

Forbush decrease caused by interacting and non-interacting passing CME

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Abstract. On 5-6 Aug. 2011 two short-time consecutive M-class solar flares led to profile of multiple Forbush Decreases showing the possible interaction of long-time passing of ICME.

Keywords. cosmic rays, flares, coronal mass ejections (CMEs), Solar-stellar connection

1. Introduction

Forbush decrease (FD) is a sudden drop in observed Cosmic Rays flux lasts from hours to days, caused by solar activities i.e. Coronal Mass Ejections (CME), and Solar flares.

2. Observation and results

The first flare (F1) of class M6.0 peaked at 13:48 UT at region N16W30 associated with ICME has speed 610 Km/s. 14 hours later, second flare (F2) of class M9.3, peaked at 03:57 UT at N19W36 associated with fast CME of speed 1315 Km/s. 38 hours later, the fast CME impact Earth causing a severe magnetic storm of $K_p = 7.8$ at 18:00 UT.

2.1. First Decrease (FD1)

High latitudes On 5 Aug 2011, Cosmic Ray flux dropped simultaneously with the arrival time of F1 and the second fast CME at 18:00 UT, peaked minimum at 21:00 UT. Fig(a) is CR intensity for 6 stations decreased by values between 4.4% for SOPB to 2.7% for PWNK; where typical M1-M3 (F1 is M6) class flare caused decreasing of $2.6 \pm 0.2\%$ [1], this deviation due to the CME effect [2]. Amplitude of decreasing shows strong dependence on latitude, and weakly with rigidity (for $R=0.3$, $\Delta I = 1.2\%$).

Mid latitudes Similar to High latitude regions, FD1 started at 18:00 UT; the amplitudes is smaller. TIBT has no response up to 1.7% in ROME which strong correlated with rigidity [Table.1].

2.2. Second Decrease (FD2)

High latitudes 14 hours later, another decrease (FD2) at 08:00 UT, due to arrival of SEPs of the F1. The amplitudes of decreasing have maximum amplitude [1] of 2.3% for SOPB to 1.9% for PWNK from the zero phase level which shows dependence on rigidity (for $R=0.3$, $\Delta I = 0.3\%$), and weakly dependent on latitude.

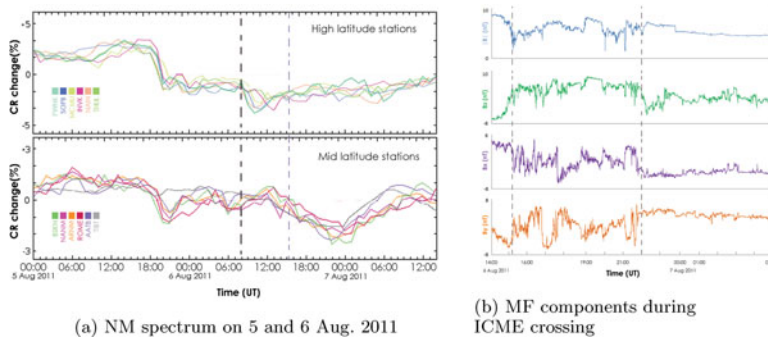
Mid latitudes Almost no observed response to the second M-class flare (F2).

2.3. ICME crossing

On 6 Aug at 15:20 UT, a wide gradually 2.5% decrease appeared at Mid-lats peaked at 22:00. The profile is typically expected when Earth passing through ICME sheath [11]. Fig(b) Shows magnetic field (MF) components $|B|, B_x, B_y, \text{ and } B_z$, a strong disturbance appeared in the $|B|, B_x, B_y, \text{ and } B_z$. B_x component had maxima-minima fluctuation that

Table 1. The selected NM stations ordered by latitude

Region	Station	Lat	Long	Alt	Rigidity	FD1 (%)	FD2 (%)	ICME passing (%)
High-Latitude	SOPB	90.00 S	0	2820	0.1	4.4	2.3	-
	MCMU	77.90 S	166.6	48	0.3	3.1	2.2	-
	THUL	76.50 N	-68.7	26	0.3	3.3	1.6	-
	INVK	68.36 N	-133.7	21	0.3	3.9	2.2	-
	NAIN	56.55 N	-61.6	46	0.3	3	1.9	-
	PWNK	54.98 N	-85.4	53	0.3	2.7	1.9	-
Mid-Latitude	AATB	43.04 N	76.9	3340	6.6	1.5	0.19	1.7
	ROME	41.86 N	12.7	0	6.2	1.7	-	1.4
	ARNM	40.47 N	44.1	3200	7.1	1.5	-	1.8
	TIBT	30.11 N	90.5	4300	14.1	-	0.2	0.56



may due to weak reconnection magnetic field which not sufficient to disturb D_{st} index, the overall increase in B_z due to the movement of ICME which compressing magnetic field along its direction which not directed to Earth to cause reconnection pattern in z component. The disturbances started with FD at 15:20 UT and ended around 22:00 UT, at the minimum amplitude.

Discussion

Consecutive flares associated with different kinematic mechanism of mass ejection cause complex FD profile based on their speed and direction regardless the order of flares caused them. The Passing of ICME may prevent SEPs to cause a FD, therefore, causing moderate wide Forbush decrease $\sim 2.5\%$ lasting for ~ 6 hours before CR intensity recovered for specific region on Earth along the path of passing. The crossing of ICME blocked CR flux above the mid latitude regions, may blocked the F2 output particle to cause any significant decrease. The study shows the possible effects of consecutive solar flares associated with ICMEs. Focused on long FD ~ 12 hours caused by CME magnetic sheath interaction with Earth, which in harmony with simulation (B. Heber et al (2013)) and, experimentally (Richardson and Cane (2011)), and verified the study done by J. Enzl *et al.*(2011) for the effect magnetic field reconnection within the ICME for few minutes.

References

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