275	-0,007	-0,007
73031	83003	G-184	11007	14,32	5,105	5,105	0,010	0,010
73001	83003	G-184	11007	15,44	29,851	29,851	-0,007	-0,007

Comparing the results of *.TIE data arrays, we can see that the processing of data, when a few lines were removed, is better only on day 09/29/2007.

There are acceleration values (which were get by using data disposal) of gravimeter network stations and their accuracy in the last *.TYN data array (Table 3.21 – 3.23).

Table 3.21. *.TYN data array (2007.09.25) using data disposal

stat	**Fix g**		**sigma**	**adj g**	**v**		
	Using all the data	**Some data disposed**			**Using all the data**	**Some data disposed**	
73001	981459,086	981459,086	0,005	981459,093	-0,007	-0,007	VILNIUS
73006	981451,793	981451,793	0,01	981451,777	0,016	0,015	MAISIAGALA
74005	981477,599	981477,599	0,01	981477,587	0,012	0,012	MOLETAI
73012	981460,280	981460,281	0,004	Didzioji Riešė			
73013	981449,767	981449,768	0,004	Dukstos			
73014	981481,074	981481,075	0,004	Eitminiskes			
73015	981474,152	981474,153	0,004	Europos centras			
73016	981457,083	981457,084	0,004	Karvys			
73020	981469,327	981469,327	0,004	Maseliskes			
73025	981470,504	981470,505	0,004	Paberze			
73030	981440,985	981440,985	0,004	Suderve			
73032	981444,611	981444,613	0,004	Avizieniai			
73033	981467,382	981467,383	0,004	Zemaiteliai			
74008	981469,546	981469,547	0,004	Bijutiskis			
74010	981473,719	981473,720	0,004	Giedraiciai			

2007.09.25	**Using all the data**	**Some data disposed**
Adjustment observations	433	433
Stations	15	15

total unknowns	19	19
SIGMA (single reading at apriori weighting	0.004	0.004

Table 3.22. *.TYN data array (2007.09.29) using data disposal

stat	Fix g		sigma	adj g	v		
	Using all the data	Some data disposed			Using all the data	Some data disposed	
73001	981459,086	981459,086	0,005	981459,089	-0,003	-0,003	VILNIUS
74004	981472,185	981472,185	0,01	981472,173	0,012	0,011	SIRVINTOS
63006	981495,146	981495,147	0,005	Ciobiskis			
64008	981487,787	981487,788	0,005	Bagaslaviski			
64010	981491,117	981491,118	0,005	Gelvonai			
73013	981449,757	981449,762	0,005	Dukstos			
73018	981470,626	981470,627	0,005	Kernave			
73022	981475,961	981475,962	0,005	Musninkai			
74014	981479,374	981479,375	0,005	Krikstenai			

2007.09.29	Using all the data	Some data disposed
Adjustment observations	282	266
Stations	9	9
total unknowns	13	13
SIGMA (single reading at apriori weighting	0.005	0.003

Table 3.23. *.TYN data array (2007.10.01) using data disposal

stat	Fix g		sigma	adj g	v		
	Using all the data	Some data disposed			Using all the data	Some data disposed	
73001	981459,086	981459,086	0,005	981459,089	-0,003	-0,003	VILNIUS
74005	981477,599	981477,599	0,01	981477,591	0,008	0,008	MOLETAI
74004	981472,185	981472,185	0,01	981472,184	0,001	0,001	SIRVINTOS
83003	981488,951	981488,951	0,01	981488,949	0,002	0,002	PABRADE
73008	981463,654	981463,654	0,004	Alionys			
73030	981472,544	981472,544	0,004	Suderve			
73031	981483,858	981483,855	0,004	Suzionys			
74009	981475,588	981475,588	0,004	Dubingiai			
74010	981473,719	981473,719	0,004	Giedraiciai			
74013	981472,812	981472,810	0,004	Kiaukliai			
74018	981473,870	981473,870	0,004	Pusne			
74022	981471,855	981471,855	0,004	Sesuoleliai			
74024	981480,147	981480,147	0,004	Videniskiai			
74026	981479,516	981479,516	0,004	Zelva			

2007.10.01	Using all the data	Some data disposed
Adjustment observations	384	382
Stations	14	14
total unknowns	18	18
SIGMA (single reading at apriori weighting	0.003	0.003

According to these *.TYN data arrays we see that if some data is disposed, the results on all days are the same or better than leaving all of the data.

3.4. Comparison of results using different treatments

Adjustment of measurements data was carried out in two ways: first data was processed for each indivudual gravimeters, later measurement data was alignmented combining reduced references of two gravimeters.

Below are the results of the corrected references and the corrections (Table 3.24 to 3.26).

Table 3.24. *.RES data array (2007.09.25) using different treatments

2007.09.25	**Treatment individually**		**Treatment combining**	
	G- 183	**G- 184**	**G- 183**	**G- 184**
DRIFT parametre, mgal/day	0.043	0.050	0.037	0.058
BIAS parameter	4114.464	4559.600	4114.466	4559.596
r.m.s. residuals	0.003	0.003	0.004	0.004

Table 3.25. *.RES data array (2007.09.29) using different treatments

2007.09.29	**Treatment individually**		**Treatment combining**	
	G- 183	**G- 184**	**G- 183**	**G- 184**
DRIFT parametre, mgal/day	0.051	0.042	0.052	0.051
BIAS parameter	4116.394	4560.322	4116.395	4560.318
r.m.s. residuals	0.002	0.003	0.003	0.003

Table 3.26. *.RES data array (2007.10.01) using different treatments

2007.10.01	**Treatment individually**		**Treatment combining**	
	G- 183	**G- 184**	**G- 183**	**G- 184**
DRIFT parametre, mgal/day	0.013	0.032	0.015	0.030
BIAS parameter	4116.462	4560.380	4116.462	4560.380
r.m.s. residuals	0.002	0.002	0.003	0.003

As we can see from these tables, different results are obtained if different treatments of data are using. In these data arrays (*.RES) better results were obtained by treating data separately.

Data of the string of measurement accuracy is shown in Table 3.27 - 3.29.

Table 3.27. *.TIE data array (2007.09.25) using different treatments

from	**to**	**inst**	**date**	**time**	**dif**		**v**	
					Treatment individually	**Treatment combining**	**Treatment individually**	**Treatment combining**
73001	73032	G-183	250907	3.50	-14.472	-14,472	0.001	0,006
73030	73032	G-183	250907	4.23	3.625	3,625	-0.007	-0,003
73013	73030	G-183	250907	4.58	-8.792	-8,792	-0.004	-0,008
73006	73013	G-183	250907	5.35	-2.020	-2,020	-0.003	-0,009
73006	73016	G-183	250907	6.08	5.307	5,307	0.003	0,000
73012	73016	G-183	250907	6.53	-3.199	-3,199	-0.004	-0,001
73001	73012	G-183	250907	7.54	1.185	1,185	-0.006	-0,002
73001	73012	G-183	250907	8.47	1.202	1,202	0.008	0,013
73012	73025	G-183	250907	9.30	10.228	10,228	0.010	0,003
73020	73025	G-183	250907	10.01	1.173	1,173	-0.001	-0,004
73020	74010	G-183	250907	10.34	4.398	4,398	0.004	0,005
74008	74010	G-183	250907	11.13	4.160	4,160	-0.008	-0,012
74005	74008	G-183	250907	11.55	-8.044	-8,044	-0.005	-0,003

74005	74010	G-183	250907	12.49	-3.865	-3,865	0.003	0,001
73033	74010	G-183	250907	13.27	6.329	6,329	-0.005	-0,007
73014	73033	G-183	250907	14.02	-13.691	-13,691	-0.006	0,002
73014	73015	G-183	250907	14.36	-6.909	-6,909	0.007	0,012
73012	73015	G-183	250907	15.14	13.862	13,862	-0.007	-0,009
73001	73012	G-183	250907	16.08	1.189	1,189	-0.003	0,002
73001	73032	G-184	250907	3.50	-14.486	-14,486	0.000	-0,008
73030	73032	G-184	250907	4.23	3.619	3,619	-0.004	-0,009
73013	73030	G-184	250907	4.58	-8.783	-8,783	-0.002	0,001
73006	73013	G-184	250907	5.35	-2.010	-2,010	-0.004	0,001
73006	73016	G-184	250907	6.08	5.311	5,311	0.003	0,004
73012	73016	G-184	250907	6.53	-3.206	-3,206	-0.004	-0,008
73001	73012	G-184	250907	7.57	1.166	1,170	-0.014	-0,016
73001	73012	G-184	250907	8.47	1.183	1,183	-0.001	-0,007
73012	73025	G-184	250907	9.30	10.239	10,239	0.007	0,013
73020	73025	G-184	250907	10.01	1.180	1,180	0.000	0,003
73020	74010	G-184	250907	10.34	4.388	4,388	-0.004	-0,005
74008	74010	G-184	250907	11.13	4.170	4,170	-0.006	-0,002
74005	74008	G-184	250907	11.55	-8.047	-8,047	-0.002	-0,005
74005	74010	G-184	250907	12.49	-3.860	-3,860	0.005	0,006
73033	74010	G-184	250907	13.27	6.336	6,336	0.003	0,000
73014	73033	G-184	250907	14.02	-13.708	-13,708	-0.008	-0,015
73014	73015	G-184	250907	14.36	-6.926	-6,926	0.000	-0,005
73012	73015	G-184	250907	15.14	13.875	13,875	0.001	0,004
73001	73012	G-184	250907	16.08	1.186	1,186	0.006	0,000

Table 3.28. *.TIE data array (2007.09.29) using different treatments

from	to	inst	date	time	dif		v	
					Treatment individually	Treatment combining	Treatment individually	Treatment combining
73001	73013	G-183	290907	5.07	-9.316	-9,318	0.007	0,007
73013	73018	G-183	290907	5.39	20.870	20,870	0.005	0,004
73018	73022	G-183	290907	6.15	5.345	5,345	0.006	0,010
63006	73022	G-183	290907	6.48	-19.184	-19,184	0.001	0,002
63006	64010	G-183	290907	7.31	-4.025	-4,025	0.005	0,003
64008	64010	G-183	290907	8.01	3.322	3,322	-0.006	-0,007
64008	74014	G-183	290907	8.32	-8.405	-8,405	0.005	0,008
74004	74014	G-183	290907	9.06	7.197	7,197	-0.007	-0,003
73022	74004	G-183	290907	9.41	-3.798	-3,798	-0.006	-0,009
73013	73022	G-183	290907	10.32	26.198	26,198	-0.003	0,000
73001	73013	G-183	290907	11.41	-9.336	-9,336	-0.009	-0,007
73001	73013	G-184	290907	5.09	-9.325	-9,321	0.012	0,004
73013	73018	G-184	290907	5.39	20.872	20,872	-0.004	0,006
73018	73022	G-184	290907	6.15	5.336	5,336	0.003	0,001
63006	73022	G-184	290907	6.48	-19.191	-19,191	-0.004	-0,005
63006	64010	G-184	290907	7.32	-4.020	-4,020	0.005	0,008
64008	64010	G-184	290907	8.01	3.328	3,328	-0.002	-0,001
64008	74014	G-184	290907	8.32	-8.409	-8,409	0.006	0,004
74004	74014	G-184	290907	9.07	7.187	7,187	-0.009	-0,013
73022	74004	G-184	290907	9.41	-3.790	-3,790	-0.006	-0,001
73001	73022	G-184	290907	10.32	26.208	16,854	0.002	-0,015

Table 3.29. *.TIE data array (2007.10.01) using different treatments

from	to	inst	date	time	dif		v	
					Treatment	Treatment	Treatment	Treatment

					individually	combining	individually	combining
73001	74004	G-183	11007	5.21	13.104	13,104	0.005	0,008
73030	74004	G-183	11007	6.07	-0.364	-0,364	-0.005	-0,004
73030	74026	G-183	11007	6.47	6.979	6,979	0.006	0,006
74024	74026	G-183	11007	7.23	-0.637	-0,637	-0.005	-0,006
74005	74024	G-183	11007	8.00	2.549	2,549	-0.005	-0,007
74005	74026	G-183	11007	8.42	1.930	1,930	0.007	0,004
74018	74026	G-183	11007	9.21	5.644	5,644	-0.004	-0,002
74013	74018	G-183	11007	9.55	1.062	1,062	-0.002	0,002
74013	74022	G-183	11007	10.37	-0.945	-0,945	0.004	0,009
73008	74022	G-183	11007	11.13	8.198	8,198	-0.005	-0,003
73008	74004	G-183	11007	11.49	8.534	8,534	0.001	0,003
74004	74010	G-183	11007	12.34	1.548	1,548	0.009	0,013
74009	74010	G-183	11007	13.04	-1.871	-1,871	-0.005	-0,002
73031	74009	G-183	11007	13.48	-8.275	-8,275	-0.006	-0,008
73031	83003	G-183	11007	14.32	5.099	5,099	0.006	0,005
73001	83003	G-183	11007	15.44	29.856	29,856	-0.006	-0,003
73001	74004	G-184	11007	5.21	13.107	13,107	0.012	0,010
73030	74004	G-184	11007	6.07	-0.363	-0,363	-0.003	-0,003
73030	74026	G-184	11007	6.47	6.981	6,981	0.009	0,008
74024	74026	G-184	11007	7.23	-0.638	-0,638	-0.007	-0,006
74005	74024	G-184	11007	8.00	2.553	2,553	-0.004	-0,003
74005	74026	G-184	11007	8.42	1.933	1,933	0.005	0,007
74018	74026	G-184	11007	9.21	5.634	5,634	-0.009	-0,011
74013	74018	G-184	11007	9.55	1.044	1,050	-0.008	-0,009
74013	74022	G-184	11007	10.37	-0.954	-0,954	0.009	0,000
73008	74022	G-184	11007	11.13	8.200	8,200	0.001	-0,001
73008	74004	G-184	11007	11.49	8.525	8,525	-0.004	-0,006
74004	74010	G-184	11007	12.34	1.537	1,537	0.006	0,002
74009	74010	G-184	11007	13.04	-1.876	-1,876	-0.004	-0,007
73031	74009	G-184	11007	13.48	-8.275	-8,275	-0.008	-0,007
73031	83003	G-184	11007	14.32	5.105	5,105	0.009	0,010
73001	83003	G-184	11007	15.44	29.851	29,851	-0.004	-0,007

Comparing the results of *.TIE data arrays we see that better results on all days are then, when the data are processed separately.

There are acceleration values of gravimeter network stations and their accuracy in the last *.TYN data array (Table 3.30-3.32).

Table 3.30. *.TYN data array (2007.09.25) using different treatments

stat	Fix g			sigma	adj g			v			
	G-183	G-184	G-183/ G-184		G-183	G-184	G-183/ G-184	G-183	G-184	G-183/ G-184	
73001	981459,086	981459,086	981459,086	0,005	981459,090	981459,095	981459,093	-0,004	-0,009	-0,007	VILNIUS
73006	981451,793	981451,793	981451,793	0,01	981451,786	981451,769	981451,778	0,007	0,024	0,015	MAISIAGAL A
74005	981477,599	981477,599	981477,599	0,01	981477,588	981477,585	981477,587	0,011	0,014	0,012	MOLETAI
73012	981460,283	981460,277	981460,281	0,004	Didzioji Riešė	Didžioji Riešė	Didžioji Riešė				
73013	981449,770	981449,764	981449,768	0,004	Dukstos	Dukstos	Dukstos				
73014	981481,070	981481,079	981481,075	0,004	Eitminiskes	Eitminiskes	Eitminiskes				
73015	981474,153	981474,152	981474,153	0,004	Europos centras	Europos centras	Europos centras				
73016	981457,090	981457,077	981457,084	0,004	Karvys	Karvys	Karvys				

73020	981469,326	981469,328	981469,327	0,004	Maseliskes	Maseliskes	Maseliskes				
73025	981470,501	981470,509	981470,505	0,004	Paberze	Paberze	Paberze				
73030	981440,984	981440,984	981440,985	0,004	Suderve	Suderve	Suderve				
73032	981444,613	981444,616	981444,608	0,004	Avizieniai	Avizieniai	Avizieniai				
73033	981467,383	981467,385	981467,380	0,004	Zemaiteliai	Zemaiteliai	Zemaiteliai				
74008	981469,547	981469,551	981469,542	0,004	Bijutiskis	Bijutiskis	Bijutiskis				
74010	981473,720	981473,719	981473,719	0,004	Giedraiciai	Giedraiciai	Giedraiciai				

2007.09.25	G-183	G-184	G-183/ G-184
Adjustment observations	222	219	433
Stations	15	15	15
total unknowns	17	17	19
SIGMA (single reading at apriori weighting	0.003	0.003	0.004

Table 3.31. *.TYN data array (2007.09.29) using different treatments

stat	Fix g			sigma	adj g			v			
	G-183	G-184	G-183/ G-184		G-183	G-184	G-183/ G-184	G-183	G-184	G-183/ G-184	
73001	981459,086	981459,086	981459,086	0,005	981459,089	981459,089	981459,089	-0,003	-0,003	-0,003	VILNIUS
74004	981472,185	981472,185	981472,185	0,01	981472,175	981472,173	981472,174	0,01	0,012	0,011	SIRVINT OS
63006	981495,150	981495,143	981495,147	0,005	Ciobiskis	Ciobiskis	Ciobiskis				
64008	981487,791	981487,786	981487,788	0,005	Bagaslaviski	Bagaslaviski	Bagaslaviski				
64010	981491,119	981491,117	981491,118	0,005	Gelvonai	Gelvonai	Gelvonai				
73013	981449,764	981449,750	981449,762	0,005	Dukstos	Dukstos	Dukstos				
73018	981470,628	981470,625	981470,627	0,005	Kernave	Kernave	Kernave				
73022	981475,966	981475,957	981475,962	0,005	Musninkai	Musninkai	Musninkai				
74014	981479,38	981479,370	981479,375	0,005	Krikstenai	Krikstenai	Krikstenai				

2007.09.29	G-183	G-184	G-183/ G-184
Adjustment observations	142	136	266
Stations	9	9	9
total unknowns	11	11	13
SIGMA (single reading at apriori weighting	0.002	0.004	0.003

Table 3.32. *.TYN data array (2007.10.01) using different treatments

stat	Fix g			sigma	adj g			v			
	G-183	G-184	G-183/ G-184		G-183	G-184	G-183/ G-184	G-183	G-184	G-183/ G-184	
73001	981459,086	981459,086	981459,086	0,005	981459,087	981459,090	981459,089	-0,001	-0,004	-0,003	VILNIUS
74005	981477,599	981477,599	981477,599	0,01	981477,594	981477,587	981477,591	0,005	0,012	0,008	MOLETAI
74004	981472,185	981472,185	981472,185	0,01	981472,185	981472,184	981472,184	0,000	0,001	0,001	SIRVINTO S
83003	981488,951	981488,951	981488,951	0,01	981488,950	981488,947	981488,949	0,001	0,004	0,002	PABRADE
73008	981463,653	981463,655	981463,654	0,004	Alionys	Alionys	Alionys I				
73030	981472,544	981472,543	981472,544	0,004	Suderve	Suderve	Suderve				
73031	981483,858	981483,852	981483,855	0,004	Suzionys	Suzionys	Suzionys				
74009	981475,589	981475,586	981475,588	0,004	Dubingiai	Dubingiai	Dubingiai				
74010	981473,723	981473,714	981473,719	0,004	Giedraiciai	Giedraiciai	Giedraiciai				
74013	981472,805	981472,818	981472,810	0,004	Kiaukliai	Kiaukliai	Kiaukliai				
74018	981473,869	981473,871	981473,870	0,004	Pusne	Pusne	Pusne				
74022	981471,856	981471,855	981471,855	0,004	Sesuoleliai	Sesuoleliai	Sesuoleliai				
74024	981480,149	981480,145	981480,147	0,004	Videniskiai	Videniskiai	Videniskiai				
74026	981479,517	981479,515	981479,516	0,004	Zelva	Zelva	Zelva				

2007.10.01	G-183	G-184	G-183/ G-184

Adjustment observations	194	194	382
Stations	14	14	14
total unknowns	16	16	16
SIGMA (single reading at apriori weighting	0.002	0.003	0.003

According to these *.TYN data arrays we see that the gravimeter G-184 do not measure so accurately as the gravimeter G-183. Results, wich were get by Gravimeter G-184, is even worse than these results, which were get by treatment combining. After the comparing different treatments we can see that better results are achieved when data of two gravimeters are treatment separately.

3.5. Comparison of results using different coefficients

Gravimetric data was processed not only with two different gravimeters on three days, but also with two different coefficients, which are using in reduction.

The first coefficient is taken before the measurements, another coefficient - is the average of two different coefficients before and after measurements. The results are shown in Table 3.33 – 3.41.

Table 3.33. *.RES data array (2007.09.25) using different coefficients

2007.09.25	Coef. before calibration		Average of calibration coef.	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.037	0.058	0.038	0.055
BIAS parameter	4114.466	4559.596	4115.139	4559.968
r.m.s. residuals	0.004	0.004	0.004	0.004

Table 3.34. *.RES data array (2007.09.29) using different coefficients

2007.09.29	Coef. before calibration		Average of calibration coef.	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.052	0.051	0.051	0.027
BIAS parameter	4116.395	4560.318	4117.069	4560.691
r.m.s. residuals	0.003	0.003	0.003	0.004

Table 3.35. *.RES data array (2007.10.01) using different coefficients

2007.10.01	Coef. before calibration		Average of calibration coef.	
	G- 183	G- 184	G- 183	G- 184
DRIFT parametre, mgal/day	0.015	0.030	0.015	0.030
BIAS parameter	4116.462	4560.380	4117.136	4560.752
r.m.s. residuals	0.003	0.003	0.003	0.003

From the *.RES data arrays we can see that better results are obtained by processing the data with average of the calibration coefficients.

Data of the string of measurement accuracy is shown in Table 3.36 - 3.38.

Table 3.36. *.TIE data array (2007.09.25) using different coefficients

from	to	inst	date	time	dif		v	
					Coef. before calibration	Average of calibration coef.	Coef. before calibration	Average of calibration coef.
73001	73032	G-183	250907	3,50	-14,472	-14.476	0,006	0.005

73030	73032	G-183	250907	4,23	3,625	3.626	-0,003	-0.002
73013	73030	G-183	250907	4,58	-8,792	-8.793	-0,008	-0.008
73006	73013	G-183	250907	5,35	-2,020	-2.020	-0,009	-0.009
73006	73016	G-183	250907	6,08	5,307	5.308	0,000	0.001
73012	73016	G-183	250907	6,53	-3,199	-3.197	-0,001	0.001
73001	73012	G-183	250907	7,54	1,185	1.186	-0,002	0.000
73001	73012	G-183	250907	8,47	1,202	1.202	0,013	0.013
73012	73025	G-183	250907	9,30	10,228	10.231	0,003	0.005
73020	73025	G-183	250907	10,01	1,173	1.330	-0,004	-0.008
73020	74010	G-183	250907	10,34	4,398	4.563	0,005	0.009
74008	74010	G-183	250907	11,13	4,160	4.160	-0,012	-0.013
74005	74008	G-183	250907	11,55	-8,044	-8.045	-0,003	-0.003
74005	74010	G-183	250907	12,49	-3,865	-3.866	0,001	0.001
73033	74010	G-183	250907	13,27	6,329	6.330	-0,007	-0.007
73014	73033	G-183	250907	14,02	-13,691	-13.693	0,002	0.001
73014	73015	G-183	250907	14,36	-6,909	-6.910	0,012	0.012
73012	73015	G-183	250907	15,14	13,862	13.864	-0,009	-0.009
73001	73012	G-183	250907	16,08	1,189	1.190	0,002	0.004
73001	73032	G-184	250907	3,50	-14,486	-14.487	-0,008	-0.007
73030	73032	G-184	250907	4,23	3,619	3.619	-0,009	-0.009
73013	73030	G-184	250907	4,58	-8,783	-8.784	0,001	0.001
73006	73013	G-184	250907	5,35	-2,010	-2.010	0,001	0.002
73006	73016	G-184	250907	6,08	5,311	5.312	0,004	0.005
73012	73016	G-184	250907	6,53	-3,206	-3.206	-0,008	-0.008
73001	73012	G-184	250907	7,59	1,170	1.167	-0,016	-0.018
73001	73012	G-184	250907	8,47	1,183	1.183	-0,007	-0.006
73012	73025	G-184	250907	9,30	10,239	10.240	0,013	0.013
73020	73025	G-184	250907	10,01	1,180	1.337	0,003	-0.001
73020	74010	G-184	250907	10,34	4,388	4.552	-0,005	-0.003
74008	74010	G-184	250907	11,13	4,170	4.170	-0,002	-0.002
74005	74008	G-184	250907	11,55	-8,047	-8.048	-0,005	-0.005
74005	74010	G-184	250907	12,49	-3,860	-3.860	0,006	0.006
73033	74010	G-184	250907	13,27	6,336	6.337	0,000	0.000
73014	73033	G-184	250907	14,02	-13,708	-13.709	-0,015	-0.015
73014	73015	G-184	250907	14,36	-6,926	-6.925	-0,005	-0.003
73012	73015	G-184	250907	15,14	13,875	13.876	0,004	0.003
73001	73012	G-184	250907	16,08	1,186	1.186	0,000	0.000

Table 3.37. *.TIE data array (2007.09.29) using different coefficients

from	to	inst	date	time	dif		v	
					Coef. before calibration	**Average of calibration coef.**	**Coef. before calibration**	**Average of calibration coef.**
73001	73013	G-183	290907	5,08	-9,318	-9.317	0,007	0.012
73013	73018	G-183	290907	5,39	20,870	20.873	0,004	0.001
73018	73022	G-183	290907	6,15	5,345	5.347	0,010	0.010
63006	73022	G-183	290907	6,48	-19,184	-19.187	0,002	0.001
63006	64010	G-183	290907	7,31	-4,025	-4.027	0,003	0.001
64008	64010	G-183	290907	8,01	3,322	3.323	-0,007	-0.006
64008	74014	G-183	290907	8,32	-8,405	-8.407	0,008	0.006
74004	74014	G-183	290907	9,06	7,197	7.202	-0,003	0.000
73022	74004	G-183	290907	9,41	-3,798	-3.798	-0,009	-0.008
73013	73022	G-183	290907	10,32	26,198	26.201	0,000	-0.005
73001	73013	G-183	290907	11,41	-9,336	-9.337	-0,007	-0.004
73001	73013	G-184	290907	5,07	-9,321	-9.322	0,004	0.008

73013	73018	G-184	290907	5,39	20,872	20.874	0,006	0.003
73018	73022	G-184	290907	6,15	5,336	5.335	0,001	-0.002
63006	73022	G-184	290907	6,48	-19,191	-19.192	-0,005	-0.005
63006	64010	G-184	290907	7,32	-4,020	-4.021	0,008	0.007
64008	64010	G-184	290907	8,01	3,328	3.328	-0,001	-0.001
64008	74014	G-184	290907	8,32	-8,409	-8.413	0,004	0.001
74004	74014	G-184	290907	9,07	7,187	7.194	-0,013	-0.008
73022	74004	G-184	290907	9,41	-3,790	-3.791	-0,001	-0.002
73001	73022	G-184	290907	11,46	16,854	26.211	-0,015	0.005

Table 3.38. *.TIE data array (2007.10.01) using different coefficients

from	to	inst	date	time	dif		v	
					Coef. before calibration	Average of calibration coef.	Coef. before calibration	Average of calibration coef.
73001	74004	G-183	11007	5,21	13,104	13.106	0,008	0.008
73030	74004	G-183	11007	6,07	-0,364	0.364	-0,004	0.004
73030	74026	G-183	11007	6,47	6,979	6.980	0,006	0.006
74024	74026	G-183	11007	7,23	-0,637	-0.637	-0,006	-0.006
74005	74024	G-183	11007	8,00	2,549	2.549	-0,007	-0.007
74005	74026	G-183	11007	8,42	1,930	1.930	0,004	0.004
74018	74026	G-183	11007	9,21	5,644	5.645	-0,002	-0.001
74013	74018	G-183	11007	9,55	1,062	1.062	0,002	0.002
74013	74022	G-183	11007	10,37	-0,945	-0.945	0,009	0.010
73008	74022	G-183	11007	11,13	8,198	8.200	-0,003	-0.002
73008	74004	G-183	11007	11,49	8,534	8.535	0,003	0.003
74004	74010	G-183	11007	12,34	1,548	1.548	0,013	0.013
74009	74010	G-183	11007	13,04	-1,871	-1.872	-0,002	-0.003
73031	74009	G-183	11007	13,48	-8,275	-8.277	-0,008	-0.009
73031	83003	G-183	11007	14,32	5,099	5.100	0,005	0.005
73001	83003	G-183	11007	15,44	29,856	29.861	-0,003	-0.001
73001	74004	G-184	11007	5,21	13,107	13.108	0,010	0.010
73030	74004	G-184	11007	6,07	-0,363	0.363	-0,003	0.003
73030	74026	G-184	11007	6,47	6,981	6.981	0,008	0.007
74024	74026	G-184	11007	7,23	-0,638	-0.638	-0,006	-0.006
74005	74024	G-184	11007	8,00	2,553	2.553	-0,003	-0.003
74005	74026	G-184	11007	8,42	1,933	1.933	0,007	0.007
74018	74026	G-184	11007	9,21	5,634	5.635	-0,011	-0.011
74013	74018	G-184	11007	9,57	1,050	1.051	-0,009	-0.008
74013	74022	G-184	11007	10,37	-0,954	-0.954	0,000	0.000
73008	74022	G-184	11007	11,13	8,200	8.202	-0,001	0.000
73008	74004	G-184	11007	11,49	8,525	8.525	-0,006	-0.007
74004	74010	G-184	11007	12,34	1,537	1.537	0,002	0.002
74009	74010	G-184	11007	13,04	-1,876	-1.876	-0,007	-0.006
73031	74009	G-184	11007	13,48	-8,275	-8.271	-0,007	-0.003
73031	83003	G-184	11007	14,32	5,105	5.106	0,010	0.011
73001	83003	G-184	11007	15,44	29,851	29.854	-0,007	-0.007

According to these *.TIE data arrays, we see that better results also are obtained by processing data with average of the calibration coefficients. The most accurate results were on 09.29 day, at least accurate – 09.25 day.

There are acceleration values of gravimeter network stations and their accuracy using different coefficients in the last *.TYN data array (Table 3.39-3.41).

Table 3.39. *.TYN data array (2007.09.25) using different coefficients

stat	Fix g		sigma	adj g		v		
	Coef. before calibration	Average of calibration coef.		Coef. before calibration	Average of calibration coef.	Coef. before calibration	Average of calibration coef.	
73001	981459,086	981459.086	0,005	981459,093	981459.093	-0,007	-0.007	VILNIUS
73006	981451,793	981451.793	0,01	981451,778	981451.777	0,015	0.016	MAISIAGALA
74005	981477,599	981477.599	0,01	981477,587	981477.589	0,012	0.010	MOLETAI
73012	981460,281	981460.280	0,004	Didžioji Riešė	Didzioji Riešė			
73013	981449,768	981449.766	0,004	Dukstos	Dukstos			
73014	981481,075	981481.077	0,004	Eitminiskes	Eitminiskes			
73015	981474,153	981474.154	0,004	Europos centras	Europos centras			
73016	981457,084	981457.083	0,004	Karvys	Karvys			
73020	981469,327	981469.167	0,004	Maseliskes	Maseliskes			
73025	981470,505	981470.506	0,004	Paberze	Paberze			
73030	981440,985	981440.982	0,004	Suderve	Suderve			
73032	981444,608	981444.611	0,004	Avizieniai	Avizieniai			
73033	981467,380	981467.383	0,004	Zemaiteliai	Zemaiteliai			
74008	981469,542	981469.547	0,004	Bijutiskis	Bijutiskis			
74010	981473,719	981473.721	0,004	Giedraiciai	Giedraiciai			

	Coef. before calibration	Average of calibration coef.
Adjustment observations	433	434
Stations	15	15
total unknowns	19	19
SIGMA (single reading at apriori weighting)	0.004	0.004

Table 3.40. *.TYN data array (2007.09.29) using different coefficients

stat	Fix g		sigma	adj g		v		
	Coef. before calibration	Average of calibration coef.		Coef. before calibration	Average of calibration coef.	Coef. before calibration	Average of calibration coef.	
73001	981459,086	981459.086	0,005	981459,089	981459.088	-0,003	-0.002	VILNIUS
74004	981472,185	981472.185	0,01	981472,174	981472.176	0,011	0.009	SIRVINTOS
63006	981495,147	981495.151	0,005	Ciobiskis	Ciobiskis			
64008	981487,788	981487.792	0,005	Bagaslaviski	Bagaslavisk			
64010	981491,118	981491.122	0,005	Gelvonai	Gelvonai			
73013	981449,762	981449.757	0,005	Dukstos	Dukstos			
73018	981470,627	981470.628	0,005	Kernave	Kernave			
73022	981475,962	981475.964	0,005	Musninkai	Musninkai			
74014	981479,375	981479.378	0,005	Krikstenai	Krikstenai			

	Coef. before calibration	Average of calibration coef.
Adjustment observations	266	267
Stations	95	9
total unknowns	13	13
SIGMA (single reading at apriori weighting)	0.003	0.003

Table 3.41. *.TYN data array (2007.10.01) using different coefficients

stat	Fix g		sigma	adj g		v		
	Coef. before calibration	Average of calibration		Coef. before calibration	Average of calibration	Coef. before calibration	Average of calibration	

		coef.			coef.		coef.	
73001	981459,086	981459.086	0,005	981459,089	981459.088	-0,003	-0.002	VILNIUS
74005	981477,599	981477.599	0,01	981477,591	981477.592	0,008	0.007	MOLETAI
74004	981472,185	981472.185	0,01	981472,184	981472.185	0,001	0.000	SIRVINTOS
83003	981488,951	981488.951	0,01	981488,949	981488.951	0,002	0.000	PABRADE
73008	981463,654	981463.653	0,004	Alionys I	Alionys I			
73030	981472,544	981483.856	0,004	Suderve	Suzionys			
73031	981483,855	981475.589	0,004	Suzionys	Dubingiai			
74009	981475,588	981473.719	0,004	Dubingiai	Giedraiciai			
74010	981473,719	981472.811	0,004	Giedraiciai	Kiaukliai			
74013	981472,810	981473.871	0,004	Kiaukliai	Pusne			
74018	981473,870	981471.856	0,004	Pusne	Sesuoleliai			
74022	981471,855	981472.544	0,004	Sesuoleliai	Sesuoliai			
74024	981480,147	981480.148	0,004	Videniskiai	Videniskiai			
74026	981479,516	981479.517	0,004	Zelva	Zelva			

	Coef. before calibration	Average of calibration coef.
Adjustment observations	382	380
Stations	14	14
total unknowns	16	18
SIGMA (single reading at apriori weighting)	0.003	0.003

After the processing we see that in the *.TYN data arrays the results also is better when average of the calibration coefficients were used. Thus, to sum up all the results we can conclude that in order to obtain accurate results we have to use average of calibration coefficients.

3.6. Accuracy Assessment

Both systematic and random errors are in the results of the gravimetric measurements. Gravimetric measurement has its own characteristics - gravimeters zero-slip. It is therefore necessary for measuring the results of treatment methods which can be effectively eliminated in a variety of measurement errors. Appropriate treatment methods of measuring results is necessary for effective measurements corrections elimination.

One of the most important data is acceleration of gravity . Results are shown in Table 3.42 - 3.44 and Fig. 3.18.

Table 3.42. Acceleration of gravity 2007.09.25

Locality	**Gravimeter Nr.183**	**Gravimeter Nr.184**	**Differences between two gravimeters**
Didžioji Riešė	981460,283	981460,277	0,006
Dūkštos	981449,770	981449,764	0,006
Eitminiškės	981481,070	981481,079	-0,009
Europos centras	981474,153	981474,152	0,001
Karvys	981457,090	981457,077	0,013
Maseliškės	981469,326	981469,328	-0,002
Paberžė	981470,501	981470,509	-0,008
Sudervė	981440,984	981440,984	0
Avižieniai	981444,616	981444,608	0,008
Žemaitėliai	981467,385	981467,380	0,005

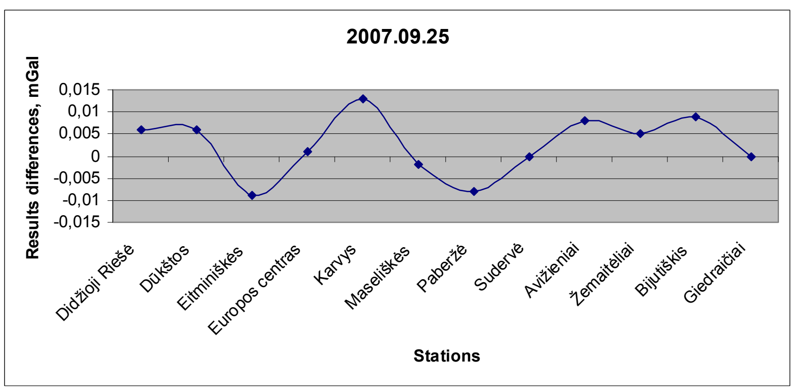
Bijutiškis	981469,551	981469,542	0,009
Giedraičiai	981473,719	981473,719	0

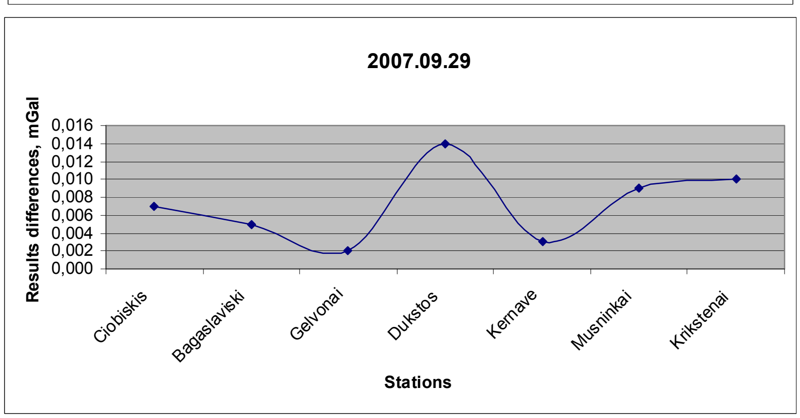
Table 3.43. Acceleration of gravity 2007.09.29

Locality	Gravimeter Nr.183	Gravimeter Nr.184	Differences between two gravimeters
Ciobiskis	981495,150	981495,143	0,007
Bagaslaviski	981487,791	981487,786	0,005
Gelvonai	981491,119	981491,117	0,002
Dukstos	981449,764	981449,750	0,014
Kernave	981470,628	981470,625	0,003
Musninkai	981475,966	981475,957	0,009
Krikstenai	981479,380	981479,370	0,010

Table 3.44. Acceleration of gravity 2007.10.01

Locality	Gravimeter Nr.183	Gravimeter Nr.184	Differences between two gravimeters
Alionys	981463,653	981463,655	-0,002
Suderve	981472,544	981472,543	0,001
Suzionys	981483,858	981483,852	0,006
Dubingiai	981475,589	981475,586	0,003
Giedraiciai	981473,723	981473,714	0,009
Kiaukliai	981472,805	981472,818	-0,013
Pusne	981473,869	981473,871	-0,002
Sesuoleliai	981471,856	981471,855	0,001
Videniskiai	981480,149	981480,145	0,004
Zelva	981479,517	981479,515	0,002





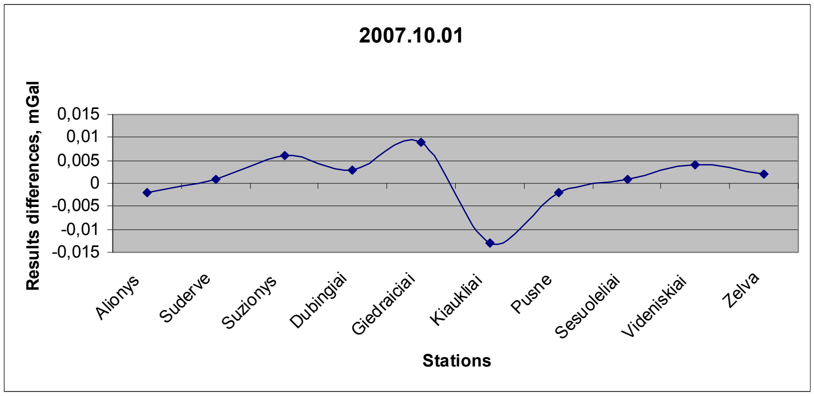


Fig. 3.18. Results differences between reduced data of two gravimeters

From these figures we can see that the differences between two gravimeters continually evolved unevenly. The best results were achieved in the 01/10/2007 date.

Also there were examined values of gravity, which were obtained using different coefficients. The results are shown in the tables below (Table 3.45-3.47) and Fig. 3.19.

Table 3.45. Values of gravity (2007.09.25) using average of the calibration coefficients

Locality	Gravimeter Nr.183	Gravimeter Nr.184	Differences between two gravimeters
Didžioji Riešė	981460,283	981460,277	0,006
Dūkštos	981449,769	981449,763	0,006
Eitminiškės	981481,072	981481,081	-0,009
Europos centras	981474,155	981474,153	0,002
Karvys	981457,089	981457,077	0,012
Maseliškės	981469,166	981469,168	-0,002
Paberžė	981470,502	981470,509	-0,007
Sudervė	981440,981	981440,983	-0,002
Avižieniai	981444,614	981444,607	0,007
Žemaitėliai	981467,386	981467,380	0,006
Bijutiškis	981469,552	981469,542	0,010
Giedraičiai	981473,721	981473,720	0,001

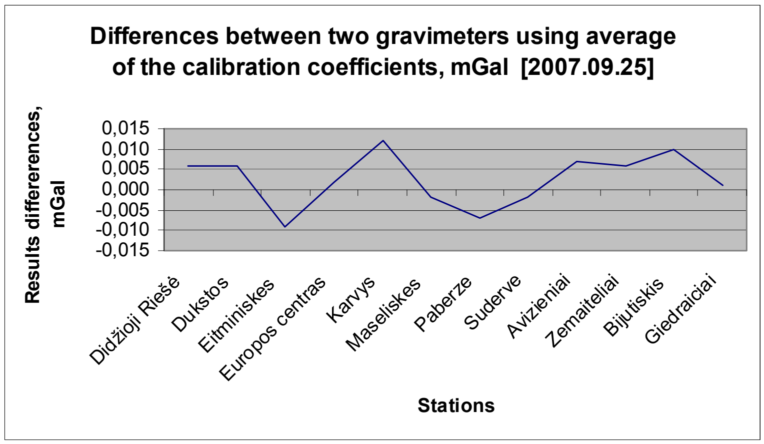
Table 3.46. Values of gravity (2007.09.29) using average of the calibration coefficients

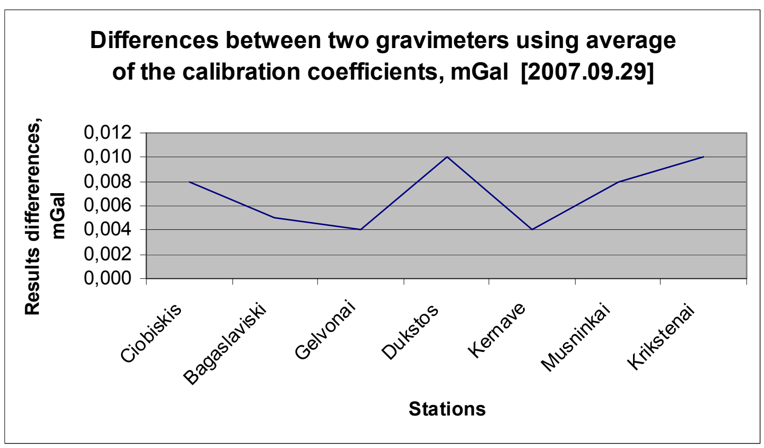
Locality	Gravimeter Nr.183	Gravimeter Nr.184	Differences between two gravimeters
Čiobiškis	981495,155	981495,147	0,008
Bagaslaviškis	981487,795	981487,790	0,005
Gelvonai	981491,124	981491,120	0,004
Dūkštos	981449,762	981449,752	0,010
Kernavė	981470,630	981470,626	0,004
Musninkai	981475,968	981475,960	0,008
Krikštėnai	981479,383	981479,373	0,010

Table 3.47. Values of gravity (2007.10.01) using average of the calibration coefficients

Locality	Gravimeter Nr.183	Gravimeter Nr.184	Differences between two gravimeters
Alionys I	981463,652	981463,654	-0,002

Sudervė	981483,860	981483,851	0,009
Sužionys	981475,591	981475,586	0,005
Dubingiai	981473,724	981473,715	0,009
Giedraičiai	981472,806	981472,817	-0,011
Kiaukliai	981473,869	981473,872	-0,003
Pusnė	981471,856	981471,855	0,001
Šešuolėliai	981472,545	981472,543	0,002
Videniškiai	981480,151	981480,146	0,005
Želva	981479,519	981479,515	0,004





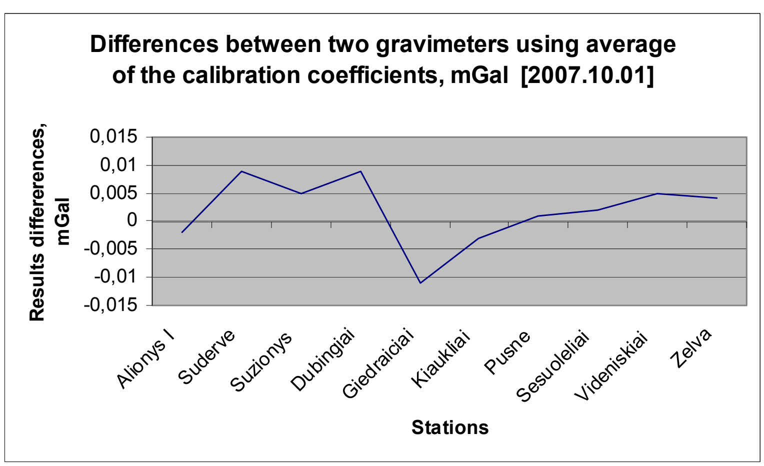


Fig. 3.19. Differences between two gravimeters using average of the calibration coefficients

After the comparing values of gravity we see that better results were those, in which average of the calibration coefficients were used.

With appropriate measurements results we can assess the accuracy of a single measurement. Two cases can be in assessing the accuracy of the results:

a) Values, measured in the same accuracy (then the differences will be same accuracy too).

b) Values, measured in different accuracy (then the differences will be different accuracy).

For every measurement there must be determined boundaries of accuracy. After processing the results, I got a wide variety of corrections. A lot of homogeneous sizes are measuring twice during the surveying work. After data processing the results was values of gravity. They were measured with two gravimeters in the same station, so it was made a results differences of double measurements (Table 3.48 – 3.50).

Table 3.48. Accurate assessment of both gravity 2007.09.25

Station	Coef. before calibration		Average of calibration coef.	
	$d_i, \mu Gal$	$d_i^2, \mu Gal$	$d_i, \mu Gal$	$d_i^2, \mu Gal$
73012	-6	36	-6	36
73013	-6	36	-6	36
73014	9	81	9	81
73015	-1	1	-2	4
73016	-13	169	-12	144
73020	2	4	2	4
73025	8	64	7	49
73030	0	0	2	4
73032	-8	64	-7	49
73033	-5	25	-6	36
74008	-9	81	-10	100
74010	0	0	-1	1
∑=12		**561**		**544**

Table 3.49. Accurate assessment of both gravity 2007.09.29

Station	Coef. before calibration		Average of calibration coef.	
	$d_i, \mu Gal$	$d_i^2, \mu Gal$	$d_i, \mu Gal$	$d_i^2, \mu Gal$
63006	-7	49	-8	64
64008	-5	25	-5	25
64010	-2	4	-4	16
73013	-14	196	-10	100
73018	-3	9	-4	16
73022	-9	81	-8	64
74014	-10	100	-10	100
∑=7		**464**		**385**

Table 3.50. Accurate assessment of both gravity 2007.10.01

Station	Coef. before calibration		Average of calibration coef.	
	$d_i, \mu Gal$	$d_i^2, \mu Gal$	$d_i, \mu Gal$	$d_i^2, \mu Gal$
73008	2	4	2	4

73030	-1	1	-9	81
73031	-6	36	-5	25
74009	-3	9	-9	81
74010	-9	81	11	121
74013	13	169	3	9
74018	2	4	-1	1
74022	-1	1	-2	4
74024	-4	16	-5	25
74026	-2	4	-4	16
∑=10		**325**		**367**

- Root mean square of double measurements using coefficient before calibration:

2007.09.25 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{561}{24}}$ =4,83 μGal .

2007.09.29 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{464}{14}}$ =5,76 μGal .

2007.10.01 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{325}{20}}$ =4,03 μGal .

here: d_i – number of double measurements;

n – number of stations.

- Root mean square of double measurements using average of calibration coefficient:

2007.09.25 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{544}{24}}$ =4,76 μGal .

2007.09.29 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{385}{14}}$ =5,24 μGal .

2007.10.01 $m_x = \sqrt{\frac{\sum d_i^2}{2n}} = \sqrt{\frac{367}{20}}$ =4,28 μGal .

here: d_i – number of double measurements;

n – number of stations.

- Root mean square of the single measurement using coefficient before calibration:

2007.09.25 $m_{\bar{x}} = \frac{m_x}{\sqrt{2}}$ =3,42 μGal .

2007.09.29 $m_{\bar{x}} = \frac{m_x}{\sqrt{2}}$ =4,07 μGal .

2007.10.01 $m_{\bar{x}} = \dfrac{m_x}{\sqrt{2}}$ =2,85 μGal .

- Root mean square of the single measurement using average of calibration coefficient:

2007.09.25 $m_{\bar{x}} = \dfrac{m_x}{\sqrt{2}}$ =3,37 μGal .

2007.09.29 $m_{\bar{x}} = \dfrac{m_x}{\sqrt{2}}$ =3,71 μGal .

2007.10.01 $m_{\bar{x}} = \dfrac{m_x}{\sqrt{2}}$ =3,03 μGal

After analysis of the results, conclusion is this: both root mean squares of the single measurement and of the double measurements on 2007.09.29 ir 2007.09.25 were better using average of calibration coefficient, and on 2007.10.01 - using coefficient before calibration.

MAIN RESULTS

1. Databases for the gravimetric data analysis were created.
2. Analysis of the gravimetric measurements was carried out. Standart deviations of references does not exceed 0,12 mGal, in most cases standart deviations have been evolved in a 0,02 – 0,05 range. The biggest corrections were in these stations: Vilnius, Kernavė, Molėtai, Širvintos.
3. Changes of references were analyzed. Values were close to 15 μGal /10 minutes. During the measurements it is necessary to check quality of measurements according to speed of references changes with gravimeter Scintrex CG-5.
4. For the measurements evaluation it is appropriate to make graphs of the reduced references differences of two gravimeters.
5. Such comparisons were carried out: what results can be obtained by disposing the worst data of the data arrays; adjustments of measurements data were carried out in two ways: first data was processed for each indivudual gravimeters, later measurement data was processed combining reduced references of two gravimeters. Also gravimetric data was processed with two different coefficients. Differences of the gravity acceleration due to the different treatments max was 2 μGal.
6. Root mean square of double measurements was from 4,03 till 5,76 μGal. Correction of single measurement – 3-4 μGal.

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Accessories

MENIU.PRG

```
***meniu programavimas***
CLEAR
SET COLOR TO R+/N
CLEAR
SET ECHO OFF
SET TALK OFF
SET MOUSE ON
SET ESCAPE ON
@ 0,0 TO 24,85 DOUB
@ 1,16 TO 6,75 DOUB
@ 2,21 SAY "VILNIUS GEDIMINAS
TECHNICAL UNIVERSITY" COLOR GR+/N
@ 3,26 SAY " Faculty of
Environmental Engineering" COLOR
GR+/N
@ 4,25 SAY "  Department of
Geodesy and Cadastre" COLOR GR+/N
@ 12,18 SAY "DATABASES OF
GRAVIMETRIC DATA ANALYSIS" COLOR
GR+/N
@ 16,44 SAY "    MADE BY: GTLmf-09
group's student" COLOR GR+/N
@ 17,58 SAY "        Ovidija
Čepaitė          " COLOR GR+/N
@ 21,38 SAY "       2011
" COLOR GR+/N
@ 24,38 SAY "If you want to start,
please press any button"
WAIT""
***********************************
**
CLEAR
SET ECHO OFF
SET TALK OFF
SET MOUSE ON
@ 0,0 TO 19,79 DOUB COLOR GR+/N
@ 1,25 SAY "LIST OF MAIN COMMANDS"
COLOR GR+/N
*@ 20,40 SAY "O.Čepaitė" COLOR
GR+/B
Define Menu GEO
Define PAD Pirmas of GEO;
Prompt "\<TASKS" at 7,2;
Key ALT+U,''
Define PAD Antras of GEO;
Prompt "\<DATA: " at 7,13 ;
Key ALT+R,''
Define PAD Trecias of GEO;
Prompt "\<INFORMATION ABOUT:" at
7,25 ;
Key ALT+V,''
Define PAD Ketvirtas of GEO;
Prompt "\<CREATOR" at 7,51 ;
Key ALT+Z,''
Define PAD Penktas  of GEO;
Prompt "\<ENDING" at 7,65 ;
Key ALT+A,''
***********************************
**
On Pad Pirmas of GEO activate
Popup Vienas
On Pad Antras of GEO activate
Popup Du
On Pad Trecias of GEO activate
Popup Trys
On Pad Ketvirtas of GEO activate
Popup Keturi
On Pad Penktas of GEO activate
Popup Penki
***********************************
**
Define Popup Vienas Margin
Relative Shadow Color Scheme 3
Define Bar 1 of Vienas Prompt
"1.Resolution of inverse geodetic
problems "
Define Bar 2 of Vienas Prompt
"2.Resolution of gravimetric
reduced data"
On Selection Popup Vienas do GEO1
***********************************
**
Define Popup Du Margin Relative
Shadow Color Scheme 3
Define Bar 1 of Du Prompt
"ENTERING"
Define Bar 2 of Du Prompt
"EDITING"
Define Bar 3 of Du Prompt
"ERASING"
Define Bar 4 of Du Prompt
"SEARCHING"
Define Bar 5 of Du Prompt
"REVIEWING"
On Selection Popup Du do GEO2
***********************************
**
Define Popup Trys Margin Relative
Shadow Color Scheme 3
Define Bar 1 of Trys Prompt
"PROGRAMME"
Define Bar 2 of Trys Prompt
"ENTERING"
Define Bar 3 of Trys Prompt
"EDITING"
Define Bar 4 of Trys Prompt
"ERASING"
Define Bar 5 of Trys Prompt
"SEARCHING"
Define Bar 6 of Trys Prompt
"REVIEWING"
On Selection Popup Trys do GEO3
***********************************
**
Define Popup Keturi Margin
Relative Shadow Color Scheme 3
Define Bar 1 of Keturi Prompt
"Programme is created by"

On Selection Popup Keturi do GEO4
***********************************
**
Activate Menu GEO
Define Popup Penki Margin Relative
Shadow Color Scheme 3
Define Bar 1 of Penki Prompt "GO
OUT"
On Selection Popup Penki do GEO5
***********************************
**
Activate Menu GEO
Deactivate Menu GEO
Set Sysmenu to default
On key Label ESC
***********************************
**
Procedure GEO1
Hide popup Vienas
Hide Menu GEO
Clear
Do Case
***********************************
**
Case Bar()=1
Define window Ok from 2,0 to
100,150 color N/W*
Activate Window OK
Do inverse_task.prg
deactivate Window OK
***********************************
**
Case Bar()=2
Define window Ok from 2,0 to
100,150 color N/W*
Activate Window OK
Do ovidijos_programme.prg
deactivate Window OK
endcase
Return
***********************************
**
Procedure GEO2
Hide popup DU
Hide Menu GEO
Clear
Do Case
***********************************
**
Case Bar()=1
Do entering.prg
***********************************
**
Case Bar()=2
Do  editing.prg
***********************************
**
Case Bar()=3
Do erasing.prg
***********************************
**
Case Bar()=4
Do  searching.prg
***********************************
**
Case Bar()=5
Do reviewing.prg
***********************************
**
Endcase
Return
*Eof
***********************************
**
Procedure GEO3
Hide popup TRYS
Hide Menu GEO
Clear
Do Case
***********************************
**
Case Bar()=1
Define window Ok from 2,2 to
18,66 Color N/W*
Activate Window OK
TEXT           ABOUT THE
PROGRAMME
                    To call a
help meniu - press button F1 at
any time.
Help list will be on the right
screen side. Desirable
paragraph can be choosen by
sliding arrows. All main
programmes meniu paragraphs are
included in the HELP
list. IF the page cannot
contain all the text of help,
it could be continue by pushing
any button.
                    Ruturn to
programme press ESC button.

  ENDTEXT
  Wait ""
  deactivate Window OK
*******************************
*******************************
***
 Case Bar()=2
  Define window Ok from 2,2 to
18,67 Color N/W*
  Activate Window OK
  TEXT
  ENTERING
  Initial data could be entered
by this part of programme.
Data entering meniu gives
opportunity to choose which
data
you want to enter.
                    If you want
to review files, you can use
these buttons:
 Esc - go out and do not save
data;
 Ctrl+End - go out and save
data;
   Tab - moving foward on the
squares;
   Shift+Tab - moving back on
the squares;
   Home - go to first square;
 End - go to last square
  ENDTEXT
  Wait ""
  deactivate Window OK
*******************************
*****
 Case Bar()=3
  Define window Ok from 2,2 to
21,68 Color N/W*
  Activate Window OK
  TEXT
  EDITING
  Initial data could be edited
in this part of programme.
Programme gives you editing
meniu, in which you could edit
file's contents in turn or by
your choice.
To edit initial data you can
use these buttons:
 Esc - go out and do not save
data;
   Ctrl+End - go out and save
data;
   Tab - moving foward by the
squares;
   Shift+Tab - moving back by
the squares;
   Home - go to first square;
   End - go to last square
                     PgUp -
return to last editing item;
                      PgDn - go
to the next item.

  ENDTEXT
  Wait ""
  deactivate Window OK
*******************************
****
 Case Bar()=4
  Define window Ok from 2,2 to
17,70 Color N/W*
  Activate Window OK
  TEXT
  ERASING
  Initial data could be erased
in this part of programme.
Data erasing meniu gives
opportunity to choose what data
you want to erase.
                  IF you want
to go out and do not save
data, you can press
button Esc.
   ENDTEXT
  Wait ""
  deactivate Window OK
*****************************
*******
 Case Bar()=5
    Define window Ok from 2,2
to 15,64 Color N/W*
  Activate Window OK
  TEXT
  SEARCHING
  This part of programme let
you search some data.
Data searching meniu gives
opportunity to choose what
data
you want to search.
                  Go out from
searching meniu press the
button Esc.
  ENDTEXT
  Wait ""
  deactivate Window OK
*****************************
*******
 Case Bar()=6
  Define window Ok from 2,2
to 16,64 Color N/W*
  Activate Window OK
  TEXT          REVIEWING
  This part of programme let
you review some data,
which were entered or edited
previously in data bases.
                  To review
data you can use these
buttons:
 Esc - return to previous
list;
   PgUp - review foward;
   PgDn - review back.
     ENDTEXT
  Wait ""
  deactivate Window OK
  endcase
*****************************
*******
Procedure GEO4
Hide popup Keturi
Hide Menu GEO
Clear
Do Case
*****************************
*******
  Case Bar()=1
  Define window Ok from 2,2
to 15,30 Color N/W*
  Activate Window OK
  TEXT
  NAME: Ovidija
SURNAME: Cepaite
DATE OF BIRTH: 1987.02.24
RECIDENCE : Vilnius
EDUCATION INSTITUTION: VGTU
COURSE: 2 (master)
GROUP: GTLmf-09
  ENDTEXT
  Wait ""
  deactivate Window OK
endcase
*****************************
*******
Procedure GEO5
Hide popup Penki
Hide Menu GEO
quit
return
```

OVIDIJOS_PROGRAMME.PRG

```
**************GRAVIMETRINIS**
************
CLEAR
SET COLOR TO R+/N
CLEAR
SET ECHO OFF
set talk off
SET DECIMALS TO 16
set cursor on
OVI="Y"
DO WHILE OVI="Y"
@ 1,1 TO 5,77 DOUB COLOR
RB/RB
@ 2,5 SAY " * * * *
RESOLUTION OF GRAVIMETRIC
REDUCED DATA * * * * " COLOR
W++++/G+
@ 3,15 SAY "Programme is
created by: GTLmf-09 gr.st.
OVIDIJA CEPAITE" COLOR W+/N+
@ 6,6 SAY "Please enter
station's geodetic
coordinates"
STORE 0 TO Lat,Long
STORE 0 TO Alt
STORE 0 TO GRAV
STORE 0 TO SD
STORE 0 TO Tilt_X,Tilt_Y
STORE 0 TO Temp
STORE 0 TO Tide
STORE 0 TO DUR
STORE 0 TO h,m,s
STORE 0 TO Time_date
STORE 0 TO TERRAIN
STORE 0 TO Year,month,day
**
Lat=54.7210846
Long=25.3373337
Alt=147.7570
GRAV=4576.501
SD=0.038
Tilt_X=-1.8
Tilt_Y=0.6
Temp=-1.96
Tide=-0.092
DUR=55
h=02
m=53
s=37
Time_date=2764.12037
TERRAIN=0.0000
Year=2007
Month=09
Day=25
**
SN="Y"
DO WHILE SN="Y"
@ 7,5 TO 34,75 double
@ 8,6 SAY "Geodetic latitude
Lat and longitude
Long,(degrees)"
@ 9,8 SAY "Lat=" GET Lat
PICTURE" ##.#######  "
@ 9,28 SAY "Long=" GET Long
PICTURE" ##.#######  "
@ 10,6 SAY "Altitude (ALT,
m)"
@ 11,8 SAY "Alt=" GET Alt
PICTURE" ###.####  "
@ 12,6 SAY "Reference of
gravimeter (GRAV, mGal)"
@ 13,8 SAY "GRAV=" GET GRAV
PICTURE" ####.###  "
@ 14,6 SAY "Correction (SD,
mGAL)"
@ 15,8 SAY "SD=" GET SD
PICTURE" #.###  "
@ 16,6 SAY "Correction of X
and Y axes tilt (tilt_X and
tilt_Y, mikroGAL)"
@ 17,8 SAY "Tilt_X=" GET
Tilt_X PICTURE" ##.#  "
@ 17,28 SAY "Tilt_Y=" GET
Tilt_Y PICTURE" ##.#  "
@ 18,6 SAY "Correction of
temperature's differences
(Temp, mikroGAL)"
@ 19,8 SAY "Temp=" GET Temp
PICTURE" ##.##  "
@ 20,6 SAY "Correction of
Lunar and Solar
attraction(Tide, mGAL)"
@ 21,8 SAY "Tide=" GET Tide
PICTURE" ##.###  "
@ 22,6 SAY "Measurement's
duration (DUR, s)"
@ 23,8 SAY "DUR=" GET DUR
PICTURE" ##  "
@ 24,6 SAY "Measurement's
time,(h.m.s)"
@ 25,8 SAY "h=" GET h
PICTURE" ##  "
@ 25,18 SAY "m=" GET m
PICTURE" ##  "
@ 25,28 SAY "s=" GET s
PICTURE" ##  "
@ 26,6 SAY "Measurement's
time by days (Time_date, p)"
@ 27,8 SAY "Time_date=" GET
Time_date PICTURE"
####.#####  "
@ 28,6 SAY "Correction of
terrain (TERRAIN)"
@ 29,8 SAY "TERRAIN=" GET
TERRAIN PICTURE"  #.####  "
@ 30,6 SAY "Measurement's
DATE (y.m.d)"
@ 31,8 SAY "Year=" GET Year
PICTURE"  ####  "
@ 31,25 SAY "Month=" GET
Month PICTURE"  ##  "
@ 31,40 SAY "Day=" GET Day
PICTURE"  ##  "
READ
**
SN="N"
@ 35,6 SAY "Correct data?
(Y\N)" GET SN PICTURE"Y"
COLOR W+/R*
READ
SN=UPPER(SN)
ENDDO
*****SKAICIAVIMAI*****
redB=Lat+tide
redL=Long+tide
redGRAV=(GRAV*0.999524)+tide
*****************************
******
clear
@ 4,47 SAY "RESULTS" COLOR
W+/G
@ 6,46 TO 16,72 DOUBLE COLOR
W*/R+
@ 7,49 SAY "Reduced latitude"
@ 8,49 SAY "redB="
@ 8,55 SAY redB PICTURE
"##.#######"
@ 10,49 SAY "Reduced
longitude"
@ 11,49 SAY "redL="
@ 11,55 SAY redL PICTURE
"##.#######"
@ 13,49 SAY "Reduced grav"
@ 14,49 SAY "redGRAV="
@ 14,60 SAY redGRAV PICTURE
"####.####"
********
SN="Y"
@ 21,8 say "SAVE DATA IN DATA
BASES? (Y/N)" GET SN PICTURE
"Y" COLOR GR+/N+
READ
SN=UPPER(SN)
IF SN="Y" THEN
@23,10 SAY 'Y - TO THE NEW
DB?    ' COLOR GR+/N+
@25,10 SAY 'N - TO ALREADY
EXISTING DB' COLOR GR+/N+
NE=SPACE(1)
@24,8 GET NE PICTURE "Y"
READ
NE=UPPER(NE)
****
IF NE="N" THEN
@27,12 SAY "OLD FILE:"
color gr+/n
FILEE=SPACE(8)
@27,30 GET FILEE
READ
CDFFILE=ALLTRIM(FILEE)+'.DB
F'

IF FILE (CDFFILE)
CLOSE DATABASES
USE &FILEE
GO TOP
APPEND BLANK
REPLACE B WITH lat,L WITH
Long,aAlt WITH alt,gGrav
WITH GRAV,sSD WITH SD,dX
WITH tilt_X,dY WITH tilt_Y;
tTemp WITH temp,tTide WITH
tide,dDur WITH DUR,hh WITH
h,mm WITH m,ss WITH s,PP
WITH time_date;
tTerrain WITH TERRAIN,yYear
WITH year,mMonth WITH
month,dDay WITH day,rB WITH
redB,rL WITH redL,rGRAV
WITH redGRAV
CLOSE DATABASES
ELSE
@ 28,12 SAY "THIS FILE DOES
NOT EXIST" color RB/N
WAIT"PRESS ANY BUTTON"
ENDIF
ENDIF
****
IF NE="Y" THEN
@26,12 SAY "NEW FILE:"
color g/n
FILE=SPACE(8)
@26,30 GET FILE
READ
CDFFILE=ALLTRIM(FILE)+'.DBF
'
IF FILE (CDFFILE)
@ 29,13 SAY "THIS FILE IS
ALREADY EXIST" color g*/n
WAIT""
ELSE
CLOSE DATABASE
CREATE TABLE &FILE;
(B N(10,7),L N(10,7),aAlt
N(8,4),gGrav N(8,3),sSd
N(5,3),dX N(3,1),dY
N(4,1),;
tTemp N(5,2),tTide
N(6,3),dDur N(2),hh N(1),mm
N(1),ss N(2),PP
N(10,5),tTerrain N(6,4),;
yYear N(4),mMonth N(1),dDay
N(2),rB N(10,7),rL
N(10,7),rGRAV N(8,3))
USE &FILE
APPEND BLANK
REPLACE B WITH lat,L WITH
Long,aAlt WITH alt,gGrav
WITH GRAV,sSD WITH SD,dX
WITH tilt_X,dY WITH
tilt_Y,tTemp WITH
temp,tTide WITH tide,dDur
WITH DUR,hh WITH h,mm WITH
m,ss WITH s,PP WITH
time_date,tTerrain WITH
TERRAIN,yYear WITH
year,mMonth WITH month,dDay
WITH day,rB WITH redB,rL
WITH redL,rGRAV WITH
redGRAV
CDFFILE=ALLTRIM(FILE)+'.CDF
'
COPY TO &CDFFILE TYPE
DELIMITED
CLOSE DATABASES
ENDIF
ENDIF
ENDIF
OVI="N"
@ 32,8 say "COUNT
MORE DATA? " COLOR
GR+/N+
@ 34,8 GET OVI
FUNCTION '*TH Y;N'
SIZE 1.5,10 COLOR B/R
READ
OVI=UPPER(OVI)
CLEAR
ENDDO
RETURN
*************
```

3rd ANNEX

ENTERING.PRG

```
*DUOMENU IVEDIMO PROGRAMA

DEFINE POPUP ivedimas
MARGIN RELATIVE SHADOW
COLOR SCHEME 4
DEFINE BAR 1 OF ivedimas
PROMPT " _____ I N T R O D
U C E   M E N U _____ "
DEFINE BAR 2 OF ivedimas
PROMPT " ------------------
----------------"
DEFINE BAR 3 OF ivedimas
PROMPT "  INTODUCE DATA,
WHICH IS CONCERNED WITH: "
COLOR R+/W* SKIP
DEFINE BAR 4 OF ivedimas
PROMPT "  - INITIAL DATA -
"
DEFINE BAR 5 OF ivedimas
PROMPT "  - STATIONS - "
DEFINE BAR 6 OF ivedimas
PROMPT "  - WORKERS - "
CLEAR
**********
ON SELECTION POPUP ivedimas
DO procedura
ACTIVATE POPUP ivedimas
RETURN
*******
PROCEDURE procedura
DO CASE
CASE BAR()=4
DO PROG1
```

```
CASE BAR()=5
DO PROG2
CASE BAR()=6
DO PROG3
ENDCASE
RETURN
*Duomenu apie pataisas
ivedimas
PROCEDURE PROG1
SELECT A
USE Initial
HIDE POPUP ivedimas
CLEAR
APPEND BLANK
set format to 1table.fmt
READ
SET FORMAT TO
read
okcancel=1
@15,20 say"Enter more data?"
COLOR GR+/N
@14,18 TO 22,41 DOUB COLOR W
@18,20 get okcancel FUNCTION
'*V YES;NO' SIZE 1,10,1
Read
if okcancel=1
SA="Y"
else
SA="N"
WAIT WINDOW 'atsaukta'
Endif
clear
RETURN
```

```
*Duomenu apie punktus
ivedimas
PROCEDURE PROG2
SELECT B
USE Stations
HIDE POPUP ivedimas
CLEAR
APPEND BLANK
set format to 2table.fmt
READ
SET FORMAT TO
read
okcancel=1
@15,20 say"Enter more
data?" COLOR GR+/N
@14,18 TO 22,41 DOUB COLOR
W
@18,20 get okcancel
FUNCTION '*V YES;NO' SIZE
1,10,1
Read
if okcancel=1
SA="Y"
else
SA="N"
WAIT WINDOW 'atsaukta'
Endif
clear
RETURN
*Duomenu apie matuotojus
ivedimas
PROCEDURE PROG3
SELECT C
```

```
USE Workers
HIDE POPUP
ivedimas
CLEAR
APPEND BLANK
set format to
3table.fmt
READ
SET FORMAT TO
READ
okcancel=1
@15,20 say"Enter
more data?" COLOR
GR+/N
@14,18 TO 22,41
DOUB COLOR W
@18,20 get
okcancel FUNCTION
'*V YES;NO' SIZE
1,10,1
Read
if okcancel=1
SA="Y"
else
SA="N"
WAIT WINDOW
'atsaukta'
Endif
clear
return
```

4th ANNEX

EDITING.PRG

```
*DUOMENU REDAGAVIMO
PROGRAMA

DEFINE POPUP RDG FROM 5,2
DEFINE POPUP RDG MARGIN
RELATIVE SHADOW COLOR
SCHEME 4
DEFINE BAR 1 OF RDG PROMPT
" _____ E D I T I N G   M E
N U _____ "
DEFINE BAR 2 OF RDG PROMPT
" -------------------------
---------"
DEFINE BAR 3 OF RDG PROMPT
"  EDIT DATA, WHICH IS
CONCERNED WITH: " COLOR
R+/W* SKIP
DEFINE BAR 4 OF RDG PROMPT
"  - INITIAL DATA -  "
DEFINE BAR 5 OF RDG PROMPT
"  - STATIONS - "
DEFINE BAR 6 OF RDG PROMPT
"  - WORKERS - "
CLEAR
**********
ON SELECTION POPUP RDG DO
PROC_RDG
ACTIVATE POPUP RDG
RETURN
*******
PROCEDURE PROC_RDG
DO CASE
CASE BAR()=4
DO PROG1
CASE BAR()=5
DO PROG2
CASE BAR()=6
DO PROG3
ENDCASE
RETURN
*DUOMENU APIE PATAISAS
REDAGAVIMAS
CLEAR
PROCEDURE PROG1
DEFINE POPUP GEO FROM 15,2
```

```
DEFINE POPUP GEO MARGIN
MOVER RELATIVE SHADOW COLOR
SCHEME 3
DEFINE BAR 1 OF GEO PROMPT
" EDIT INITIAL DATA BY: "
COLOR R+/W*
DEFINE BAR 2 OF GEO PROMPT
"--------------------------
"
DEFINE BAR 3 OF GEO PROMPT
"   Reference of gravimeter
"
DEFINE BAR 4 OF GEO PROMPT
"   Time in days        "
******
SELECT A
USE INITIAL
******
ON SELECTION POPUP GEO DO
PROC_GEO
ACTIVATE POPUP GEO
RETURN
***
PROCEDURE PROC_GEO
SET CURSOR OFF
DO CASE
CASE BAR()=3
DO PROG13
CASE BAR()=4
DO PROG14
ENDCASE
SET CURSOR ON
RETURN
***
*Redagavimas pagal
Gravimetro atskaita
PROCEDURE PROG13
HIDE POPUP RDG
HIDE POPUP GEO
CLEAR
@ 2,15 SAY " DATA EDITING
"
@ 0,0 TO 3,86 DOUB
@ 0,0 TO 24,86 DOUB
USE INITIAL
RD="T"
do while RD="T"
```

```
Atskaita="             "
@ 4,2 TO 7,84 DOUB COLOR G/W
@ 5,3 say "ENTER REFERENCE OF
GRAVIMETER, WHICH YOU WANT TO
EDIT " get Atskaita picture
"####.###" COLOR N/W
READ
clear
locate for GRAV=Atskaita
if GRAV#Atskaita
@ 14,15 say "THIS REFERENCE OF
GRAVIMETER DOES NOT EXIST!
(press ENTER) " COLOR G/N
read
clear
endif
do while GRAV=Atskaita
set format to 1table.fmt
READ
clear
continue
enddo
set format to
@ 16,15 say "EDIT MORE DATA?
(Y/N)" get RD picture "!"
COLOR GR+/N
read
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE
*Redagavimas pagal laika
paromis
PROCEDURE PROG14
HIDE POPUP RDG
HIDE POPUP GEO
CLEAR
@ 2,15 SAY " DATA EDITING  "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
RD="Y"
do while RD="Y"
paromis="            "
@ 4,2 TO 7,76 DOUB COLOR G/W
```

```
@ 5,3 say "ENTER TIME
IN DAYS, WHICH YOU WANT
TO EDIT " get paromis
picture "####.#####"
COLOR N/W
READ
clear
locate for
Time_date=paromis
if Time_date#paromis
@ 14,15 say "THIS TIME
DOES NOT EXIST!
(press ENTER) " COLOR
G/N
read
clear
endif
do while
Time_date=paromis
set format to
1table.fmt
read
continue
enddo
set format to
@ 16,15 say "EDIT MORE
DATA? (Y/N)" get RD
picture "!"COLOR GR+/N
read
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE
*DUOMENU APIE PUNKTUS
REDAGAVIMAS
CLEAR
PROCEDURE PROG2
DEFINE POPUP GEO2 FROM
15,2
DEFINE POPUP GEO2
MARGIN MOVER RELATIVE
SHADOW COLOR SCHEME 3
DEFINE BAR 1 OF GEO2
PROMPT " EDIT STATIONS
DATA BY: " COLOR R+/W*
```

```
DEFINE BAR 2 OF GEO2 PROMPT
" -------------------------
-- "
DEFINE BAR 3 OF GEO2 PROMPT
" Station  "
DEFINE BAR 4 OF GEO2 PROMPT
" Time in days    "
******
SELECT B
USE STATIONS
******
ON SELECTION POPUP GEO2 DO
PROC_MAT1
ACTIVATE POPUP GEO2
RETURN
***
PROCEDURE PROC_MAT1
SET CURSOR OFF
DO CASE
CASE BAR()=3
DO PROG23
CASE BAR()=4
DO PROG24
ENDCASE
SET CURSOR ON
RETURN
****Redagavimas pagal
punkto numeri
PROCEDURE PROG23
HIDE POPUP RDG
HIDE POPUP GEO2
CLEAR
@ 2,15 SAY " DATA EDITING
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
USE STATIONS
RD="Y"
do while RD="Y"
punktas=0
@ 4,2 TO 7,43 DOUB COLOR
G/W
@ 5,3 say "ENTER STATION
NUMBER " get punktas
picture "#####" COLOR N/W
READ
clear
locate for Station=punktas
if Station#punktas
@ 14,15 say "THIS STATION
NUMBER DOES NOT EXIST!
(press ENTER) " COLOR G/N
read
clear
endif
do while Station=punktas
set format to 2table.fmt
READ
continue
enddo
set format to
@ 16,15 say "EDIT MORE
DATA? (Y/N)" get RD picture
"!" COLOR GR+/N
READ
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE
*Redagavimas pagal laika
paromis
PROCEDURE PROG24
HIDE POPUP RDG
HIDE POPUP GEO2
CLEAR
@ 2,15 SAY " DATA EDITING
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
RD="Y"
do while RD="Y"
paromis2=0
@ 4,2 TO 7,69 DOUB COLOR
G/W
@ 5,3 say "ENTER TIME IN
DAYS OF EDITING STATION"
get paromis2 picture
"####.#####" COLOR N/W
READ
clear
locate for
Time_date=paromis2
if Time_Date#paromis2
@ 14,15 say "THIS TIME DOES
NOT EXIST!   (press ENTER)
" COLOR G/N
read
clear
endif
do while Time_date=paromis2
set format to 2table.fmt
read
continue
enddo
set format to
@ 16,15 say "EDIT MORE
DATA? (Y/N)" get RD picture
"!" COLOR GR+/N
READ
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE

*DUOMENU APIE MATUOTOJUS
REDAGAVIMAS
CLEAR
PROCEDURE PROG3
DEFINE POPUP GEO3 FROM 15,2
DEFINE POPUP GEO3 MARGIN MOVER
RELATIVE SHADOW COLOR SCHEME 3
DEFINE BAR 1 OF GEO3 PROMPT "
EDIT WORKERS DATA BY: " COLOR
R+/W*
DEFINE BAR 2 OF GEO3 PROMPT "-
------------------------------
-- "
DEFINE BAR 3 OF GEO3 PROMPT "
Surname  "
DEFINE BAR 4 OF GEO3 PROMPT "
Time in days    "
******
SELECT C
USE WORKERS
******
ON SELECTION POPUP GEO3 DO
PROC_MAT2
ACTIVATE POPUP GEO3
RETURN
***
PROCEDURE PROC_MAT2
SET CURSOR OFF
DO CASE
CASE BAR()=3
DO PROG33
CASE BAR()=4
DO PROG34
ENDCASE
SET CURSOR ON
RETURN
****Redagavimas pagal
matuotojo pavarde
PROCEDURE PROG33
HIDE POPUP RDG
HIDE POPUP GEO3
CLEAR
@ 2,15 SAY " DATA EDITING  "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
USE WORKERS
RD="Y"
do while RD="Y"
pavarde="              "
@ 4,2 TO 7,49 DOUB COLOR G/W
@ 5,3 say "ENTER WORKER'S
SURNAME " get pavarde picture
"XXXXXXXXXXXXXX" COLOR N/W
READ
clear
locate for Surname=pavarde
if Surname#pavarde
@ 14,15 say "THIS SURNAME DOES
NOT EXIST (press ENTER) "
COLOR G/N
read
clear
endif
do while Surname=pavarde
set format to 3table.fmt
read
continue
enddo
set format to
@ 16,15 say "EDIT MORE
DATA? (Y/N)" get RD
picture "!" COLOR GR+/N
READ
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE
*Redagavimas pagal
laika paromis
PROCEDURE PROG34
HIDE POPUP RDG
HIDE POPUP GEO3
clear
@ 2,15 SAY " DATA
EDITING  "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
RD="Y"
do while RD="Y"
paromis3=0
@ 4,2 TO 7,69 DOUB
COLOR G/W
@ 5,3 say "ENTER TIME
IN DAYS OF EDITING
STATION " get paromis3
picture "####.#####"
COLOR N/W
READ
clear
locate for
Time_date=paromis3
if Time_date#paromis3
@ 14,15 say "THIS TIME
DOES NOT EXIST!
(press ENTER) " COLOR
G/N
read
clear
endif
do while
Time_date=paromis3
set format to
3table.fmt
READ
clear
continue
enddo
set format to
@ 16,15 say "EDIT MORE
DATA? (Y/N)" get RD
picture "!" COLOR GR+/N
READ
clear
RD=upper(RD)
enddo
CLEAR
return
CLOSE DATABASE
```

5th ANNEX

SEARCHING.PRG

```
DEFINE POPUP PSK FROM 5,2
DEFINE POPUP PSK MARGIN
RELATIVE SHADOW COLOR
SCHEME 3
DEFINE BAR 1  OF PSK
PROMPT " _____ S E A R C
H I N G  M E N U _____
"
DEFINE BAR 2 OF PSK
PROMPT "-------------"
DEFINE BAR 3 OF PSK
PROMPT "  SEARCH DATA,
WHICH IS CONCERNED WITH:
" COLOR R+/W* SKIP
DEFINE BAR 4 OF PSK
PROMPT "  TIME IN DAYS  "
DEFINE BAR 5 OF PSK
PROMPT "  NAME OF
GRAVIMETER  "
CLEAR
ON SELECTION POPUP PSK DO
PROC_PSK
ACTIVATE POPUP PSK
RETURN
**
PROCEDURE PROC_PSK
DO CASE
   CASE BAR()=4
   DO PROG1
   CASE BAR()=5
   DO PROG2
ENDCASE
RETURN
*___________________BENDRA
PAIESKA________**
PROCEDURE PROG1
HIDE POPUP PSK
CLEAR
@ 2,15 SAY " DATA SEARCHING
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB

SELECT A
USE INITIAL
SELECT B
USE STATIONS
SELECT C
USE WORKERS
GO TOP
SET CURSOR ON
STORE 0 TO LAIIIKAS
@ 4,2 TO 7,47 DOUB COLOR G/W
@ 5,3 SAY ' ENTER TIME IN
DAYS' GET LAIIIKAS PICTURE
"####.#####" COLOR N/W
READ
LOCATE WHILE .NOT.EOF() FOR
Time_date=LAIIIKAS
IF FOUND()
SET FORMAT TO together.fmt
EDIT ALL NOEDIT NOAPPEND FOR
A.Time_date=B.Time_date
EDIT ALL NOEDIT NOAPPEND FOR
B.Time_date=C.Time_date
EDIT ALL NOEDIT
NOAPPEND FOR
A.Time_date=C.Time_date
WAIT ''
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 16,21 SAY 'THIS TIME
DOES NOT EXIST ! '
COLOR G/N
WAIT ''
CLEAR
ENDIF
RETURN
*___________________BEND
RA PAIESKA pagal
grav___________________
___**
PROCEDURE PROG2
HIDE POPUP PSK
CLEAR
```

```
@ 2,15 SAY " DATA
SEARCHING "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB

SELECT B
USE STATIONS
SELECT C
USE WORKERS
GO TOP
SET CURSOR ON
STORE "            " TO
GRAVIM
@ 4,2 TO 7,55 DOUB COLOR
G/W
@ 5,3 SAY ' ENTER NAME OF
GRAVIMETER' GET GRAVIM
PICTURE "XXXXXXXXXXXXX"
COLOR N/W
READ
LOCATE WHILE .NOT.EOF() FOR
Instrument=GRAVIM
IF FOUND()
SET FORMAT TO together2.fmt
EDIT ALL NOEDIT NOAPPEND FOR
B.Instrument=C.Instrument
WAIT ''
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 16,21 SAY 'THIS NAME
OF GRAVIMETER DOES NOT
EXIST ! ' COLOR G/N
WAIT ''
CLEAR
ENDIF
RETURN
```

6th ANNEX

ERASING.PRG

```
* istryn.FMT (DUOMENU
SALINIMO PROGRAMA)
*PROCEDURE REDAG
DEFINE POPUP SAL MARGIN
RELATIVE SHADOW COLOR
SCHEME 4
DEFINE BAR 1  OF SAL
PROMPT " _____ R E M O V
A L   M E N U _____ "
DEFINE BAR 2 OF SAL
PROMPT " ----------------
------------------"
DEFINE BAR 3 OF SAL
PROMPT " DELETE DATA,
WHICH IS CONCERNED WITH:
" COLOR R+/W* SKIP
DEFINE BAR 4 OF SAL
PROMPT "  - INITIAL DATA
-  "
DEFINE BAR 5 OF SAL
PROMPT "  - STATIONS - "
DEFINE BAR 6 OF SAL
PROMPT "  - WORKERS - "
CLEAR
***
ON SELECTION POPUP SAL DO
PROC_SAL
ACTIVATE POPUP SAL
RETURN
**
PROCEDURE PROC_SAL
DO CASE
   CASE BAR()=4
   DO PROG4
   CASE BAR()=5
   DO PROG5
   CASE BAR()=6
   DO PROG6
ENDCASE
RETURN
*******************SALINT
I DUOMENIS APIE
PATAISAS****************
********
           PROCEDURE
PROG4
HIDE POPUP SAL
SELECT A
USE INITIAL
CLEAR
@ 2,2 SAY " DATA REMOVAL
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
A="Y"
Atskaita="                "
@ 4,2 TO 9,68 DOUB COLOR
G/W
@ 5,3 SAY " ENTER THE
REFERENCE OF GRAVIMETER, "
COLOR N/W
@ 7,3 SAY " WHICH YOU WANT
TO DELETE" GET Atskaita
PICTURE "####.###" COLOR
N/W
READ
LOCATE FOR GRAV=Atskaita
IF GRAV!=Atskaita
@ 16,21 SAY 'THIS REFERENCE
DOES NOT! ' COLOR G/N
READ
CLEAR
ENDIF
*DO WHILE FOUND()
BROWSE FOR GRAV=Atskaita
@19,16 SAY "PRESS ESC"
COLOR B/N
CLEAR
KINT="N"
@14,15 SAY "ARE YOU SURE
THAT YOU WANT TO DELETE
DATA?(Y/N)"GET KINT PICTURE
"!" COLOR GR+/N
READ
KINT=UPPER(KINT)
CLEAR
IF KINT="Y"
DELETE FOR GRAV=Atskaita
PACK
ELSE
RECALL FOR GRAV=Atskaita
ENDIF
CONTINUE
SET FORMAT TO
@14,15 SAY "DO YOU WANT TO
CONTINUE DELETION OF
DATA?(Y/N)"GET A PICTURE
"!" COLOR GR+/N
READ
CLEAR
*ENDDO
CLEAR
RETURN
********************SALINTI
DUOMENIS APIE
PUNKTUS********

PROCEDURE PROG5
HIDE POPUP SAL
SELECT B
USE STATIONS
CLEAR
@ 2,15 SAY " DATA REMOVAL
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
A="Y"
Sstation=0
@ 4,2 TO 7,70 DOUB COLOR
G/W
@ 5,3 SAY " ENTER THE
STATION, WHICH YOU WANT TO
DELETE " GET Sstation
PICTURE " ##### " COLOR
N/W
READ
LOCATE FOR
Station=Sstation
IF Station!=Sstation
@ 16,21 SAY ' THIS STATION
DOES NOT EXIST! ' COLOR
G/N
READ
CLEAR
ENDIF
*DO WHILE FOUND()
BROWSE FOR
Station=Sstation
@ 19,16 SAY "PRESS ESC"
COLOR G/N
KINT="N"
@14,15 SAY "ARE YOU SURE
THAT YOU WANT TO DELETE
DATA?(Y/N) "GET KINT
PICTURE "!" COLOR GR+/N
READ
KINT=UPPER(KINT)
CLEAR
IF KINT="Y"
DELETE FOR
Station=Sstation
PACK
ELSE
RECALL FOR
Station=Sstation
ENDIF
CONTINUE
SET FORMAT TO
@14,15 SAY "DO YOU WANT TO
CONTINUE DATA
REMOVAL?(Y/N)" GET A
PICTURE "!" COLOR GR+/N
READ
CLEAR
*ENDDO
CLEAR
RETURN
***
********************SALINT
I DUOMENIS APIE
MATUOTOJUS********
PROCEDURE PROG6
HIDE POPUP SAL
SELECT C
USE WORKERS
CLEAR
@ 2,15 SAY " DATA
REMOVAL  "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
A="Y"
matuot="                  "
@ 4,2 TO 7,76 DOUB
COLOR G/W
@ 5,3 SAY " ENTER THE
SURNAME, WHICH YOU
WANT TO DELETE " GET
matuot PICTURE
"XXXXXXXXXXXXX"  COLOR
N/W
READ
LOCATE FOR
Surname=matuot
IF Surname!=matuot
@ 16,21 SAY ' THIS
SURNAME DOES NOT
EXIST! ' COLOR G/N
READ
CLEAR
ENDIF
*DO WHILE FOUND
BROWSE FOR
Surname=matuot
@ 19,16 SAY "PRESS
ESC" COLOR G/N
KINT="N"
@14,15 SAY "ARE YOU
SURE THAT YOU WANT TO
DELETE DATA?(Y/N) "GET
KINT PICTURE "!" COLOR
GR+/N
READ
KINT=UPPER(KINT)
CLEAR
IF KINT="Y"
DELETE FOR
Surname=matuot
PACK
ELSE
RECALL FOR
Surname=matuot
ENDIF
CONTINUE
SET FORMAT TO
@14,15 SAY "DO YOU
WANT TO CONTINUE
DELETION OF
DATA?(Y/N)" GET A
PICTURE "!" COLOR
GR+/N
READ
CLEAR
*ENDDO
CLEAR
RETURN
```

7th ANNEX

REVIEWING.PRG

```
* PERZIURA.FMT (DUOMENU
PERZIUROS PROGRAMA)
*PROCEDURE PRZ
DEFINE POPUP PRZ MARGIN
RELATIVE SHADOW COLOR SCHEME 4
DEFINE BAR 1  OF PRZ PROMPT "
_____ R E V I E W I N G   M E N
U _____ "
DEFINE BAR 2 OF PRZ PROMPT "
----------------------------
-----"
DEFINE BAR 3 OF PRZ PROMPT "
REVIEW DATA, WHICH IS
CONCERNED WITH: " COLOR R+/W*
SKIP
DEFINE BAR 4 OF PRZ PROMPT "
- INITIAL DATA -  "
DEFINE BAR 5 OF PRZ PROMPT "
- STATIONS - "
DEFINE BAR 6 OF PRZ PROMPT "
- WORKERS - "
CLEAR
CLEAR
***
ON SELECTION POPUP PRZ DO
PROC_PRZ
ACTIVATE POPUP PRZ
RETURN
**
PROCEDURE PROC_PRZ
DO CASE
   CASE BAR()=4
   DO PROG1
   CASE BAR()=5
   DO PROG2
```

```
   CASE BAR()=6
   DO PROG3
   ENDCASE
RETURN
*******************PATAISU
PERZIURA *******************
PROCEDURE PROG1
@ 15,22 SAY "REVIEW INITIAL
DATA:" COLOR G+/B
DEFINE POPUP GRV FROM 17,24
DEFINE POPUP GRV MARGIN MOVER
RELATIVE SHADOW COLOR SCHEME 3
DEFINE BAR 1 OF GRV PROMPT "
REVIEW DATA BY:  " COLOR R+/W*
SKIP
DEFINE BAR 2 OF GRV PROMPT  " -
-----------------  "
DEFINE BAR 3 OF GRV PROMPT "
Reference of gravimeter "
DEFINE BAR 4 OF GRV PROMPT  "
Height  "
**
SELECT A
USE INITIAL
ON SELECTION POPUP GRV DO
PROC_GRV
ACTIVATE POPUP GRV
RETURN
***
PROCEDURE PROC_GRV
SET CURSOR OFF
DO CASE
   CASE BAR ()=3
   DO PROG13
   CASE BAR ()=4
   DO PROG14
   ENDCASE
SET CURSOR ON
RETURN
***
*_________________ GRAV____
**
PROCEDURE PROG13
HIDE POPUP PRZ
HIDE POPUP GRV
CLEAR
@ 2,15 SAY " DATA REVIEWING "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT A
GO TOP
SET CURSOR ON
STORE "             " TO GRV
@ 4,2 TO 7,60 DOUB COLOR G/W
@ 5,3 SAY ' ENTER REFERENCE OF
GRAVIMETER ' GET GRV PICTURE
"####.###" COLOR N/W
READ
LOCATE WHILE .NOT.EOF() FOR
GRAV=GRV
IF FOUND()
SET FORMAT TO 1table.fmt
EDIT ALL NOEDIT NOAPPEND FOR
GRAV=GRV
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,15 SAY 'THIS REFERENCE OF
GRAVIMETER DOES NOT EXIST!'
COLOR G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
***
*_____PAGAL AUKSTI_____-
***
PROCEDURE PROG14
HIDE POPUP PRZ
HIDE POPUP GRV
CLEAR
@ 2,15 SAY "  DATA REVIEWING"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT A
GO TOP IN A
SET CURSOR ON
STORE "             " TO AUKST
@ 4,2 TO 7,30 DOUB COLOR G/W
@ 5,3 SAY 'ENTER HEIGHT' GET
AUKST PICTURE "###.####" COLOR
N/W
READ
LOCATE WHILE .NOT.EOF() FOR
Alt=AUKST
IF FOUND()
SET FORMAT TO 1table.fmt
EDIT ALL NOEDIT NOAPPEND FOR
Alt=AUKST
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,22 SAY 'THIS HEIGHT DOES
NOT EXIST!' COLOR G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
***
**********************
PUNKTU PERZIURA*************
**
PROCEDURE PROG2
@ 15,16 SAY "DATA REVIEW
ABOUT STATIONS" COLOR G+/B
DEFINE POPUP PNKT FROM 17,27
DEFINE POPUP PNKT MARGIN
MOVER RELATIVE SHADOW COLOR
SCHEME 3
DEFINE BAR 1 OF PNKT PROMPT "
REVIEW DATA BY:  " COLOR
R+/W* SKIP
DEFINE BAR 2 OF PNKT PROMPT
" ------------------  "
DEFINE BAR 3 OF PNKT PROMPT "
Station number "
DEFINE BAR 4 OF PNKT PROMPT "
Locality "
SELECT B
USE STATIONS
**
ON SELECTION POPUP PNKT DO
PROC_PNKT
ACTIVATE POPUP PNKT
RETURN
***
PROCEDURE PROC_PNKT
SET CURSOR OFF
DO CASE
   CASE BAR ()=3
   DO PROG23
   CASE BAR ()=4
   DO PROG24
ENDCASE
SET CURSOR ON
RETURN
***
*________PAGAL PUNKTO
NUMERI____

**
PROCEDURE PROG23
HIDE POPUP PRZ
HIDE POPUP PNKT
CLEAR
@ 2,15 SAY " DATA REVIEWING "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT B
GO TOP
SET CURSOR ON
STORE 0 TO PNKT
@ 4,2 TO 7,40 DOUB COLOR G/W
@ 5,3 SAY ' ENTER STATION
NUMBER ' GET PNKT PICTURE
"#####" COLOR N/W
READ
*MATUOT='*'+ALLTRIM(MATUOT)+'
*'
LOCATE WHILE .NOT.EOF() FOR
station=PNKT
IF FOUND()
SET FORMAT TO 2table.fmt
EDIT ALL NOEDIT NOAPPEND FOR
station=PNKT
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,25 SAY 'THIS STATION
NUMBER DOES NOT EXIST!' COLOR
G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
***
*____________________PAGAL
VIETOVE____________________-
***
PROCEDURE PROG24
HIDE POPUP PRZ
HIDE POPUP PNKT
CLEAR
@ 2,15 SAY " DATA REVIEWING "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT B
GO TOP IN B
SET CURSOR ON
STORE "               " TO VIET
@ 4,2 TO 7,50 DOUB COLOR G/W
@ 5,3 SAY 'ENTER TITLE OF
LOCALITY' GET VIET PICTURE
"XXXXXXXXXXXXXX" COLOR N/W
READ
LOCATE WHILE .NOT.EOF() FOR
locality=VIET
IF FOUND()
SET FORMAT TO 2table.fmt
EDIT ALL NOEDIT NOAPPEND FOR
locality=VIET
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,22 SAY 'THIS TITLE OF
LOCALITY DOES NOT EXIST!'
COLOR G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
*********************
MATUOTOJU PERZIURA
************
**
PROCEDURE PROG3
@ 15,10 SAY "DATA REVIEW
ABOUT WORKERS" COLOR G+/B
DEFINE POPUP MAT FROM 17,30
DEFINE POPUP MAT MARGIN MOVER
RELATIVE SHADOW COLOR SCHEME
3
DEFINE BAR 1 OF MAT PROMPT "
REVIEW DATA BY:  " COLOR
R+/W* SKIP
DEFINE BAR 2 OF MAT PROMPT  "
------------------  "
DEFINE BAR 3 OF MAT PROMPT "
Surname "
DEFINE BAR 4 OF MAT PROMPT "
Phone number "
SELECT C
USE WORKERS
**
ON SELECTION POPUP MAT DO
PROC_MAT
ACTIVATE POPUP MAT
RETURN
***
PROCEDURE PROC_MAT
SET CURSOR OFF
DO CASE
   CASE BAR ()=3
   DO PROG33
   CASE BAR ()=4
   DO PROG34
ENDCASE
SET CURSOR ON
RETURN
***
*_____________PAGAL
MATUOT_PAV___________________
__________

**
PROCEDURE PROG33
HIDE POPUP PRZ
HIDE POPUP MAT
CLEAR
@ 2,15 SAY " DATA REVIEWING "
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT C
GO TOP
SET CURSOR ON
STORE "              " TO MAT
@ 4,2 TO 7,50 DOUB COLOR G/W
@ 5,3 SAY ' ENTER SURNAME OF
WORKER' GET MAT PICTURE
"XXXXXXXXXXXXXX" COLOR N/W
READ
*MATUOT='*'+ALLTRIM(MATUOT)
+'*'
LOCATE WHILE .NOT.EOF() FOR
surname=MAT
IF FOUND()
SET FORMAT TO 3table.fmt
EDIT ALL NOEDIT NOAPPEND
FOR surname=MAT
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,25 SAY 'THIS SURNAME
OF WORKER DOES NOT EXIST!'
COLOR G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
***
*____________________PAGAL
TEL_NR____________________-
***
PROCEDURE PROG34
HIDE POPUP PRZ
HIDE POPUP MAT
CLEAR
@ 2,15 SAY " DATA REVIEWING
"
@ 0,0 TO 3,79 DOUB
@ 0,0 TO 24,79 DOUB
SELECT C
GO TOP IN C
SET CURSOR ON
STORE 0 TO MATT
@ 4,2 TO 7,45 DOUB COLOR
G/W
@ 5,3 SAY ' ENTER PHONE
NUMBER' GET MATT PICTURE
"#########" COLOR N/W
READ
LOCATE WHILE .NOT.EOF() FOR
Tel=MATT
IF FOUND()
SET FORMAT TO 3table.fmt
EDIT ALL NOEDIT NOAPPEND
FOR Tel=MATT
SET FORMAT TO
CLEAR
CONTINUE
ELSE
@ 17,22 SAY 'THIS PHONE
NUMBER DOES NOT EXIST!'
COLOR G/N
WAIT ''
CLEAR
ENDIF
GO TOP
SHOW POPUP PRZ
RETURN
**********
```

8th ANNEX

REDUCED DATA

a) 2007.09.25

Miestas	Atskaitos 183	Atskaitos 184
VILNIUS	4573,558	5018,696
	4573,558	5018,696
	4573,557	5018,696
	4573,557	5018,695
	4573,558	5018,697
	4573,557	5018,696
	4573,558	5018,697
	4573,558	5018,697
	4573,556	5018,696
	4573,558	5018,698
Avižieniai	4559,086	5004,212
	4559,084	5004,213
	4559,085	5004,21
	4559,083	5004,21
	4559,083	5004,211
	4559,077	5004,2
	4559,081	5004,21
	4559,082	5004,21
	4559,08	5004,211
	4559,078	5004,209
Sudervė	4555,453	5000,59
	4555,451	5000,589
	4555,45	5000,588
	4555,451	5000,589
	4555,449	5000,587
	4555,455	5000,601
	4555,449	5000,588
	4555,464	5000,579
	4555,446	5000,588
	4555,448	5000,588
Dūkštos	4564,24	5009,371
	4564,24	5009,37
	4564,239	5009,37
	4564,241	5009,368
	4564,239	5009,368
	4564,237	5009,367
	4564,235	5009,368
	4564,236	5009,367
	4564,237	5009,369
	4564,236	5009,368
MAIŠIAGALA	4566,256	5011,378
	4566,256	5011,375
	4566,259	5011,375
	4566,257	5011,375
	4566,257	5011,375
	4566,252	5011,375
	4566,253	5011,374
	4566,254	5011,374
	4566,252	5011,373
	4566,252	5011,374
Karvys	4571,559	5016,685
	4571,56	5016,686
	4571,559	5016,686
	4571,56	5016,684
	4571,559	5016,683
	4571,56	5016,683
	4571,56	5016,683
	4571,561	5016,683
	4571,558	5016,682
	4571,559	5016,68
D.Riešė	4574,758	5019,886
	4574,758	5019,884
	4574,756	5019,885
	4574,754	5019,883
	4574,754	5019,882
	4574,753	5019,882
	4574,753	5019,88
	4574,75	5019,882
	4574,751	5019,881
	4574,749	5019,88
VILNIUS	4573,564	5018,719
	4573,564	5018,717
	4573,563	5018,718
	4573,563	5018,714
	4573,562	5018,713
	4573,559	5018,71
	4573,559	5018,712
	4573,558	5018,71
	4573,56	5018,709
	4573,558	5018,709
D.Riešė	4574,76	5019,892
	4574,759	5019,892
	4574,758	5019,89
	4574,757	5019,888
	4574,754	5019,887
	4574,753	5019,887
	4574,752	5019,886
	4574,759	5019,887
	4574,751	5019,886
	4574,751	5019,885
Paberžė	4584,979	5030,124
	4584,98	5030,123
	4584,978	5030,124
	4584,978	5030,123
	4584,976	5030,123
	4584,975	5030,122
	4584,976	5030,122
	4584,975	5030,121
	4584,973	5030,121
	4584,973	5030,12
Maseliškės	4583,8	5028,94
	4583,803	5028,943
	4583,802	5028,942
	4583,803	5028,942
	4583,803	5028,942
	4583,802	5028,943
	4583,802	5028,944
	4583,802	5028,943
	4583,804	5028,945
	4583,803	5028,946
Giedraičiai	4588,201	5033,334
	4588,201	5033,332
	4588,199	5033,334
	4588,198	5033,334
	4588,195	5033,333
	4588,194	5033,332
	4588,195	5033,332
	4588,193	5033,334
	4588,193	5033,334
	4588,191	5033,334
Bijutiškis	4584,031	5029,164
	4584,032	5029,16
	4584,031	5029,161
	4584,03	5029,16
	4584,03	5029,159
	4584,028	5029,159
	4584,029	5029,158
	4584,029	5029,158
	4584,027	5029,156
	4584,028	5029,157
MOLĖTAI	4592,072	5037,204
	4592,071	5037,206
	4592,071	5037,204
	4592,069	5037,204
	4592,07	5037,204
	4592,07	5037,201
	4592,068	5037,202
	4592,067	5037,203
	4592,068	5037,202
	4592,068	5037,203
	4592,07	5037,204
	4592,066	5037,206
	4592,067	5037,204
	4592,067	5037,205
	4592,068	5037,205
	4592,064	5037,206
	4592,069	5037,207
	4592,068	5037,205
	4592,068	5037,206
	4592,068	5037,203
Giedraičiai	4588,203	5033,343
	4588,204	5033,343
	4588,203	5033,342
	4588,205	5033,341
	4588,202	5033,343
	4588,203	5033,342
	4588,2	5033,342
	4588,2	5033,341
	4588,201	5033,343
	4588,2	5033,341
Žemaitėliai	4581,871	5027,005
	4581,87	5027,005
	4581,87	5027,002
	4581,869	5027,001
	4581,868	5027,001
	4581,867	5027
	4581,866	5027,002
	4581,866	5027,001
	4581,866	5027,002
	4581,865	5026,999
Eitminiškės	4595,556	5040,707
	4595,555	5040,704
	4595,555	5040,702
	4595,555	5040,704
	4595,552	5040,702
	4595,553	5040,701
	4595,554	5040,701
	4595,551	5040,701
	4595,552	5040,702
	4595,551	5040,701
Europ.Centr	4588,642	5033,775
	4588,639	5033,775
	4588,638	5033,775
	4588,639	5033,775
	4588,637	5033,775
	4588,637	5033,776
	4588,636	5033,776
	4588,636	5033,776
	4588,638	5033,778
	4588,637	5033,783
D.Riešė	4574,775	5019,908
	4574,774	5019,908
	4574,774	5019,906
	4574,773	5019,908
	4574,774	5019,906
	4574,773	5019,907
	4574,77	5019,908
	4574,771	5019,91
	4574,771	5019,908
	4574,771	5019,909
VILNIUS	4573,582	5018,723
	4573,582	5018,723
	4573,582	5018,722
	4573,582	5018,722
	4573,58	5018,722
	4573,58	5018,721
	4573,578	5018,722
	4573,578	5018,72
	4573,576	5018,72
	4573,577	5018,721
	4573,577	5018,721
	4573,576	5018,721
	4573,578	5018,72
	4573,576	5018,721
	4573,576	5018,722
	4573,576	5018,72
	4573,576	5018,72
	4573,575	5018,72
	4573,575	5018,72
	4573,576	5018,719

b) 2007.09.29

Miestas	**Atskaitos 183**	**Atskaitos 184**
VILNIUS	4575,482	5019,409
	4575,482	5019,407
	4575,481	5019,408
	4575,48	5019,408
	4575,482	5019,408
	4575,48	5019,407
	4575,481	5019,409
	4575,481	5019,409
	4575,481	5019,409
	4575,481	5019,409
	4575,482	5019,408
	4575,483	5019,409
	4575,482	5019,408
	4575,483	5019,409
	4575,482	5019,409
	4575,483	5019,41
	4575,483	5019,409
	4575,484	5019,41
	4575,482	5019,409
	4575,483	5019,409
Dukstos	4566,167	5010,088
	4566,165	5010,085
	4566,165	5010,084
	4566,164	5010,084
	4566,163	5010,082
	4566,162	5010,082
	4566,161	5010,082
	4566,159	5010,08
	4566,162	5010,08
	4566,159	5010,08
Kernave	4587,029	5030,952
	4587,028	5030,95
	4587,028	5030,951
	4587,027	5030,951
	4587,026	5030,951
	4587,027	5030,948
	4587,025	5030,95
	4587,024	5030,951
	4587,025	5030,949
	4587,025	5030,949
Musninkai	4592,37	5036,285
	4592,37	5036,285
	4592,369	5036,285
	4592,366	5036,284
	4592,365	5036,282
	4592,366	5036,282
	4592,367	5036,283
	4592,365	5036,283
	4592,365	5036,283
	4592,367	5036,283
Ciobiskis	4611,551	5055,474
	4611,554	5055,473
	4611,552	5055,469
	4611,553	5055,471
	4611,551	5055,469
	4611,55	5055,47
	4611,549	5055,469
	4611,549	5055,469
	4611,548	5055,469
	4611,549	5055,468
Gelvonai	4607,524	5051,448
	4607,524	5051,447
	4607,524	5051,446
	4607,522	5051,445
	4607,523	5051,445
	4607,522	5051,443
	4607,52	5051,445
	4607,518	5051,443
	4607,518	5051,444
	4607,518	5051,444
Bagaslaviškis	4604,196	5048,116
	4604,198	5048,116
	4604,194	5048,116
	4604,194	5048,116
	4604,194	5048,116
	4604,193	5048,115
	4604,193	5048,114
	4604,193	5048,115
	4604,191	5048,113
	4604,193	5048,115
Krikstenai	4595,788	5039,706
	4595,786	5039,703
	4595,786	5039,702
	4595,786	5039,7
	4595,785	5039,701
	4595,784	5039,698
	4595,782	5039,699
	4595,783	5039,697
	4595,783	5039,698
	4595,782	5039,698
SIRVINTOS	4588,585	5032,511
	4588,583	5032,509
	4588,581	5032,505
	4588,582	5032,505
	4588,581	5032,504
	4588,58	5032,503
	4588,579	5032,502
	4588,578	5032,502
	4588,578	5032,501
	4588,577	5032,501
Musninkai	4592,375	5036,291
	4592,374	5036,29
	4592,375	5036,291
	4592,372	5036,288
	4592,371	5036,288
	4592,37	5036,288
	4592,37	5036,289
	4592,369	5036,288
	4592,369	5036,288
	4592,369	5036,287
Dukstos	4566,171	5010,079
	4566,172	5010,079
	4566,172	5010,077
	4566,171	5010,078
	4566,172	5010,078
	4566,17	5010,077
	4566,17	5010,077
	4566,169	5010,077
	4566,171	5010,077
	4566,168	5010,077
VILNIUS	4575,504	5019,453
	4575,505	5019,447
	4575,503	5019,442
	4575,504	5019,439
	4575,501	5019,436
	4575,501	5019,433
	4575,502	5019,432
	4575,501	5019,43
	4575,5	5019,43
	4575,499	5019,429
	4575,499	5019,427
	4575,499	5019,426
	4575,499	5019,426
	4575,5	5019,425
	4575,499	5019,425
	4575,501	5019,426
	4575,5	5019,426
	4575,502	5019,426
	4575,5	5019,426
	4575,5	5019,423

c) 2007.10.01

Miestas	Atskaitos 183	Atskaitos 184
VILNIUS	4575,548	5019,471
	4575,547	5019,469
	4575,549	5019,469
	4575,549	5019,469
	4575,55	5019,47
	4575,548	5019,471
	4575,549	5019,47
	4575,549	5019,472
	4575,549	5019,469
	4575,548	5019,47
	4575,548	5019,471
	4575,547	5019,469
	4575,547	5019,471
	4575,549	5019,473
	4575,549	5019,47
	4575,549	5019,469
	4575,549	5019,469
	4575,55	5019,469
	4575,549	5019,469
	4575,549	5019,467
SIRVINTOS	4588,653	5032,574
	4588,654	5032,573
	4588,655	5032,571
	4588,651	5032,569
	4588,651	5032,57
	4588,651	5032,569
	4588,649	5032,566
	4588,649	5032,567
	4588,648	5032,567
	4588,647	5032,567
Suderve	4589,011	5032,93
	4589,008	5032,928
	4589,01	5032,926
	4589,008	5032,928
	4589,009	5032,926
	4589,008	5032,926
	4589,007	5032,926
	4589,006	5032,925
	4589,005	5032,926
	4589,004	5032,924
Zelva	4595,983	5039,905
	4595,983	5039,903
	4595,982	5039,902
	4595,981	5039,899
	4595,982	5039,9
	4595,979	5039,897
	4595,981	5039,896
	4595,979	5039,898
	4595,977	5039,898
	4595,978	5039,898
Videniskiai	4596,615	5040,536
	4596,617	5040,533
	4596,616	5040,53
	4596,614	5040,53
	4596,613	5040,53
	4596,612	5040,529
	4596,61	5040,528
	4596,611	5040,529
	4596,611	5040,528
	4596,611	5040,528
MOLETAI	4594,062	5037,975
	4594,062	5037,974
	4594,061	5037,973
	4594,059	5037,973
	4594,059	5037,972
	4594,059	5037,972
	4594,058	5037,973
	4594,056	5037,973
	4594,056	5037,972
	4594,055	5037,972
Zelva	4595,985	5039,905
	4595,985	5039,902
	4595,984	5039,902
	4595,983	5039,901
	4595,983	5039,9
	4595,982	5039,901
	4595,982	5039,9
	4595,982	5039,899
	4595,98	5039,899
	4595,979	5039,898
Pusne	4590,335	5034,264
	4590,336	5034,261
	4590,335	5034,259
	4590,334	5034,258
	4590,333	5034,258
	4590,334	5034,259
	4590,333	5034,258
	4590,333	5034,258
	4590,332	5034,257
	4590,332	5034,258
Kiaukliai	4589,27	5033,214
	4589,271	5033,212
	4589,272	5033,208
	4589,271	5033,207
	4589,271	5033,207
	4589,271	5033,206
	4589,27	5033,204
	4589,269	5033,204
	4589,269	5033,203
	4589,268	5033,203

Sesuoleliai	4588,323	5032,249
	4588,324	5032,246
	4588,324	5032,247
	4588,323	5032,245
	4588,321	5032,244
	4588,32	5032,243
	4588,321	5032,242
	4588,32	5032,241
	4588,32	5032,242
	4588,319	5032,243
Alionys	4580,121	5024,043
	4580,12	5024,046
	4580,119	5024,044
	4580,12	5024,044
	4580,118	5024,047
	4580,119	5024,044
	4580,115	5024,046
	4580,118	5024,044
	4580,119	5024,045
	4580,118	5024,048
SIRVINTOS	4588,652	5032,573
	4588,651	5032,572
	4588,652	5032,572
	4588,652	5032,572
	4588,65	5032,57
	4588,649	5032,57
	4588,648	5032,571
	4588,647	5032,57
	4588,644	5032,571
	4588,644	5032,571
Giedraiciai	4590,192	5034,108

	4590,193	5034,104
	4590,191	5034,105
	4590,192	5034,103
	4590,191	5034,106
	4590,192	5034,106
	4590,189	5034,106
	4590,188	5034,107
	4590,188	5034,108
	4590,187	5034,107
Dubingiai	4592,058	5035,983
	4592,058	5035,982
	4592,059	5035,98
	4592,057	5035,98
	4592,057	5035,979
	4592,057	5035,977
	4592,056	5035,975
	4592,055	5035,976
	4592,054	5035,976
	4592,054	5035,977
Suzionys	4600,329	5044,252
	4600,328	5044,25
	4600,328	5044,248
	4600,327	5044,247
	4600,326	5044,245
	4600,324	5044,243
	4600,324	5044,244
	4600,322	5044,241
	4600,323	5044,244
	4600,322	5044,239
PABRADE	4605,421	5049,344
	4605,422	5049,343

	4605,421	5049,343
	4605,42	5049,341
	4605,418	5049,341
	4605,415	5049,34
	4605,418	5049,341
	4605,416	5049,34
	4605,416	5049,34
	4605,415	5049,341
VILNIUS	4575,559	5019,49
	4575,56	5019,488
	4575,559	5019,488
	4575,56	5019,487
	4575,557	5019,486
	4575,557	5019,488
	4575,556	5019,488
	4575,557	5019,488
	4575,555	5019,487
	4575,554	5019,486
	4575,557	5019,488
	4575,556	5019,488
	4575,556	5019,488
	4575,554	5019,488
	4575,555	5019,487
	4575,556	5019,488
	4575,556	5019,488
	4575,557	5019,488
	4575,556	5019,488
	4575,557	5019,488

9th ANNEX

DISPOSED DATA

Gravimeter	**2007 09 25**	**2007 09 29**	**2007 10 01**
# G-183	s 28 s 43	s 21	**-**
# G-184	s 16 s 26 s 71 s 72 s 73 s 74 s 75 s 77	s 111 s 112 s 113 s 114 s 115 s 115 s 116 s 117 s 118	s 91 s 92

Vilniaus Gedimino technikos universiteto egzaminų sesijų ir baigiamųjų darbų rengimo bei gynimo organizavimo tvarkos aprašo 2010–2011 m. m.
6 priedas

VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

Ovidija Čepaitė, 20055141

(Studento vardas ir pavardė, studento pažymėjimo Nr.)

APLINKOS INŽINERIJOS FAKULTETAS

(Fakultetas)

Geodezija ir kartografija, GTLmf-09

(Studijų programa, akademinė grupė)

BAIGIAMOJO DARBO (PROJEKTO)
SĄŽININGUMO DEKLARACIJA

2010 m. Birželio 08 d.

(Data)

Patvirtinu, kad mano baigiamasis darbas (projektas) tema Gravimetrinių matavimų rezultatų apdorojimo analizė

patvirtintas 20____ m. ________________________d. dekano potvarkiu Nr. _______________, yra savarankiškai parašytas. Šiame darbe (projekte) pateikta medžiaga nėra plagijuota. Tiesiogiai ar netiesiogiai panaudotos kitų šaltinių citatos pažymėtos literatūros nuorodose.

Parenkant ir įvertinant medžiagą bei rengiant baigiamąjį darbą (projektą), mane konsultavo mokslininkai ir specialistai: Reiner Jäger

Mano darbo (projekto) vadovas prof. habil. dr. Petras Petroškevičius

Kitų asmenų indėlio į parengtą baigiamąjį darbą (projektą) nėra. Jokių įstatymų nenumatytų piniginių sumų už šį darbą niekam nesu mokėjęs(-usi).

OVIDIJA ČEPAITĖ

(Parašas) (Vardas ir pavardė)