VARIATIONS OF THE SECOND ORDER HARMONICS OF GEOPOTENTIAL FROM THE ANALYSIS OF THE LAGEOS SLR DATA FOR 1988-2003

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The paper is devoted to study of the second order harmonics of the geopotential from the analysis of satellite laser ranging to LAGEOS 1 and LAGEOS 2. All available observations for 1988-2003 (about 2000000) are taken from the Crustal Dynamics Data Informational System (CDDIS) and the European Data Center (EDC). These observational data were analyzed by means of the programming system ERA (Krasinsky, 1996). Initial site positions were taken from ITRF2000 solution. Transformation from the Terrestrial Reference Frame to Celestial Reference Frame is carried out using IAU (1976) precession, IAU (1980) nutation, celestial pole offsets and Earth rotation parameters taken from EOP (IERS) C04 series.

The main aim is to estimate the in-phase amplitude of the K_1 tidal wave in the tesseral harmonics C_{21} and S_{21} which manifest themselves as sinusoidal oscillations ΔC_{21} and ΔS_{21} with the period of one sidereal day, given in IERS Conventions 2000 for the normalized coefficients $\overline{C}_{21}$ and $\overline{S}_{21}$ in the form

$$\left(\Delta\overline{C}_{21}\right)_{K_1} = K_1 \sin(\Theta_g + \pi)\,, \qquad \left(\Delta\overline{S}_{21}\right)_{K_1} = K_1 \cos(\Theta_g + \pi)\,,$$

with Θ_g being the Greenwich Mean Siderial Time and $K_1 = 471.8 \times 10^{-12}$. This wave is caused by the differential rotation of the Earth's fluid core.

The data analysis has been performed into two steps. The whole time span was divided into 7-day arcs. It turned out that 7-day interval is the optimal period of time for which there are sufficient numbers of normal points. At the first step six coordinates and velocities, along-track acceleration and reflectance coefficients were adjusted by the least-squares data fitting. At the second step simultaneously with these parameters the K_1 amplitude and the correction to the normalized zonal harmonic $\overline{C}_{20}$ have been estimated. The last values are regarded as global parameters for the time interval of one year, while the orbital parameters are considered as the local ones on each arc. As a result:

$$K_1 = (415.4 \pm 23.7) \times 10^{-12}\,, \qquad \Delta\overline{C}_{20} = (-1.9 \pm 2.1) \times 10^{-11}.$$

One can see that the estimated K_1 is slightly different from the given above convention value $K_1 = (471.3 \pm 21.7) \times 10^{-12}$ and rather different from the value $K_1 = (634.8 \pm 81.4) \times 10^{-12}$ estimated from the analysis of the Etalon SLR data (Ivanova, 2003) by the same procedure that for Lageos SLR data. It should be noted that the error for the amplitude K_1 obtained from the Lageos observations is less than that of determined from the Etalon data. These results are shown in figures 1 and 2 respectively.

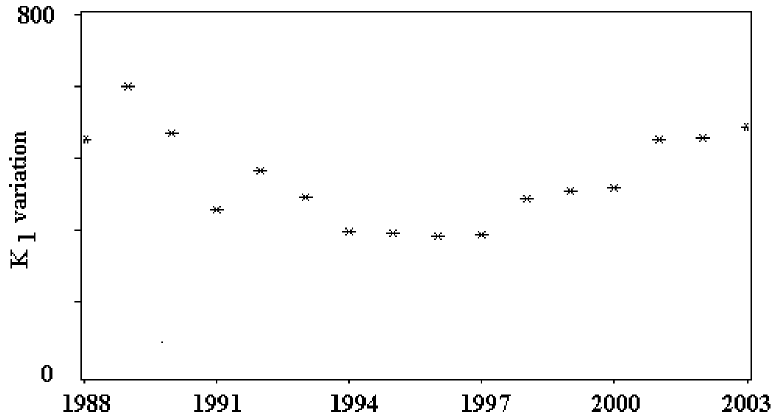

Figure 1: Variation of the amplitude of the tidal wave $K_1 \times 10^{12}$

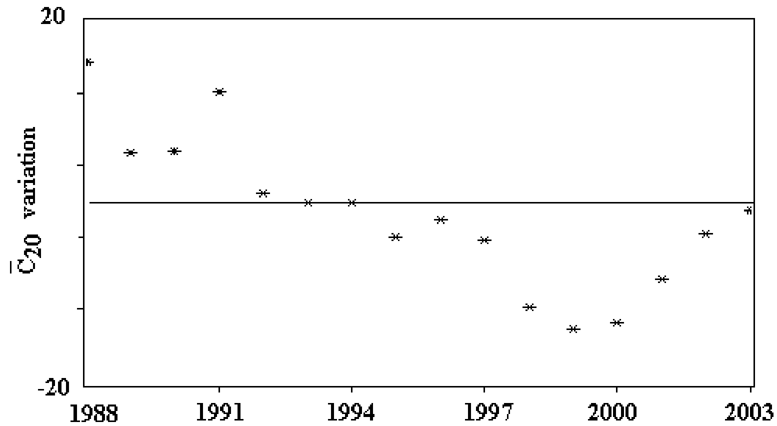

Figure 2: Variation of the geopotential harmonic $\Delta\overline{C}_{20} \times 10^{11}$

This investigation will be continued using the new theory of rotation of deformable Earth with the viscous fluid core which is developing now in the Institute of Applied Astronomy by G. Krasinsky (Krasinsky, 2005).

REFERENCES

Ivanova T. V., N. V. Shuygina, 2003, Variations of the second order harmonics of geopotential from the analysis of the Etalon SLR data for 1992–2001. Proc. Journees-2003 "Astrometry, geodynamics and Solar system dynamics: from milliarcseconds to microarcseconds", A.Finkelstein, N.Capitaine (eds.), 207-208.

Krasinsky G. A., M. V. Vasilyev, 1996, ERA: knowledge base for ephemeris and dynamical astronomy, Proc. of IAU Colloquium 165, 239.

Krasiniky G. A., 2005, Rotation of the deformable Earth with the viscous fluid core. 1. Mathematical model, Submitted to the Celestial Mechanics and Dynamical Asrtronomy.