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Review Article

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Synchronism of the Events on the Sun and the Earth - A Sign of External Influence on the Solar System

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Abstract

To solve fundamental and applied problems, it is useful to detect signs of external influences on the Solar system from the synchronous responses of the Earth's shells, using a systemic and interdisciplinary analysis of solar-terrestrial relations - taking into account, along with solar activity and GCR fluxes, the endogenous activity of the Earth due to gravitational effects on the Earth with the sides of the Moon, the Sun and other celestial bodies of the Solar system during its barycentric motion in the gravitational field of the Galaxy, as well as the effects of perturbations on the Solar system as a whole. At the same time, the mechanism, energy, cyclicity, synchronism, change in the shape of the Earth and gravity, polar asymmetry and jump-like manifestations of solar-terrestrial relations, instability of the Earth's daily rotation become explainable. The Solar system is subject to external influences of gravity of the heavy planets of Jupiter and Saturn in the course of its barycentric motion in the gravitational field of the Galaxy, as well as the bringing in solar system of additional energy when exposed to a heterogeneous interstellar environment.

Keywords: Solar-Terrestrial Relations (STR), Solar Activity (SA), Endogenous Activity Of The Earth (EEA), Earth's Center of Mass (ECM), Instability of the Earth's Daily Rotation (IEDR), Global Warming (GW), Greenhouse Effect (GE)

Introduction

The study of STR is carried out according to national and international scientific programs and projects. Despite this, there is still no generally accepted opinion about the initial factors, their role and contributions to changes in geophysical and geodynamic phenomena until our publications, since fragmentary or superficial approaches to the study of STR have prevailed for a long time. Dissociation in studying the nature of STR from the standpoint of various disciplines of natural science leads to unsuccessful attempts to explain them with the concepts of individual ones and, as a result, to incomplete accounting, mixing and even distortion of the original causes of the studied variations of STR [1, 2].

The concept of "solar-terrestrial relations" is inherently much broader than the concept of "space weather". Their manifestations are caused by processes and events occurring in all internal and external shells of the Earth: solid and liquid cores, plastic and solid mantles, lithosphere, atmosphere, and magnetosphere and near-Earth space. The study of the connections of processes and events occurring in all the envelopes of our planet is recognized as one of the three main directions in modern Earth sciences [3, 4].

The actuality of studying and explaining the nature of STR is due to the need to take them into account when using many modern technologies, including warning systems and minimizing possible damage. Accounting for STR is greatly hampered by their variability. The variability of STR is determined by the impact of both initial (external), and derivatives, in this case, ground factors [1, 2]. The first ones traditionally include geo effective solar electromagnetic radiation, streams of energetic particles and the solar wind, and also GCR fluxes [5-10. The latter are ground-based responses to the impact of external factors, as well as the consequences of a person's treatment of the surrounding environment (distortion of relief, reservoir, deforestation, pollution, etc.).

Search for approaches to the study and explanation of solar-terrestrial relations

One of the properties of STR is their inconsistency, variability in different time scales. To understand the current state of studying STR, it is necessary to take into account its evolution in earlier times, the division of natural science into many disciplines, unsuccessful attempts to explain events and processes with the concepts of one of them, the lack of systematic study and interdisciplinary of their explanations, the use of only part of external (natural) factors of influences to the Earth. The methodology for studying manifestations of STR has been reduced mainly to clarifying the relationships and interconnections of the responses of the Earth's shells to external influences, mainly solar activity (SA) and galactic cosmic rays (GCR), by analyzing the correlation relationships of trends of the indices of interest and modeling the relationships between them in search of their mechanisms, cyclical and other

forms of manifestations of STR.

Since reliable data of instrumental measurements at the required time scales are absent, proxy data are used, which makes the quality of reconstruction dependent on errors of the proxy database and inevitably leads to uncertainty of results. Although the literature on the effect of SA, for example, on climate — a clearly multidimensional manifestation of the STR, is extensive, many of these studies were based on inadequate statistics and incorrect procedures [10-13]. The selection of ground responses can often occur (unintentionally or otherwise) as a result of the use of limited data intervals and / or the selection of compared parameters. This is the main cause of specific problems in studying the effects of SA on climate. Errors in the study of STR and their causes are analyzed in detail [10, 14, 15]. In addition to this, one should substantiate the presence of the physical meaning and role of the average annual temperature T cp / year.

Speaking of proxy data, without taking into account any anthropogenic factors: when determining the role of SA on large time scales, assuming its main source of energy, it is checked by the accuracy of its prediction. The latter has become very difficult to derive from the observed numbers of sunspots and fit close enough into the prediction of several future solar cycles or even into one solar cycle, until the cycle progresses well. In many models, there is a consistent discrepancy for the 24 CA cycles between measured and predicted sunspot numbers. This disagreement is a clear sign that something is missing in determining the SA for the number of sunspots that are a collective product of many instruments and observers around the world. This discrepancy also indicates that the appearance of sunspots on the surface of the Sun during the solar cycle is due to the action of some physical processes of the solar dynamo, which have not yet been considered in models.

It has been found that the polarity of the solar background magnetic field is always opposite to the leading polarity of the sunspots, while the time and locations of the appearance of sunspots on the surface of the Sun are actually controlled by this background magnetic field. Studies of the effects of the interaction of this solar background magnetic field - a new CA proxy for a hundred thousand years ago showed: the oscillations of the base magnetic field of the Sun are related to the long-term inertial motion of the Sun around the Solar system barycenter and are closely related to the increase in solar radiation and the temperature of the Earth over the past two centuries; also the orbital effects of the Earth's rotation around the Sun and any other movement of the Sun itself, the manifestation of the polar asymmetry of the SA shorter periods of solar-terrestrial activity, weather seasons are caused by an increase or decrease in solar illumination caused, in turn, by the inclination of the Earth's axis towards or away from the Sun, time scales for hundreds and thousands of years, including significant great solar minimums: Maunder minimum (1645 -1715), minimum Wolf (1200), minimum Oort (1010-1050), minimum of Homer (800-900 BC), combined with great solar maximums: the medieval warm period (900-1200), the Roman warm period (400–10BC), forecast for the upcoming Great Solar Minimum similar minimum Maunder (2020-2055) [16].

The energy arriving on Earth with solar radiation is lower than the energy of ground response, therefore non-linear amplification mechanisms, inverse and interconnections are proposed to explain the detected correlations. However, modeling the interrelationships of various ground-based processes and their parameters is carried out mainly by statistical analysis and identification of correlations, without identifying the causes and mechanisms of their manifestations, quantitative assessments of the role and contributions of the original factors to noticeable changes [10, 15]. In addition, the focus continues on the determining role of the anthropogenic factor [15].

As a progress in not fully logical and objective approaches, taking into account in a number of works ground responses to the effects of not only external factors, but also intermediate (instability of the Earth's daily rotation (IEDR), non-tidal effects, etc.) and even partially (natural) - for example, cosmophysical effects [3, 4, 6, 17-19]. However, the authors are often limited to logical constructions, without resorting to specific numerical estimates of dynamic and energy effects, explanations of the nature and mechanisms of responses. In search of the causes of warming, scientists went over virtually all possible terrestrial factors, including those whose impact on climate is far from obvious: drifts of the geographic and geomagnetic poles of the Earth, variations in the daily rotation of the Earth and an increase in the endogenous, specifically volcanic activity of the Earth. Earthquakes and volcanic eruptions are geodynamic indicators of STR, so the correlation of the content of greenhouse gases in the atmosphere with the volcanic activity of the Earth can only serve as indirect evidence of the existence of a connection between these processes. Others discuss and try to explain natural processes by intermediate effects and ground-based responses, without knowing all of their original causes on the surface of the Earth and in the near-Earth space environment, manifestations of natural oscillations in the Earth's climate system [20, 21].

The leading climatologists of the United States until 2014 called the process of global warming underway as a temperature anomaly [22, 23]. In Roskomgidromet, where probabilistic models are still used for weather forecasting with their justifiability ~ 60%, dependencies on many factors are noted; one of them is the El Niño phenomenon of irregular periodicity. Analysis of the influence of different factors on temperature did not reveal any clearly dominant factor [24]. To assess the real quantitative contribution to climate change, both SA and anthropogenic factors proposed to take into account changes in circulation in the atmosphere and the ocean and the efficiency of energy exchange between the ocean and the atmosphere [25]. There are various hypotheses explaining the changes in the Earth's temperature by the corresponding changes in the CA [7, 12, 13, 22, 23].

The occurrence of global warming is finally recognized by the Intergovernmental Panel on Climate Change (IPCC) undoubtedly, but its main cause is still considered to be the anthropogenic factor [20]. The most convincing experimental confirmation of the small role of the greenhouse effect are high-precision satellite observations, indicating a significant change in the global energy balance of the climate system over the past 20 years [26]. The IPCC report states that the effect of solar and volcanic activity can be attributed to half of the temperature changes before 1950, but after 1950 their overall effect was about zero. In particular, the influence of GE since 1950, according to the IPCC, is 8 times higher than the effect of SA. The highest estimates of the contribution of SA to warming lie in the range of 16 to 36% of the contribution of GE depending on the version of the reconstruction of the evolution of CA in the past [27]. Due to the differential nature of SA at different time scales, the role and contribution of SA in STR strongly depend on the time

interval: in the intervals of up to 25 years, the contribution of SA is less than 2%, and about 100 years - the contribution is up to 30–40% and for 1000 years on a scale, the average contribution of SA to the variance of temperature changes is of the order of 20% [28]. On a larger time scale, contributions from cosmophysical factors are assumed [5, 6, 29, 16-19].

Therefore, it is possible to explain only a fraction of climate change with the impact of SA. When analyzing astrophysical effects on climate, researchers, trying to attribute climate trends to the effects of SA, face the following difficulties: the solar impact has significant uncertainties, the responses of the climate system in general and the duration of glacial ice in particular are non-linear, the dating of the duration of fluctuations of external factors have uncertainties; complex models of global circulation need to account for all nonlinear interactions and feedback mechanisms within the climate system [12].

An analytical review on the impact of the CA on climate, scientists from 18 scientific organizations in England, USA, Switzerland, Germany and Holland is indicative [10]. Specialists in CA and climate have shown that understanding the effects of solar variability (SV) on the Earth's climate requires knowledge of itself (SV), solar-terrestrial relations (STR), and the mechanisms that determine the response of the Earth's climate system. Outlines their understanding in each of these three areas. Observational data and mechanisms, including variations of solar irradiation (SI) and GCR fluxes on decadal and secular time scales, as well as variations of the Earth's climate on associated time scales, including variations of ozone, temperatures, winds, clouds, precipitation, and regional variability, such as the monsoon and the North Atlantic Oscillation (NAO). Discussed the available solar and climatic indices. The mechanisms proposed for explaining climate observations, including the effects of variations in solar irradiation [SI] and charged particles, as well as feedbacks, are described. The contributions of solar variations to current global climate changes are discussed. Carefully analyzed the approaches and results of a large number of foreign studies published in recent decades. Two broad categories of solar effects mechanisms are given - variations of solar radiation and modulation of corpuscular radiation, and it is assumed that a very small impact can cause a significant climatic effect if it is present for a long time or if there are nonlinear responses giving increased feedbacks. Much of the evidence for solar exposure to climate rests on simple statistical characteristics, such as correlation coefficients, which indicate a relationship, but not a causal mechanism.

In addition, there is internal variability in the climate system, and the resulting register is only one of the realizations of possible responses, which makes it difficult to test the hypothetical mechanisms of solar exposure to climate. Highlighting the contribution of CA to climate strongly depends on how the climate system responds to a particular impact. Since the response of the climate system may be non-linear, the response function may differ from the impact function. Despite the fact that current climate models are far from perfect, they have the potential to simulate the spatial and temporal variability of the climate system as a result of the impact of a particular mechanism and can be used to calculate composite ensembles of responses and relationships to estimate internal variability. An important step towards a better understanding of the effects of CA on climate change is to assess the ability of climate models to match the observed pattern of regional sensitivity to the effects of SA. An important question is how to distinguish the mechanism among the various options discussed? The effects of total solar irradiation (TSI) include UV exposure, and, at first glance, there is no need to distinguish them. However, energies from different intervals of the solar spectrum are absorbed at different heights of the Earth's atmosphere. Changes in TSI can directly affect the surface, while changes in UV directly affect the stratosphere. Therefore, according to, it is necessary to distinguish between these mechanisms in order to determine which of them are required to be taken into account in climate models in order to obtain the most reliable result [10]. However, limiting the existing concepts of environmental variability and the factors that cause it has led Gray et al, to listing numerous unanswered questions, as well as listing the required additional information and data and requiring further clarification of mechanisms, etc.

Another significant evidence of the inability to explain environmental disturbances perceived as catastrophic is the great concern to the UN Secretary-General and Heads of State in 2010 of more than 300 well-known scientists from 85 countries who attached "The GEOCHANGE report on the global change of the geological environment" changes in energy in all layers of our planet since the late 1990 [30]. The Report presents for the first time simultaneously recorded synchronous global natural changes in all the Earth's shells. Earth was a very informative detector of external influences. The responses of all the Earth's shells turned out to be synchronous with the events in the observable layers of the solar atmosphere, which are useful in understanding the essence of the STR [1, 2].

The discontinuous events recorded in the Earth's shells and the observed atmospheric layers of the Sun in 1997–1998 are indications of an increase in the Earth's geodynamic activity, indicating natural disasters: 1) an increase in the drift velocity of the north magnetic pole by more than 500% from 1980 to 2010. - a sign of the beginning of an increase in geodynamic activity of the Earth; 2) the direction of the ECM secular drift and the trajectory of its pole on the Earth's surface with a turn of almost 90o in 1997–1998 towards the Taimyr Peninsula; 3) the beginning of anomalous changes in the geophysical parameters of the Earth recorded using the satellite laser ranging system (LDS) of the United States, including the 1998 jump in the values of the J2 coefficient reflecting the ratio of the Earth's radii at the equator and poles, i.e. Earth forms; 4) a jump in the Earth's rotational speed, an increase in seismic and volcanic activity: a sharp increase in the number of strong earthquakes and the number of people killed in strong earthquakes according to an exponential law in 1997–1998; deep minimum of volcanic activity and its subsequent sharp increase; 5) the change in the level of the World Ocean, which coincided in time with the anomaly of the coefficient J2, is actually 3 times greater than the effect of the redistribution of water masses in the World Ocean, and the abrupt anomalous increase in the global temperature of the troposphere in 1998; 6) a discontinuous change in solar radiation in 1998; 7) a sharp change in the trend of annual numbers of both catastrophic tsunamis and medium and weak tsunamis, the trend of annual tsunami numbers since 1998 is described by exponential dependence; 8) a sharp increase in the number of tornadoes, North Atlantic tropical storms, the total number of hurricanes in the Atlantic basin, a steady increase in the number of floods; 9) the jump in the number of forest fires in 1998. Collectively, these synchronously occurring sporadic changes in natural conditions are called the global "energy jump" of processes in all layers of the Earth - the lithosphere, hydrosphere, atmosphere and magnetosphere. Most of the events are inexplicable, attributed to

anomalies, some - to requiring further study [30]. The list of events of this kind can be supplemented from other sources.

The jump-like changes in the activity of various geophysical and geodynamic phenomena were studied from the standpoint of a geo model of forced core oscillations and deformation of the Earth's mantle, which considers them as consequences of a fundamental phenomenon — a jump in the center of mass of the core relative to the center of mass of the mantle [31-33]. This phenomenon is called "kernel galloping" [34]. The very fact of such a behavior of the nucleus was revealed by a unidirectional jump of the ECM, predicted and detected based on satellite observations of the DORIS system [35]. Synchronized with geodynamic events recorded in the observed atmospheric layers of the Sun in 1998: an jump-like change in average annual levels of solar radiation, a jump in trends in the radii of the Sun, an increase in the rate of coronal mass ejections, acceleration the beginning of the 24th SA cycle and the shape of its growth branch [1, 2].

It is believed that the climate system includes a number of feedbacks that change its response to external influences. The feedbacks include: moisture content of the atmosphere (increased humidity during air heating contributes to additional warming due to the greenhouse properties of water vapor), albedo change (the area of snow and ice on the planet decreases with warming, which leads to increased absorption of solar energy and additional warming), changes in cloud cover (may affect both warming and cooling), changes in the carbon cycle (for example, CO^2 release during soil thawing). The main negative feedback is the increase in infrared radiation from the earth's surface into space as it heats up. The high uncertainty of some feedbacks is the main reason that climate models are able to predict only the ranges of possible warming values, and not their exact values for a given impact scenario. The IPCC projections reflect the range of possible values covered by the term "likely" (more than 66% probability, according to experts) for selected impact scenarios [36].

The verification of the astronomical nature of decadal and multi-decade variations of global surface temperatures, starting from 1850 along the orbits of the planets, revealed very similar power spectra [37]. On two registragrams, eleven frequencies closely correspond with a period between 5 to 100 years. Among them: large climatic fluctuations of the "peak-trough" type with an amplitude of about 0.1 and 0.25 °C and periods of about 20 and 60 years, respectively, synchronized with the orbital periods of Jupiter and Saturn; 11- and 22-year solar cycles are visible, the 9.1-year cycle is synchronized with the orbital cycles of the Moon. A phenomenological model based on these astronomical cycles can be used for a good reconstruction of temperature fluctuations from 1850 and partial predictions for the 21st century. It has been established that at least 60% of global warming recorded since 1970 was caused by the combined effect of the above-mentioned natural climate fluctuations. A partial forecast indicates that the climate may be stabilized or cool until 2030–2040. Possible physical mechanisms were discussed qualitatively with an emphasis on the phenomenon of collective synchronization of coupled oscillators [37]. Synchronization of STR manifestations on the galactic time scale was also found [5].

The study of the evolution of the SA, the climate and the tectonic activity of the Earth showed that these processes change simultaneously, as if they were due to one reason. Researchers have a natural temptation to ascribe the controlling functions of their own branch of knowledge: solar, atmospheric, tectonic processes, or the effects of electromagnetic, magnetic, and gravitational fields. As will be shown below, climatic variations are caused by extraterrestrial effects, so the Solar system as a whole must be considered. Therefore, it is impossible to first deal with the internal processes of interaction of land, sea and atmosphere, and then assesses the influence of external forces. Changes in the SA and lunar-solar tides form the interaction of land, sea and atmosphere. The gravitational fields of the celestial bodies of the Solar System periodically change the solar and seismic activity, the circulation of the Earth's air and liquid masses, and already these changes mainly form climatic fluctuations. The interaction of the mentioned processes explains all intra-century warming and cooling that occurred over the past 400 years [6].

The problem of energy sources that determine the thermal regime and tectonic activity is one of the fundamental ones in planetary geophysics. It should be solved systematically, taking into account modern data on the composition, structure and evolution of the Earth. The main processes can only be deep energy, reducing the potential (internal) energy of the planet and the Earth – Moon system to the greatest extent due to its transformation into the thermal and kinetic energy of the motion of the Earth's masses. The nature of the endogenous activity of the Earth is associated not only with gravitational, but with gravitational-thermal convection. In turn, any movements of the Earth's masses are also accompanied by dissipation of kinetic energy and the release of heat, which contributes to the partial melting of the substance of the upper mantle and thereby feeding the Earth's magnetism. This heat is gradually lost with the thermal radiation of the Earth through its surface and is dissipated in space [38].

The most powerful energy processes occurring in the depths of our planet include: 1) gravitational differentiation of terrestrial matter by density, leading to the separation of the Earth into a dense iron oxide core, residual silicate mantle, light aluminosilicate crust and hydrosphere with the atmosphere; 2) the decay of radioactive elements, leading to the release of thermal energy; 3) tidal interaction of the Earth with the Moon. The impact of all other endogenous energy sources is either disproportionately less or completely reversible due to convective mass transfer in the mantle. The Earth's magnetic field is also excited by endogenous energy sources [39, 40]. The problem of changes in the Earth's climate should be solved systemically, on the basis of a rigorous physical theory, taking into account the evolution of the atmospheric composition, the geological situation, involving data on fluctuations of the luminosity of the Sun, the precession of the Earth's rotation, taking into account the existing feedbacks in this complex system, and not climate dependence on atmospheric concentration of so-called greenhouse gases [39, 40].

Despite differences in the branches of knowledge and, accordingly, differences in approaches, processes and factors recognized as key ones: antiphase or polar asymmetry gradually accumulated; deep geodynamics as the main process of energy supply [11, 39, 40]. The dominant role of the nucleus was considered, including its displacements, interaction processes at the core – mantle interface, the internal structure, kinematics of the Earth's structures, deformation, and interaction of its shells [3, 11, 39-41]; interactions of the celestial bodies of the Solar system with each other [3, 39, 40], the influence of external forces in the solar system and distant cosmic forces [3, 6, 17-19, 37, 41]. This contributed to the recognition of the

concept of endogenous activity of the Earth, based on the provisions of celestial mechanics [35, 42].

The study of variations in the daily rotation of the Earth of non-tidal origin stimulated the emergence of hypotheses explaining STR [7, 9, 13]. Among climatic factors, the following were called: the movement of the Earth's poles, mechanical effects on the Earth's atmosphere, global water exchange, the exchange of angular momentum between the mantle and the Earth's liquid core [42], finally, the gravitational effect [1, 2, 33-35, 44. However, when considering the relationships of the IEDR and global changes in natural processes, contradictions were discovered, to eliminate which we had to recognize the existence of *a third factor*, along with SA and GCR, at the same time affecting the processes in the earth's core and climate system - gravitational effects. The whole complex of phenomena arising in the earth's shells is called a generalized tide, since the attraction of non-spherical, heterogeneous shells of the Earth, occupying eccentric positions by the Moon, Sun and other planets, leads to relative displacements and oscillations of their centers of mass, to forced mass movements [5, 6]. The long-term IEDR correlates with geophysical, hydro meteorological, geomagnetic, biological, and other processes, because they all have the same celestial-mechanical root cause - generalized tides [45, 46]. Thus, the perennial oscillations of the angular velocity of the Earth's rotation are an integral index of global changes [43].

The key issue of the theory of natural planetary processes on Earth

(And on other celestial bodies) is the question of the sources of energy of endogenous activity and the basic mechanism of the energetic cyclic excitation of celestial bodies. The solution of this age-old problem has been proposed on the basis of the mechanism of excitation of the shells of the celestial body of the Solar system by the other external celestial bodies. The main position of the developed geodynamic concept is that the planets, satellites and the Sun are shells systems (on the Earth: core, mantle, etc.) that perform translational-rotational motions relative to each other or undergo small mutual deformations and other changes under the gravitational the impact of all the surrounding celestial bodies [36].

The most important results were the prediction and justification of the existence of the secular trend of the center of mass of the Earth (ECM) with respect to the mantle, confirmed in the data of space geodesy, and its physical explanation as a consequence of the secular near-polar northern drift of the Earth's core relative to the mantle (with a speed of 27.4 ± 0.8 mm / year). The change in tides in time in the viscoelastic mantle of the planet, generated by the gravitational interaction with the moving core, leads to scattering in the matter of the planet (in the mantle) mechanical energy, which is converted into heat and forms a temperature field inside the planet. Thus, the ECM age-old trend and many other issues of geodynamics, geophysics, and other Earth sciences are explained using the gravitational mechanism of the forced buildup of the core and mantle of a celestial body and their interaction [5, 6].

The shifts of the core lead to the shifts of the ECM with respect to the mantle, which are currently (approximately since 1993) available for studying by methods of space geodesy. At the same time, a wide range of ECM the shifts of the core lead to the shifts of the ECM with respect to the mantle, which are currently (approximately since 1993) available for studying by methods of space geodesy. At the same time, a wide range of ECM fluctuations was revealed and its age-old trend in the northern direction (towards the Taimyr Peninsula) was confirmed [36, 47]. By the DSM displacements, it is possible to restore the nature and features of the relative displacements of the core and mantle of the Earth, to study the geodynamic consequences of these displacements, such as deformations of the mantle layers, variations of its elastic energy, dissipation power and heat flux formation on the planet, redistribution of fluid masses, etc.

Cyclic displacements of the massive nucleus have cyclic gravitational effects on all the shells of the Earth, including its biosphere. All life on Earth is under the control of the "heart of the Earth" - the oscillating core-mantle system. All geological, geophysical and geodynamic processes are cyclical in nature and occur synchronously. Modern data from space geodesy on variations in the ECM position and variations in the second harmonic coefficients and higher order harmonics clearly support the existence of a secular trend and oscillations of the Earth's core [38]. According to Yu. V. Barkin, "actively working scientists of the world actually could not offer any theoretical substantiation to these geodetic changes of the Earth".

The geodynamic model of forced relative displacements of the nucleus has already received an application when studying and solving complex geophysical problems. A number of geodynamic and geophysical phenomena received a theoretical explanation in good agreement with observational data. *In geodynamics*, when explaining the secular drift of the pole of the axis of rotation and non-tidal acceleration in the axial rotation of the Earth [32, 36, 48]. In *gravimetry*, in explaining the observed secular changes in gravity at the worlds leading gravimetric stations. In *oceanology*, when explaining the secular change of both the global ocean level and its average levels in the Northern and Southern Hemispheres [35, 36]. In *geodesy*, when interpreting the observed secular shortening of the lengths of latitudinal circles in the Northern Hemisphere and elongations in the Southern Hemisphere [33], as a result, the Earth has not a spherically symmetric, but a "quasi-pervious" shape [49, 36], as well as solving problems of *seismology* and *climatology* and explaining a wide range of *geophysical*, *geodynamic*, *geodesic phenomena* on the Earth and other planets and satellites [35, 36, 48]. The discovery of the secular drift of the ECM finally brought us to an understanding of the nature of the Baikal-Rift process [50].

According to estimates, based on the *concept of endogenous activity of the Earth* (EEA) (with the simplification of circular orbits of planets and expressions of force functions and gravitational interaction), the energy balance of the Earth and the power of processes are: seismic events 3×10^{10} W, volcanic events 10^{10} W, thermal convection 10^{13} W, heat flux $(4.4–4.8) \times 10^{13}$ W, tides 4×10^{11} W, dissipation due to core oscillations and viscoelastic deformations of the mantle 3.38×10^{14} W, the total power of the energy dissipation in the Earth's mantle is 10^{14} - 10^{15} W (upper estimate 1.45×10^{16} W [12]. The impact of all other endogenous energy sources is either disproportionately less or completely reversible due to convective mass transfer in the mantle. Gravitational differentiation of terrestrial matter is the most powerful source of endogenous energy on Earth, which can also feed the Earth's magnetic field in the electrically conductive substance of the external (liquid) core of the Earth [40, 41, 48].

The concept of EEA explains the mechanism and manifestations of the responses of the Earth's shells to an external effect: energy, cyclicity, synchronicity, polar asymmetry and a change in the shape

of the planet, jump-like. The above confirms that the study of the STR was previously at the search stage, it is now possible to take into account all the initial (external) factors causing the variability of the natural environment [2].

Conclusion

The Earth is simultaneously under the influence of both continuously changing radiation fluxes of the Sun, the solar wind and GCR, and endogenous activity caused by the gravitational influence from the Moon, the Sun and other planets in the process of barycentric movement of the Solar system in the gravitational field of the Galaxy and the perturbations of the Solar System as a whole external influences [1, 2, 51]. The study and explanation of STR is possible only with consideration of all natural causes and their variability. The synchronism of the heliogeophysical indices jumps clearly indicates an external impact on the Solar system, including on the Earth. Fundamental and applied research of STR in the interests of many modern industries should be carried out taking into account all the above.

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