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QUANTITATIVE DESCRIPTION OF GEOMAGNETIC ACTIVITY FOR STUDY OF HELIOGEOMAGNETIC FACTORS INFLUENCE ON THE BIOSPHERE

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Abstract. There is presented a brief review of current state of quantitative assessment of geomagnetic activity based on classic indices of geomagnetic activity used for study of heliogeomagnetic factors influence on the biosphere. Geomagnetic activity is the most visible description of state and dynamic of many physical processes in the Earth's space environment caused by the energy of solar radiation and corpuscular effect. Namely these processes rather than geomagnetic field variations more often can generate the mechanism of specific influence of magnetospheric substorms and magnetospheric storms (magnetic substorm and magnetic storm are only elements pf these events) on biology objects. Positive and negative properties of classic indices of geomagnetic activity AE (AU, AL), Kp (ap), aa, Dst, PC are analyzed. There are shown resources for more correct assessment of the Earth's magnetic field state for specific problems of space weather influence on the biosphere as well.

The space weather as a set of heliogeophisical factors and its influence on the human health has been studied for a long time ([*Breusand Rapoport*, 2003 and references therein]. A true analysis of the influence level depends on the choice of quantitative assessment of space weather and biosphere state. Space weather states are described by some quantitative parameters (indices of solar activity, solar wind parameters, indices of geomagnetic activity and so on) but human health states have no any quantitative assessment. At the moment, more or less proper geomagnetic indices of the Earth's space environment states are regularly published. As far as indices describing the human health states have not been introduced, there is no solution to the problem of negative influence of space weather on the human health. Scientists who monitor the biosphere, should start elaborating indices that could describe the biosphere states. Geophysists, in their turn, should improve the existing techniques of quantitative description of solar and geomagnetic activity, taking into consideration the fact that Space weather as a specific parameter of the Earth's space environment or parameter of any field of the Earth can influence any biological object.

Geomagnetic activity is the most visible description of the state and dynamics of many physical processes in the Earth's space environment caused by the energy of solar radiation and corpuscular effect. These processes more often than geomagnetic field variations make biological objects bear the influence of magnetospheric substorms and magnetospheric storms (magnetic substorm and magnetic storm are only elements of these events). A quantitative description of geomagnetic activity for scientific geophysical problems should differ from that for the problems of space weather influence on the biosphere and human health.

According to modern conception of magnetospheric processes physics, indices of geomagnetic activity K, Kp, AE(AU, AL), PC, Dst, being in use for many years, have some drawbacks that do not allow one to describe properly the geomagnetic situation during any time period. So, from the geomagnetic field data there is extracted a specific daily variation, that describes a periodic variation of the geomagnetic field only by definition but not properly. Then, on the base of the remaining data. K-indices are derived.

Such extracting may distort the magnetic field variation, especially during a quiet period. K-indices are derived as a maximum drop of the value of one of the two horizontal components of the geomagnetic field vector in 3-hourly interval. The table of amplitudes converting to K-index does not depend on the local time or season of the year. K-indices scale is from 0 to 9, which was established by volitional decision. As we know, K = 9 corresponds to the amplitude of the geomagnetic perturbation, which occurred on April 16, 1938 as the most intensive disturbance registered prior to that time.

The Kp-index, called the planetary index of geomagnetic activity is derived from K-indices and it has the same drawbacks. Moreover during magnetic storms Kp-index does not reflect the planetary geomagnetic activity generated by the ring current, currents on the magnetopause, magnetotail current, but registers the local activity of auroral electrojets. It is due to the fact that auroral zone is extended and auroral ionospheric electrojets shift southward to the area of Kp-index observatories location. As a result, Kp-index observatories become 'AE(AU, AL)-indices observatories' during magnetic storms. In other words, the Kp-index description of seasonal variation of geomagnetic activity only reflects the distribution of magnetic storms number. The real geomagnetic activity is the total activity over the Earth's surface during a year**.** However the intense geomagnetic perturbations caused by magnetic storms take place only in a period of time that constitutes 5-8 % of all hours within a year.

AE (AU, AL)-indices were introduced for the monitoring of auroral electrojets intensity. Nevertheless this monitoring is not always proper enough for the next reasons:

1) location of AE (AU, AL)-indices observatories is changed (various) in different hours of day and the intensity of westward and eastward auroral electrojets may be registered differently. It is a well-known UT-variation of AE (AU, AL)-indices.

2) electrojet intensity is determined by the indices according to extremal amplitude of geomagnetic perturbations at the local point of observation. It means that the observatory which registered the maximum amplitude of the geomagnetic field, was located closer to electrojet location, but at the point where the electrojet current amplitude was not maximum. At the same time another observatory was located further from the electrojet location, but at the point where the electrojet current amplitude was maximum. As a result AE (AU, AL)-indices can not describe the current intensity in the polar oval in a proper way.

3) during magnetic storms auroral electrojets shift southward and AE(AU, AL)-indices observatories are not able to register the true intensity of electrojets.

4) when there are no substorms geomagnetic activity may shift from the auroral zone northward to the polar cap. At that case AE(AU, AL)-indices do not give any opportunity to describe the real state of high-latitude current systems as well. When the vertical component of the Interplanetary magnetic field is northward (Bz > 0) the Polar Cap index PC does not describe the geomagnetic activity in the near pole region properly either.

As to aa-index we have the longest series of its data since the end of the XIX century. As derived from K-indices aa-index has the same drawbacks. Besides, aa-index is determined in nanateslas converted from K-indices table of two observatories only. As K-indices scale from 0 to 9 is connected with specific magnetic storm of 1938, aa-index does not describe the dynamics of the geomagnetic field state during different periods of geomagnetic activity.

Dst-index is derived from the data of 4 magnetic observatories only and does not allow to properly describe the ring current asymmetry that may reach 70-80% of the ring current amplitude.

The introduction of these indices of geomagnetic activity shows that the scientists for all of them were willing to register intense geomagnetic perturbations caused by magnetic storms and magnetic substorms. For these high amplitude perturbations the reference level of the geomagnetic field amplitude is not as important as for the registering a perturbation start and its temporary dynamics. Besides when classical indices of geomagnetic activity were introduced the method of registering high latitude geomagnetic variations was rather rough, it was carried out with photographic records with the scanning rate of 20 mm per hour. The modern technique of digital scanning of the magnetic field allows to have 1-sec scanning of registering signal and to register its amplitude with a high accuracy.

When analysing the quantitative assessment of geomagnetic activity we examine different approaches to find specific information in geomagnetic variations that can be used in solving scientific and applied problems.

We would like to propose that a following hypothesis for large-scale magnetospheric current system that has been existing for many years, has a most steady state, should be determined. The STEADY STATE of variable magnetic field of the Earth corresponds to the steady state of the magnetosphere. We suppose to determine the STEADY STATE by simple processing of the hourly averaged values of geomagnetic field components measured at magnetic observatories and by plotting a histogram of distribution of hourly averaged values of the amplitude of geomagnetic field components at a magnetic observatory for every hour of a day for every season and also for a series of years within solar activity cycles. A set of the most frequent amplitudes for every hour for each season of every year is called the level of STEADY STATE of the Earth' magnetic field. If that STEADY STATE exists it is possible to find the reference level of geomagnetic activity. It would be similar to a weather report: ' Now we have such-and-such temperature and such-and-such pressure whereas the statistical values are such-and-such.' And everybody would be able to determine if the deviation from the reference level is considerable or not. Basing on the STEADY STATE we would be able to describe classification of space weather states more properly and to use it for solving scientific and applied problems.

As our studies of geomagnetic data from observatories producing aa-index have demonstrated the STEADY STATE really can be determined. The variation of the Main magnetic field of the Earth, seasonal and annual variation of the ionospheric conductivity within a solar cycle and variation of parameters of Interplanetary magnetic field and Solar wind exert an influence on the STEADY STATE in one way or another.

To verify that a practical application of the STEADY STATE of geomagnetic field is possible we used the STEADY STATE of horizontal component of the geomagnetic field registered at IZMIRAN observatory which is located 30 km from Moscow to analyze the Moscow ambulance data for 1979-1981 [*Breus and Rapoport*, 2003].

References

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