Decreasing of axial angular momentum of oceanic both fluid continental masses and its contribution to non-tidal acceleration of rotation of the Earth

Yu.V. Barkin

Sternberg Astronomical Institute, department of celestial mechanics and gravimetry, Moscow, Russian Federation
(barkin@inbox.ru, 07-495-9328841)

Modeling constructions have shown, that a variation of geopotential coefficients, since the second harmonic, are determined basically by redistributions of fluid masses in the top shells of the Earth [1]. Only on a variation of coefficients of the first harmonic essential influence renders displacement of the centre of mass in the basic mantle reference system.

By the similar redistribution of masses it is obviously possible to estimate a variation of the axial moment of inertia of the full Earth, including an atmosphere and ocean, on a value of variation of coefficient of the second zonal harmonic of geopotential: $\dot{C}/C = 2\dot{J}_2/(3I)$ ($I = 0.3307$ is a dimensionless polar moment of inertia of the Earth, C is the polar moment of inertia of the Earth). According to satellite observations $\dot{J}_2 = (2.7 \pm 0.4) \cdot 10^{-11}$ 1/yr[2] and, hence, we obtain an estimation $\dot{C}/C = $ - $(5.4 \pm 0.8) \cdot 10^{-11}$ 1/yr. We use this value for an establishment of the new phenomenon - acceleration of return superrotation of fluids in western direction. For what we shall take advantage of known estimations of secular non-tidal acceleration of rotation of the rigid Earth: $\dot{\omega}/\omega = (6.9 \pm 1.2) \cdot 10^{-11}$ 1/yr (corresponding variation LOD makes -0.6 ± 0.1 ms/cy) [3] and variations of angular velocity of axial rotation of the Earth because of secular increase of a polar atmosphere angular moment: -0.56 ms/cy[4]. On Salstein's data for 1970 - 2002 a positive trend of polar component of the angular momentum really exists. Corresponding reduction of duration of day is characterized by velocity -0.525 ms/cy.

First of the given values has been obtained by results of observations of solar eclipses over last 2500. And the second value has been obtained on the data on variations of specified component of the angular momentum for last 60 years. Thus, in present epoch an acceleration of superrotation of an atmosphere is observed. Which results in delay of rotation of the Earth with relative acceleration $\dot{\omega}/\omega = $ (-6.5) $\cdot 10^{-11}$ 1/yr. It means, that there is other mechanism which results in significant positive angular acceleration of rotation of the Earth $\dot{\omega}/\omega = (13.4 \pm 1.2) \cdot 10^{-11}$ (to this value there corresponds a negative variation LOD in -1.16 ± 0.10 ms/cy).

The similar mechanism can be only a redistribution of oceanic masses (currents) and subsoil waters and fluids in aggregate. Thus, the data of astronomical and geophysical observations unequivocally specify that the phenomenon of strengthening of circulation of continental waters (in particular subsoil waters) in the western direction should be observed. Or negative trend in total value of the angular axial momentum of ocean and a hydrology of continents. Attributes of an intensification of the western drift of oceanic masses are seen in rather old data for 1981-1989 (Brosche et al., [5]). On these data secular changes in redistribution of oceanic masses cause reduction of LOD with velocity of ≈ -0.16 ms/cy. And both hemispheres northern and southern bring contributions comparable on value: ~ -0.074 ms/cy (NH) and ~ -0.089 ms/cy (SH). These values, certainly, are rather approached and have estimated character.

In global currents at ocean the similar situation in strengthening of circulation in the western direction in present epoch should be observed. We shall emphasize, that the question is not existence of those or other planetary currents, but about their slow changes as it is described above. As the size of a variation of angular velocity because of redistribution of water masses is rather significant, it should be observed in the modern data on variations of the angular momentum of ocean and as a whole of fluid masses.

Let $\dot{R}$ is a secular variation of the angular momentum of fluid masses of the Earth in present epoch. $G = C\omega$ is unperturbed value of the angular momentum of rotary motion of full system the Earth. According to the mentioned above works the following estimations of secular variations of the axial angular momentum of ocean and its northern and southern hemispheres [5] were obtained:

$$\left(\dot{R}/G\right)_{ON} = -0.12 \text{ ms/cy}, \quad \left(\dot{R}/G\right)_{OS} = -0.12 \text{ ms/cy}, \quad \left(\dot{R}/G\right)_{O} = -0.24 \text{ ms/cy},$$

and according to work [6] for hydrological, oceanic and their total fluids making the axial angular momentum the following estimations have been obtained:

$$\left(\dot{R}/G\right)_{H} = -0.34 \text{ ms/cy}, \quad \left(\dot{R}/G\right)_{O} = -0.22 \text{ ms/cy}, \quad \left(\dot{R}/G\right)_{H+O} = -0.55 \text{ ms/cy}.$$

Results will be coordinated among themselves. For example, for the full axial momentum of all fluids (atmospheres, ocean, continental and ground) in the specified two models turn out small values: $\left(\dot{R}/C_0\omega\right)_{A+H+O} = -0.03$ ms/cy, $\left(\dot{R}/C_0\omega\right)_{A+H+O} = -0.05$ ms/cy, as it follows from dynamic conclusions about non-tidal acceleration of rotation of the Earth.

Excluding from consideration a time interval 1997.0-1999.0, which corresponds to spasmodic changes of all natural processes of the Earth (Barkin, 2002), for velocity of decrease of the hydrological and oceanic angular momentums before and after the specified period we obtain rough estimates: - 0.7-0.9 ÷ ms/cy. These estimations at least do not contradict the basic conclusions to the given work about increase of the western displacement and currents of fluids of the Earth. More exact analysis will need the data of supervision for longer time intervals. The similar rough estimate on the data [5] turns out for oceanic making secular changes of the angular momentum. It gives negative change LOD with velocity -0.16 ms/cy. Thus, it is possible to assume, that there is an effective mechanism of secular increase of streams of water (fluid) masses on continents in the western direction. On the other hand according to work [5] roughly it is possible to estimate trend of the angular momentum of in common oceanic and hydrological fluids. It appears, that redistributions of these masses in present epoch results in acceleration of rotation of the Earth.

The appropriate reduction of duration of day here makes approximately-0.52 ms/cy. Thus strengthening of redistribution of terrestrial waters and fluids in the western direction really proves to be true. These estimations are obtained at exception of the period 1997.0-1999.0 when there was rather fast spasmodic change (increase) of duration of day approximately on 0.038 ms.

References

[1] Barkin Yu.V. (2007) Celestial geodynamics and solution of the fundamental problems of geodesy, gravimetry and geophysics. Proceedings of IUGG XXIV General Assembly, Perugia, Italy 2007: Earth: Our Changing Planet (Perugia, Italy, July 2-13, 2007), (S) – IASPEI, JSS011, p. 2149. www. iugg2007perugia.it.

[2] Cheng M.R., Shum C.K. and Tapley B.D. (1997) Determination of long-periodic changes in the Earth's gravity field from satellite laser ranging observations. Journal of Geophysical research, V. 102, No. B10. pp. 22377-22390.

[3] Stephenson F.R. and Morrison L.V. (1995) Long term fluctuations in the Earth's rotation:700 BC to AD 1990, Phil. Trans. R. Soc. Lond., A, 351, p. 165-202.
[4] Abarca del Rio R. (1999) The influence of global warming in Earth rotation speed. Ann. Geophys., 17, 806-811.

[5] Brosche P., Wunsch J., Maier-Reimer E., Segschneider J., Sundermann J. (1997) The axial angular momentum of the general circulation of the oceans. Astron. Nachr. 318, V.3, 193-199.

[6] Chen J. (2005) Global mass balance an the length-of-day variation. Journal of Geophysical research, V. 110, B08404, doi: 10.1029/2004JB003474.

[7] Barkin Yu.V. (2002) Explanation of endogenous activity of planets and satellites and its cyclicity. Izvestia cekzii nauk o Zemle. Rus. Acad. of Nat. Sciences, Issue 9, December 2002, M.: VINITI, pp. 45-97. In Russian.