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External factors of solar-terrestrial relations

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We consider the status of investigations into solar-terrestrial relations and show that they are still at the search stage, because, without accounting for all of the external causes, there is no explanation for the mechanisms, energetics, cyclicity, polar asymmetry, inversion, synchronism of events and processes, instability of the Earth's diurnal rotation, stepwise and other peculiarities of their manifestations. We propose, along with the effects of solar activity and galactic cosmic ray (GCR) flows on the Earth, to also account for the role and contribution of the Earth's endogenous activity into solar-terrestrial relations. This activity is caused by force of gravity from the Moon, Sun, and other planets on our planet during the barycentric motion of the Solar system in the Galaxy gravity field, as well as by the disturbances of the Solar system in general from outside through the processes and events in the near and far space. This study is presented for the benefit of developing a system and interdisciplinary investigation of solar-terrestrial relations with a complete account for all the primary global factors affecting the Earth.

Keywords: Solar-terrestrial relations (STR), solar activity (SA), galactic cosmic rays (GCR), Earth's endogenous activity (EEA), Earth's diurnal rotation instability (EDRI), greenhouse effect (GE), Earth's mass center (EMC)

1 Introduction

Solar-terrestrial relations determine the state and varaiability of the habitat and activities of mankind. The urgency of the study and explanation of the nature of STR is because of its significance in the use of many present-day technologies which are used to warn of and mitigate possible damage. The STR variability is caused by the effect of both primary (external) and derivative (terrestrial) factors (Smolkov, Barkin 2014). The former have traditionally involved geoeffective variable solar electromagnetic emission, flows of energetic particles and solar wind, along with galactic cosmic ray (GCR) flows (Berry 1991; Dergachev et al. 2000; Haigh et al. 2005; White 2010;

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Heliophysics Envolving 2010; Gray et al. 2010 and others). The latter are terrestrial responses to the force of external factors as well as the consequences of man's management of the environment.

Solar-terrestrial relations are much wider per se than the space weather concepts. Their manifestations are caused by the processes and events occurring in all the Earth's internal and external layers: solid and liquid cores, plastic and solid mantles, lithosphere, atmosphere, magnetosphere, and even in the close near-Earth space. Studying associations of the processes and events occurring in all the listed layers of our planet has been acknowledged as one of 3 mainstreams in present-day geosciences (Khain 2009).

2 State of studying solar-terrestrial relations

One of the constant properties of the environment is its inconstancy. Its variability occurs on various time scales. The methodology of studying STR manifestations mostly involves revealing the associations and correlations of the Earth's shell responses to forcings from outside (till now – mainly due to SA and GCRs) by analyzing and correlating the associations of trends of interesting indices and modeling these associations to investigate their mechanisms. To understand the current state of the associations, one should account for their evolution in former times. The latter is not provided by reliable data collected by use of equipment over required time scales but instead proxy data is used, which inevitably leads to uncertainties in results when studying STRs. The special literature concerning the solar variability effect on, for example, climate, is extensive, however much is based on inadequate statistics and non-sound procedures. Widespread errors and their causes are defined and realized. The selection of terrestrial responses can often arise (inadvertently or otherwise) due to the use of limited data intervals and/or due to the choice of compared parameters. It is the principal cause of specific problems that arise when studying the SA effect on the climate (Lockwood et al. 2010).

SA variation energetics incoming to the Earth is lower than the energy of terrestrial responses. Therefore, to explain and elucidate the revealed correlations there are several proposals including non-linear increase mechanisms, feedbacks and interdependences, modeling using various interdependences of terrestrial processes, their parameters (White 2010; Gray et al. 2010). There is an obvious insufficiency of statistical analyses and correlations, and it is necessary in revealing the causes and mechanisms for their manifestations, a search for quantitative assessments when analyzing the role and contributions of initial factors to noticeable variations, for example, in the Earth's climate, along with continuing orientation to the anthropogenic factor (White 2010).

Current global warming has been finally acknowledged and accepted without doubt by the Intergovernmental Panel on Climate Change (IPCC), but its main cause has still been assigned to greenhouse gases, i.e. to the anthropogenic factor (Sobering IPCC Report 2014). This situation remains for many years the Framework Convention on Climate Change adopted 12.12.2015 by the 21st international conference in Paris. The most convincing experimental verification of the insufficient role of the greenhouse effect is the data from high-precision satellite observations testifying to an

essential change in the global energy balance of the climate system over the last 20 years (Golovko 2003). The imposed consensus on acknowledging the greenhouse effect (anthropogenic factor) as the main cause of climate change revealing the harmful effect STR nature (Sorokhtin et al. 1991).

In the search for the cause of global warming, scientists analyzed, indeed, all possible terrestrial factors, sometimes distant by their nature from climate variations. Noted were the drifts of the Earth's geographical and geomagnetic poles, the Earth's diurnal rotation variations, and growth in the Earth's endogenous activity (particularly, volcanic activity). The IPCC report affirms that solar and volcanic activity may elucidate half of the temperature changes until 1950, but their cumulative effect after that time was about zero. In particular, the greenhouse effect since 1950, according to IPCC, has been 8 times higher that the SA effect. Later papers improved the estimates for the SA effect on warming after 1950. Nevertheless, the conclusions have remained approximately the same: the best estimates of the SA contribution to warming are within 16% to 36% of the greenhouse effect contribution depending on the version of the SA evolution reconstruction in the past (Stott 2003). But the reconstruction quality essentially depends on the availability and errors of proxy-data bases (Avsyuk 1996; de Jager et al. 2010; Gray et al. 2010; Lockwood 2012), extracted from the annals of ancient civilizations, the disintegration of the radioactive elements of cosmic origin. Climate variability observed in the past by the Antarctic ice cores up to 740 thousand years, but "sea records" subject to violations of chronological order (Levy 2012).

An analytical overview of the STR study (Gray et al. 2010) found a large number of questions unanswered and explanations, as well as the transfer of the required additional information and data to further elucidate the mechanisms, etc. It is assumed that even very weak forces are accepted as causing a significant effect on climate, if present for a long time, if there are non-linear responses providing a feedback increase. The bulk of the proof for the solar forcing on climate depend on simple statistical associations such as correlation coefficients, that indicate a relation, but are not sufficient to indicate any causal mechanism. Besides, there is a considerable internal variability in the climate system, and the observed record is only one implementation of the possible responses. This represents a notable challenge when endeavoring to check the mechanism hypotheses. Detecting the solar contribution to the climate dramatically depends on how the climate system may respond tn a specific forcing. Because the climate system may response in a non-linear way, the response function may differ from the forcing function. The only way to overcome this challenge is to use corresponding climate models. Although the present-day climate models are far from perfect, they have a potential for imitating the space-time variability of the climate system as a result of the specific mechanism forcing, and many calculations (composite collections of responses and associations) may be performed to estimate the internal variability. The estimate for the capacity of climatic models to correspond to the observed picture of the regional sensitivity to the SA forcing is an important step in improving the insight into the SA forcing on the climate change. An important question is: how does one distinguish the mechanism among their discussed different versions (Gray et al. 2010; Jackson 2012)?

Should one follow the traditional views on the STR nature, it should be noted that the SA contribution (with what geophysical variations, for example, the climate,

are correlated first of all) dramatically depends on the time interval due to the STR differential character on different time scales. SA appears to be not the only and determining factor: within 25-yr intervals, the SA contribution is less than 2%; within decades, the SA contribution grows; within 100 years, the SA contribution is 30–40%, and on the 1000-yr scale, the average SA contribution to the temperature variation dispersion is about 20% (Nagovitsin 2012); on a larger time scale, cosmophysical factors' contributions are already assumed (Dergachev, Raspopov 2000; 2004, 2008, 2015; Kropotkin et al. 1963). Hence, the SA forcing may supposedly elucidate, in fact, only a part of climate changes (but upon establishing their mechanisms).

Several variations in global surface temperatures were recorded since 1850, and it was tested whether all decadal and multidecadal climate variations have an astronomical nature. The records deduced by the planet orbits represent very similar power spectra. On two records, eleven frequencies with a 5–100-yr period correspond closely. Among them, large climate variations of the peak-trough type with the amplitude near 0.1 and 0.25C and the periods near 20 and 60 years, respectively, are synchronized with the orbital periods of Jupiter and Saturn. In the temperature records, 11- and 22-yr solar cycles are also visible. The 9.1-yr cycle is synchronized with the orbital cycles of the Moon. The phenomenological model based on these astronomical cycles may be used for a good reconstruction (character recovery) of the temperature variations since 1850, and for partially forecasting the 21st century. At least, 60% of global warming observed since 1970 is established to be caused by a joint function of the above natural climate variations. A partial forecast shows that the climate may be stable or cool until 2030–2040. Possible physical mechanisms were qualitatively discussed with an accent on the collective synchronization of the coupled oscillators (Scafetta 2010). Also, revealed was a synchronization of the STR manifestations on galactic time scales (Berry 1991, 2006).

When analyzing astrophysical forcings on the climate, the following difficulties were noted that face researchers when they try to assign climate trends to SA forces: the solar forces have significant uncertainties, the climate system responses in general and the glacial epoch durations, in particular, are non-linear; dating of fluctuation duration and SA have uncertainties, as well as contributions of volcanic and other forcings; complex models for global circulation require accounting for all nonlinear couplings and feedback mechanisms within the climate system (de Jager 2010).

Studying the evolution of SA and of the Earth's climate and tectonic activity showed that these processes change synchronously (simultaneously) as though they were driven from one center. Researchers have a natural temptation to assign the conductor's functions to their own domain of knowledge: to solar, atmospheric, tectonic processes or to forcings of electromagnetic, magnetic, and gravity fields. But in this competition, the Solar system in general wins, i.e., the main sources of climate variations are located outside the Earth. Therefore, it is impossible to first understand the internal processes of the coupling among the land, the sea, and the atmosphere, and then to estimate the effect of external forces, like, for example, the politicized Kyoto Protocol ideologists do. The SA variations and luni-solar tides are just the factors that form the coupling among the land, the sea, and the atmosphere. Gravity fields of the Solar System bodies periodically change the solar and seismic activity, circulation of the Earth's air and liquid masses, and then these changes mainly form climate variations. The coupling of the above processes elucidates and explains all

the intracentennial warmings and coolings of the climate that occurred over the last 400 years (Berry 1991, 2006).

The most powerful energy processes occurring in the internal structure of our planet are three global processes: 1) gravity differentiation of the terrestrial substance by density, which results in stratification of the Earth into the dense oxide-iron core, residual silicate mantle, light silica-alumina crust, and the hydrosphere with the atmosphere; 2) radioactive elements decay resulting in the thermal energy release; 3) tidal coupling between the Earth and the Moon. All the other endogenous energy sources are either incommensurably less than those listed, or are completely dissipated due to convective mass exchange in the mantle. Endogenous energy sources also excite the Earth's magnetic field (Sorokhtin et al. 1991, 2010). Despite the difference in professional interests and, correspondingly, in approaches, there inevitably accumulated joint or individual recognitions of the key processes: phase opposition or polar asymmetry (Avsyuk 1996), recognition of the deep geodynamics as the energy supply basic process, i.e. common understanding (Sorokhtin et al. 1991, 2010) of the core's role (Avsyuk 1996; Osipov et al. 1999), the dominant role of the core's displacements, the processes at the mantle–core boundary, the Earth's internal structure, kinematics of its structures, deformation and coupling of its shells (Khain 2008; Avsyuk 1996; Sorokhtin et al. 1991, 2010; Osipov et al. 1999), the coupling of the Solar System celestial bodies among themselves, a necessity in a system study of the climate nature (Khain et al. 2008; Sorokhtin et al. 1991, 2010), effect of the cosmic forces external in the Solar System and in the remote space (Osipov et al. 1999; Khain et al. 2008; Dergachev etc. 2000, 2004, 2008, 2015; Scafetta 2010).

Studying the Earth's diurnal rotation variations of non-tidal origin boosted the emergence of hypotheses to elucidate and explain STRs (Haigh et al. 2005; Heliophysics Envolving 2010; Lockwood 2012). Among climate factors were termed (referred to as): motion of the Earth's poles, mechanical forcings on the Earth's atmosphere, global water exchange, angular momentum interchange between the Earth's mantle and liquid core, and, finally, gravitational forces (Sidorenkov 2002, 2006; Sidorenkov 2009) from the geomodel (Smolkov, Barkin 2013, 2014). But when addressing the EDRI relations and natural process global variations, some contradictions arose, and to minimise these, attention was paid to the existence of the third cause affecting simultaneously the processes in the Earth's core and in the climate system. The entire complex of the phenomena originating throughout the process in the Earth's shells was termed a generalized tide (Sidorenkov 2002, 2006, 2009), because, besides classical tides, attraction of the Earth's non-spheric inhomogeneous shells that take eccentric positions from the Moon, Sun, and other planets results in relative displacements and variations in their mass centers, in forced mass shifts (Barkin 1996, 2000). The long-term EDRI correlates with geophysical, hydrometeorological, geomagnetic, biological, and other processes (Gorkavyy et al. 1994; Velikanov 2006) because all of them have the same celestial-mechanical original cause – generalized tides. Thus, multi-year variations in the Earth's rotation angular velocity are an integral index of global variations (Sidorenkov 2002, 2006, 2009).

The key problem for the theory of natural planetary processes on the Earth (and on other celestial bodies) is the issue of the EEA energy sources, and of the main mechanism for the energy cyclic excitation of celestial bodies. A solution to this centennial challenge is offered based on the mechanism for excitation of the celestial

body shells by external celestial bodies. The basic proposition of the developing geodynamic concept is that planets, satellites, and the Sun represent systems of shells according to their evolution (the Earth has the core, mantle, etc.). The shells execute minor reciprocating and rotating motions relative to one another, thus causing deformation and other changes under the effect of gravity from all the surrounding celestial bodies (Barkin 2002).

Geodynamics of forced oscillations of the Earth's core and mantle under the effect of the force of gravity from external celestial bodies has developed since 1995-1996. The major result was the prediction and justification of the EMC centennial trend relative to the mantle. This trend obtained well-defined corroborations in the space geodesy data, and is mechanically interpreted as a consequence of the centennial near-polar northern drift of the Earth's core relative to the mantle (at 27.4 +/- 0.8 mm/year). The temporal variation in tides (generated by gravity forces of the coupling with the mobile core) in the viscoelastic mantle of the planet results in the mechanical energy dispersion in the planet material (in the mantle). This energy converts into heat and forms the temperature field inside the planet. This and many other problems of geodynamics, geophysics, and other geosciences are solved through the gravity mechanism for the forced swing of a celestial body's core and mantle (Barkin 1999, 2002).

The core displacements result in EMC shifts relative to the mantle. The EMC shifts have been currently (approximately since 1993) accessible to study through the space geodesy techniques. A wide variety of EMC variations were revealed and also the centennial trend of moving northward was found (into the Taimyr Peninsula region) (Gobinddass et al. 2009; Barkin et al. 2007; Barkin 1995). On the other hand, by the EMC displacements, one can restore the style and peculiarities of relative displacements of the Earth's core and mantle, study geodynamic consequences of these displacements, such as the mantle layer deformations, its elastic energy variations, the dissipation power, and the formation of the heat flow on the planet, of other physical fields, reallocation of fluid masses, etc.

Cyclic displacements of the core produce cyclic gravitational forces on all the Earth's shells, including its biosphere. All life on Earth is under vigilant attention and control from the "Earth's heart", the core-mantle oscillating system. All geological, geophysical, and geodynamic processes have a cyclic character and occur synchronously. The present-day data from space geodesy on the EMC position variations, on the second-harmonic coefficient variations, and on the variations in higher-order harmonics explicitly testify to the existence of the centennial trend and oscillations of the Earth's core. In fact, scientists of the world could not propose any theoretical justifications for the studied geodesic variations in the Earth (Barkin 2013).

The geodynamic model of forced relative displacements of the core has already obtained impressive applications when studying and solving complex geophysical problems. A number of geodynamic and geophysical phenomena obtained a theoretical explanation in good agreement with the observational data. In geodynamics, it is the explanation of the rotation axis pole centennial drift and non-tidal acceleration in the Earth's axial rotation (Barkin 1996, 2010; Goncharov et al. 2012; Barkin 2013). In gravimetry, it is the explanation of the observed centennial variations in gravity at the known leading gravimetric stations of the world (Barkin 2010). In oceanology, it is the explanation of the centennial variation in the ocean level, both global and

mean levels in the Northern and Southern Hemispheres (Barkin 2009; Barkin 2011). In geodesy, it is interpreting the observed phenomena of the latitude circle length centennial shortenings in the Northern Hemisphere and their stretchings in the Southern Hemisphere (Barkin 2013). Also, this model facilitated solving problems in seismology and climatology, and in a wide range of other geophysical, geodynamical, and geodesical phenomena on the Earth and other planets and satellites (Barkin 2009, 2012, 2013).

With reference to estimates, proceeding from the EEA concept, the Earth's energy balance and the power of the processes are: seismic events – 3×10^{10} W, volcanic events 10^{10} W, thermal convection – 10^{13} W, heat flow (4.4–4.8) $\times10^{13}$ W, tides – 4×10^{11} W, dissipations due to the core oscillations and visco-elastic deformations in the mantle – 3.38×10^{14} W, gross power of the energy dissipation in the Earth's mantle – 10^{14}–10^{15} W. All the remaining endogenous power sources are either incommensurably less that those enumerated, or are completely dissipated due to the convective mass exchange in the mantle. The gravity differentiating of the terrestrial substance is the most powerful source of the Earth's endogenous energy, it can simultaneously feed the Earth's magnetic field (Sorokhtin etc. 1991, 2010; Barkin 2012).

3 Evidence of external forcings on the Earth and Solar system

The list of spasmodic changes in natural processes which occurred in 1997–1998 is reported in surveys from GEOCHANGE (International Committee on Problems of Global Variations in Geological Medium) uniting research organizations and scientists from more than thirty countries (Khalilov 2010) and from the Global Flood Detection System (experimental system which aims to provide alerts to avoid flood disasters). This list provides evidence of the impact of these changes on the Earth and Solar system:

- acceleration of the north magnetic-pole drift speed by more, than 500% (1980 through 2010) reflecting the start of the growth of the Earth's geodynamic activity (Fig. 1);

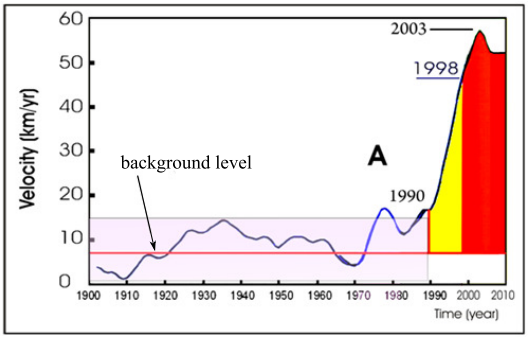


Figure 1 Convulsive increase in the northern geomagnetic pole motion speed in 1998 (Olsen, Mandea 2007) (http://onlinelibrary.wiley.com/doi/10.1029/2007EO290001/ epdf; (http://geo-change.org/Pdf/Will_the_Magnetic_North_Pole.pdf).

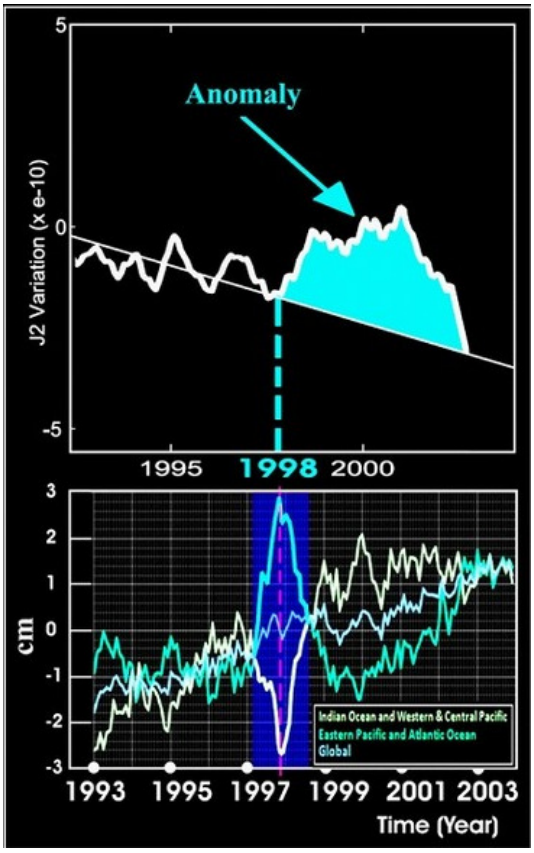


Figure 2 J2 variations (top), the ocean level dynamics (Indian, West and Central Pacific, East Pacific and Atlantic), and the general plot of the world ocean level fluctuations (bottom) (Khalilov 2010). Maximal values of the ocean level variations are synchronized (1998) with the onset of a sharp jump in J2. Since 1998, the mass transfer changed its direction. The geophysical causes for the present J2 growth are indefinite. It means a great change in the global mass distribution (Cox, Chao 2003). The impact on climate of these rapid displacements in the glacial and oceanic masses remains a subject to study.

• onset of the abnormal variations in some geophysical parameters of the Earth recorded by the USA satellite laser ranging system (LRS), including the 1998 jump in the J2 coefficient reflecting the ratio between the Earth's equatorial and pole radii (Figs 2, 3);

• increase in seismic and volcanic activity: a sharp growth in the number of strong earthquakes and the number of victims at strong earthquakes by exponential low; in 1997–1998, recorded was a deep minimum in the volcanic activity and its successive sharp growth;

• the 1998 spasmodic solar radiation change effect on the global climate changes (Fig. 8);

• change in world ocean level synchronous with the J2 coefficient anomaly, in fact, 3 times exceeding the effect of the water mass reallocations in the world ocean

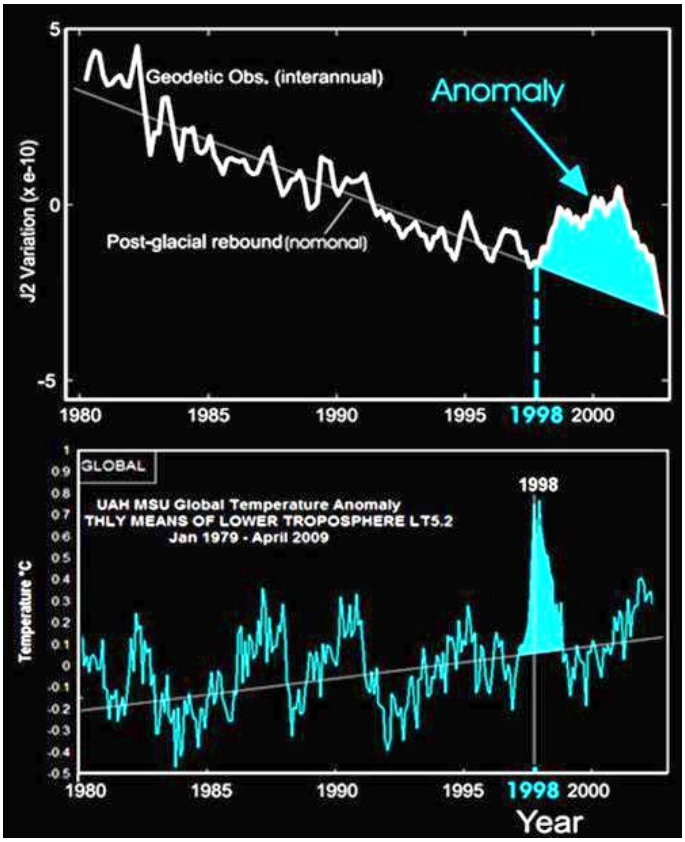


Figure 3 Synchronous spasmodic changes in J2 ∼Re/Rp and global temperature in the troposphere. In 1998, NASA (by using LRS) recorded an anomalously high change in the so-called J2 ∼Re/Rp coefficient (Cox et al. 2002), i.e. the Earth's shape, reallocation of its mass. The NASA experts appeared to be in confusion reporting that if, before 1998, satellites recorded a steady decrease in the Earth's radius within the equator and its increase within the poles, this trend has dramatically turned into the opposite one since 1998: the Earth began expanding within the equator and shrink within the poles. It was an absolutely unusual jump in the Earth's deformation, and there has been no unambiguous convincing answer in the NASA community concerning the causes of this phenomenon (Khalilov 2010).

(Fig. 2),

• global variations in the troposphere temperature: spasmodic anomalous growth in the troposphere global temperature in 1998 (Figs 3, 5);

• tsunami: a sharp change in the trend of annual numbers, both for disastrous tsunami and for medial and weak ones, "jump" in annual numbers of tsunami since 1998 has been described by exponential trends;

• sharp growth in the numbers of tornados in the North Atlantic tropical storms, in the total number of the Atlantic basin hurricanes, stable increase in the number of floods; significant and unusual events 1997 December through 1998 February;

• "jump" in increase in the number of forest fires in 1998.

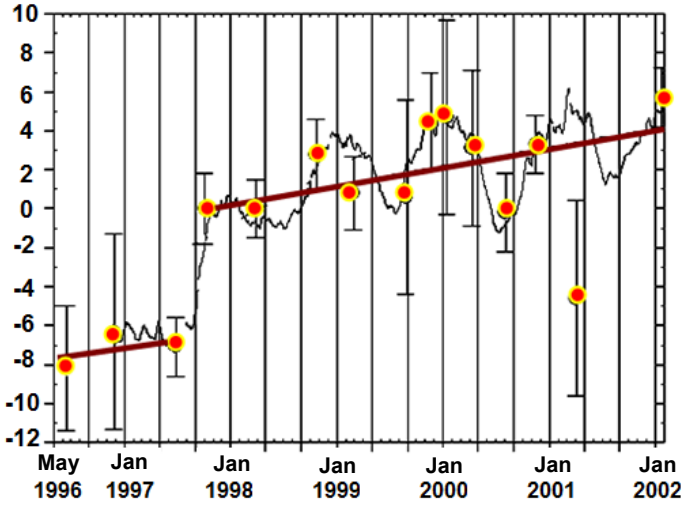


Figure 4 Gravity jump at the Medicina station (Italy) in 1997–1998. The ordinate axis presents the measurement results with absolute gravimeters (circles) and with superconducting gravimeters (thin black curve). The values on the ordinate axis are in microgalls (Zerbini et al. 2001).

Cumulatively, these sporadic changes which occurred synchronously in the natural environment were referred to by the authors of the reports as global "energy jump" of the processes in all the Earth's layers: lithosphere, hydrosphere, atmosphere, and magnetosphere. The surveys' authors correlate the onset of the global "energy jump" to 1998. The jump of the Earth's mass center by about 20 mm along the polar axis, a sharp 90° bend in the trajectory of the mass center epicenter on the Earth's surface (Fig. 1), jump in the second zonal harmonic coefficient J2 (by 2.5×10^{-10}) (Figs. 2, 3), jump in the gravity value at the Medicina gravimetric station (by 5.5 microgall) (Fig. 4), spasmodic increase in the ocean mean global level by 7.2 mm, jumps in the ocean mean levels in the Northern and Southern Hemispheres (15 mm, 0 mm) (Fig. 2), decrease in the period of the Earth's free nutation, and jumps in other natural processes – all of them occurred synchronously in 1997–1998 (the list of such characteristic events can be supplemented from other sources (Figs 5–9)).

The authors studied spasmodic changes in the activity of various geophysical and geodynamical phenomena in terms of the geomodel of the forced oscillations of the Earth's core and the deformation of the Earth's mantle, addressing these changes as consequences of a fundamental phenomenon – a jump of the core mass center relative to the mantle mass center (Barkin 2011, 2013; Smolkov, Barkin 2013). This phenomenon was termed "core galloping" (Barkin 2011). The fact of the similar behavior of the core was revealed by a unidirectional jump of the Earth mass center (EMC) predicted and detected based on the DORIS satellite observations (Zotov, Barkin 2009).

Noting a substantial increase in the geodynamic activity of our planet since 1998, the GEOCHANGE International Committee is still guided by only solar activity as an external action, based only on correlations without elucidating and explaining

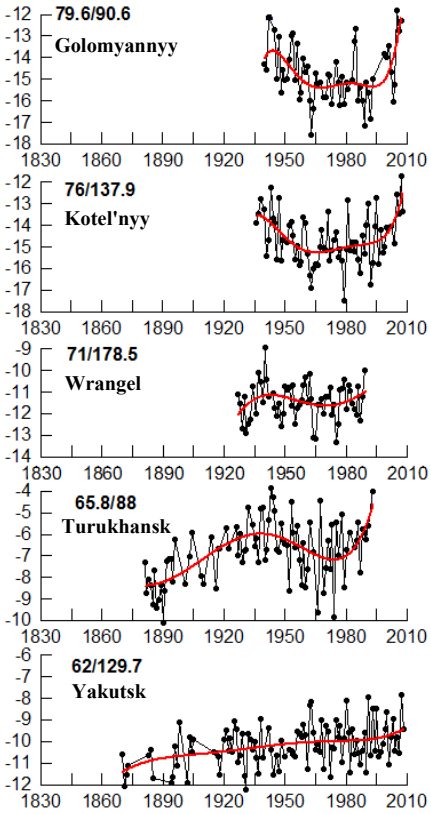


Figure 5 Earth's core preferentially displaces polarward, on various time scales, exerting a direct force of gravity on all the Earth's layers and shells, deforming and exciting them. The greatest force falls on the Earth's polar regions, which explains their increased geodynamical and geophysical activity. It is, for example, a higher variability of the averaged temperatures in the Taimyr Peninsula region, where the EMC current displacement pole is projected. A spasmodic warming was recorded at the Golomyannyy and Kotel'nyy meteorological stations in 1997–1998. At the Yakutsk latitude, one observes only evolutional behavior of the averaged temperature (Smolkov et al. 2011, 2013).

their physical mechanisms, without accounting for the contribution of gravity forcing on the Earth and disregarding the changes in the depth geodynamics. The role of solar activity was shown in Barkin (2000, 2011, 2013), including its role for spasmodic changes in the activity of processes (and not only in 1998). Reliable observational data testify that variations in the fundamental shells of the Sun and of the planets occur synchronously and inter-connectedly. We pay special attention to the shell relative motion non-inertial property in the Solar System barycenter reference system. The Sun's mass center motion in the barycentric reference system dramatically correlates with geodynamical and geophysical processes.

The provided complex of heliogeodynamical spasmodic events that occurred synchronously in 1997–1998 is clear and explainable within the concept of the Earth's endogenous activity and its geodynamic model (Barkin 2011, 2013; Smolkov, Barkin

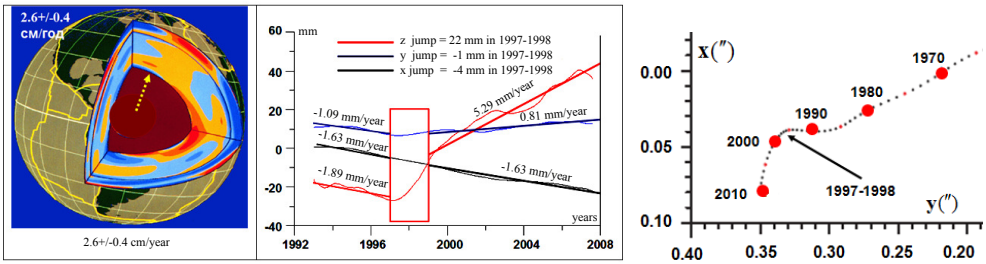


Figure 6 Earth's interior, direction of the EMC centennial drift, and the trajectory of its pole on the Earth's surface in 1990–2010 with an ∼90° turn in 1997–1998 in the Taimyr Peninsula region (Zotov, Barkin 2009).

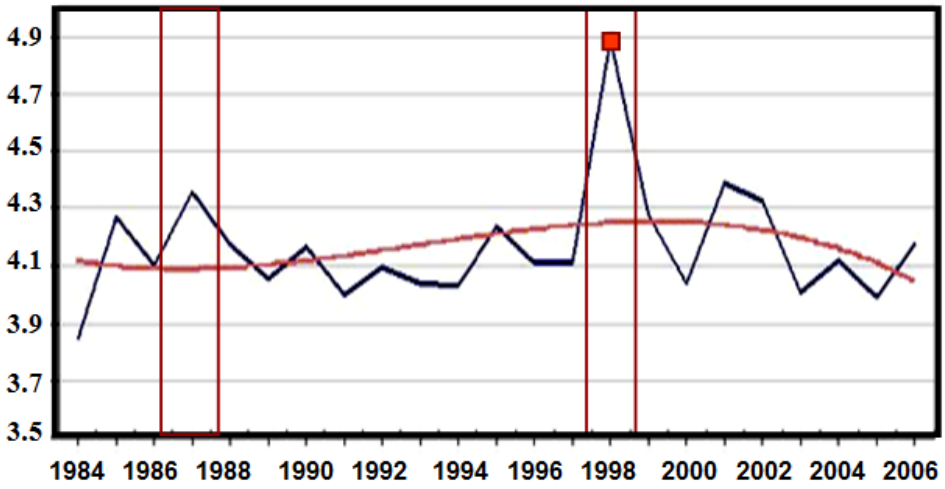


Figure 7 Spasmodic change in the mean-annual levels of solar radiation in 1998. The Monterrey, MX, solar radiation incident. 1983 July – 2005 December. (1 unit = 1000 Kcal/m^2; dark blue is the mean-annual approximation, and brown is the cubic approximation in Kcal/m^2).

2013). Noted is the systemic character of the recurring jumps of the core and of natural processes in other years, in particular, over 1986–1987, 2001–2002, 2010–2012, etc. It is particularly important that the synchronous jumps in natural processes occur not only on the Earth, but also on the Sun, Moon, Mars, and other Solar System bodies (Barkin 2013). The synchronism of jumps in heliogeophysical indices explicitly testifies to an external action on the Solar System, also including the Earth.

After the jumps, the level of geodynamical and geophysical activity over all the indices persistently increased. A significant increase in the level of evolutionary trends after jumps can only occur by adding the energy of the planet and the Solar system as a whole. A noticeable effect on the Solar system, and, consequently, on the Earth, provides the electromagnetic structure of the interstellar plasma clouds and deep Space (Bryushinkin 1990). Therefore, it is possible to add additional mass and energy in the Solar system from the outside, as it coincided with the release of the heliosphere in

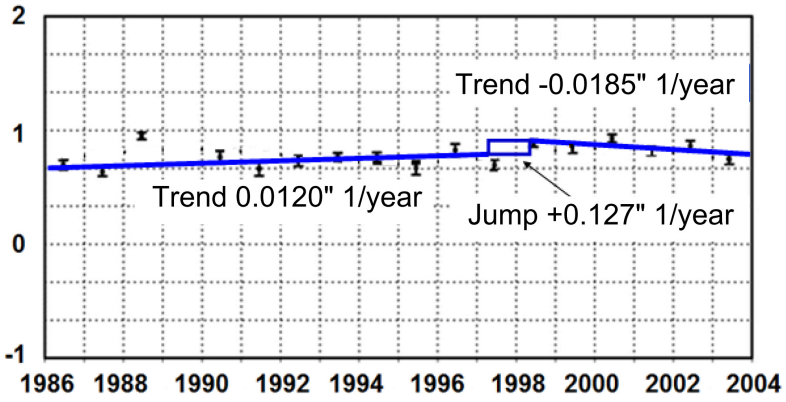


Figure 8 Linear trends of the solar radius before and after the spasmodic radius change in 1997–1998 by +0”187. Estimates of linear trends are – 0.0083”/yr (before the jump) and – 0.0124”/yr (after the jump) (Chapman et al. 2008).

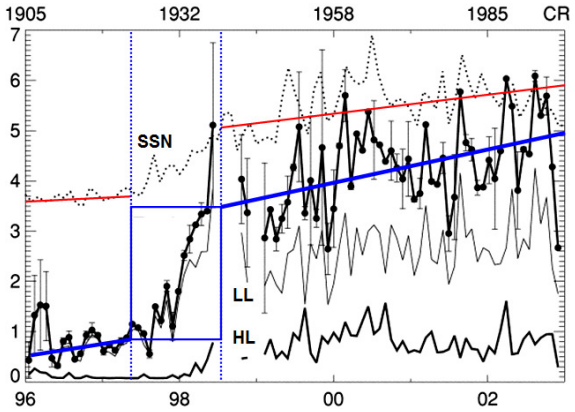


Figure 9 CME (coronal mass ejection) propagation velocities averaged over Carrington periods from the LASCO data (thick line with dark circles) as compared with daily values of sunspot numbers (SSNs). The errors for each rotation are estimated from the SOHO data. LL and HL are the velocity behaviors of low- and high-latitude CMEs, respectively (Gopalswamy 2003).

inhomogeneous interstellar medium (Automatic interstellar probe Voyager 1: NASA News 2009, 2013, 2014). The circumstances of the interaction of the Solar system from interstellar medium (ISM) indicate interaction with the interstellar clouds of plasma of the heliosphere at its intersection heterogeneous ISM – charged particles of heliospheric origin leave the heliosphere and interstellar medium surrounding high-energy particles flows into the heliosphere. During the exit of the heliosphere Voyager 1 first recorded instrumentally the disturbance of the Solar system from the outside. Under such circumstances convulsive nature of jumps of geodynamic and geophysical parameters could be the caused failure of tension which is stored as a result of asymmetric and eccentric interaction of the Earth’s shells thanks to trigger influence from

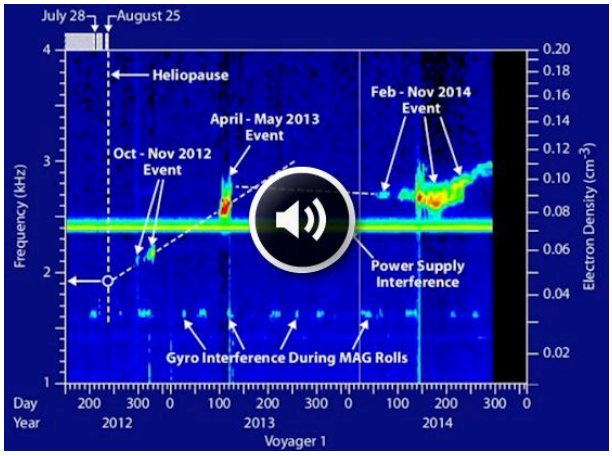


Figure 10 Voyager Buffeted by Interstellar "Tsunami Waves". The Voyager 1 susceptibility to possible forces from interstellar "Tsunami Waves" in 2012 October–November, 2013 April–May, and in 2014 February-November (http://science.nasa.gov/science-news/science-at-nasa/2014/16dec_voyagercme/).

the outside. Later, it was found Voyager 1 crossing interstellar "tsunami wave" in October–November 2012, April–May 2013 and February–November 2014 (Fig. 10). Another unique fact of the potential exposure of the Solar system (including Earth) exposed by the inhomogeneous interstellar medium registered by NASA's Interstellar Boundary Explorer (IBEX) 10 July 2013 (see Fig. 11).

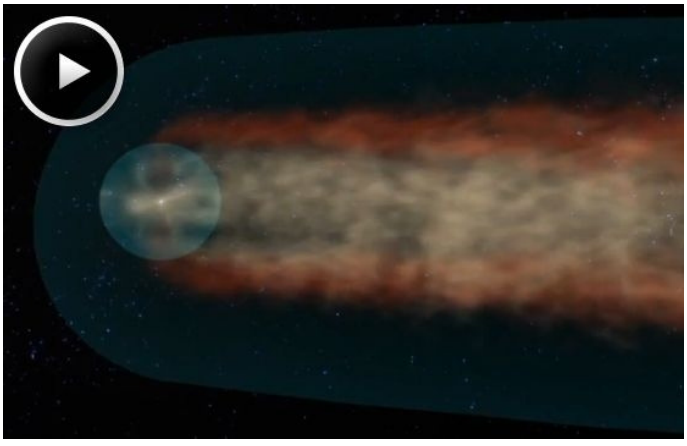


Figure 11 Videochart fragment of the Solar System tail/heliotail recorded, for the first time, by NASA's Interstellar Boundary Explorer (IBEX) 2013 July 10. The tail-cut structure resembles a 4-petal flower. The two side petals are filled with slow moving particles and the upper and lower petals with fast moving particles. The entire shape is rotated slightly indicating that it is influenced by the forces of the Sun and the local galaxy (http://science.nasa.gov/science-news/science-at-nasa/2013/10jul_ibex/).

4 Conclusion

The Earth is, at the same time, under the influence of continually changing flows of solar radiation, solar wind, galactic cosmic rays, as well as the gravitational forces from the Moon, the Sun and other planets. Therefore, natural processes in the Earth shells are caused by not only CA and GCR, but also by the endogenous activity of the planet. The gravitational effect on the Earth is performed directly by each and all of the corporate bodies of the solar system during its movement relative to the barycenter (its center of mass), generally under the influence of the Galaxy. Therefore, along with the GCR flux, there are two more external determining factors causing the two branches of STR and related environmental variability when using many terrestrial and orbital technologies: 1) Impact of geoeffective flows of electromagnetic radiation of the Sun, and the energetic particles of the solar wind, responsible for the disturbance of the atmosphere and hydrosphere, ionosphere and magnetosphere; 2) Transformation of energy during EMC displacement changing the shape of the Earth, IEDR, translational displacement, and deformation of all the shells due to the gravitational effects of the Moon, the Sun, and other planets responsible for the disturbance of the geomagnetic and gravity fields of the Earth; converting a part of the mechanical energy into thermal deformation, etc. (Barkin 2011; Barkin, Klige 2012), the creation of the Earth's additional thermal field changing correspondingly to EEA. The approach, based on partially taking into account the impact of external factors on Earth, leaves unanswered the old and new questions (Kondratyev 2004; Barenbaum 2010). STRs should be understood as "external-earthly" relations, as the Earth synchronously and simultaneously responds to external influences on it from all the celestial bodies of the Solar System, as well as the Solar System as a whole.

The basic and applied STR research should be done in the interests of many present-day industries taking account of all the factors stated in this paper (Smolkov, Barkin 2014).

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