The variations of the local gravity vertical which was caused by the anthropogenic factors

Yu. Nefed'ev (1), A. Kistersky (1), V. Lapaeva (1), and M. Kutlenkov (1)
(1) Engelhardt Astronomical Observatory, Russia (star1955@mail.ru / Fax: +7843-2927797)

Abstract

The influence of the annual change of a water level for Kuybyshev reservoir on change of the local gravity vertical and latitude EAO is considered. The method of the calculation gravity vertical variations as depended of the water oscillations level in Kuibyshev reservoir is given. The variations value of gravity vertical can reach a value to 0.015".

1. Introduction

The anthropogenic interference on nature causes the redistribution of substance masses in the surface layer of the Earth. Hundred million tons of coal per annum mine in the largest coalfields. The largest reservoirs have nearly hundred million tons of water. And the half of this water mass is variable, because it can increase or decrease depending on a regime of work of the Hydro-Electric Power Station.

Any changes in distribution of water masses lead to the changes in directions of the gravity vertical in this place. As a result, it causes distortions in the geodetic and astrometric observations. It is necessary to take into account such errors. Also many geodynamics phenomena in Earth interior are closely connected with the gravity direction.

2. Method of calculations

The method of calculation the gravity vertical variations as depended of the water level oscillations in Kuibyshev reservoir was designed. The influence of the gravity vertical variations on latitude observations in Engelhard Astronomical observatory and geometrical leveling were performed.

In the different time periods, the gravity vertical variations in meridian plane can reach a value $\xi = 0.029''$. That is why we should add some corrections in latitude observations (in winter time: +0.0145" and in summer time: - 0.0145").

During the period from 1978 to 1985 years "Water" corrections were calculated according to water level notes of the water-gauge post called "Verhniy Uslon". The annual gravity vertical variations were compared with the latitude observations in order to confirm the effectiveness of these corrections.

The latitude variations are depended of the Earth pole periodic moving in 80 - 85% . The remaining part is so-called "Z-member" or non-polar latitude changes. Their spectrum is broad enough and it is caused by the different reasons. It is well known that water level variations have an annual period and, therefore, they have an influence on annual component of the Z-member. This annual component in this turn depends on many factors, such as fictitious factors (errors of declination and proper stars motion) and real factors (moon-sun tides). Therefore, the series of observations were taken, where all the well-known reductions were taken into account. From this series observations the annual component of Z - member was obtained by the method of the harmonic analysis. It is equal to:

$$Z_{year} = 0.016''\cos(360°\mathrm{t} + 172°) \qquad (1)$$

Thus, from comparison Z_{year} with annual fluctuation gravity vertical ξ (Fig. 1) we came to the conclusion that the residual annual wave in non-polar latitude variations are caused by the influence of the water-level annual oscillations. After taking into account the "water" corrections, the annual component in the non-polar latitude variations will be excluded.
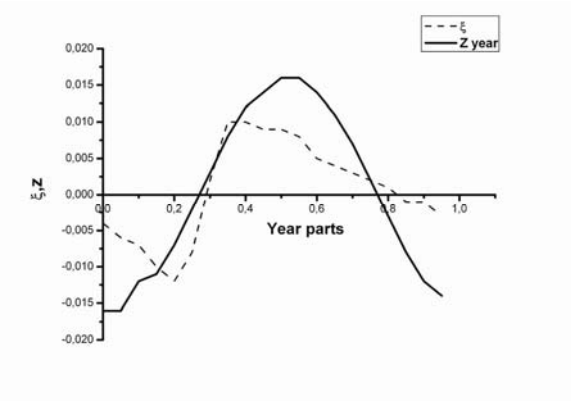
Figure 1: The comparison during year of the influence the change level water reservoir on gravity vertical variations ξ with non - polar latitude variations

However, this result is incomplete without consideration invisible ground waters oscillations. Simultaneously, with the change of the water level in the reservoir, the level of the ground waters will be also changed. It will be have an influence on a gravity vertical position in the observational place.

3. Summary and Conclusions

The water level rising of the Kuibyshev reservoir brings to the raising of the ground waters level. When the water level of the reservoir raises, the water percolate in hollowness and pores of the soil. It means that variable part of the water mass of Kuibyshev reservoir, which is related with the annual oscillations of the reservoir level, is a larger value. Therefore, we need to know the quantity of hollowness and pores in soil in order to define a variable part of the water mass of Kuibyshev reservoir.

The Volga River ground water has a bearing as ground water in rivers valleys. The coefficient of the total porosity for the bottom of Volga river in average equal to 42.5 %. After takeoff into account this fact we obtained the quantity of the complementary influence water level oscillations in Kuibyshev reservoir on local gravity vertical deviation. This quantity in average equal to 0.000884" on every meter of change of the underground water surface level or - 0.0053 for six meters mid-annual change of the level. Finally,

together with the previous quantity we have obtained the gravity vertical deviation 0,0342".

This anthropogenic correction by order of magnitude is greater than correction due to moon-sun tides influence. This result can be very useful in geodetic surveying, for example, for creation of the national leveling system.