"Physics of Auroral Phenomena", Proc. XXXIII Annual Seminar, Apatity, pp. 197 - 200, 2011

Polar Geophysical Institute

ON MANIFESTATION OF PERIODICAL DISTURBANCES OF INTERPLANETARY MEDIUM IN FLUCTUATIONS OF UNTIL OXIDATION HALF-TIME

E.S. Gorshkov[1], V.V. Ivanov[1], V.V. Sokolovski [2]

[1] *St. Petersburg Branch of the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of The Russian Academy of Sciences, Saint Petersburg, Russia*
[2] *The Institute for Analytical Instrumentation of The Russian Academy of Sciences, Saint Petersburg, Russia*

Abstract. The sequence of daily data of unithiol oxidation half-time (UOHT) with sodium nitrite during the 21-year cycle of solar activity (SA) was analyzed. It was shown that fluctuations of UOHT are determined by combined influences of cosmophysical factors of various origins, relating to manifestations of SA and basic (gravitational) disturbances caused by the Sun, and that the leading role of a certain cosmophysical factor in this relation depends on the phase of the SA cycle. The influence of periodical disturbances of interplanetary medium on the UOHT fluctuations observed is also described.

1. Introduction

There are several works on influence of various physical factors on unithiol test results published [for example, 1], but we still cannot consider this field to be completely explored. Not so long ago it was thought that unithiol oxidation half-time is basically determined by influence of cosmophysical agents of electromagnetic origin (solar and geomagnetic activities). However, the year long monitoring (1996-1997) at the Antarctic station Mirniy revealed influence of a physical factor of another origin and relating to gravitational disturbances from the Sun to the Earth and the Moon [2]. The spectral content of UOHT gave explanation to the periods related to manifestation of the disturbance from the Sun to the Moon: c.14.8 days (variation), c.31.8 days (evection). A reliable correlation between annual fluctuations of UOHT and the known gravitational factors influencing the biosphere and being characterized with equation of time (ET) and equation of the equinoxes (EE) [3] was detected.
The results made it possible to analyze the sequence of daily average UOHT indices for 1974-1985 from new points of view.
It should be mentioned that UOHT measurements in the indicated period were aimed at solving a variety of tasks and, due to the fact, the regularity of tracking indices was not constant throughout the 21-year period. We decided to address to the data due to our intention to collect (in retrospective) maximum data in order to solve the most urgent task (to our opinion), which is related to a combined influence of various cosmophysical factors on the UOHT dynamics. Since there is no strict compliance between genetic (electromagnetic or non-electromagnetic origin) and time characteristics of different kinds of UOHT fluctuations, we use a better-known time periodization to describe experimental data. In accordance to the periodization, rhythms are divided into mesorhythms (24 hours to 2 months), circannian rhythms and months-long rhytms. We used STATISTICA 6.0 software and the method of adaptive filtration (for detecting months-long periods).

2. Mesorhythms and circannian fluctuations in the dynamics of unithiol test results

In the spectrum of UOHT fluctuations (after the polynomial trend was excluded), the spectral analysis revealed harmonics with periods relating to the influence of cosmophysical factors of both electromagnetic and non-electromagnetic origins: 55.35, 52.51, 74.47, 16.38, 31.75, 60,24, 64, 44.04, 21.11, 25.13, 28.64 and 14.95 days. Obviously, the periods correlate with the periods of solar and geomagnetic activities [4], as well as with the nutation periods (evections and variations).
For the interval respective to the minimum and increase of SA (1975-1978), there were mainly the periods approximate to solar disturbance periods that revealed themselves in the UOHT spectra most distinctly. Their amplitudes are noticeably higher than the amplitudes of the harmonics describing the periods of solar and geomagnetic activities. At the maximum of the cycle (1979-1981) the influence of SA increases, comparing to the gravity influence.
We used the 5^{th} degree polynomial smoothing method to detect UOHT circannian fluctuations (CF) within the time interval of 1975-1984. As natural analogues to the detected CF, we chose the above-mentioned equation of time, which describes onward motion of the Earth, and the equation of the equinoxes, which defines ripples in the spin motion of the Earth (the degree of misalignment of the Earth's axe in relation to the celestial pole) – similarly to the work [2].

Correlations between CF and the relevant changes in SA, ET and EE during each year of the 21-year SA cycle were analyzed. It is obvious that the correlations are not equal: at the minimum and during the increase of SA (1976-1979) the correlation coefficients *(r)* for CF of UOHT and variations of ET and EE are negative, while at the maximum and during the decrease of SA (1980-1983) they are positive. The respective values of the correlation coefficients (hereinafter $p<0.05$) are within the range from (-0.8) to 0.9 and from (-0.88) to 0.87. Also, value of *r* between CF of UOHT and ET and between CF of UOHT and EE varies from (-0.42) in 1975 to 0.67 in 1984. The dynamics of *r* rates for CF of UOHT and ET and CF of UOHT and EE during the studied period is virtually the same, which is explained with synchronous "behavior" of the two kinematic factors in spite of a certain influence of the EE trend caused by the main nutation with the period of 18.6 years. It comes under notice that the correlations between CF of UOHT and SA and between CF of UOHT and ET and EE are inverse, which indirectly proves that the very cosmophysical factors, particularly, SA and ET, has physical interrelations.
Furthermore, there is no detectable direct relation between CF of UOHT and SA variations, while the correlation between CF of UOHT and ET and EE appeared obviously modulated by changes in SA during the 21-year cycle.

3. Cycles of planet interactions in the Solar system and fluctuations in unithiol test results

To detect rhythms with periods longer than 1 year, we studied the consequence of experimental monthly average values of UOHT (129 indications for the period of September 1974 – May 1985). In this context and due to real processes being poorly explored, we found a special interest in the cycles of interactions between celestial bodies in the Solar system (SS) determined by repeated similar relative positions of two, three and more planets, which can be detected through systematic screening of planetary periodicities [5].
Planetary conjunctions (especially of two planets, up to Jupiter inclusively) occur quite frequently – every 3 to 27 months. Furthermore, the cyclic disturbances of interplanetary medium caused by the planetary conjunctions last from 19.1 to 78 months. Since solar plasma fluxes are registered at the Earth, it is reasonably admissible that the conjunctions of Mercury-Venus (Mrc-Ven) and of Mercury-Earth (Mrc-Ert) manifest themselves in the geomagnetic data as the peaks relating to the 19- and 22-23-month cycles [6]. On the other hand, since the cosmic radiation comes mainly from the areas beyond the Earth's orbit, we can expect the conjunctions of Earth-Mars (Ert-Mar) and Earth-Jupiter (Ert-Jup) to be more efficient to some geophysical processes. These conjunctions relate to the 26-, 39-, 53- and 78-month cycles. The first of them has been well-known in meteorology for almost a hundred years. It is the so-called quasi-two-year cycle, which is almost absent in the spectrum of SA. The cycle's presence in the terrestrial processes testifies in favour of their certain correlation to situation in the interplanetary space. The spectral analysis of the primary curve of monthly average values of UOHT confirmed the presence of the quasi-two-year cycle of 25.6 months.
Until the present time, the vast majority of detected (or assumed) regularities in the chain of interrelations between the Sun and the interplanetary medium were the results of statistic analysis of ground-based observations, with correlation and spectral analyses engaged. As for temporal consequence of monthly average values of UOHT, the capacities of the standard methods are apparently insufficient. This fact prompted us to use the method of adaptive filtration, which stands out among the common methods thanks to its ability to detect nonharmonic components in analyzed signal. Also, this method has already been applied in geophysics [for example, 7].
Engaging the data on heliocentric longitude of the planets in SS for 1974-1985, which are presented in annual star almanacs, allowed to detect the temporal moments of the inferior and superior (in respect of the Sun) conjunctions of Mercury and Venus (Mrc-Ven), Mercury and Earth (Mrc-Ert), Venus and Earth (Ven-Ert), as well as the oppositions and conjunctions of Mercury and Mars (Mar), Jupiter (Jup), Saturn (Sat), Uranus (Urn), Neptune (Npt) and Pluto (Plt), etc.
We performed a range of consequent calculation operations to estimate a probable relation between the rhythm of UOHT fluctuations and the periodicity of interactions of the planets in the SS. Fig.1 demonstrates the components of UOHT S_1, ..., S_7 (curves 2-8) resulted from adaptive filtration of the primary range of monthly average values (1) for the period of September 1974 – May 1985 (f is a bandwidth, 1/month). We also did spectral analysis of UOHT fluctuations, its components and SA variations. The results are shown in Table 1 (periods of the first harmonics in bold).
In agreement with the considerations above, we compared the detected periodicities to the periodicity of pair conjunctions of the planets.
The interaction of each pair of planets with their orbit times known is characterized with a quantitative measure – conjunction intensity (CI) – that is the amount of conjunctions per month.
The analysis of periods of planets' CI shows that there is one or several evident harmonics in the spectrums of CI of a range of planets (Mrc-Jup, Mrc-Urn, Mar-Urn, Mar-Npt and Mar-Plt) having the same periods as UOHT harmonics and, to a lesser degree, SA harmonics. Also, a 64-month rhythm manifests itself in the spectra of UOHT, SA and Mrc-Jup CI. There is a 42.67-month rhythm manifesting itself in the spectra of S_5, S_6, S_7, SA, Mrc-Ven CI and Mrc-Ert CI.

A search for extreme points for the correlation coefficients of UOHT and CI, SA and CI was made by applying the method of successive phase displacement (from 1 to 29 months onward and backward) of CI of respective planets. Also, the positions of the closest and, as a rule, local extreme points allowed to detect phase displacements of some processes in respect to other ones and to estimate correlations (direct or inverse). Furthermore, the dynamics of changes in the correlation coefficients was used to separate a general rhythm (periods between local maximum points of *r*, in months) for each pair of processes.

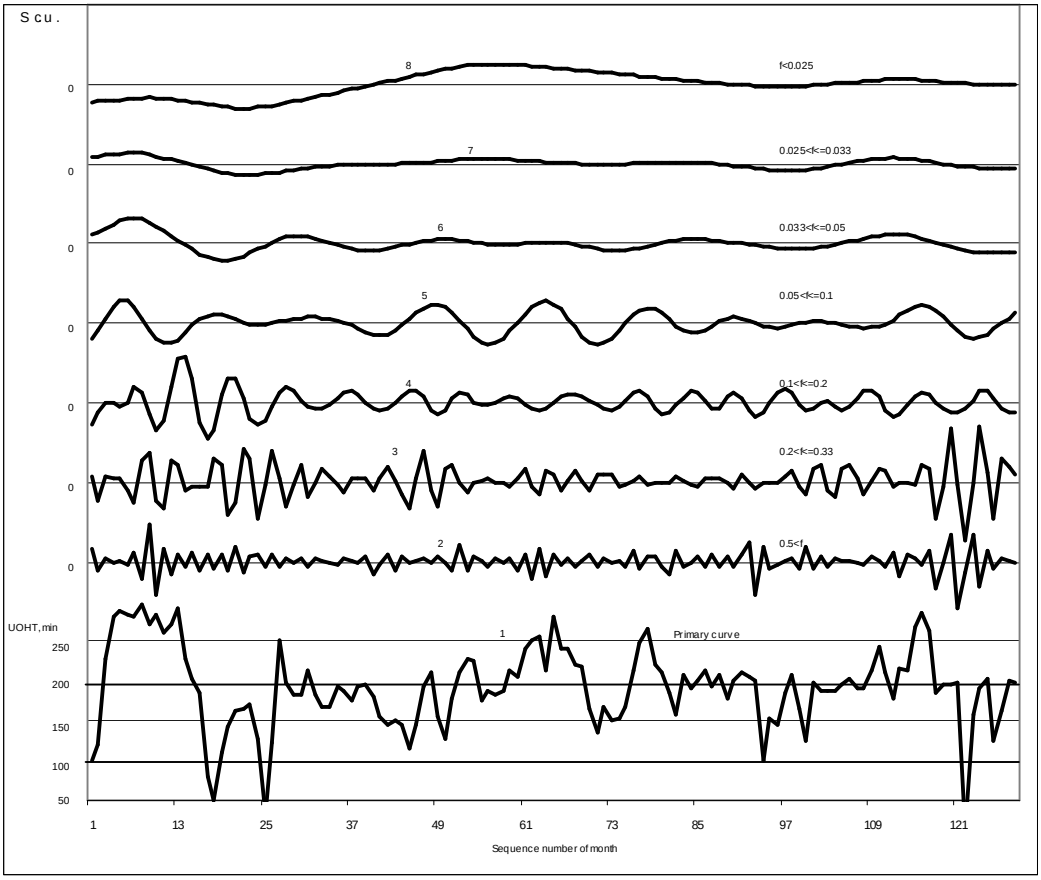

Fig. 1. Components of UOHT S_1, ..., S_7 (curves 2-8) resulted from adaptive filtration of the primary range of monthly average values (1).
As there is a frequency pulsation in the curves S_1, ..., S_7, manifesting themselves as wave trains with the maximum amplitude in the center of each train (Pic.1), we added the values of their periods (underlined) to Table 1.

Table 1. Results of spectral analysis of UOHT, S_1,…, S_7 and SA.

Index	Interval (months)					
	0-10	10-20	20-30	30-40	40-50	>50
UOHT	8	18.29	21.33, **25.6**			64
S_1	2.03, **2.06**-2.91	13, 15.3				
S_2	3.46-**4.27**-4.92	19.1	22.9, 23.7			
S_3	6.1-**8**, 8.53		29	35, 35.9		58
S_4	9.14	**14.22,** 16, 18.29	21.33			66.4
S_5		18.29	21.33, **25.6**		42.67	64
S_6			21.33, **25.6**	32	42.67	64
S_7			25.6	32	42.67	**64**, 128
SA	9.14	10.67			42.67	**64**, 128

It was found that the correlation coefficients for UOHT, SA and CI of Mrc-Jup and Mar-Npt vary in clearly defined waves. The periods of rhythmic processes of circa 40 months (with CI of Mrc-Jup) and circa 22 months (with CI of mar-Npt) are in agreement with the results of spectral analysis. The period of 42.67 months was detected in the

spectra of CI of Mrc-Jup, SA and the components of UOHT - S_5, S_6, S_7, and the period of 21.33 months – in the spectra of CI of Mar-Npt, SA, UOHT and its components – S_4, S_5, S_6.

We also reveal the character of relation between the studied indices and their rhythmic processes, in particular – changes in SA being 4 months behind by phase from the relevant changes in CI of Mrc-Jup and Mar-Npt and the correlation between them being inverse. Considering the correlations between UOHT and CI of Mrc-Jup and Mar-Npt, for the first pair of planets there is no phase displacement and the correlation is inverse, while for the second pair there is a 4-month delay in phase of UOHT changes respective to the relevant changes in Mar-Npt CI and the correlation is direct.

The analysis of the results helps to detect a new communality of the planets' CI values for optimal and equal phase displacements, with the period between local maximum points of *r*, considering UOHT and SA, being equal. The communality includes Mrc-Jup (Sat, Urn), Ven-Npt, Ert-Mar (Jup, Sat), Mar-Jup (Sat, Urn, Npt, Plt). While there is such a wide range of periods revealed (common for CI, on one hand, and for UOHT and SA, on the other hand), all of them correspond with the known periods of pair planetary conjunctions [6], which are 2.9-3.8 months for Mrc-Ert (Mar, ..., Plt), 7.4-7.8 months for Ven-Jup (Sat, ..., Plt), 11 months for Ven-Mar, 1.2 months for Ven-Ert and 22.7-26.8 months for Ert-Mar, Mar-Jup (Sat, ..., Plt). The period of >50 months can be relevant to pair conjunctions of Jup-Ert (Ven, Mar) or with conjunctions of three planets, for example, Mrc-Ven-Ert (57.1 months) or Mrc-Ven-Mar (52.6 months). It is noticeable that the correlation curves for UOHT and CI of Mrc-Mar (Jup) and Ven-Ert (Jup, Plt) and for SA and CI of these planets are correlating between each other at a high level. Superposition of the correlation curves leads to a sufficient growth of the correlation coefficients. For instance, *r* values for CI of Mrc-Jup, Mrc-Urn and Mar-Npt make 0.83, 0.69 and (-0.67), respectively.

The authors of the work [8] focus attention on the fact that the cycles resulted from mutual positions of planets (19.1, 22-23, 26, 39, 53 and 78-month long) are well reflected in terrestrial processes. Our comparison of the rhythms of UOHT, its components S_1, ..., S_7, SA and CI, including the procedure of phase alignment for these processes, not only supports the idea but also fills it with physical content.

Therefore, unithiol test, which plays a large role in researching molecular mechanisms of heliobiological correlations, can be considered as a peculiar kind of a marker at studying interplanetary interactions in the Solar system.

References

1. Sokolovski V.V. Thiolsulphide system in organism reactions to environmental factors. St.Petersburg, Nauka Publishing, 2008. P.112.
2. Gorshkov E.S., Shapovalov S.N., Sokolovski V.V., Troshichev O.A. On fluctuations of reaction rate for unithiol oxidation with nitrite ion being determined with gravity// Biophysics. – 2000. – V.45, issue 4. – p. 631-635.
3. Dubrov A.P. Geomagnetic field and life. L.:1974. 173 p.
4. Vladimirski B.M., Temuryantz N.A.//Influence of solar activity on biosphere-noosphere. Heliobiology from A.L.Chizhevsky to our days. M.:MIEPU,2000. 373 p.
5. Reznikov A.P. Fortelling natural processes with learning system. Novosibirsk.:Nauka Publishing, 1982. 292p.
6. Miroshnichenko L.I. Solar activity and the Earth. M.: Nauka Publishing, 1981. 145 p.
7. Popov V.A. Applying adaptive filtration in geophysics: Practical approach. Preprint No.5 (1055). M.: IZMIRAN, 1994. 28 p.
8. Mizun U.G., Hasnulin V.I. Our health and magnetic storms. M.: Znanie Publishing, 1991. 192 p.