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EFFECT OF CORONAL MASS EJECTIONS ON COSMIC RAY INTENSITY AND GEOMAGNETIC INDICES FOR THE PERIOD OF 1996-2013

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Abstract: Coronal Mass Ejection is a huge burst of solar corona with an extremely high speed. In this work we have included a new approach in this direction. We have studied the effects of halo coronal mass ejections on cosmic rays and geomagnetic field of Earth in association with quiet and disturbed events for the period of 1996-2013 which covers the solar cycle 23 and ascending phase of solar cycle 24. We have adopted the chree analysis super epoch method in our analysis. Daily values of Oulu Neutron monitor are taken in chree analysis. It affects cosmic rays by decreasing their intensity followed by slow recovery. It affects space weather through geomagnetic indices such as disturbance storm time index (Dst) and Ap-index. Results of this study show that CMEs alone and in association with quiet and disturbed events can produce short term transient decrease in cosmic ray intensity. We have done similar analysis for geomagnetic activity taking the geomagnetic Ap and Dst indices. Analysis indicates a significant increase in geomagnetic activity due to influence of CMEs in association with quiet and disturbed events.
Keywords: Coronal Mass ejection, geomagnetic activity, quiet and disturbed events cosmic rays.

1. INTRODUCTION

Coronal Mass Ejections (CMEs) are described as the mass ejection of matter from the coronal region of the Sun. These CME events generally occur in large numbers during the period of high solar activity carry large amount of plasma ($\approx 10^{25}$J & 10^{13}Kg) into interplanetary medium. Currently interplanetary manifestations of CMEs are known as ICMEs. The fast (500 km^{-1}) CME coming from the sun into interplanetary medium are the solar corona features that contain high magnetic field fluctuations.

Many scientists suggests that solar cycle dependent modulation of galactic cosmic rays can be explained by the presence of CMEs related magnetic in-homogeneities with Heliosphere [1-3]. They studied the effect of Interplanetary CME on cosmic ray intensity for the period of

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1996-2007. Singh and Shrivastava [4] suggested that ICMEs can produce geomagnetic activity with an increase in Ap and decrease in Dst. In this work we examine effect of halo CMEs on cosmic rays and geomagnetic field of the Earth for a period of 1996-2013 covers declining phase of solar cycle 23 and inclining phase of solar cycle 24.Events of CME in association with quiet and disturbed events is also included.

2. DATA AND METHOD OF ANALYSIS

In this work observations of CMEs are taken from LASCO/SOHO, EIT/SOHO & GEOS satellites. Those CMEs which have span angle $=360^0$ are considered as full halo CMEs. Quiet and disturbed events are defined in the context of Ap index. The days having value of Ap index ≤6 continuously for ≥ 5 days are termed as quiet days. The very first day in this context is the onset day of quiet event. Similarly days having value of Ap index ≥ 7 continuously for ≥ 5 days are termed as disturbed days. The very first day in this context is the onset day of disturbed event In this approach we have 508 events of halo CME, 67 events of halo CME associated with quiet events 126 halo CME events associated with disturbed events and only 3 CME events are associated with both quiet and disturbed events. These events are selected from CME catalogue for the period of 1996-2013 (http://cdaw.gsfc.nasa.gov/CME_list).

In order to evaluate the atmospheric response to ICME disturbances, the daily values of geomagnetic interplanetary index Ap and Dst are taken from solar geophysical data books/internet website http://nsdc.gsfc.nasa.gov/omniweb. Quiet and disturbed event catalogue is obtained from daily values of Ap index on yearly basis.

The Dst index is representative of the magnetic effect of low latitudes and Ap index shows the effect at mid-latitudes. Daily values of Oulu (0.78cm) neutron monitor data have been taken for analysis. The present study investigated by means of superposed epoch analysis. The changes in cosmic ray intensity as well as geomagnetic field is used on longer time scale (5days before and 10 days after the day of event)

3. RESULT AND DISCUSSIONS

Various Solar phenomenons such as solar flare and solar wind were noticed to vary cosmic ray intensity [5, 6]. After recognition of CME in 1971, it is the main factor affecting cosmic ray intensity on long term basis [7].

Many researchers also studied the combined effect of CME in association with Solar flares and various categories of Solar flares It was suggested by Jothe and Shrivastava [8] that a strong solar flare alone is capable of producing FD's. In 2014 Persai [9] and Singh noted that the solar flares in association with CME in northern hemisphere are more effective in producing FD events in CRI. Kharyat et al. 2016 [10] suggests that CMEs adds magnetic flux to the interplanetary magnetic field which also produces geomagnetic storms, FD's in cosmic ray intensity and produces major disturbances in the interplanetary medium. The disturbance in the interplanetary medium is the primary causes of geomagnetic disturbances .We have noticed effect of halo CME on cosmic ray intensity and geomagnetic field (i.e. Ap and Dst) in association with quiet and disturbed events.

To observe the average behavior of cosmic rays intensity variation during the period (1996-2013) for halo CME events chree analysis for -5 to +10 days have been plotted in figure as percentage deviation of data from Oulu neutron monitor station. Zero days corresponds the onset day of halo CME. Similar method applied for various categorizations with zero day corresponds to the respective associated event. Further the analysis has been extended on short term basis to draw combined effect of these CMEs on geomagnetic field by adopting chree analysis super epoch method for Dst and Ap as depicted in the figure. Figure 1 shows the variation of CRI, Ap and Dst for halo CME events. Figure 2 ,3 and 4 shows such variations with onset day for the events of CME in association with quiet, disurbed and both (quiet and disturbed).

The results of our analysis can be summarised as follows:

1. The study reveals the fact that for halo CME events maximum depression is observed after 4 days for Cosmic ray intensity, 3 days for Dst from onset day. A significant increase in Ap is observed after 2 days from onset day of CME. It reveals that CME occurrence is important for cosmic ray modulation. This in turn produce shock disturbance highly effective in stimulating geomagnetic disturbance as well as cosmic ray decreases.

2. The maximum depression in Cosmic Ray Intensity is observed for the events in association with disturbed events and for Dst in association with quiet events. While maximum peak for Ap is observed for the events in association with quiet as well as disturbed events.

3. All parameters shows two peak or depression points. Cocmic ray intensity shows such behaviour in association with quiet events .Dst and Ap shows it in association with both quiet as well as disturbed events . Also Ap shows same for quiet events.

4. The minimum depression value for Cosmic Ray Intensity and Dst is obtained for combined association with quiet and disturbed events. Minimum peak value for Ap is observed for quiet event association.

4. CONCLUSION

1.CME produce short term transient decrease in cosmic ray intensity and enhancement in geomagnetic field on short term basis .

2. Variations for all the three parametrs in association with disturbed events follows the pattern of variation for halo CME .

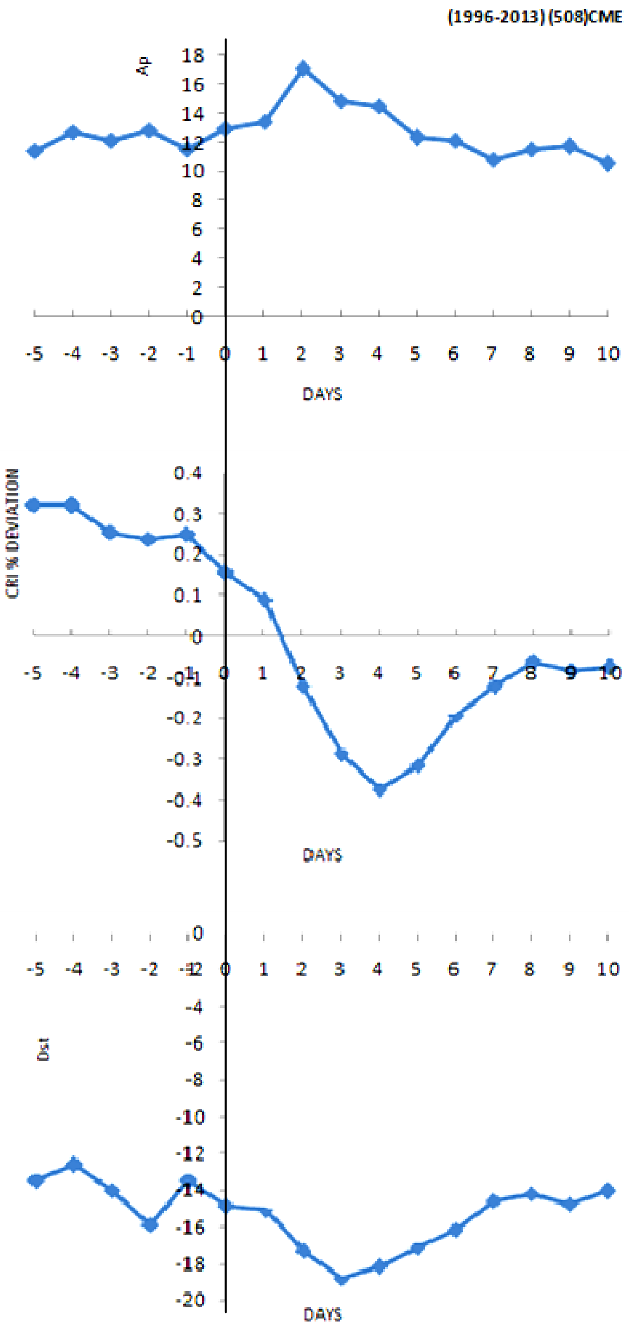

Figure 1: Shows chree analysis of Ap, CRI, and Dst for the period of 1996-2013 for Halo CME events. Zero day correspond to the arrival day of CME

3. For all types of events i.e. halo CME, halo CME in association with quiet events, in association with disturbed events and in association with both quiet and disturbed events Ap and Dst follows traditional pattern .But CRI shows quiet unusual pattern of variation in association with quiet events and both quiet and disturbed events.

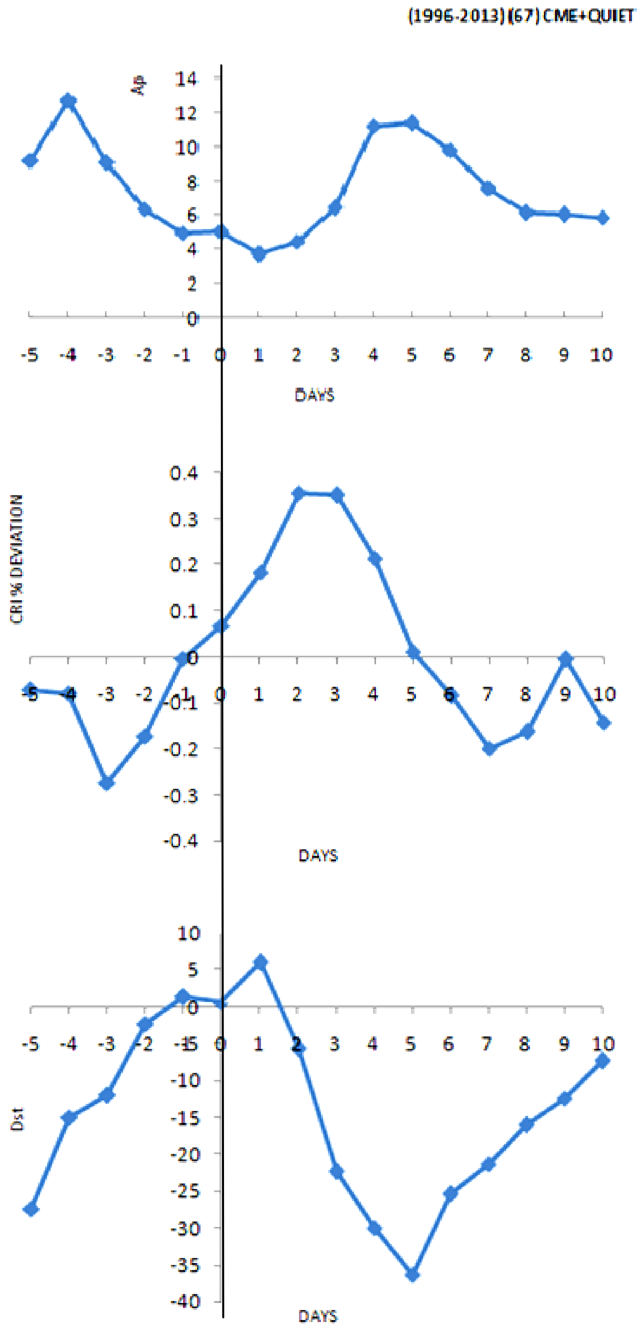

Figure 2: Shows chree analysis of Ap, CRI, and Dst for the period of 1996-2013 for Halo CME events associated with quiet events. Zero day correspond to the arrival day of CME in association with quiet event

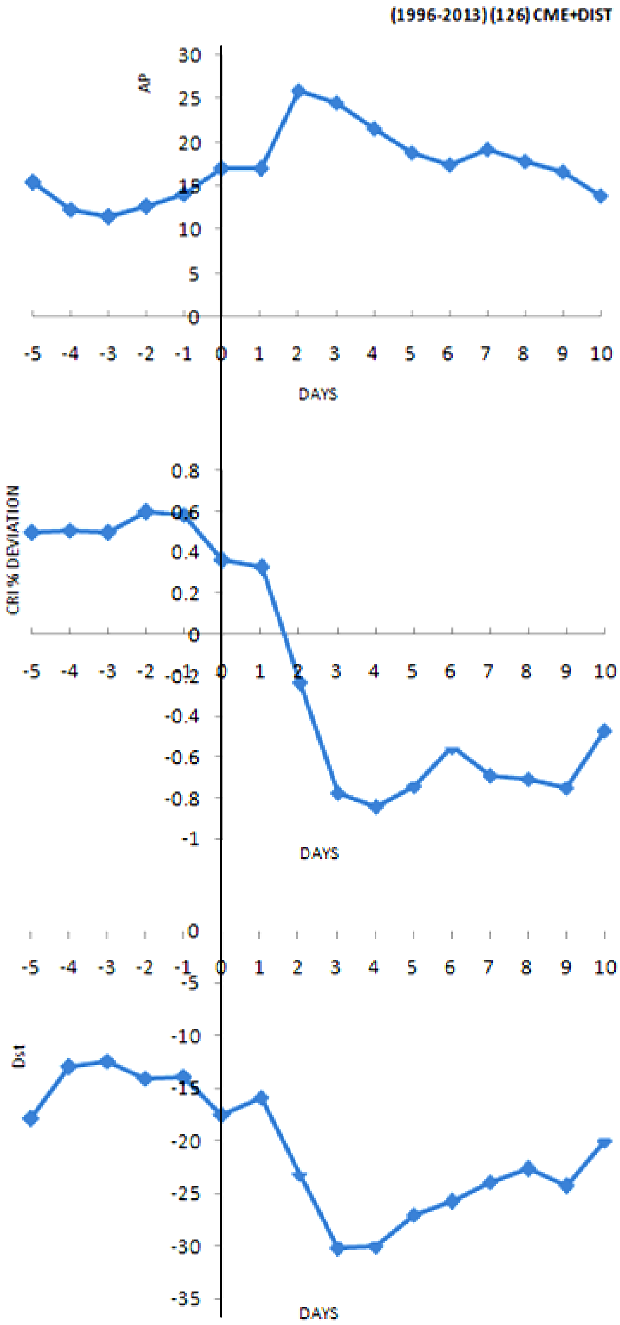

Figure 3: Shows chree analysis of Ap, CRI, and Dst for the period of 1996-2013 for Halo CME events associated with disturbed events. Zero day correspond to the arrival day of CME in association with disturbed event

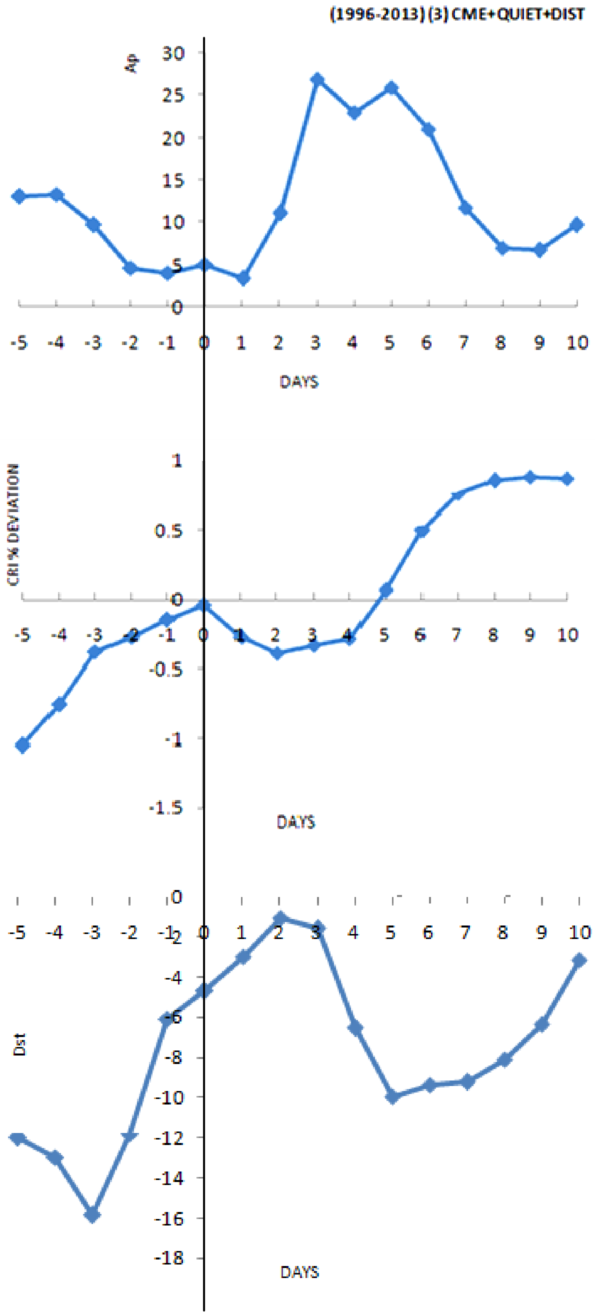

Figure 4: Shows chree analysis of Ap, CRI, and Dst for the period of 1996-2013 for Halo CME events associated with disturbed as well as quiet events. Zero day correspond to the arrival day of CME in association with quiet as well as disturbed event

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REFERENCES

[1] Lara.N.et.al., 2008, "Effects of Coronal Mass Ejections on the Long Term Cosmic Ray Modulation." Alejandro Lara and Rogelio Caballero Lòpez Proc. 30th Int. Cos. Ray Conf.**1**, 299-303

[2] Shrivastava P.K., 2005 "Study of large solar flares in association with Halo coronal mass ejections and their helio-longitudinal association with Forbush decreases of cosmic ray." Proc. 29 Int. Cosmic Ray Conf., Vol. **1**, Pune, India: 355-358.

[3] Mishra B.K. et. al., 2010 Ultra Science **22(10)**, 91-94

[4] Shrivastava P.K. and Singh G. 2008. "Relationship of interplanetary coronal mass ejections with geomagnetic activity." Indian Journal of Radio and Space Physics: 244-248.

[5] Garde S.K. et. al, 1983 Proc.18th Int. Cosmic ray Conf. **3**, 278-381

[6] Shrivastava P.K., Shukla R.P. 1994:"High Speed solar wind streams of two different origins cosmic ray variation during 1980-1986." Solar Physics, **154**, 177-185

[7] Shrivastava P.K. 2007 "Effect of interplanetary coronal mass ejection on cosmic ray intensity variation." Asian Journal of Physics, (**1**): 91-93.

[8] Jothe M. K., and Shrivastava P. K. 2011 Ind. J. of Radio and Space Phys., **40**, 179-182.

[9] Persai N. & Singh N. 2014 Study of solar flares around the Sun and their association with Forbush decreases and Coronal Mass Ejections for the period of 2000-2010. Int. J. of Theoritical and Applied Science **6 (2)**, 10-12.

[10] Kharyat H., Prasad L., Mathpal R.,Garia S., Bhatt B., 2016 Solar Physics, **291**,603.