"Physics of Auroral Phenomena", Proc. XXXIII Annual Seminar, Apatity, pp. 13 - 16, 2011

Polar Geophysical Institute

Kp INDEX CORRECTION IN ORDER TO ELIMINATE EXCESS IMPACT OF HIGH LATITUDE MAGNETOSPHERIC DISTURBANCES

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The present research working out of a technique of correction of the Kp-index is devoted. It will allow to avoid superfluous influence of foreign polar sources and is more reliable to estimate planetary geomagnetic disturbance. The algorithm of preliminary magnetogram clearing used for calculation of the specified index of planetary geomagnetic activity is offered.

1. Introduction

Recently with the advent of the new narrowly focused indices for description the solar and geomagnetic activity, which offered by various institutes (for example, ULF-index Institute of Physics of the Earth, RAS [*Kozyreva and Kleymenova, 2008*]), a question of reliability of early create the planetary indices is arising. So, Kp index has been created in 1949 by Bartels (Julius Bartels, till 1964 the director of Institute of Researches of Solar System of Max Plank, Germany). This index intended for representation of planetary geomagnetic disturbances in a simple scale from 28 values. In 1951 it has been officially recognized by the International Association on studying of problems of Geomagnetism and Aeronomy (IAGA). More detailed information one can be found on Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences: http:// www-app3.gfz-potsdam.de/kp_index, http:// www.gfz-potsdam.de/pb2/pb23/niemegk/kp_index/kp.html.

Kp index under the geomagnetic data received at 13 earth stations is calculated, distributed on globe in subauroral latitudes (49°-62°). Today it is widely at studying of dynamic communications between a solar wind and magnetosphere, in problems of estimation of plasma-pause position and other plasma regions. Also it used as an input parameter of various mathematical magnetospheres and ionospheres models. It well known that strong magnetospheric disturbances the excessive contribution to settlement values of Kp index can give. The algorithm of calculation of Kp index existing now called to describe planetary geomagnetic disturbance does not allow to consider dynamics of existential change magnetosphere-ionosphere current systems, resulting change of topology of a magnetic field during the periods magnetospheric disturbances. Errors of an existing planetary Kp index during the periods strong magnetospheric disturbances are shown. At this time the sizes and position of borders of a polar cap and auroral zones change. There can be a situation when the network of stations of calculation of Kp partially appears in polar region so calculated during these moments value of Kp index local subauroral activity is correspond, instead of planetary geomagnetic activity.

2. Check of existence Kp index error

The prospective error of an index not with a technique of its calculation is connected, but with a base material – magnetograms from observatories. Really, in disturbed day observatories in subauroral latitudes on magnetograms the same dynamics of disturbances, as high-latitude stations is register. Influence substorm activity on magnetometer indications at stations of calculation Kp on an example of 2004 can be shown. It was found out that ~30% from observatories influence of the general in middle-latitude and high-latitude area magnetosphere source of disturbances contain. As a result calculate values of the Kp-index overestimated is appear. It is clearly visible on an example magnetograms from two observatories located at different latitudes approximately on one magnetic meridian (station of calculation of Kp-index Meanook (MEA, geom. latitude $61,7^0$/longitude $305,7^0$) and high-latitude station of calculation of AE-index Yellowknife (YKC, geom. latitude $69,2^0$/longitude $296,6^0$)). The Fig. 1 shows magnetograms for horizontal components of geomagnetic field during disturbed day on January, 7th, 2004. Other situation during the periods of absence strong magnetospheric disturbances is observed. The Fig. 2 illustrates magnetograms from the same observatories, but already in quiet day on April, 29th, 2004.

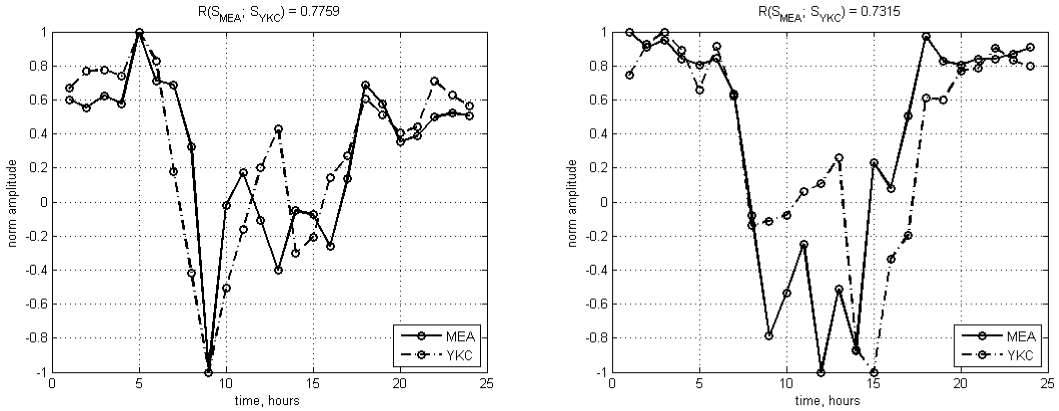

Fig. 1. Normalized magnetograms for geomagnetic field horizontal components H (a) and D (b) in disturbed day on January, 7th, 2004

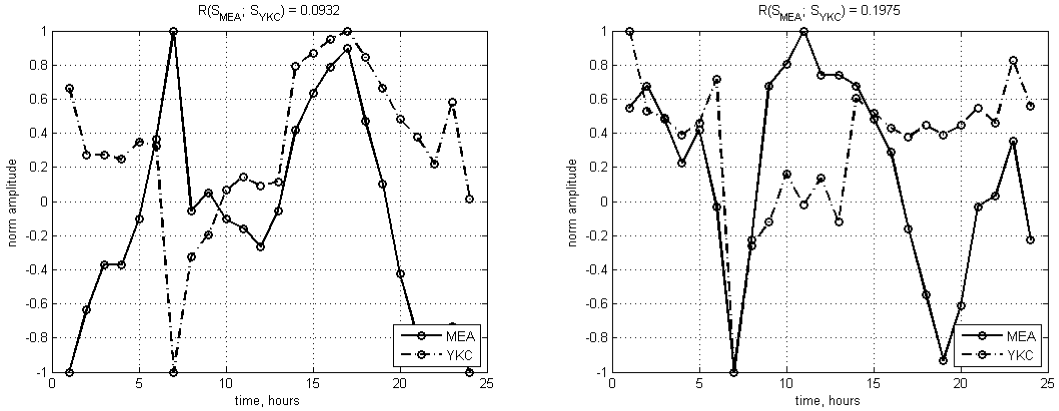

Fig. 2. Normalized magnetograms for geomagnetic field horizontal components H (a) and D (b) in quiet day on April, 29th, 2004

In disturbed day high correlation (correlation factor |R|>0.7) between magnetic recordings on considered observatories is marked. Development magnetospheres processes on polar and subauroral stations under the influence of the general source it allows to assume. Substorm activity on subauroral observatories of calculation Kp, i.e. to the south of usual, is marked. As a result the data used for an estimation planetary geomagnetic disturbance is deformed. It conducts to growth of a prospective physical error of the calculated Kp index for this day. For check of this hypothesis we will in addition into consideration the magnetic data from low-latitude geomagnetic observatory Fresno (FRN, geom. latitude $43{,}5^0$), not belonging network of Kp observatories, is entered. For this data regression analysis together with the data of high-latitude observatory Yellowknife we will execute.

Research has shown that substorm activity essential influence on the data of a low-latitude observatory does not render. Low factors of correlation between low-latitude and high-latitude magnetograms from stations of calculation Kp index it is confirmed. The analysis of materials for 2004 middle-latitude observatories Kp index and corresponding to them along a geomagnetic meridian high-latitude observatories ~30% magnetograms existence of the general magnetosphere source of disturbances (|R |>0.7) is shown. Therefore, for the purpose of an exception of superfluous influence polar electrojets at station of calculation of Kp, subtract from magnetograms these observatories «the polar contribution» it is necessary. In the given research this term as a signal from the prospective general source generating processes in polar and subauroral zone is understood. In this connection, offered correction of Kp index of planetary magnetic activity, clearing of the polar contribution magnetograms from observatories of calculation Kp is reduced. The specified index dynamics of existential change magnetosphere-ionosphere current systems as a result of change of topology of a magnetic field during the periods strong magnetospheric disturbances will allow considering.

3. Algorithm of «clearing» magnetograms from the polar contribution is working out

Correction of an existing Kp index change of algorithm of its calculation is assumes. It consists in addition of some new stages. The offered algorithm sequence of following actions is contains. For everyone observatories of calculation of Kp the high-latitude observatory corresponding to it is defined, i.e. pairs of observatories are

established. Magnetic recordings of Kp observatories demanding clearings by means of the correlation analysis of magnetic recordings for each pair of observatories on excess correlation factor (|R |>0.5) is established. The signals on the selected magnetograms are decomposed in Fourier series and correlated with the high-latitude signal harmonics from the purified signal removed. The cleared corrected signal inverse Fourier transform is obtained. Then, repeating official algorithm of calculation of the Kp-index on corrected magnetograms specified Kp index which is not containing superfluous influence polar electrojets we calculate.

In a Fig. 3 «clearing» magnetogram example from observatories Meanook of calculation of Kp-index from the polar contribution registered at high-latitude station Yellowknife of calculation of AE-index in disturbed day on January, 7th, 2004 is shown. Correlation between signals at performance of offered operation practically to zero decreases. The same pairs of magnetograms have been resulted earlier in a Fig. 1 where for them high correlation (more than 0.7) was marked.

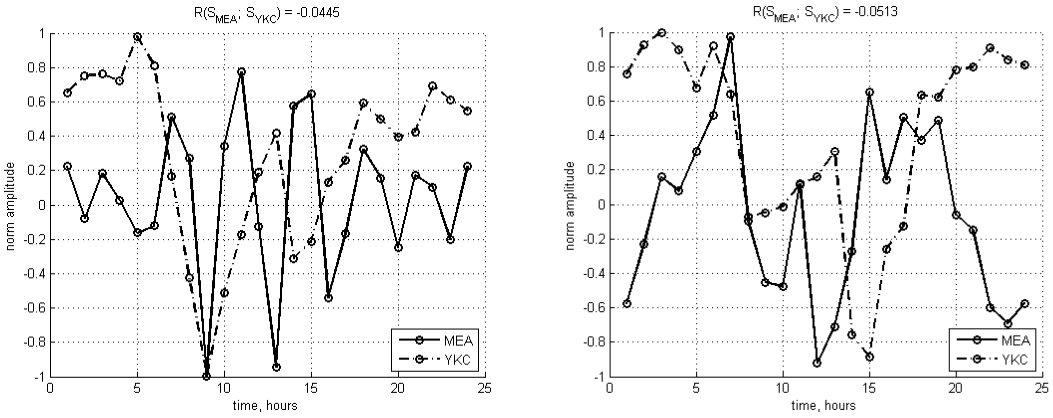

Fig. 3. Normalized magnetograms for horizontal geomagnetic field component H and D in disturbed day on January, 7th, 2004. Magnetograms from Meanook observatory of calculation of Kp-index of the polar contribution are cleared

4. Calculation of a new index on the basis of «cleared» magnetograms

Results on calculation of the specified index of Kp for 2004 is presented. Coordinates of pairs observatories selected for realization of algorithm of specification of an index are presented in Table 1. Here each middle-latitude observatory of Kp index is compared with high-latitude observatories. The high-latitude observatory is approximately on the same geomagnetic meridian as an observatory of calculation of Kp index (http://www.wdc.bgs.ac.uk).

Table 1. Grouping of the selected pairs of observatories.

Station			Geomag. coord.	
№	Code	Name	Lat.	Long.
1	LER*	Lerwick	62.0°	89.2°
	SOD	Sodankyla	63.7°	120.6°
2	MEA*	Meanook	61.7°	305.7°
	YKC	Yellowknife	69.1°	296.4°
3	SIT*	Sitka	60.4°	279.8°
	CBB	Cambridge Bay	76.7°	299.1°
4	ESK*	Eskdalemuir	57.9°	83.9°
	HRN	Hornsund	73.5°	127.5°
5	UPS*	Uppsala	58.5°	106.4°
	ABK	Abisko	65.9°	115.4°
6	OTT*	Ottawa	55.8°	355.0°
	PBQ	Poste-de-la-Baleine	66.2°	350.2°
7	BFE*	Brorfelde	55.4°	98.6°
	SOD	Sodankyla	63.7°	120.6°
8	HAD*	Hartland	54.0°	80.2°
	SOD	Sodankyla	63.7°	120.6°
9	WNG*	Wingst	54.1°	95.1°
	ABK	Abisko	65.9°	115.4°
10	NGK*	Niemegk	51.9°	97.7°
	SOD	Sodankyla	63.7°	120.6°
11	FRD*	Fredericksburg	48.6°	353.1°
	PBQ	Poste-de-la-Baleine	66.2°	350.2°
12	CNB*	Canberra	-42.9°	226.8°
	CMO	College	65.1°	259.2°
13	EYR*	Eyrewell	-47.2°	253.8°
	CMO	College	65.1°	259.2°

Clearing of the superfluous polar contribution for each of the specified 13 pairs observatories is executed. At the final stage the official algorithm of calculation of an Kp index on corrected (cleared) magnetograms is realised. In a

Fig. 4 the fragment of the calculated annual sequence of the corrected three-hour values of Kp index on an interval from July, 18th till July, 22nd, 2004 is shown. In addition for comparison on this plot Kp calculated by us on the basis of original magnetograms, and also the published official values of Kp are resulted. Some discrepancy of last two indices use in our case public magnetograms is caused. While published official Kp on a basis magnetograms «for internal using» is calculated.

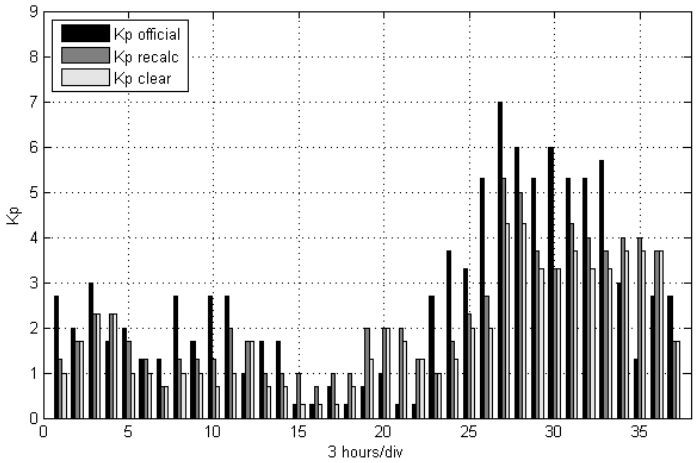

Fig. 4. Fragment of sequence of values from July, 18th to July, 22nd 2004 of the recalculated (clear) index of Kp on the basis of cleared magnetograms (light columns), published values of the Kp-index (black columns) and calculated by us without clearing magnetograms (grey columns)

5. Conclusion

The mid-annual disorder of values between published official (Kp official) and the corrected index (Kp clear) ±0.9 point in a digital index scale is observed. Between calculated by us on the basis of without clearing magnetograms (Kp recalc) and the corrected index (Kp clear) the disorder ±0.7 point has made. It has appeared that in 80% of cases of value of published official Kp the calculated index on the basis of cleared magnetograms is exceeded. By results of the executed comparative analysis we will assume that the error of an official planetary Kp-index shown during the periods strong magnetospheric disturbances to true values on the average 25% not less than in 60% of cases is added. Thus, the use proposed correct Kp-index to avoid excessive influence of the polar sources and the planetary geomagnetic disturbance more reliably to estimate.

Acknowledgments. Work is executed at partial support under grant of the RFBR 09-05-00495, and also program Ministry of Education and Science «Development of higher school scientific potential (2009-2010, project N 1623)».

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