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ANALYSIS OF VERTICAL DEFLECTION DIFFERENCES OBTAINED BY ASTROGEODETIC AND GRAVIMETRIC METHODS [1]

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Abstract. Components of vertical deflection as a function of anomaly potential are determined by using astrogeodetic or gravimetric methods. In this paper components of deflections obtained by astrogeodetic method were considered as conditionally correct and deflection of components determined by using gravimetric method, from conditionally correct values, were shown as digital terrain model quality functions and adopted hypothesis on the earth's crust masses density.

1. GRAVIMETRIC DETERMINATION OF COMPONENTS OF VERTICAL DEFLECTION

When gravimetrically determining vertical deflections ξ_0 and η_0 model of Integral geodesy was used but of course within well known remove-restore technique (Heiskanen and Moritz 1967, Tscherning 1998).

All of the determinations were made on the basis of the:

- Global geopotential model EGM96 coefficient,
- Regional gravimetric measurements database (Bilibajkić *et al.* 1979),
- Digital terrain model specially created for these researches.

In accordance with the method itself previous preparations of mentioned data set were performed.

In **remove** procedure and aiming at the usage of the model of Integral geodesy

- determinations of free air anomalies Δg_{FA} in points of the regional gravimetric measurement were performed,
- long wave characteristic Δg_{GGM} was removed by usage of the global geopotential model EGM96, and

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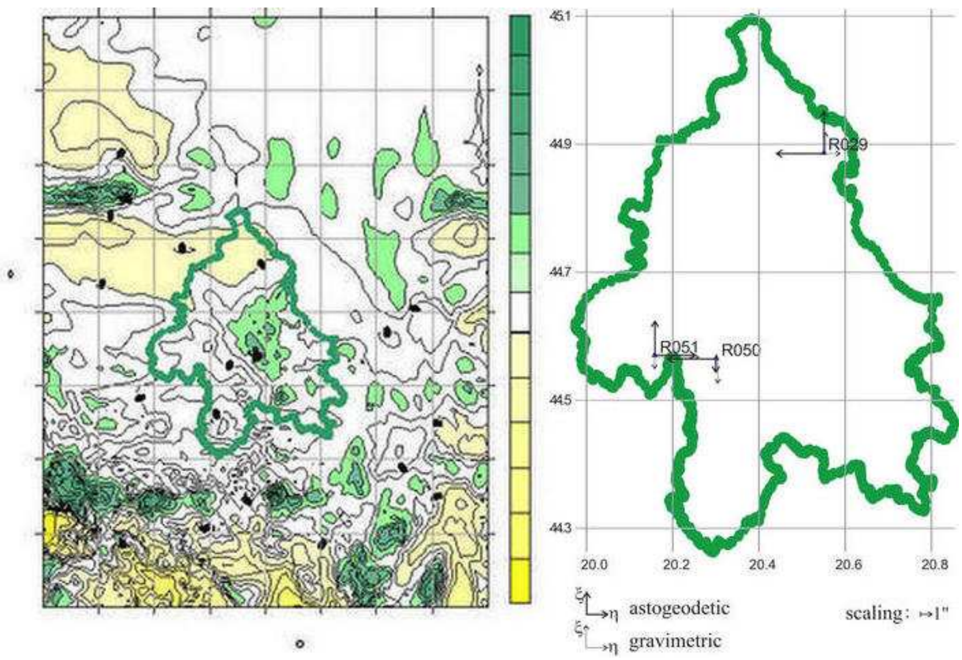

Figure 1: a) Residual anomalies Δg [mGal] b) Differences.

- the influence of the topography and its compensation Δg_T was removed by usage of the theory of isostasy within Airy - Heiskanen model (topography effect A_T and compensation influence A_C) of formed residual anomaly (Fig. 1) expressed as (Forsberg and Tscherning):

$$\Delta g = \Delta g_{FA} - \Delta g_{GGM} - \Delta g_T \tag{1}$$

where

$$\Delta g_T = A_T - A_C. \tag{2}$$

Within **restore** procedure:

- Global vertical deflection component ξ_{GGM}, η_{GGM} was determined by use of global geopotential model EGM96.
- Regional component ξ_{IG}, η_{IG} was calculated by using the model of Integral geodesy in previously formed residual anomalies of the observational results,
- Local component - isostasy effect ξ_{ISO}, η_{ISO} was determined in accordance with the Airy-Heiskanen model (Vanicek 1982).

Total value of vertical deflection was obtained in the form of an addition (Arabelos and Tziavoss 1983):

$$\xi_G = \xi_{GGM} + \xi_{IG} + \xi_{ISO} \quad (3)$$
$$\eta_G = \eta_{GGM} + \eta_{IG} + \eta_{ISO} \quad (4)$$

where the isostasy effect was defined through values ($\Delta\rho = -0.4\frac{\text{g}}{\text{cm}}$, $T = 32\text{km}$):

$$\xi_{ISO} = -\xi_T + \xi_C \quad (5)$$
$$\eta_{ISO} = -\eta_T + \eta_C. \quad (6)$$

Numeric calculation of vertical deflection was carried out in tree points of the referent GPS network that are situated in the territory of the city of Belgrade. Digital terrain model, shaped aiming at the necessity of visible topographic masses influence determination on the observation results covers the area of $43^\circ.75 < B < 45^\circ.75$ and $19^\circ.50 < L < 21^\circ.50$. Value of the local component was calculated for two different digital model resolutions (7 and 5 arc seconds) and obtained results show complete concordance.

2. ASTROGEODETIC DETERMINATION OF VERTICAL DEFLECTION COMPONENTS

Determination of astrogeodetic deflection of vertical was made by application of specially constructed measuring system composed of (Ogrizović 2002):

- Motorized theodolite Leica TM 5100/A,
- GPS sensor placed in SiRF LX/1 GPS processor,
- Mobile PC with original specially composed conducting program.

Method of equal zenith distances with the measurements in almucantar $Z = 50^\circ$ was applied.

Original specially conceived conducting program allowed the selection of the next star that was to be observed from the observation program established ad hoc out of geodetic coordinates that were obtained by autonomous regime from GPS receiver.

Maintenance of time and synchronization of clocks in mobile PC was effectuated by catching 1PPS impulses through a special GPS receiver output.

As soon as the next star for observation was selected a suitable RPC (Remote Procedure Call) request was made to motorized theodolite for his positioning into sought for azimuth and almucantar. Registration was done by manual contact using specially constructed push button tied to a serial port of mobile PC that initiated interrupt function that does the measurements and its registration by sending the RPC request to theodolite and by notifying the answers.

Transit of each star was registered approx. 10 times. Stars were chosen so that they can cover the horizon evenly. Measurements were processed using the Least-Squares method.

In Table 1 and Table 2 gravimetric (ξ_G, η_G) and astrogeodetic (ξ_A, η_A) components of deflection of vertical as well as differences ($\Delta\xi, \Delta\eta$) are shown.

Table 1: Gravimetric deflections of vertical

Pt.name	ξ_{GGM}	ξ_{IG}	ξ_{ISO}	ξ_G	$-\eta_{GGM}$	η_{IG}	η_{ISO}	η_G
R029	0.92	1.27	-0.30	1.89	3.14	-1.51	0.01	1.63
R050	1.65	-2.89	-1.16	-2.40	2.95	-2.79	-0.15	0.01
R051	1.74	-1.75	-1.25	-1.26	2.36	0.51	-0.05	2.81

Table 2: Astro-geodetic deflections of vertical and differences

Pt.name	ξ_A	η_A	$\Delta\xi$	$\Delta\eta$
R029	3.98	-4.44	-2.09	6.07
R050	-1.46	-4.26	-0.93	4.27
R051	2.72	2.59	-3.98	0.22

3. CONCLUSION

Comparing the gravimetric and astro-geodetic deviation of vertical it is easy to note that there are significant differences. Possible reason of noted differences one can find in an inadequate resolution of digital terrain model or in the existence of rough errors in the results of gravimetric measurements.

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