Correlation between the variations of cosmic ray geomagnetic thresholds and interplanetary parameters during various phases of the geomagnetic disturbance in November 2004

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ABSTRACT

The geomagnetic cutoff rigidity R (momentum per unit charge) is the threshold rigidity below which the particle flux becomes zero due to geomagnetic shielding. The properties of the geomagnetic screen vary greatly during magnetic storms, depending on the dynamic interaction of the solar wind (SW) magnetic fields with the magneto-spheric fields and currents. The correlation between the variations of geomagnetic cutoff rigidity ΔR and interplanetary parameters and geo-magnetic activity indexes during various phases of the superstorm on November 7 – 8, 2004 has been calculated. On the scale of the entire storm the most geoeffective para-meters were Dst, Kp, and SW speed V, while other parameters, including total interplanetary magnetic field B and Bz component, were effective at different phases of the storm.

METHODS

The Δ*R* values have been found with two methods: (1) the spectrographic global survey method (SGS), in which the determination of the cutoff rigidity R_{SGS} is based on data from the neutron monitor network [1, 2], and (2) a method in which the particle trajectories are calculated numerically in a model magnetic field of the magnetosphere to determine the cutoff rigidity R_{ef}.

REFERENCES

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2. *Dvornikov V.M., Kravtsova M.V., Sdobnov V.E.* Diagnostics of the electromagnetic characteristics of the interplanetary medium based on cosmic ray effects // Geomagnetizm and Aeronomy. V. 53. N 4. P. 430–440. 2013.

Superstorm on 7-8 November, 2004

Preliminary phase (before the storm: 03-19 UT, 07.11
Main phase: from 20 UT, 07.11-06 UT, 08.1.04
Recovery phase: 07-24 UT, 08.11

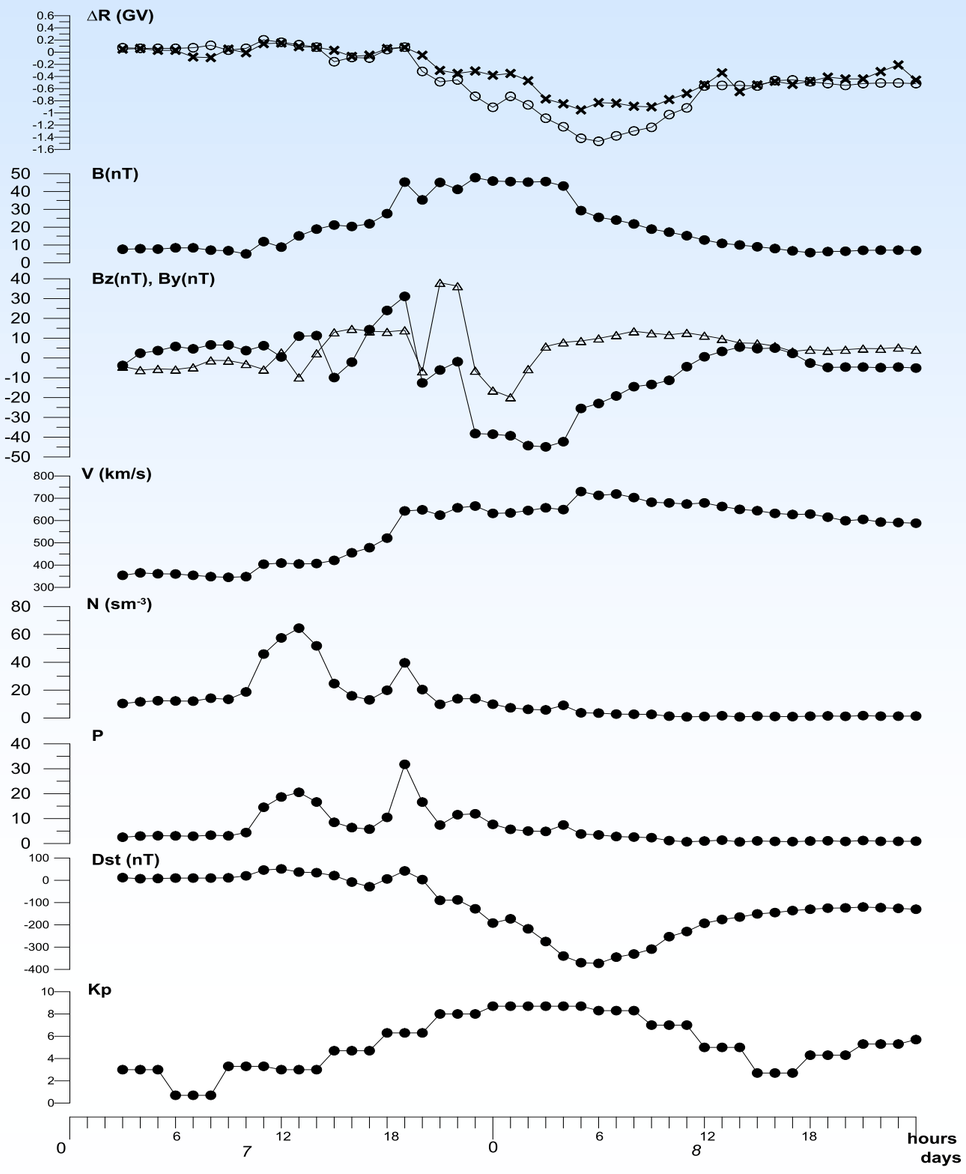

Fig. 1. STORM 07–08.11.2004. Time variations of IMF, solar wind parameters and geomagnetic field indexes. DR_{ef} – ○, DR_{sgs} – ×

CONCLUSION

On the scale of the entire storm 7-8.11.04, the most geoeffective parameters were Dst, Kp and solar wind dynamic parameters, while at different phases of the storm the relative impact of all parameters, including IMF, varied. This is due to the fact that in response to changes in the parameters of the SW and IMF global current systems (ring current around the Earth, currents on the magnetopause, currents of the tail of the magnetosphere, currents at high latitudes) are developed, and they evolve over time. At the same time, the formation, intensification and disintegration of these current systems occur on different time scales. This results in a different relative contribution of current systems to the Δ*R* and determines the specific response of the cutoff rigidities to changes in the parameters of the helio- and geomagnetosphere in different phases of the storm.

GEOEFFECTIVE PARAMETERS

Correlation coefficients
|*k* |≥ 0.50

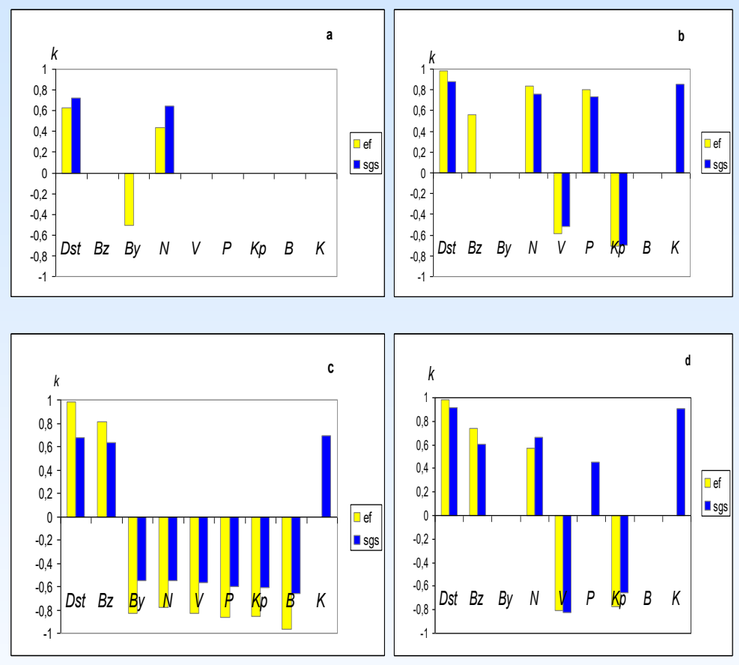

Fig. 2. Correlation (coefficient *k)* of ΔR_{sgs} and ΔR_{ef} with parameters of IMF, solar wind and geomagnetic field. Correlation coefficient *K* between ΔR_{sgs} and ΔR_{ef} is also shown.

RESULTS

We calculated the correlation of variations in the geomagnetic cutoff rigidity ΔR_{SGS} *and* ΔR_{ef} with interpla-netary parameters and the *Dst* and *Kp* indexes of geomagnetic activity during the storm on 7-8 Nov. 2004. The results obtained by these two methods are well consistent with each other.

ΔR dependence from Dst and Kp

Among all of the parameters, the *Dst* index has the greatest influence on ΔR_{SGS} and *ΔRef.* Dependence on *Kp* is less than on *Dst*.

ΔR dependence from IMF

Strong correlation/anticorrelation between Δ*R* and B, as well as with all IMF components is found only in the recovery phase.

ΔR dependence from SW parameters

During the main phase the strong correlation between Δ*R* and solar wind density *N* and pressure *P* is found. On the recovery phase there is the strong dependence of Δ*R* on *N, P* and *V.* The correlation between Δ*R* and *V* is negative, and with *N* and *P* it is positive during the main phase and negative in the recovery phase

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