COMPARATIVE STUDY BETWEEN ASTROGEODETIC METHODS USED IN DETERMINING VERTICAL DEFLECTION

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ABSTRACT. The determination of the geoid-ellipsoid relative position is one of the main tasks of geodesy. This can be performed by many methods but we tried to do by astronomical determination of the deviation of the vertical. In this sense we realized two sets of measurements one of them with an electronic total station (the method was already described in precedent articles of Journées) and another, for safety and comparisons, with a CCD astrolabe. The results show that the actual geodetic devices can be used with success to this type of works.

1. INTRODUCTION

How the geocentric coordinates are determined respect to the Earth's center, the geodetic coordinates respect to the reference ellipsoid, the astronomical coordinates are determined respect to the local vertical from observation's point. The deviation of the vertical is usually decomposed in two orthogonal components: one component on the north-south direction (ξ) and an east-west or prime vertical component (η). The relations between astronomical coordinates and geodetic coordinates are: $\xi = \Phi - \mathrm{B}$ and $\eta = (\Lambda - \mathrm{B})\cos \mathrm{B}$. The next relation, on the base of these two components, gives the total deviation of the vertical: $\varepsilon^2 = \xi^2 + \eta^2$. The deviation of the vertical on some azimuthally direction (α) is: $\varepsilon_\alpha = \xi \cos\alpha + \eta \sin\alpha$ that is a frequently relation in geodetic calculations.

The main task was to perform some comparative studies between two methods concerning astro-geodetical determination of vertical deflection:

- First method (A): a classical method using the modernized astrolabe (CCD camera and GPS time measurement);

- Second method (B): a completely new method (already described in earlier articles in Proceedings of Journées 2002, Journées 2004) using Leica TC 2002 geodetic total station.

The both methods were applied to Astronomical Institute of Romanian Academy (GPS coordinates - WGS84 ellipsoid: latitude N 44°24'43".05955; longitude = E 26°07'38".02430

Targets:

- Studies concerning the benefits, limitations and drawbacks of both methods, comparative statistical analysis between methods;

- Testing Leica instrument and the specific mathematical algorithm for vertical deflection determination versus an unambiguous, well-known method and secure devices;

- Preparing of Leica TC 2002 total station for mounting a micro CCD camera to the optical system and GPS time receiver for fully automation of the method.

2. RESULT AND STATISTICAL ANALYSIS

The mean values from the next tables were obtained from 25 nights of observations with astrolabe and 5 nights of observation with Leica TC 2002 total station.

CCD Astrolabe (A)	Mean value	Max value	Min value	Δ=Max - Min
ξ (arcsec)	11.707	12.252	10.669	1.583
η (arcsec)	4.801	5.592	4.187	1.405
u (arcsec)	12.655	13.399	11.461	1.938
Leica TC 2002 (B)	Mean value	Max value	Min value	Δ=Max - Min
ξ (arcsec)	11.150	11.455	10.661	0.794
η (arcsec)	4.422	4.869	3.460	1.409
u (arcsec)	12.006	12.447	11.639	0.808

Table 1: Comparative results

The statistical analysis required:

- Comparison between the results obtained from night to night of observations, separately for each method;

- Comparison between the results obtained from the two methods;

The statistical analysis was performed for:

- Evaluation of the global precision of the methods

- Evaluation of the accuracy of the methods (relieved of the systematic errors)

The results of statistical analysis demonstrate that:

- Bartlett test (verification of the variance homogeneity) do not confirm the hypothesis of the variance homogeneity in this case it was used the weight arithmetic average and the standard deviation as weight average of the individual standard deviations;

- F test (comparison of the variances of the two methods) between of the precisions of the methods exist a significant difference. Method A is more precise for evident reasons;

- Student test (comparison of the average of the methods) between of the precisions of the methods exist a significant difference. Both methods do not present systematic errors at an significant level. The differences between method A and method B are the consequence of the random errors, both in ξ and η components;

- Successive differences test (verification of the existence of some factors with a systematic action on the results) does not exist a source of systematic errors at a significant level, both in ξ and η components.

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