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Correlated study of Halo CMEs with cosmic ray intensity variations

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Abstract

In the present study, we investigate the relationship between Coronal Mass Ejection (CME) and Cosmic ray intensity (CRI) variation on long-term basis. In this work, we have studied the effects of CMEs rates on cosmic rays for the period of 1996 to 2008. We have used three different neutron monitors data located at Beijing, Hermanus and Kiel. To carry out the study, we take all Coronal Mass Ejection data of LASCO during the period of solar cycle 23. From the analysis, we observed a good relationship between occurrence rate of CMEs and cosmic ray intensity variation.

The variation in Galactic Cosmic Ray (GCR) intensity due to solar activity has been known since almost half century ago[1]. Many mechanisms have been proposed to explain the decreasing GCR flux in inner heliosphere[2]. The basis of GCR Modulation theory was established by Parker[3].

CMEs are large scale phenomena that change the configuration of the IMF and clearly modulate the cosmic ray intensity on short term basis. Therefore it is natural that CME may also play a vital role in cosmic ray modulation on long-term basis. CMEs are contributing to the propagating barriers (GMIRs) that are believed to be the cause of long-term cosmic ray modulation.

Recently Shrivastava[4] and Lara *et al.*,[5] and after the identification of Coronal Mass Ejections in 1974, a number of investigators have proposed that the agent which is transporting the solar activity information, in the form of magnetic perturbations, short-term transient decreases in cosmic ray intensity, and causing cosmic ray modulation. The above results are extended for the analysis of the Halo CMEs.

Data & Method of Analysis:

In present study we have used the data received from the three different neutron monitors located at Beijing (latitude 39.08, cutoff rigidity 10.07 GeV), Hermanus (latitude –34.42, cutoff rigidity 4.90 GeV) and Kiel

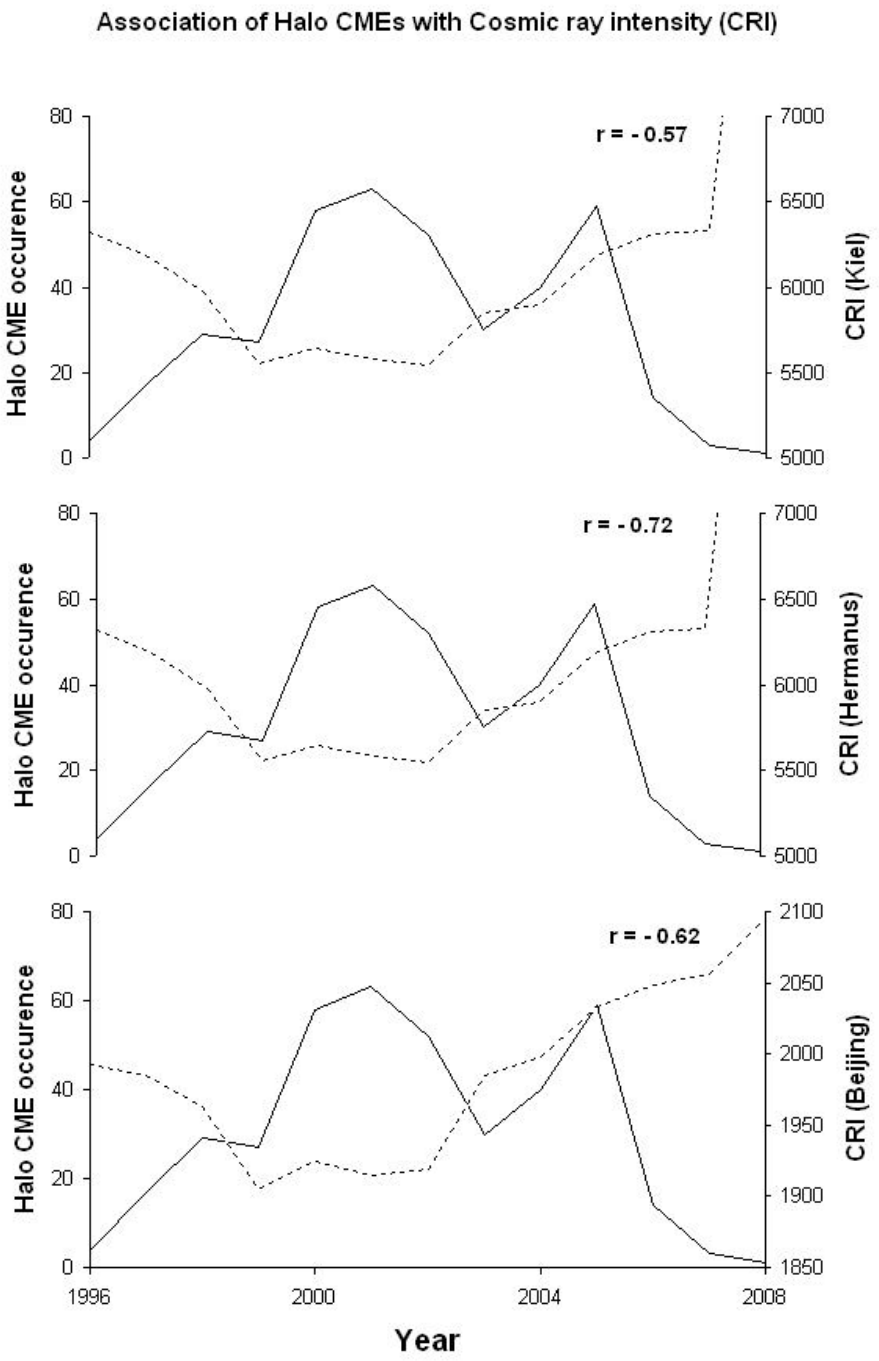

Figure 1. Shows relation between the no. of occurrence of Halo CMEs with cosmic ray intensity for different neutron monitors.

(latitude 54.33, cutoff rigidity 2.29 GeV). Kiel station is located at middle/high latitude having low cutoff rigidity, while Beijing and Hermanus (HRMS) are located at low latitude having high/normal cutoff rigidity. We have used all the 397 halo CMEs data observed by SOHO/LASCO from 1996 to 2008 taken from the SOHO/LASCO Halo CME catalog.

In the figure 1, the number of occurrence of Halo CMEs per year has been correlated against the cosmic ray intensity (CRI) for all the three neutron monitors data taken in the analysis. Starting from the bottom panel of figure 1, the First, Second and Third panels show the association of Halo CMEs occurrence with cosmic ray intensities of neutron monitors Beijing, Hermanus and Kiel respectively. We have found the correlations, which are:

(i) $r = -0.62$ --- for the neutron monitor Beijing,
(ii) $r = -0.72$ --- for the neutron monitor Hermanus,
(iii) $r = -0.57$ --- for the neutron monitor Kiel.

It is now inferred from this analysis that the low latitude stations Beijing and Hermanus show highly anti-correlation, while high latitude station Kiel shows a normal anti-correlation.

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