The study of periodic changes in altitude of the satellite permanent stations of the world

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The following investigations were implemented in order to study the period of harmonic oscillations of time series of permanent GNSS stations, which are caused by various geophysical factors.

A database of daily time series had been created for 111 permanent stations, there observations were running for at least 3 years. Permanent stations cover the latitudinal zone within +600 to -600. Algorithm and program for processing time series and determination of the optimal harmonic functions were developed.

Kinematics model of the satellite station is described by the following equation

$$h = at+b+c*\cos(t-t0-n*p)+s*\sin(t-t0-n*p),$$

where a,b - coefficients of regression equation of linear displacement of station; c,s - harmonic coefficients, t-t0 - time observations at the station, n - number of periods of oscillation p, which fit in the interval t-t0.

Presented equation was calculated at each epoch of observations for each station and coefficients a, b, c, s were determined by the method of least squares.

On database 60 stations were selected for the study. The criterion for selection was the availability of clearly specified minimum of function of standard deviation of approximate curve from measurement results depending on the duration of the period of oscillations.

From the analysis of created database it can be argued that harmonic oscillations of permanent stations depend on geographic station location and location of satellite receivers.

According to results of processing it was defined that amplitude of periodical oscillations is changing in the bounds from 2.0 mm till 10.2 mm; period – from 348.9 days till 392,7 days. The largest amplitudes of function of harmonic oscillations are on the permanent stations that are in the heart of the continent, and the smallest amplitudes are on the stations placed along the coastline and on the islands, which apparently due to the capacity of the Earth's crust. It should be noted that the maximums of oscillation amplitudes of permanent stations reflect the power of the Earth's crust.

Epoch of maximum raise of permanent station during the first and last years of observations has the displacement with time due to the fact that the optimal duration of the period oscillation does not correspond strictly one year and may have deviation of ± 30 days. The period of oscillations in vertical position of permanent stations is in the range from 349 till 393 days. The values of isolines of oscillation period increase from the equator to the poles. I.e. the duration of the period of vertical oscillations of the permanent station is the function of latitude, that is obviously conditioned by the gravity of the sun. Therefore in the equatorial zone duration of oscillations is about 1 year.

Summing up performed researches it were made conclusions that the wave of the six-month period with a length of 90 ° in latitude is passed across the Earth globe, and the amplitude depends on the power of the Earth's crust.