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PHYSICS OF EARTH, ATMOSPHERE, AND HYDROSPHERE

Contrasting Secular Changes in Average Ocean Levels of the Northern and Southern Hemispheres

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Abstract—The origin and mechanisms of the South–North-directed secular ocean tide are discussed. The average rates of the rise in ocean levels in the Northern and Southern Hemispheres are determined. The secular tide of ocean waters from the Southern Hemisphere to the Northern Hemisphere that were predicted and discovered by the author in 2005 is caused by gravitation of the core, which drifts to the north relative to the mantle. This tide was reliably confirmed by modern studies of the coastal changes in ocean level. Further studies of this tide are important and may play a key role in understanding the asymmetry and inversion of many natural processes in the Northern and Southern Hemispheres, as well as in explanation of the high endogenic activity of the Earth and other bodies of the Solar System.

Keywords: secular tide, drift of the Earth's center of masses, northern core drift, mechanisms of excitation of the Earth layers.

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INTRODUCTION

The South–North-directed secular ocean tide was discovered by the author and described in quasistatic approximation in 2005–2008 [1–3]. This tide has another origin than the lunar–solar tides and is caused by gravitation of the northward drift of the Earth's core. The shift of the Earth's core (as well as the gravitation center) relative to the mantle generates a slow northward secular tide of ocean and atmospheric masses (underground waters and all fluids) from the Southern Hemisphere [4]. Similar events are also observed during the redistribution of the fluid masses in the crust of Mars, the seas of Titan, and other bodies of the Solar System. Along with the fundamental tide from the core, we studied other events that cause secular changes in the ocean level, e.g., deformational changes in the Earth's surface detected by satellite GPS observations. The role of the asymmetric positions of continents relative to the Northern and Southern Hemispheres and the modern thermal factors that increase the volume of the ocean and its heat expansion have been studied. Due to these factors, the rate of the rise in the global ocean level is accepted as 1.4 mm/year [5] and all of the above factors allowed its explanation. As a result, contrasting variations in its average levels were detected in the Northern and Southern Hemispheres. The average ocean level increases at a rate of ~2.45 ± 0.32 and 0.67 ± 0.30 mm/year in the Northern and Southern Hemispheres, respectively [4, 5], i.e., the contrasting change in the average N–S ocean levels is 1.78 mm/year.

EVIDENCE FOR THE EXISTENCE OF THE SOUTH–NORTH OCEAN TIDE

A South–North-directed asymmetric tide has also been confirmed by modern observations from coastal tidal stations for the last 30 years [6]. The theoretical value of the rate of the rise in the global ocean level is 1.61 ± 0.36 mm/year [5], which is consistent with its modern determinations on the basis of observations from coastal tidal stations, including their vertical geodesic shifts [7]. The contrast of the rates of the rise in the average ocean levels in the Northern and Southern Hemispheres for the last 100 years is ~0.9 mm/year. The authors used the tide-gauge and GPS data to reveal the vertical shifts of proper coastal stations. The data on 76 stations were studied in detail as a result of strict selection criteria. The average rates of the changes in ocean level were estimated for the entire 20th century: 2.0 ± 0.2 and 1.1 ± 0.2 mm/year for the Northern and Southern Hemispheres, respectively [7]. Similar values (2.45 ± 0.30 and 0.67 ± 0.30 mm/year) were obtained in [3, 4], which considered a shorter period of ~30 years with a more expressive contrast in the rise in the average ocean levels of the Northern and Southern Hemispheres. The data on stations in the high latitudes (>60°) were ignored in [7], which decreased the contrast in the rates of the changes in ocean levels in the Northern and Southern Hemispheres.

It should be noted that, according to our studies, the post-glacial rebound effects and effects of vertical shifts of the observation stations contribute insignificantly to the studied parameters of the change in

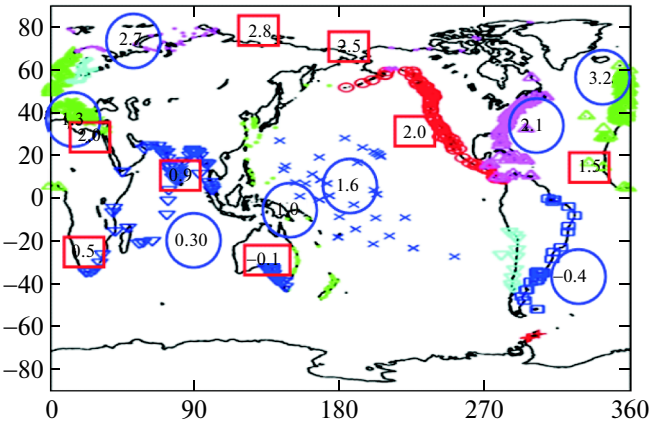

Fig. 1. Regions of the World Ocean and the positions of the reviewed tidal stations, after [6], for which we used estimations of the average rates of the change in ocean level for approximately 20–25 years (indicated inside the circles and squares in mm/year). Formally, they are ascribed to the centers of these regions, after [5].

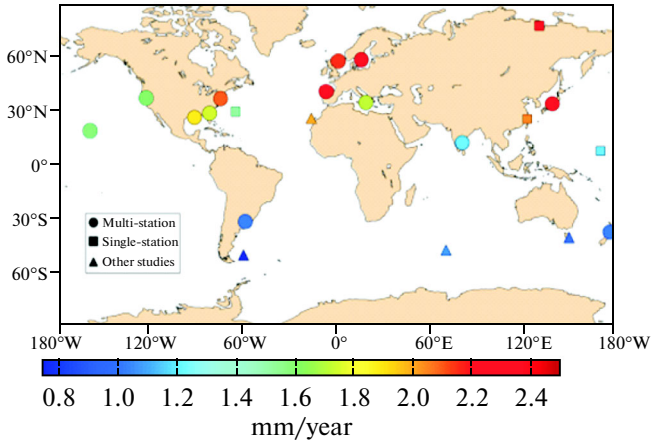

Fig. 2. Regional trends of the change in sea level on the basis of the data on 76 tide-gauges that were selected and corrected for the effects of post glacial rebound and taking the vertical constituents of the rates of coastal stations (according to the GPS data) into account. Stations from recently published works are marked by triangles. The figure is taken from [7].

ocean level [8]. Studies of the secular South–North-directed ocean tide require additional intense investigations and are of great scientific importance for oceanology, climatology, geodesy, and other Earth sciences. Taking the above criticism into account, we should note that the results of works [5] and [7] are quite consistent with each other and confirm both the South–North-directed ocean tide and the fundamental event of a secular northward drift of the Earth's core relative to the mantle. According to our first estimates, the average rates of the rise of the average ocean levels in the Northern and Southern Hemispheres are 2.45 ± 0.30 and 0.67 ± 0.30 mm/year [5]. We used the observation data on tidal stations for last 30 years, when the contrasting rise in ocean level in the Northern and Southern Hemispheres seems more expressive (Figs. 1, 3).

Let us note that, according to our studies, the effects of post-glacial rebound and the effects of the vertical shifts of tidal stations that have been observed contribute insignificantly to the studied parameters of the changes in ocean levels [5, 8]. This is certainly confirmed in Table 1 from [7].

The selection of observation stations in [7] is rather appropriate, but is characterized by large gaps between the stations in the high latitudes (higher than 60° N and lower than 60° S), as well as in the Southern Hemisphere [7] (Figs. 1, 2). However, according to our theory, contrasting changes in the average rates of the change in ocean level are manifested precisely in the high latitudes of both hemispheres. Thus, the results of [2, 5] could be more precise in comparison with [7]. In any case, the problem of the northern ocean tide requires more study.

The major features and conclusions of [5, 7] are in agreement and confirm the existence of a South–North-directed ocean secular tide (Fig. 3), but demand further thorough study.

AN EXPLANATION OF ERRONEOUS ALTIMETRIC DETERMINATIONS OF THE RATE OF THE RISE OF THE OCEAN LEVEL IN THE SOUTHERN HEMISPHERE

The contradiction in the values of the rates of the change in the global ocean level as measured by the classical (coastal and island observations) and satellite (altimetric observations) methods is well known to specialists who study the ocean level. The latter method overestimates the values by two times (3.53 mm/year) in comparison with the classical method (1.6 ± 0.30 mm/year [5] and 1.8 ± 0.5 mm/year [7]). This contradiction was first explained by the author in 2007 on the basis of a new fundamental geodynamic event: a secular northward drift of the Earth's center of mass relative to the mantle.

It is easy to show that only this effect in satellite measurements leads to a fictitious decrease in the average ocean level in the Northern Hemisphere at a rate of -2.37 ± 0.13 mm/year, a rise in the average ocean level in the Southern Hemisphere at a rate of 2.66 ± 0.165 mm/year, and a rise in the average global level of the World Ocean at a rate of 0.54 ± 0.03 mm/year [2, 5]. These outcomes will occur in altimetric observations, even if the real ocean level is permanent.

However, we should add the real values of the rates that are measured by the coastal method on the basis of the data on tidal stations to the fictitious values. This will result in the following values of altimetric rates for all latitudes in the ocean areas: 0.08, 3.33 ± 0.30, and

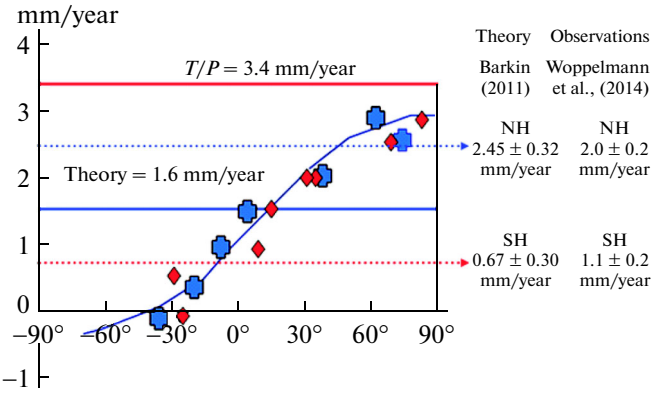

Fig. 3. The theoretical curve of the correlation between the rate of the rise in ocean level during the last 25 years and the latitude in comparison with observed values of those rates for regions of the World Ocean (marked by crosses and rhombs) [5]. The comparison of the average rates of the rise in the global ocean level and that in the Northern and Southern Hemisphere are after [5] and [7].

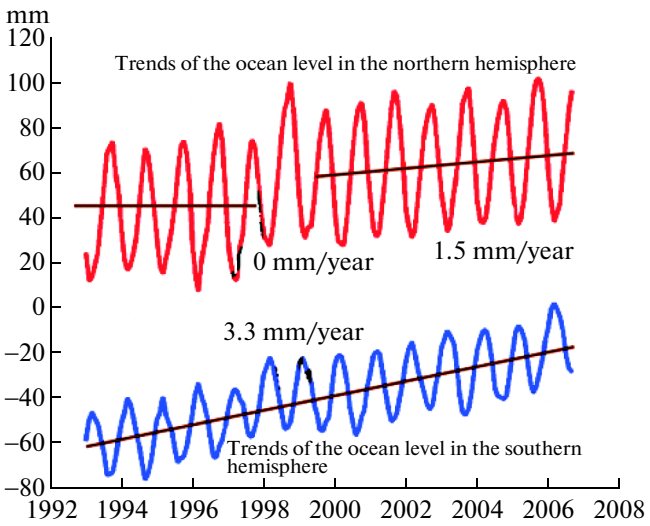

Fig. 4. Variations in the average ocean level in the Northern (red line) and Southern (blue line) Hemispheres of the Earth according to altimetric data of the Topex-Poseidon satellites from 1993 to 2008 [4]. The secular trends of the average rates of the rise in ocean level in the Northern and Southern Hemispheres are shown.

2.15 ± 0.39 mm/year for the Northern and Southern Hemispheres and the global ocean level, respectively. These values are in agreement with their satellite values (Fig. 4) [4].

The average altimetric rates of the change in ocean level for the Northern and Southern Hemispheres are approximately 0.5–1 and 3.35 mm/year, respectively [4]. They do not correspond to the real characteristics of the change in ocean levels in the Northern and Southern Hemispheres of the Earth and its global secular change. According to the coastal measurements, the real values of the rates of the rise in the average ocean levels in the Northern and Southern Hemispheres and the entire ocean are 2.45 ± 0.32, 0.67 ± 0.30, and 1.61 ± 0.36 mm/year [5].

The value of the altimetric rate of the rise in the ocean level of the Southern Hemisphere was predicted as early as 2007. It was considered as erroneous, because a secular northward polar drift of the center of the Earth's masses was ignored [2, 5]. It was clearly shown that the rates of the rise in the global ocean level in both the Northern and Southern Hemispheres that are determined by altimetric data will be completely different from those determined by the coastal data. Nerem [9] from the United States confirmed precisely this erroneous altimetric rate in his report at the Americas Meeting (Brazil, Iguassu Walls, 2010). The rate of the rise in ocean level in the Southern Hemisphere, according to his altimetric data, was very large (3.4–3.8 mm/year) in comparison with coastal determinations in the Southern Hemisphere [9]. Thus, the erroneous altimetric determinations of the rates of the rise in ocean level in the Northern and Southern Hemisphere that I predicted and described were completely confirmed. These conclusions were based on a new fundamental geodynamic event: a secular drift of the Earth's core relative to the mantle, ignoring which it is impossible to explain the behavior of the ocean [10].

We compare the theoretical values of the rates of the change in ocean level with their values, which are based on the modern altimetric measurements of the altitudes of the Topex-Poseidon satellites [5]. As in the indicated measurements, the drift of the center of the Earth's mass is ignored, thus we should add components in the changes of ocean level in the Northern and Southern Hemispheres. The drift of the mass center (at a rate of 5.29 mm/year in the Northern Hemisphere) leads to an additional (fictitious) component in the value of the rate of secular variations in the ocean level in the Northern and Southern Hemispheres (–3.03 and 3.40 mm/year, respectively). Thus, in comparison with the altimetric data, we obtain the following rates of the change in ocean level for the Northern and Southern Hemispheres: –0.05 and 3.36 mm/year, respectively. The value of the average rate of the rise in ocean level for the Southern Hemisphere almost coincides with the observed global altimetric rate value of 3.35 mm/year.

Some qualitative agreement for the Northern Hemisphere is based on the fact that the average altimetric rate of the change in ocean level (~0.5–1 mm/year) is much lower than for the Southern Hemisphere. The suggested model and theoretical interpretations allow explanation and a more thorough understanding of the most complicated effects in the behavior of the ocean in the Northern and Southern Hemispheres.

These conclusions were based on a new fundamental geodynamic event: a secular drift of the Earth's

core relative to the mantle, ignoring which it is impossible to explain the behavior of the ocean. Of course, this core drift leads to various geodynamic and geophysical outcomes, many of which have already been supported by the modern observation data [5] in different Earth sciences (geodesy, geodynamics, geophysics, climatology, geotectonics, and others).

CONCLUSIONS

The aim of this work is to pay close attention to the ocean event discussed above, first of all, to the mechanism of forced swinging and shifts of the Earth's core relative to the mantle [5]. Precisely this mechanism is responsible for the contrasting changes in natural processes in the Northern and Southern Hemispheres of the Earth, in particular, for contrasting changes in the average ocean level. New ocean tides that were predicted by the author and caused by the mobile Earth's core [1] are found in the coastal and satellite data on the global level of the ocean and its parts (in the Northern and Southern Hemispheres). These ocean tides require further detailed study and specification. The mechanism is universal and plays an important role in asymmetric changes in the fluid envelopes of other planets and moons, in particular, Titan (a moon of Saturn), as well as the Sun.

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