Geomagnetic Cutoff Variation Observed with TIBET Neutron Monitor

H.Miyasaka,[1] K.Kudela,[2] S.Shimoda,[1] Y.Yamada,[1] E.Sakamoto,[1] K.Munakata,[3] T.Yuda,[4] Y.H.Tan,[5] J.L.Zhang,[5], Y.Q.Tang,[5] H.Lu,[5] H.B.Hu,[5] Labaciren,[6] X.R.Meng,[6] and A.F.Yuan,[6]

(1) RIKEN (The Institute of Physical and Chemical Research), Wako, Saitama, Japan

(2) Institute of Experimental Physics, Slovakia Academy of Sciences, Kosice, Slovakia

(3) Department of Physics, Shinshu University, Nagano, Japan

(4) Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya, Japan

(5) Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

(6) Department of Mathematics and Physics, Tibet University, Tibet, China

Abstract

From the TIBET neutron monitor observation, we have observed a strong correlation between cosmic ray intensity and geomagnetic disturbance. One of the strongest geomagnetic storm occurred at March 31, 2001 with this solar maximum period has shown the clear coincidence with the peak cosmic ray intensity and the time of Dst reached to the minimum. This feature indicates the short term changes of geomagnetic cutoff.

1. Introduction

During the strong geomagnetic disturbance on March 31, 2001, several neutron monitors including our TIBET neutron monitor (NM) has observed a time variations of cosmic ray intensity. At the low and medium latitude (high and medium cutoff) NM stations observed a clear intensity increase while the high latitude (low cutoff) stations observed continuous decrease after the onset of the storm.

Here we will report about TIBET NM event according with the geomagnetic disturbance which occurred at the solar maximum period (From January 1999 to December 2002).

TIBET NM station has started as a part of Japan-China international cosmic ray observation program on September 1998 [3,4]. The stable continuous data taking has started since October 1998 and working through the solar maximum phase. The location of the TIBET NM station is at Yangbajing International

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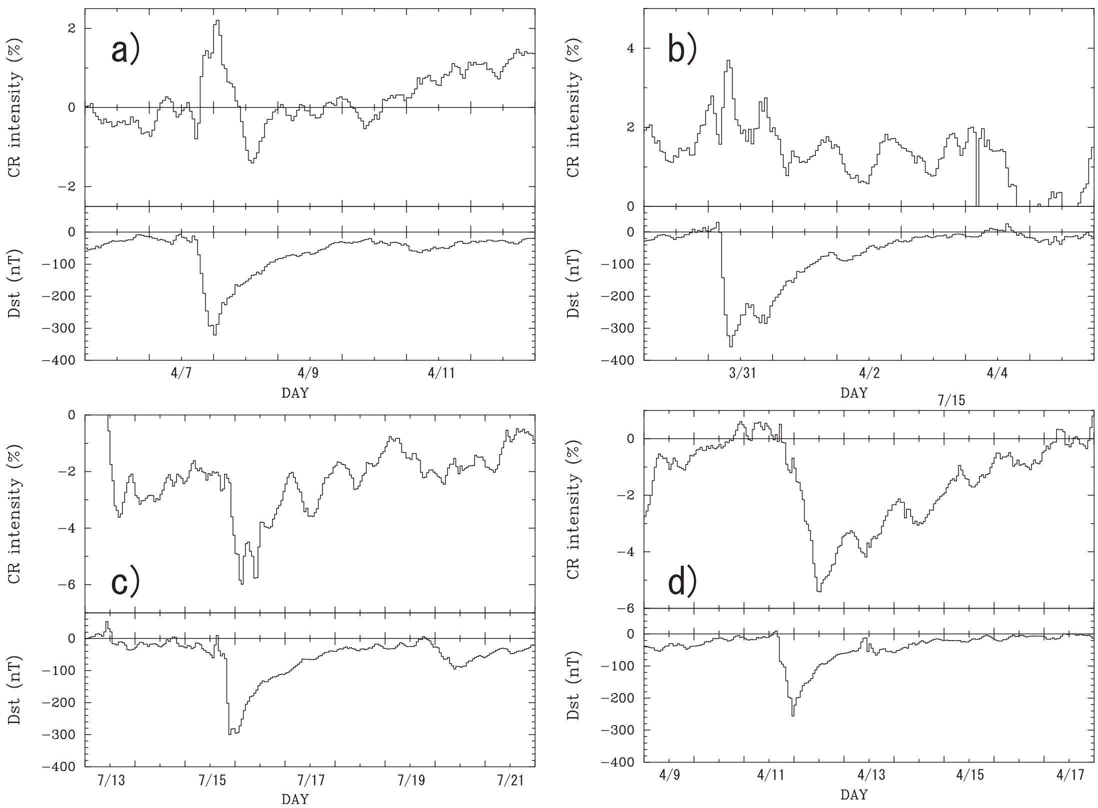

Fig. 1. Cosmic ray intensity (%) observed at TIBET neutron monitor and Dst value (nT) are shown. Each of the figure shows the magnetic disturbance occurred at (a)2000/04/07, (b) 2001/03/31, (c) 2000/07/15 and (d) 2001/04/11.

Cosmic Ray Observatory (30.11°N 90.53°E, 4300m above sea level, cutoff rigidity 14.1GV). The observation system consists of 28 NM-64 neutron counters and records the single counts and multiplicity 1 to 8 from each two adjacent counters and thus this station performed as a highest counts rate (1.07×10^7 counts per hour) with high geomagnetic cutoff and high time resolution.

2. Observation

One of the largest geomagnetic disturbance since TIBET NM station started has occurred on March 31, 2001 (Peak Dst = -358nT at 8UT). While this geomagnetic disturbance, we have observed the CR intensity increase in coincidence of Dst decrease which are shown in Fig 1 b). Figure 2 a) shows the similar CR intensity increase coincident with geomagnetic disturbance (Peak Dst = -321nT) occurred on April 7, 2000.

Contrary to these CR intensity increase, we also observed the CR intensity decrease during the geomagnetic disturbance. Figure 1 c) and d) shows these

Table 1. List of geomagnetic disturbance (Dst > 200nT) with the period of January 1999 to December 2002. The size of CR intensity variation (Δ CR intensity) during the disturbance has also shown.

Date	Peak Dst (nT)	Δ CR intensity (%)
1999/10/22	-237	2.27
2000/04/07	-321	2.28
2000/07/15	-300	-0.38
2000/08/12	-237	1.62
2001/03/31	-358	2.12
2001/04/11	-256	-0.84
2001/11/06	-277	2.69
2001/11/24	-213	-0.62

decrease event which occurred at July 15, 2000 (Peak Dst = -300nT) and April 11, 2001 (Peak Dst = -256nT).

Table 1 has listed the Δ CR intensity (%) during the large geomagnetic disturbance (Dst > 200nT) . The Δ CR intensity has simply estimated by taking the difference between the CR intensity of geomagnetic storm onset and peak time. Note that the CR intensity increase event relatively coincidence the peak intensity time and the minimum Dst time but the CR intensity decrease event delay the minimum intensity from minimum Dst time.

3. Analysis

The CR intensity increase during the geomagnetic disturbance thought is as a result of cutoff rigidity has decreased and lower rigidity particles has observed. The CR incident asymptotic directions are oriented to the night-side of the magnetosphere and thus the ring current evolution increased the magnetospheric transparency in the tail. To examine this feature, we have estimated the geomagnetic cutoff rigidity from the particle trajectories computations. The geomagnetic field for this computation, we adapt Tsyganenko 89 model [5] with extension of Dst parameter [1]. This model has modified to use Dst for the effective ring current field parameter as following:

$$C_5(Dst) = -10220 + 408.5Dst. \tag{1}$$

From the particle trajectories simulation with modified Tsyganenko model, we have estimate the cutoff rigidity variation of the March 31, 2001. The result has shown in Fig 2 with observed CR intensity (%).

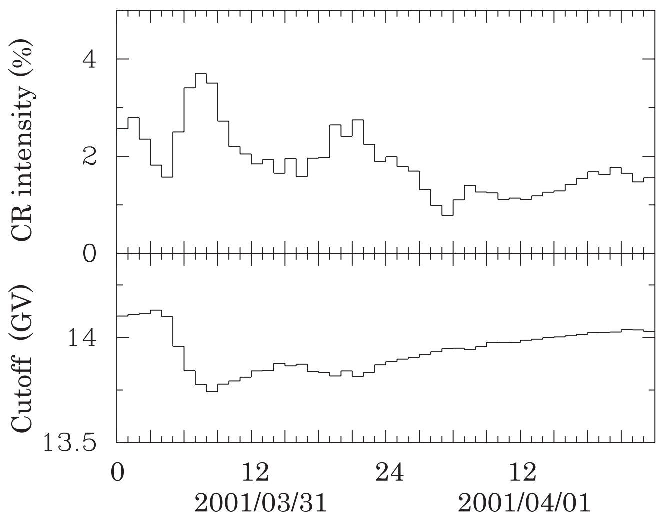

Fig. 2. Cutoff rigidity (GV) variation of March 31, 2001 to April 1 which has estimated from Tsyganenko 89 model with Dst extension are shown. Hourly cosmic ray intensity (%) observed at TIBET neutron monitor are also shown.

4. Discussion and Conclusion

Figure 2 shows a relatively good correspondence of the observed NM profile with cutoff variation. Using the coupling function [2], cutoff rigidity variation indicated the CR intensity increase of 2.4%, which is almost in consistence with the observed peaked value. This result indicates the short term changes of geomagnetic cutoff occurred at the geomagnetic disturbance and Dst value is improving the picture of cutoffs during high activity periods. Since cutoff rigidity decrease while geomagnetic disturbance, we can not explain simply of CR intensity decrease event at July 15, 2000 and April 11, 2001 as shown at Fig 1. c) and d). Those CR intensity decrease event has occur during the Forbush decrease phase so this may think as cutoff may decrease with the geomagnetic disturbance but the interplanetary source CR intensity has decreased with IMF disturbance and thus we can not observe at CR intensity increase. This CR intensity decrease event with geomagnetic disturbance during the Forbush decrease phase need farther work in future.

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