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Galactic cosmic ray spectrum of the Forbush decreases of March 2012

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Abstract: During March 2012, a lot of intense solar events took place and three great Forbush decreases were produced starting from March 7th to March 21st. In this work, the analysis of the solar and geomagnetic events producing these Forbush decreases is presented. Moreover, the power spectrum of the galactic cosmic ray intensity recorded by neutron monitors during this series of Forbush decreases, are studied analytically.

1 Introduction

Fast decreases of the galactic cosmic ray (GCR) intensity about 1-2 days followed by its gradual recovery typically lasting several days are called Forbush decreases (Fds) [1]. They are observed after large solar flares and coronal mass ejecta (CMEs) [2]. A series of three Fds during March 2012 was occurred due to strong solar events, such as M- and X-class solar flares and halo CMEs. In this work a detailed analysis of these events, as recorded by polar and middle latitude neutron monitor (NM) stations of the north hemisphere, by using hourly values of the GCR intensity from the Neutron Monitor Data Base (NMDB) (www.nmdb.eu) is performed, as well as the GCR spectrum of the primary cosmic ray flux at the edge of the magnetosphere and the spectral index are calculated.

2 Description of the events

From March 4-21, 2012 a lot of solar flares and partial and halo CMEs took place on the Sun. In general 74 C-flares, 17 M-flares and 3 X-flares occurred on solar atmosphere and 16 halo and partial halo CMEs at the solar corona. They were observed from GOES and SOHO/LASCO satellites (ftp.ngdc.noaa.gov; cdaw.gsfc.nasa.gov). As a result of these events three Fds were observed at Earth. The first one happened on March 7, 2012 with an amplitude of 4.5 per cent. The greater one of the solar cycle 24 happened on March 8, 2012 with amplitude of 11.7 per cent and the third one took place on March 12, 2012 with amplitude of 5.7 per cent. The amplitudes were calculated from the IZMIRAN database by using the GSM method, for cosmic ray particles of rigidity 10 GV which is close to the effective rigidity of the particles being registered by neutron monitor worldwide network [3]. Studying the above Fds with respect the rigidity of each NM station, it is observed that the recorded amplitude was about the same for polar and middle latitude NM stations of the north hemisphere. The maximum value for the Kp index reached the value of 8, while the minimum value of the Dst index was -143nT [4], which means that an intense geomagnetic storm took place.

3 Galactic power spectrum

According to the coupling coefficient method [5], secondary cosmic ray measurements can be linked to the primary incident cosmic ray particles via specific mathematical functions that take into account the acceptance vectors for each detector (NM stations), based on its local characteristics [6],[7]. In order to study analytically the temporal changes of the rigidity spectrum of the GCR intensity that was

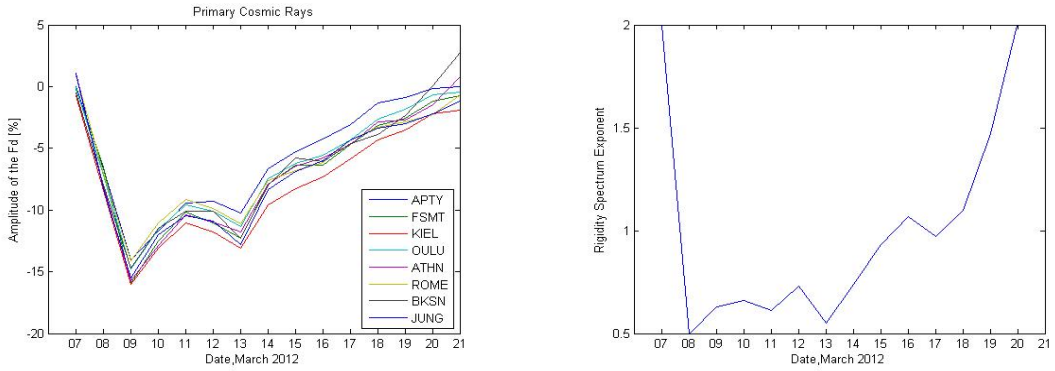

Figure 1: The calculated variations of the GCR intensity in the heliosphere for the NM stations of Apatity, Fortsmith, Kiel, Oulu, Athens, Rome, Baksan, Jungfraujoch (left panel) and the temporal changes of the rigidity spectrum exponent (right panel) from 7 to 21 of March 2012, are presented.

recorded on March 7-21, 2012, daily averaged data of eight neutron monitors obtained from NMDB, were used. According to the coupling coefficient method the amplitude of the Fd in free space was calculated considering that it should be independent of the local characteristics of the detector. In our analysis we have calculated the integral providing the values of spectrum exponent ranging from 0.5 to 2 with a step of 0.01, considering the coupling coefficient expression for the solar maximum [5]. In order to pinpoint the exponent, we considered the difference between the mean amplitude and the amplitude of the specific detector. Then its standard deviation for a series of 151 values of exponent was calculated taking the difference of the amplitudes to be minimum (Fig. 1).

4 Conclusions

The Fd of March 2012 were the most intense ones of the solar cycle 24 up to now. It is concluded that the amplitude of the recorded Fds is about the same in the polar neutron monitor stations as well as in the middle latitude ones, independent of the rigidity of each station until 6 GV. Moreover,the calculated values of the rigidity spectrum exponent was varied from a maximum 2.00 to a minimum value of 0.50 as it is expected. These results are in agreement with previous studies concerning the Fd of September 2005 [7] and August 2010 [8].

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References

[1] Forbush, S.E.: 1937, Phys. Rev. 51, 1108-1109

[2] Cane, H.V.: 2000, Space Sci. Rev. 93, 55-77

[3] Belov, A.V., Baisultanova, L., Eroshenko, E. et al.: 2005, J. Geophys. Res., 110, 9, A09520

[4] Lingri, D., Papahliou, M., Mavromichalaki, H. et al.: 2013, Proc. 11th Hel.A.S Conference

[5] Clem, J. and Dorman, L.: 2000, Space Sci. Rev., 93, 355-359

[6] Dorman, L.: 2004, Cosmic rays, Kluwer Academic Publishers

[7] Alania, M. and Wawrzynczak, A.: 2012, Adv. Space Res., 50, 725-730

[8] Livada, M., Papaioannnou, A. and Mavromichalaki, H.: 2013, Proc. 11th Hel.A.S Conference