11th Hel.A.S Conference
Athens, 8-12 September, 2013
CONTRIBUTED POSTER

Magnetospheric cut-off rigidity changes during the magnetic storms of the years 2011 and 2012

G. Katsoulakos[1], *D. Millas*[1], *A. Laoutaris*[1], *K. Kontiza*[1], *H. Mavromichalaki*[1], *E. Eroshenko*[2], *A. Belov*[2], *V. Yanke*[2]
[1]Department of Physics, University of Athens, Athens, Greece
[2]. Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation RAS, Moscow, Russia

Abstract: Disturbances in the Earth's magnetic field during magnetic storms can cause essential changes in the charged particle trajectories in the magnetosphere. This has two main consequences for ground-level observations, changing the effective cut-off thresholds and the effective asymptotic directions of the particles. Both consequences are important for cosmic rays (CR). During these events an increased amount of energy is transferred into the magnetosphere. The cosmic ray intensity variations during the recent magnetic storms of the years 2011 and 2012 covering the ascending phase of the solar cycle 24, were analysed using data from about 30 neutron monitor stations of the worldwide network. The corresponding variations of the geomagnetic indices and the geomagnetic cut-off rigidity changes of each neutron monitor station were calculated by the global survey method. The latitudinal distribution of the stations shows that maximum changes at the geomagnetic cut-off rigidities occur in the middle latitude stations around the rigidity of 6.5-9.0 GV.

1 Introduction

A geomagnetic storm is an intense and prolonged magnetic activity due to the strong coupling of Earth's magnetosphere with the solar wind. The increase in the solar wind flux caused by solar phenomena, such as a Solar Flare or a Coronal Mass Ejection (CME), compresses the magnetosphere and interacts with the Earth's magnetic field, transferring an increased amount of energy into the magnetosphere. Specifically, the magnetospheric ring current is significantly augmented, generating a magnetic field of opposite polarity compared to the Earth's magnetic field. The frequency of magnetic storms depends on the phase of the solar cycle and on the intensity of the storm. During the ascending phase, more magnetic storms are observed and more intense storms may also occur. In this work we examine a number of rather weak magnetic storms, developed during the ascending phase of the 24th solar cycle (2011-2012), trying to define the connection between Dst-index, cosmic ray variations and cut-off rigidity changes (dRc). For this purpose, hourly data from Neutron Monitors of the worldwide network were used, in order to evaluate cosmic ray variations caused by disturbances of the Earth's magnetic field. In order to study magnetic storms, the geomagnetic indices Dst and Kp were used. Dst index is used to describe perturbations of the Earth's magnetic field near the equator and Kp is a geomagnetic index over the globe. The latter is used to characterize a storm via the NOAA G scale.

2 Data and Method

Hourly corrected for pressure cosmic ray intensity data were obtained from IZMIRAN Neutron Monitor database ftp://ftp.izmiran.ru/pub/izmiran/. Dst index data were obtained from the World Data Center for Geomagnetism http://swdcwww.kugi.kyoto-u.ac.jp/dstdir/. Note that for the year 2012, the values of Dst are not yet corrected, so uncertainties in these results may exist. The global survey

method (GSM), which is conceptually a version of spherical analysis, has been utilized for our calculations. In this work, the version described by Belov et al. [2],[3] has been used to analyse all the events. It is assumed that only the first harmonic of CR anisotropy contributes significantly. The optimal isotropic part of cosmic ray variations together with its anisotropic components can be calculated by the data of the available NM stations. This approach is based directly on this difference between the model and experimental data during periods of distorted magnetosphere Fig.1.

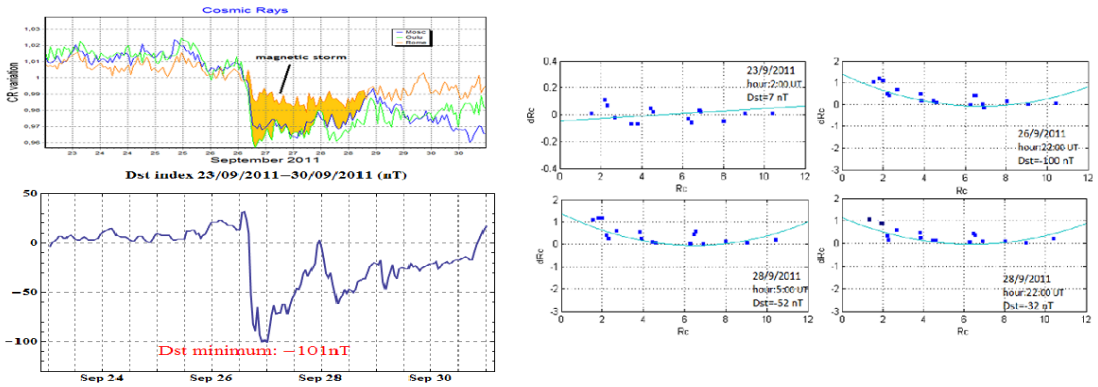

Figure 1: CR variations for middle latitude (Rome - orange) and polar stations (Oulu - green, Moscow - blue) (upper left panel) and Dst index variations (lower left panel) during the event of 26/09/2011, are presented. The corresponding cut-off rigidity variations (dRc) versus the cut-off rigidity (Rc): before the main phase, in the the peak phase and in the recovery phase of the storm are illustrated in the right panels. Marks indicate the points obtained by the GSM applied to the data of the worldwide NM network.

3 Results & Conclusions

From the study of six confirmed events during the years 2011 and 2012, it is concluded that the cut-off rigidity variations caused by the magnetospheric ring current during the main phase of a magnetic storm do not show a significant longitudinal dependence because of the ring symmetry [4],[5],[6]. On the contrary, there is an important latitudinal dependence and the maximum dRc values were recorded in middle latitude stations. This fact indicates that neutron monitor stations in the range of rigidities from 6.50 GV to 9.00 GV is really important in the recording of strong geomagnetic events.

Acknowledgements: The authors thank the collaborators from the following Neutron Monitor stations providing their data: APATITY, ATHENS, BAKSAN, BARENTSBURG, CAPESCHMIDT, EREVAN, EREVAN-3, ESOI, FORTSMITH, INUVIK, IRKUTSK, KIEL, LOMNICKY STIT, McMURDO, MOSCOW, NORILSK, NOVOSIBIRSK, NEWARK, OULU, SOUTH POLE, THULE, TIXIE BAY, YAKUTSK. Many thanks to the Kyoto geomagnetic center for the Dst-index values.

References

[1] Baisultanova, L. M., Belov, A., Yanke, V.G.: 1995, Proc. 24th ICRC 4, 1090.

[2] Belov. A, Baisultanova, L., Buetikofer, R. et al.: 2005a, Proc 29th ICRC 2, 385.

[3] Belov. A, Baisultanova, L., Eroshenko, E., Mavromichalaki, H. et al.: 2005b, JGR , 110, A09S20.

[4] Flueckiger, E. O., Smart, D. F. and Shea, M. A.: 1981, Proc. 17th ICRC, 244.

[5] Flueckiger, E. O., Smart, D. F. and Shea, M. A.: 1987, Proc. 25th ICRC 4, 216.

[6] Mavromichalaki, H., Eroshenko, E., Belov, A., Yanke, V. et al.: 2013, Journal of Physics, Conf. Series 409, 012201.