THE INFLUENS OF QUIET ASYMMETRIC MAGNETOSPHERE ON THE CUTOFF RIGIDITIES OF THE MAIN CONE

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U S S R

1. Introduction. Some earlier studies (1-4) show that cutoff rigidities of cosmic-ray particles in the model magnetospheric fields of internal and external sources have daily variations caused by asymmetry of the magnetic field due to the currents induced at the magnetopause and tail currents.

The purpose of this paper is to examine cutoff rigidities of the charged particles coming down at the middle latitudes. The mathematical model that is used to specify the geomagnetic field for this investigation is due to Tsyganenko and Usmanov (5). This model of the magnetospheric field is based on the merged IMP-HEOS experimental data set and includes all known at the present time current systems of the magnetosphere: magnetopause, ring, magnetotail currents. Being based upon experimental data, this model implicitly takes into account the magnetic effect of field-aligned currents. Moreover this model includes the effects of changes in the tilt angle of the geodipole to the Sun-Earth line (Ψ) within the limits from -35° up to $+35^{\circ}$ according to annual and daily variations. A separate account of the contribution from different magnetospheric current systems has made it possible to track the Kp - dependence of their main physical parameters.

2. Methods. The suitable methods of trajectory calculations are to be described by Shea and Smart in (6). The trajectory-tracing of cosmic-ray particles is performed by the Gill modification (7) of the Runge-Kutta iteration method applied to the equation for charged particle motion in a magnetic field:

$$\ddot{\bar{r}} = \frac{em}{c}\,\dot{\bar{r}} \times \bar{B}$$

The trajectory calculations has been performed for the particles with rigidities ranging from 750 Gv to the first forbidden trajectory with the step size of 0.01 Gv at the cosmic-ray stations Moscow, Irkutsk and Noricura in the superquiet conditions (Kp=0). A trajectory has been considered as forbidden if either 30 000 steps were not enough for a particle to pass beyond the sphere of the radius equal to 25 Earths radii or it returned to the Earth. The last allowed trajectory corresponding to main cone cutoff (1-2) was taken as the threshold rigidity.

3. Results and discussion. Cutoff rigidities were obtained for three Earths orbital positions (summer and winter solstice and equinox). Displaying the results of calculations one can see (Fig. 1) that the duirnal variation of the cutoff rigidities at the stations Irkutsk and Noricura have rather regular character with the maximum corresponding to the morning hours (9^h-12^h) and minimum in the evening (20^h-22^h). The time of the maxumum and minimum don't change appreciably throughout the year but the curve for the station Noricura has an additional maximum at the 18^h on the 22 of december. Diurnal variations for the station Moscow do not have such regular character. As the Fig. 1 shows the cutoff rigidity daily oscillation amplitude is greater for stations with lower cutoff rigidities. For example, the amplitude is 0.15 Gv and 0.02 Gv at the station Moscow and Noricura respectively. One can observe a certain variation of the differences between the maximum and minimum values of cutoff rigidities when the angle Ψ changes. These differences are maximal in summer and amount to 5%, 1.5%, 0.25% of the mean cutoff rigidity value for the stations Moscow, Irkutsk and Noricura respectively. The amplitude of the cutoff rigidity decreases by almost one half of that

quantity at the equinox. The latter result agrees with the Fig.4 of (8) showing that the cutoff rigidity daily variation (which is defind in (8) in the same manner as in the present study according to the last allowed trajectory) observed at the high-latitude station College (Alaska) is greater in summer than in winter or at the equinox.

4. Conclusions. Thus even in the superquiet periods (Kp= 0) the magnetosphere asymmetry causes the daily variations of cutoff rigidities at the middle-latitude stations which are expected to bring the greatest contribution to the observed daily variation of the cosmic- ray neutron intensity about 0.25% at the sea level station Irkutsk and 0.2% at the mount station Noricura.

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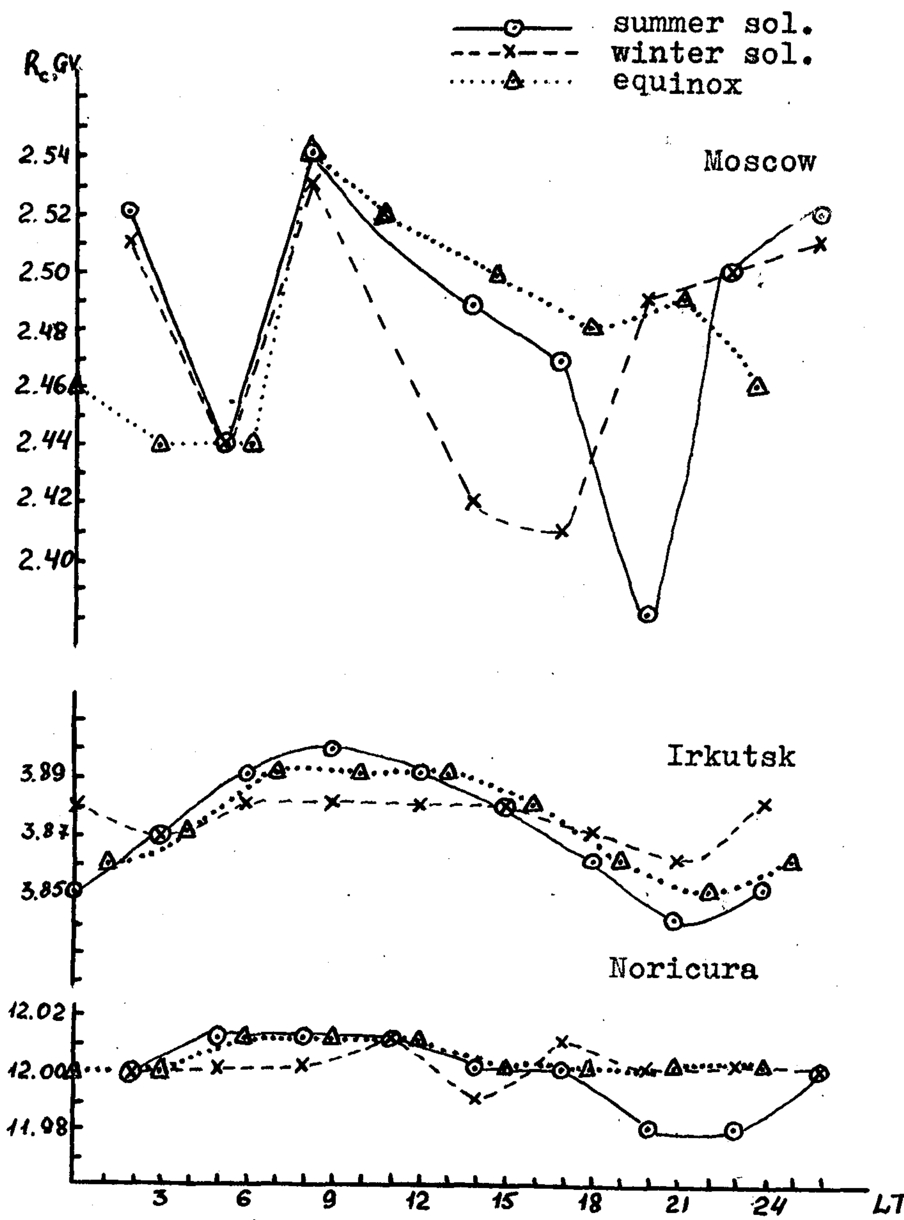

Fig.1. Daily variation of the vertical cutoff rigidities in the magnetospheric field according to the model of Tsyganenko-Usmanov (5).