ON REDUCTION OF RESULTS OF JOINT ASTRONOMICAL, GEODETIC, AND GEOPHYSICAL OBSERVATIONS TO ONE GEOMETRICAL CENTRE

M. Tyshchuk, A. Gozhy

Poltava Gravimetrical Observatory, NAS of Ukraine
27/29 Myasoedova Str., 36029 Poltava, Ukraine
e-mail: pgo@poltava.ukrtel.net

There are tasks, for which decision it is necessary to determine small temporal changes of various astronomical, geodetic and geophysical parameters in any epoch in the same place and to reduce results of measurements to the same geometrical centre. In the paper is informed, how this reducing task is decided at experimental station of joint observations in the Stepanivka village.

INTRODUCTION

In modern geodesy and geophysics there are a lot of scientific and practical tasks, which decision requires to determine small temporal changes of spatial position of a site, value and direction of a gravity, other geodetic and geophysical parameters from observations in the same place [1, 2]. At such determinations all basic results of observations in any epoch should be referred to the same geometrical centre. However, practically it is impossible to combine all kinds of observations at the geometrical centre. Usually, they are carried out on the auxiliary centres, which are placed near to basic centre. Then, all results reduced to one main centre by additional linear and angular measurements.

SET OF OBSERVATIONS SITES

In the Poltava Gravimetrical Observatory the experimental station of joint astronomical, geodetic and geophysical observations (JAGGO) is created for determination of changes of a spatial position of sites, value and direction of a gravity, other geodetic and geophysical parameters. The station is in the Stepanivka village at the base of the laboratory building of the URAN-2 radio telescope [3, 5]. It consists of four sites of observations (Fig. 1):

1. basic site for geophysical and astronomical determinations;
2. site of geodetic determinations of coordinate changes;
3. site of linear-angular geodetic determinations;
4. site of geodetic and geophysical determinations.

Main $1m$ and additional $1a$ bases of site 1 with the geometrical centres are in underground floor of the laboratory building. The site 2 is located on a roof of this two-storeyed building. The sites 3 and 4 are placed in pavilions of the second floor of the building. In 380 m to north from the basic site is azimuth bench mark AM.

REDUCING MICRONETWORK

In all cases, when one part of observations at the station is made on a terrestrial surface or above it, and other part of observations is made in underground rooms, the linear elements of reductions can amount to several tens meters. It causes necessity for creation of special reducing linear-angular network for determination of position of all additional centres relatively basic one at the station of joint observations.

In Fig. 1 the scheme of horizontal location of the reducing network of a microtrilateration is given. It consists of three triangles. The linear measurements in the network will be carried out by measuring tapes, wires and other means. The reduction of the measured lines to horizon and measurement of the elevations between sites is carried out by geometrical levelling method. For orientation of the network on an azimuth, the horizontal angles between the direction $site2 - AM$, which azimuth is known, and sides of the network will be measured.

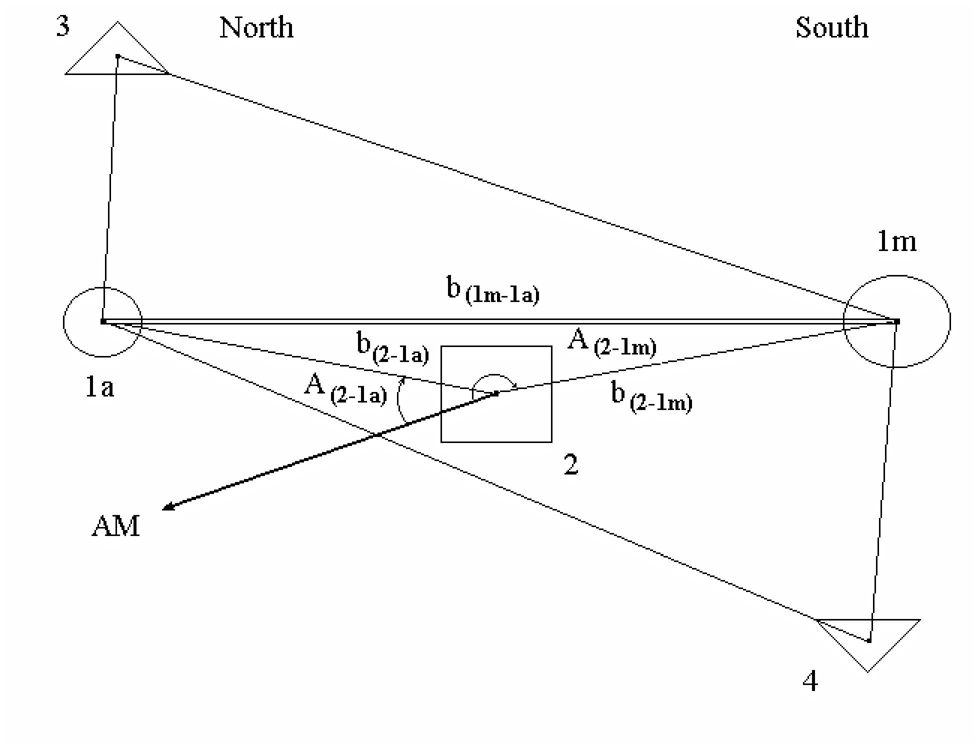

Figure 1. Scheme of horizontal location of the observations sites and general view on reducing micronetwork ($1m$ is the main geometrical centre and $1a$ is the additional geometrical centre of the basic site 1 for geophysical and astronomical determinations; 2 is the site of geodetic determinations of coordinate changes; 3 is the site of linear-angular geodetic determinations; 4 is the site of geodetic and geophysical determinations; AM is the azimuth bench mark; A is the azimuth, b is the length of side of triangle $1m - 2 - 1a$)

SCHEME OF REDUCING MEASUREMENTS

Let us in details consider an example of reduction of GPS-measurements results at the site 2 of geodetic determinations to the centres of main $1m$ and additional $1a$ bases of site 1 for geophysical and astronomical observations. To determine elements of reduction, it is necessary to make the following steps (Fig. 2):

1. Above vertical holes through all floors of the building, which are above the centres $1m$ and $1a$, to set tripods 5 and 6, to which are suspended measuring tapes 7 and 8 with plummets, which are centered above the centres.
2. At the centres $1m$, $1a$, and 2 to set levelling staffs 14, 15, and 16.
3. To set levels 10 and 11, to give horizontal directions 12 and 13.
4. For determination of inclined distance $1m - 1a$ to stretch measuring tape 9 in immediate proximity from the vertically set tapes 7 and 8. Then, tape 9 is transferred for measurements of inclined distances between vertical directions $7 - 2$ and $2 - 8$.
5. From levelling to receive the elevations $\Delta h_{(2-1m)}$, $\Delta h_{(2-1a)}$, and $\Delta h_{(1m-1a)}$ between the appropriate centres.
6. From readings on measuring tapes 7, 8 and levelling staff 16 in places of their contact with tape 9 to receive elevations between extreme points of the appropriate inclined distances. To determine horizontal distances $b_{(2-1m)}$, $b_{(2-1a)}$, and $b_{(1m-1a)}$.
7. At the centre 2 to measure horizontal angles between the sides of the network and direction on azimuth bench mark AM for determination of the azimuths $A_{(2-1m)}$ and $A_{(2-1a)}$.
8. To determine heights of the centres $1m$ and $1a$ by the simple formulas:

$$\begin{aligned} H_{1m} &= H_2 - \Delta h_{(2-1m)}, \\ H_{1a} &= H_2 - \Delta h_{(2-1am)}. \end{aligned} \tag{1}$$

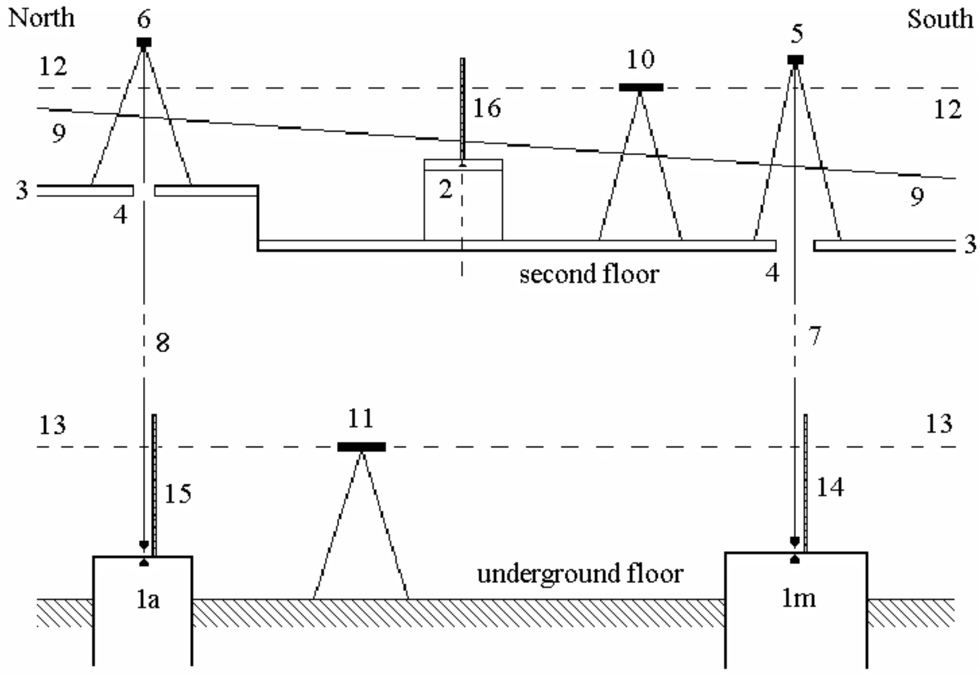

Figure 2. Scheme of vertical location of geometrical centres, determination of elevations and measurement of inclined distances ($1m$ is the main geometrical centre; $1a$ is the additional geometrical centre; 2 is the geometrical centre of the site of geodetic determinations; 3 is the roof of the building; 4 are the vertical holes through all floors of the building; 5 and 6 are the tripods; 7 and 8 are the vertical measuring tapes with plummets; 9 is the tape for measurement of inclined distances; 10 and 11 are the levels; 12 and 13 are the horizontal directions; 14, 15, 16 are the levelling staffs)

9. To determine latitudes and longitudes of the centres $1m$ and $1a$ by the known formulas [4]:

$$\begin{aligned} \varphi_{1m} &= \varphi_2 + \rho\,/M_2 \cdot b_{(2-1m)} \cdot \cos A_{(2-1m)}, \\ \varphi_{1a} &= \varphi_2 + \rho\,/M_2 \cdot b_{(2-1a)} \cdot \cos A_{(2-1a)}, \end{aligned} \tag{2}$$

$$\begin{aligned} \lambda_{1m} &= \lambda_2 + \rho\,/N_2 \cdot b_{(2-1m)}/15 \cdot \sin A_{(2-1m)}/\cos\varphi_2, \\ \lambda_{1a} &= \lambda_2 + \rho\,/N_2 \cdot b_{(2-1a)}/15 \cdot \sin A_{(2-1a)}/\cos\varphi_2. \end{aligned} \tag{3}$$

Here ρ is the radian in arcseconds, M_2 is the radius of meridian curvature in point 2, N_2 is the radius of prime vertical curvature in point 2.

[1] *Gozhy A. V.* On expediency of creation in Ukraine of several points of joint astronomical, geodetic and geophysical observations in deep vertical mines // Geodesy, Cartography and Aerosurvey.–Lviv, 2000.–N 60.–P. 11–15.

[2] *Gozhy A.* Substantiation of expediency of creation in Ukraine a special network of points of joint complex astronomical, geodetic and geophysical observations for changes of their spatial position.–Modern Achievements of Geodetic Science and Manufactures.–Lviv, 2003.–P. 98–102. (in Ukrainian).

[3] *Gozhy A., Tyshchuk M.* Creation of station of joint astronomical, geophysical and geodetic observations for geodynamics // Kinematics and Physics of Celestial Bodies. Suppl. Ser.–1999.–N 1.–P. 113–114.

[4] *Kuznetsov A. N.* Geodetic astronomy.–Moscow: Nedra, 1966.–372 p. (in Russian).

[5] *Tyshchuk M., Gozhy A.* Creation of experimental station of joint astronomical, geodetic and geophysical observations.–Modern Achievements of Geodetic Science and Manufactures.–Lviv, 2003.–P. 103–109. (in Ukrainian).