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Kinematics of center of mass of the Earth

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The regular analysis of kinematics of the centre of mass of the Earth in the basic terrestrial system of coordinates connected to an axis of rotation and Greenwich meridian [1] is carried out. A basis of research temporal series of values of the Cartesian coordinates of the centre of mass x_C, y_C and z_C on DORIS systems for 1992-2008 make (IGN - ftp://cddis.gsfc.nasa.gov/doris/products/ geoc/ ign07wd01.geoc.Z), and also their analytical approximation sets of trigonometrically terms obtained by A.A. Lyubushin [2]:

$$x_C = 5.27\cos\left(\frac{2\pi}{0.980}t - 40^0 16\right) + 1.86\cos\left(\frac{2\pi}{0.468}t - 246^0 31\right) + 1.45\cos\left(\frac{2\pi}{9.813}t - 114^0 34\right) +$$
$$+1.43\cos\left(\frac{2\pi}{0.159}t - 235^0 4\right) + 1.06\cos\left(\frac{2\pi}{0.468}t - 148^0 33\right) + 1.02\cos\left(\frac{2\pi}{9.813}t + 36^0 17\right),$$
$$y_C = 5.18\cos\left(\frac{2\pi}{1.032}t - 32^0 10\right) + 2.01\cos\left(\frac{2\pi}{4.906}t - 143^0 36\right) + 1.48\cos\left(\frac{2\pi}{1.509}t - 93^0 41\right) +$$
$$+1.40\cos\left(\frac{2\pi}{0.490}t + 39^0 15\right) + 1.06\cos\left(\frac{2\pi}{0.318}t - 156^0 75\right) + 1.06\cos\left(\frac{2\pi}{9.813}t - 178^0 28\right),$$

(1)

$$z_C = 25.04\cos\left(\frac{2\pi}{0.980}t - 205^0 52\right) + 13.60\cos\left(\frac{2\pi}{0.323}t - 69^0 83\right) + 9.92\cos\left(\frac{2\pi}{6.541}t - 66^0 57\right) +$$
$$+9.80\cos\left(\frac{2\pi}{0.192}t - 129^0 39\right) + 6.99\cos\left(\frac{2\pi}{1.509}t - 44^0 68\right) + 6.65\cos\left(\frac{2\pi}{0.162}t - 208^0 47\right) +$$
$$+6.18\cos\left(\frac{2\pi}{0.241}t - 238^0 55\right) + 5.61\cos\left(\frac{2\pi}{0.107}t - 130^0 42\right) + 5.60\cos\left(\frac{2\pi}{0.137}t - 253^0 92\right) +$$
$$+5.38\cos\left(\frac{2\pi}{0.479}t - 162^0 2\right) + 3.36\cos\left(\frac{2\pi}{0.293}t - 248^0 22\right) + 1.44\cos\left(\frac{2\pi}{0.088}t - 88^0 46\right).$$

Here amplitudes of terms are given in mm and time t is calculated in years from initial date of 1993.0.

For a discrete set of values of coordinates the geometrical places of points on an equatorial plane Oxy on meridian planes Oxz and Oyzhave been obtained and studied.

On analytical approximation (1) the time dependences are investigated of the Cartesian coordinates of the centre of mass x_C, y_C and z_C; cylindric coordinates $\rho_C = \sqrt{x_C^2 + y_C^2}$, $\varphi_C = \arcsin(z_C/\rho_C)$ and z_C; spherical coordinates (module of radius-vector, latitude and longitude) $r_C = \sqrt{x_C^2 + y_C^2 + z_C^2}$, $\phi_C = \arcsin(z_C/r_C)$, $\lambda_C = \arctan(y_C/x_C)$ ($\cos\lambda_C = x_C/\rho_C$, $\sin\lambda_C = y_C/\rho_C$).

Annual variations of the specified time dependences are separately investigated. The trajectory of the center of mass on a coordinate plane " latitude - longitude " is constructed and features of behavior of a trajectory on surfaces of the Earth and possible correlations with large catastrophic events are investigated for period of 1993-2008. The phenomenon on monotonous increasing of seismic activity from February to November-December (with certain

local minimums and maximums) has been discovered. A correlation of phenomenal earthquakes with long-periodic trend of center of mass has been studied.

For the first time are in details investigated velocity and its various components of the motion of the centre of mass. Diagrams of time dependences for the period of 1993-2008 for Cartesian components of velocities $\dot{x}_C$, $\dot{y}_C$ and $\dot{z}_C$ are constructed and investigated; for the module of velocity $v_C = \sqrt{\dot{x}_C^2 + \dot{y}_C^2 + \dot{z}_C^2}$; for radial and transversal components of velocity of motion of a projection of the centre of mass on an equatorial plane $\dot{\rho}_C$ and $\rho_C\dot{\varphi}$; radial, transversal and tangential components of velocity of spatial motion of centre of mass: $\dot{r}_C$, $r_C\dot{\phi}$ and $r_C \cos\phi\dot{\lambda}$.

Similar time dependences are investigated for components of vector of acceleration of the centre of mass in cylindrical and in spherical coordinates, and also feature of change of radius of curvature.

A preliminary research of temporal dependences of dynamic characteristics (in conditional units): kinetic energy of the centre of mass, components of angular momentum of the center of mass in Cartesian reference system $Oxyz$ has been fulfilled.

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