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ЗАДАЧИ УСТАНОВЛЕНИЯ ЕДИНОЙ СИСТЕМЫ ВЫСОТ

THE JOINT HEIGHT SYSTEM ESTABLISHMENT TASKS

Демьянов Г.В. / Demianov G.V.

доктор технических наук, заведующий геодезическим отделом Центрального научно-исследовательского института геодезии, аэросъемки и картографии / Doctor of Technical Sciences, Head of the Geodetic Department, Central research Institute of Geodesy, Aerial Survey and Cartography

e-mail: gleb@geod.ru

Майоров А.Н. / Mayorov A.N.

кандидат технических наук, Центральный научно-исследовательский институт геодезии, аэросъемки и картографии / Candidate of Technical Sciences, Head of the Geodetic Department, Central research Institute of Geodesy, Aerial Survey and Cartography

e-mail: gleb@geod.ru

Сермягин Р.А. / Sermiagin R.A.

Заведующий лабораторией геодезической гравиметрии, Центральный научно-исследовательский институт геодезии, аэросъемки и картографии / Candidate of Technical Sciences, Head of the Geodetic Department, Central research Institute of Geodesy, Aerial Survey and Cartography

e-mail: gleb@geod.ru

Аннотация. В работе рассмотрены актуальные вопросы изучения гравитационного поля Земли с целью создания единой глобальной системы высот. Приведены некоторые результаты исследований, полученных с использованием современных моделей геопотенциала. Предложены направления сотрудничества национальных и международных организаций на пути совместного изучения расхождений существующих систем высот.

Ключевые слова: Геодезия, геопотенциал, системы высот, гравитационное поле Земли.

Abstract. The actual questions of study Earth's gravitational field to create a single global system of heights. Some results of research derived from current models of the geopotential. Proposed areas of cooperation between national and international organizations towards a joint study of the discrepancies existing heights.

Keywords: Geodesy, geopotential, the system of heights, the gravitational field of the Earth.

Following to the tendency of globalization and simplifying practical application of Molodenskiy theory we have to accept joint origin of height reference and set $U_0=W_0$ picking out one more geoid – common earth equipotential surface which potential W_0 equals to potential U_0 of normal gravity on the reference ellipsoid [Demianov, Mayorov, Yurkina, 2009, Demianov, Mayorov, 2010].

Common Earth ellipsoid represents the earth as an average value on the oceans in particular. Common earth ellipsoid taken as a nor-

mal one satisfies the condition $\int\limits_{\sigma}\zeta d\sigma = 0$ for the whole earth.

Hence, meaning $U_0=W_0$ represents potential close to its mean value W0 on the oceans the same way. Thus the solution $U_0=W_0$ will be an optimal approach to the geoid of *Gauss-Listing* in average for the whole earth.

The surface of common earth ellipsoid is the reference one along with determination of ellipsoid (geodetic) heights.
In that very case the use of normal heights H^{γ} and heights of quazigeoid ζ allows to agree in strong and definitely way the leveling data with the results of determination of ellipsoid (geodetic) heights H^{G} using satellite data.

Here we could not exclude possibility to use geopotential numbers. Just because we have strong coexistence between these values of normal height and geopotential:

$$W_i = \gamma_m H_i^{\gamma}$$

Due to the theory of M.S.Molodensky the sum of normal height and height of quazigeoid theoretically equals to geodetic height of the point of physical surface of the earth above common earth ellipsoid taken as a normal one.

$$H = H^{\gamma} + \zeta,$$

where H is a geodetic height; $H\gamma$ – normal height; ζ – height of quazigeoid.

This condition is not true, stipulated by errors of measurements and differences of regional reference systems of normal heights.

The value of the correction to j-rang regional height system to come to common earth height system will be determined over whole sample of N – geodetic points for all those we know as follows

$$\Delta H_i^{\gamma} = \frac{1}{N}\sum_{i=1}^{i=N}\left[H_i^{G} - \left(H_i^{\gamma} + \zeta_i\right)\right]$$

Thus, fixed and marked initial point where the normal height equals to zero is not exists. Normal height is zero in that very point on the earth surface where true potential Wi equals to normal one U0 on the surface of the common ellipsoid. In this very point the surfaces of geoid and quazigeoid supposed to be coincided: Wi=W0=U0. In principal, position of the point could not be known.

In these conditions, the problem to create new modern planetary gravitation models becomes very important. In 2008 TsNIIGAiK construct new global gravitational model GAO 2008 using given projects (GRACE and CHAMP) to solve the problem of creation of gravimetrical geoid.

Using models GAO 2008 and EGM 2008 we valued possibilities to determine corrections to regional systems of normal heights according to suggested technology. The results of such valuation are shown in table 1. All scope of using data was divided at three groups on territorial location. First group includes the data for the territory of the USA, second – for the territory of West Europe. For the territory of Russia we used data of its European part. All calculations for the both models were done due to total range of coefficients up to 360- range.

Corrections to the regional height systems.

Region	Mean difference H_{mean}(m)		Number of points
	GAO2008	EGM2008	
USA	+0.55	+0.53	6169
West Europe	+0.07	+0.09	87
European Russia	-0.09	-0.14	320

The principal to divide the data for groups first of all is connected with those idea that each group is using its own system of leveling heights. For the territory of the USA – NAVD-88, for the territory of West Europe – Amsterdam system, for Russia – Baltic (Kronshtadt) system.

Thus, *ΔHmean* values for different groups characterize difference between height systems for the territories of the USA, Europe and Russia from common earth one established according to the above mentioned principles. The data about the difference between leveling data of Amsterdam and Baltic system proves the actual situation of the obtained results. Due to leveling data and GAO2008 model data this difference is equal to 16cm.

Because of preliminary evaluation of model EGM-2008 along with creation of the model we could assume that Bouguer anomalies were used as an initial data for the territory of Russia but not anomalies on the free air. Calculated differences *ΔHmean* are having systematic differences correlated over amount and sign with the Bouguer correction.

We have all base to think that the use of data of European space complex GOCE will bring to substantial identification of parameters of global navigation models and consequently will increase accuracy of construction of common European system of normal heights.

It is not possible to solve the problems both of creation of precise quasigeoid (and creation of global models as well) and determination of joint system of heights independently. It is not difficult to calculate, if we have systematic error about 0,1mgl in the anomalies of gravity for the territory of about 1000km in radius this will bring to the error of 10cm in determination of height of quasigeoid. In its turn, if a system of heights for the territory differs at 30cm from the common earth W0=U0 (and this is quite real case), this is a reason of a systematic error of gravity anomaly at 0,1mGl. That's why both tasks must be solved together.

Globalization of modern geodesy gives the tusk to create international integration on solving fundamental problems. Exactly wide international integration had provided creation of reference geodetic network spread well enough over all territory of the globe as well as precise realization of common earth geocentrical coordinate system. It is only possible to solve the problem of creation of joint common earth system of heights on the modern level of accuracy in condition of wide international cooperation. In this condition we have to expect sufficient compensation of the influence of errors of gravimetric quasigeoid helpfully to the condition

$$\int_\sigma \zeta d\sigma = 0.$$

The first order and required elements of such cooperation should be the tasks as follow:

- leveling connection of State (national) leveling nets of European states;
- creation of joint massive of data of mean anomalies over trapeziums of 5x5 for the North hemisphere;
- build precise quasigeoid of Europe and Asia continent;
- construction of precise planetary models of gravitational field of earth using modern space missions GRACE, CHAMP and GOCE.

The result of such cooperation will be creation of joint common system of normal heights.

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