Observation of precursory decrease by the narrow angle muon telescope at MT. Norikura

K. Fujimoto,[1] A. Okada,[2] T. Aoki,[2] Y. Ohashi,[2] K. Mitsui,[3] H. Kojima,[1] K. Munakata,[4] S. Yasue,[4] C. Kato,[4] T. Kuwabara,[4] M. Mori,[4] K. Takizawa[4]
(1) Nagoya Womens University, Nagoya 467–8610, Japan
(2) Institute for Cosmic Ray Research, University of Tokyo, Kashiwa, Chiba 277–8582, Japan
(3) Faculty of Management Information, Yamanashi Gakuin University, Kofu 400, Japan
(4) Physics Department, Faculty of Science, Shinshu University, Matsumoto 390–8621, Japan

Abstract

The narrow angle muon telescope at Mt. Norikura has been operated since May 1998. The telescope covers 50 degrees of the sky with angular resolution of about 7 degrees. The counting rates of event are plotted in the two-dimensional maps of 21 times 21 bin. The precursory decrease before Forbush decrease was observed by the telescope at April 11 in 2001. The two-dimensional maps of this precursors show cosmic ray collimated flow confined with about 15 degrees in pitch angle across the shock from the inside of the Forbush decrease, from the simulation. This fact cleary gives evidence for the reconfirmation of the existence of IMF-guided collimated flow, responsible for the precursory decrease.

1. Precursory decrease

We observed precursory decrease of cosmic rays of almost 2 percent at April 11 at 2001 before Forbush decrease at April 12, as shown in Figure 1. The normalized counting rate(percent) of the vertical telescope shows asfunction of the day of year on the horizontal axis over 10 days(local time at Japan). The onset of the SSC which coincides with shock arrival occurred at 21 local time April 11 2001. After the onset of SSC, Forbush decrease of cosmic rays of about 4 percent occurred. A sharp dip of the counting rate of the vertical telescope at 10 hour at April 11 in 2001 before Forbush decrease of cosmic rays, seen in Fig. 1, might correspond to the precursory decrease of cosmic rays. The differences for ij-th telescope of the counting rate from a level (averaged counting rate to 1 hour from 6 hour) are plotted in the two-dimensional maps of 21*21 bin of the telescope during 8 to13 hour(L.T.) as shown in Fig. 2a.

The decreasing region (almost 1 percent) of 2*2 bin are appeared in center-

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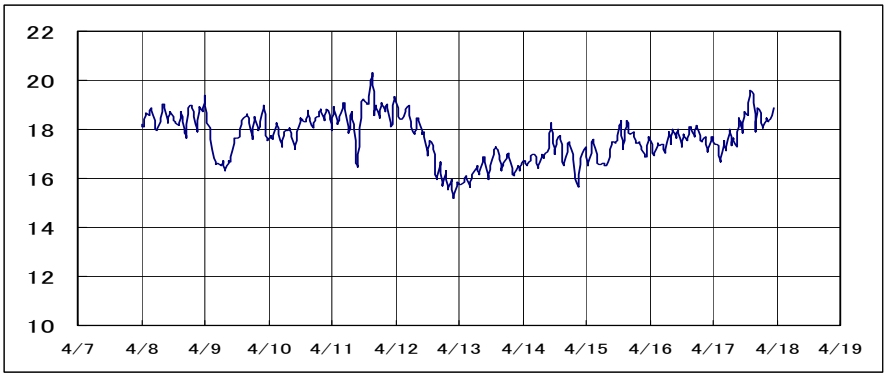

Fig. 1. The normalized counting rate(percent) of the vertical telescope at the nroangle muon telescope at Mt. Norikura after pressure correction as function of the day of year on the horizontal axis over 10 days(local time at Japan) at April 2001.

east side at 9 hour. At 10 hour, the decreasing region (1.5 percent) are seen almost at center region. You can see in the figure that loss cone type decreasing region move to the direction of south-west from 11 hour to13 hour.

2. The response of the telescope to collimation flow of cosmic rays

We estimate the response of our telescope to collimation flow responsible to precursory decrease of cosmic rays. The decrement of the cosmic ray intensity for 21*21 telescope (Dij) are expected, assuming the power exponent zero of the rigidity spectrum of collimation flow, which exist in geographic latitude 20 degrees north and geographic longitude 12 hour local time and the cone-angle of which is 15 degrees. We calculate Dij taking account the influence of cosmic rays geomagnetic deflection and nuclear interaction with the terrestrial material (Murakami et al. 1979) and also the geometrical configuration of the muon telescope. Fig. 2b shows the 2-D picture of the decrement of the respective telescope (Dij) to collimation flow of cosmic rays during 8 hour to 13 hour (L.T.). The similarity between the observation pattern to the simulation pattern is seen during 8 hour to 13 hour. This fact clearly gives evidence for the confirmation of the existence of IMF-guided collimation flow of cosmic rays, responsible for the precursory decrease.

3. Conclusion

The observation pattern during 8–13 hour local time, is very resemble to the estimated pattern, assuming that the collimation flow (15 degrees) of cosmic rays exist in the geographic latitude 20 degrees north and longitude 12 hour local

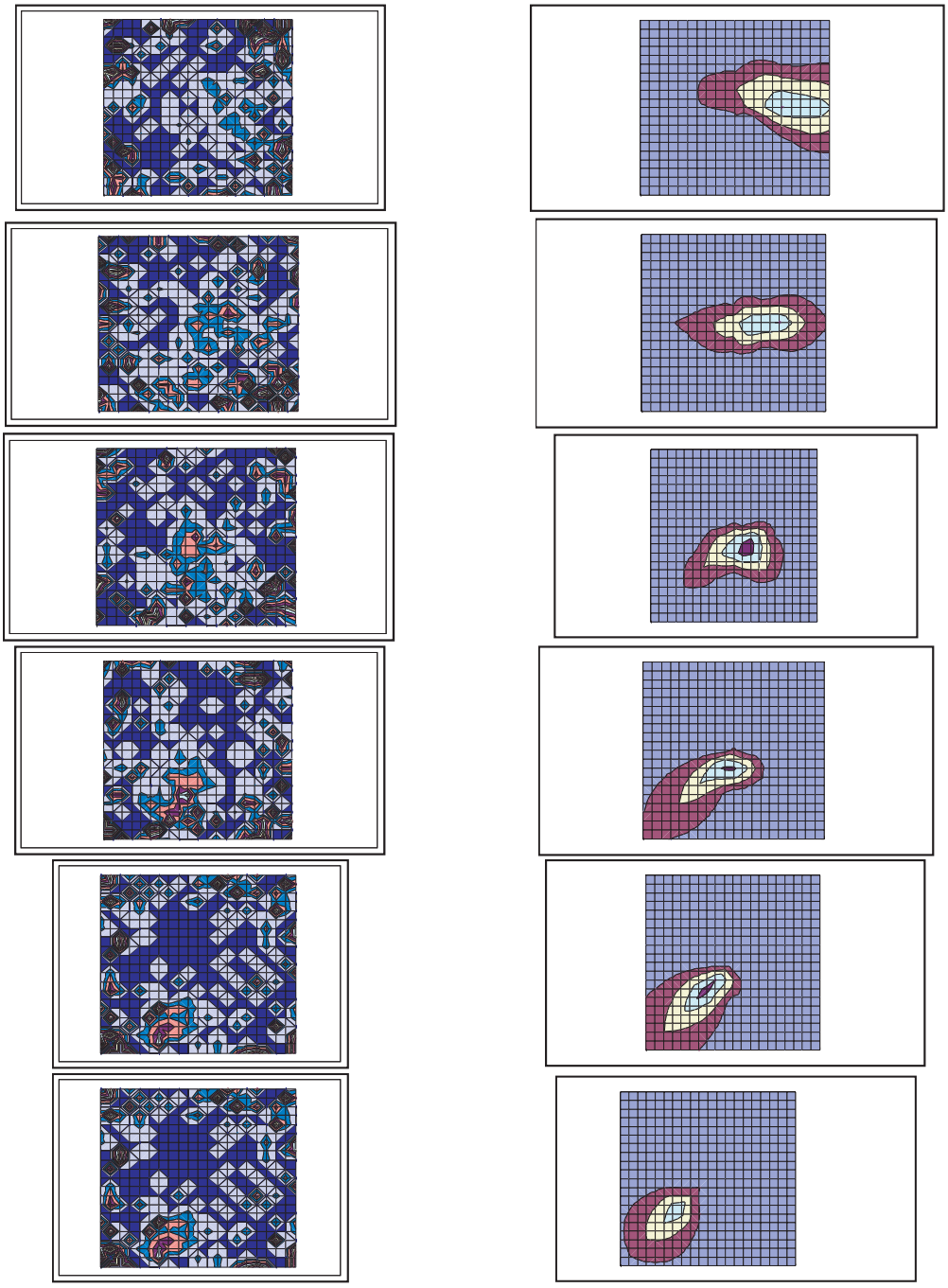

Fig. 2.a and 2.b Upward side is North- and right side is east-telescope. The differences for ij-th telescope of the counting rate from a level (averaged counting rate to 1 hour from 6 hour (L.T.) are plotted in the two-dimensional map of 21*21 bin of the telescope during 8 hour to 13 hour at April 11 2001 as shown in Fig. 2a. Fig. 2b shows the calculated 2D picture of the decrement of the respective telescope to collimation flow of cosmic rays from 8 hour to 13 hour (L.T.), which exist in geographic latitude 20 degrees north and longitude 12 hour local time and collimation angle is 15 degrees.

time. This gives clear evidence the existence of the collimation flow confined in 15 degrees at pitch angle. If the interplanetary magnetic field almost exist in solar ecliptic plane, considered that latitude of the direction of the collimation flow is about 20 degrees north in April 11.

4. References

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