

Forbush decreases detected by ASEC monitors during 23rd solar activity cycle

A.Chilingarian, N. Bostanjyan

***Cosmic Ray Division, Yerevan Physics
Institute, Alikhanyan brother 2, Yerevan
36, Armenia, bostan@crdlx5.yerphi.am***

Outline

Fd believed to be an attenuation of the Galactic Cosmic Ray (GCR) flux due to passing Interplanetary Coronal Mass Ejection. In this paper we present statistical study of Forbush decreases detected by ASEC particle detectors during 23 solar intensity cycle (1998 – 2006).

We investigate:

- magnitudes of Fd in different particle fluxes measured by Aragats Space Environmental Center (ASEC) monitors;
- correlations between magnitudes of Fd and different parameters of Interplanetary Coronal Mass Ejection (ICME), namely:
 - ICME sizes,
 - speeds,
 - density
 - Bz

Introduction

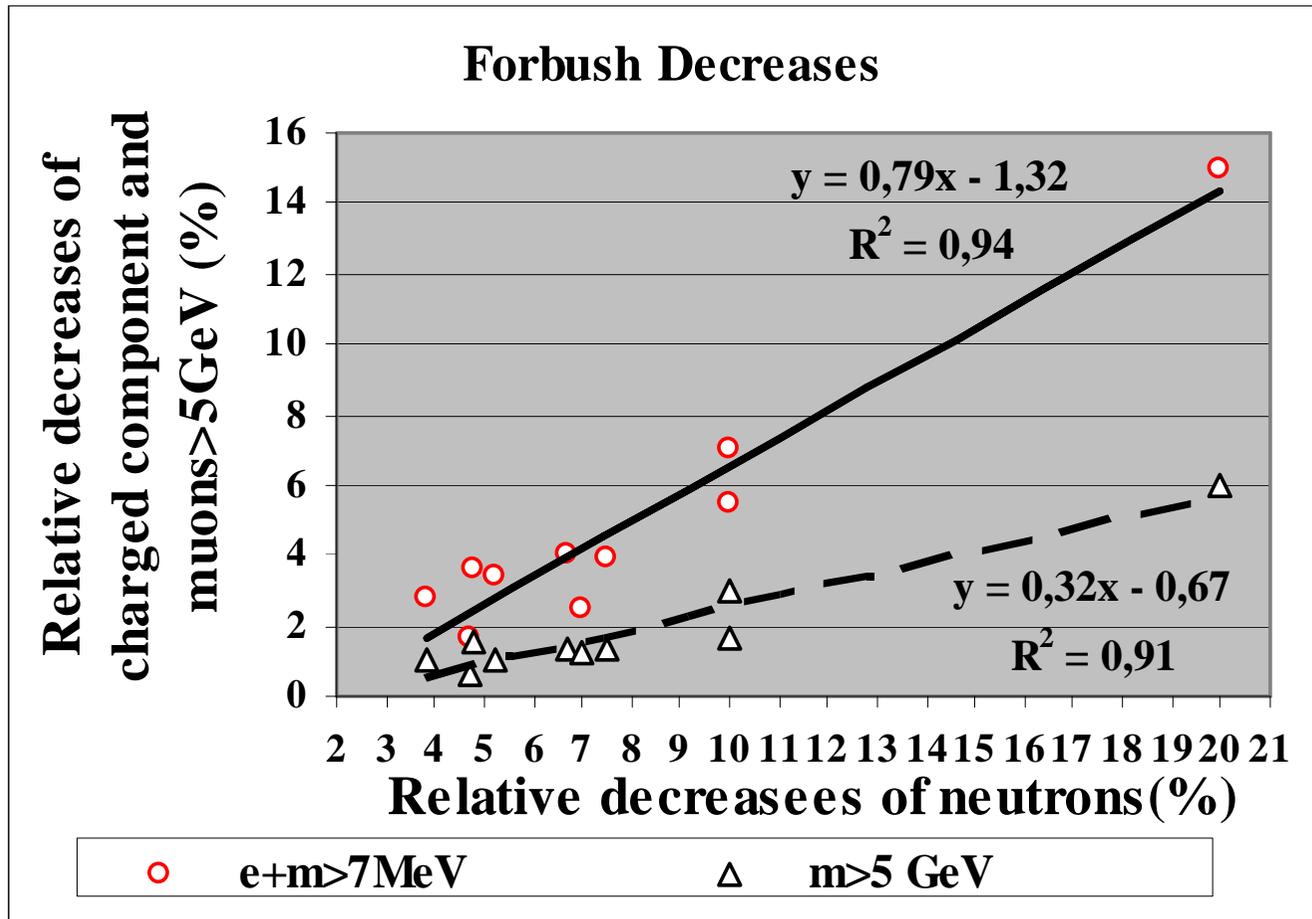
The attenuation of the GCR flux due to ICME is dependent upon the size of the ICME, speed of the ICME, the strength of the magnetic fields in the ICME, the orientation of the ICME and pre-shock conditions of IMF. However, to improve physical understanding of Space Weather (SW) drivers, an inverse problem of SW investigations based on the particle detector and space-born facilities data can be formulated:

- to choose such Fd which are caused by single CME
- measure Fd magnitude in different species of secondary cosmic rays;
- using available compatible information on ICME parameters from space-born facilities investigated different correlations between magnitude of Fd and parameters of ICME;
- investigated correlations between parameters of ICME

Secondary cosmic rays have different most probable energy of primary “parent” proton/nuclei. These energies at ASEC range from 7 to 60 GeV. New particle detectors now starting to operate at ASEC will prolong this maximal energy up to 200 GeV.

We present statistical study of 32 Fd detected by ASEC particle detectors during 23 solar intensity cycle (1998-2006). Forbush decreases at Aragats Space Environmental Center (ASEC) during 23rd solar activity cycle ranges from about 1.5% to 20% in secondary neutron flux, 1.7-15% in charged low energy particle flux and 0.6-6% in >5 GeV muon flux.

As it is expected, the relative decrease of definite species of secondary cosmic rays is inversely proportional to the most probable energy of primary generated this specie. Most pronounced Fd is observed in neutron flux (~20%) and lowest - in 5 GeV muon flux (~6%).



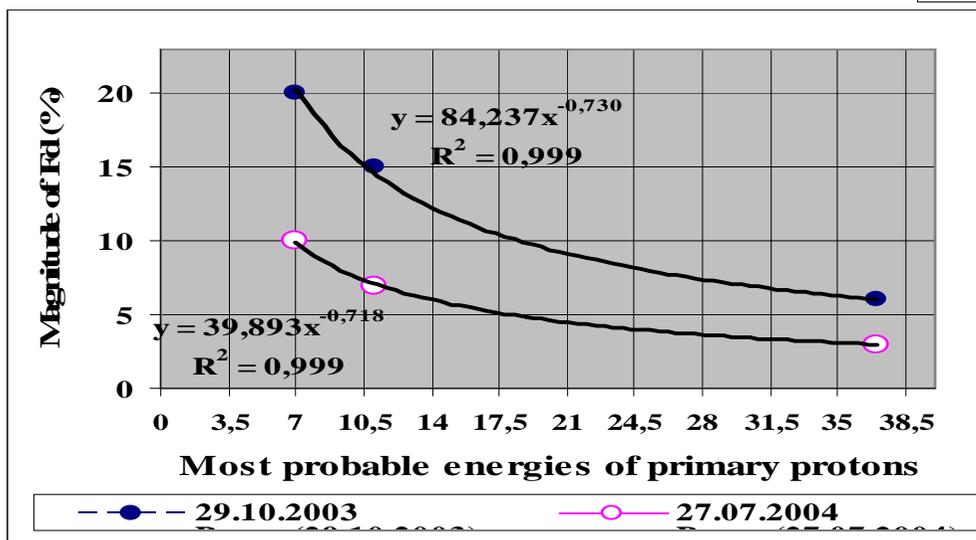
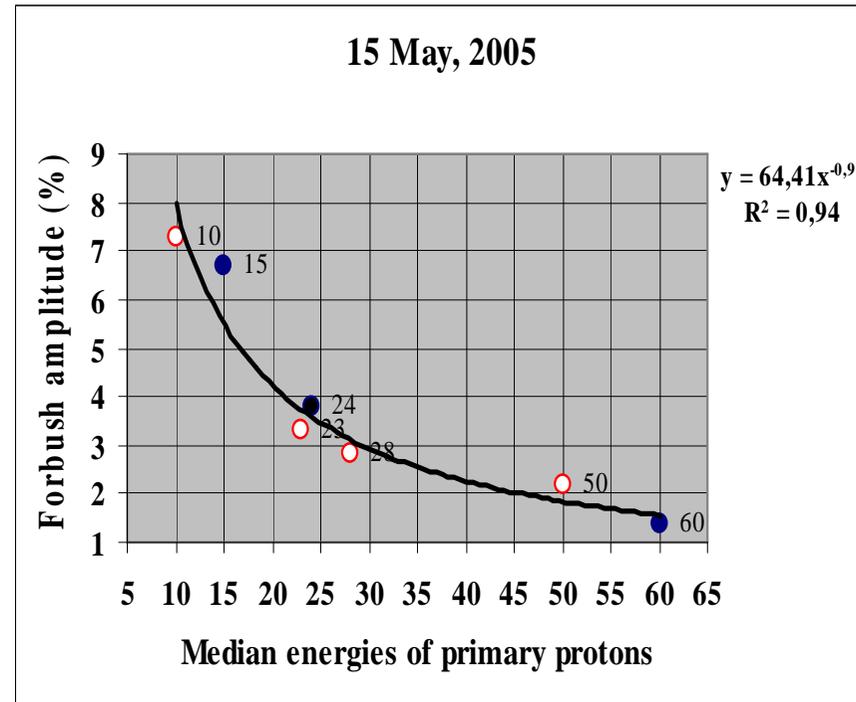
**Correlation matrix of time series of different secondary fluxes measured by
ASEC at 29 October 2003**

For enormously large ICMEs correlations coefficients are very near to 1. In Table we present the correlation matrix of largest detected Fd of 23 cycle at October 2003. We can see very large correlation coefficients between neutron and 5 GeV muon fluxes (most probable energies 7 and 37 GeV). This means that that ICME was so huge that equally influence GCR flux at least till energies up to 50 GeV.

Type of facility	ANM 3200m	NANM 2000m	SNT Thr0	SNT Thr 1	SNT Thr 2	SNT Thr 3	SNT Thr 4	Muons > 5Gev
ANM	1							
NANM	1.00	1						
SNT Thr 0	0.99	0.99	1					
SNT Thr 1	0.99	0.99	1.00	1				
SNT Thr 2	0.99	0.99	0.99	1.00	1			
SNT Thr 3	0.98	0.98	0.99	0.99	0.99	1		
SNT Thr 4	0.98	0.98	0.99	0.99	0.99	0.99	1	
Mu > 5Gev	0.97	0.97	0.97	0.97	0.97	0.96	0.95	1

Joint analysis of Fd with MEPhI muon detector data

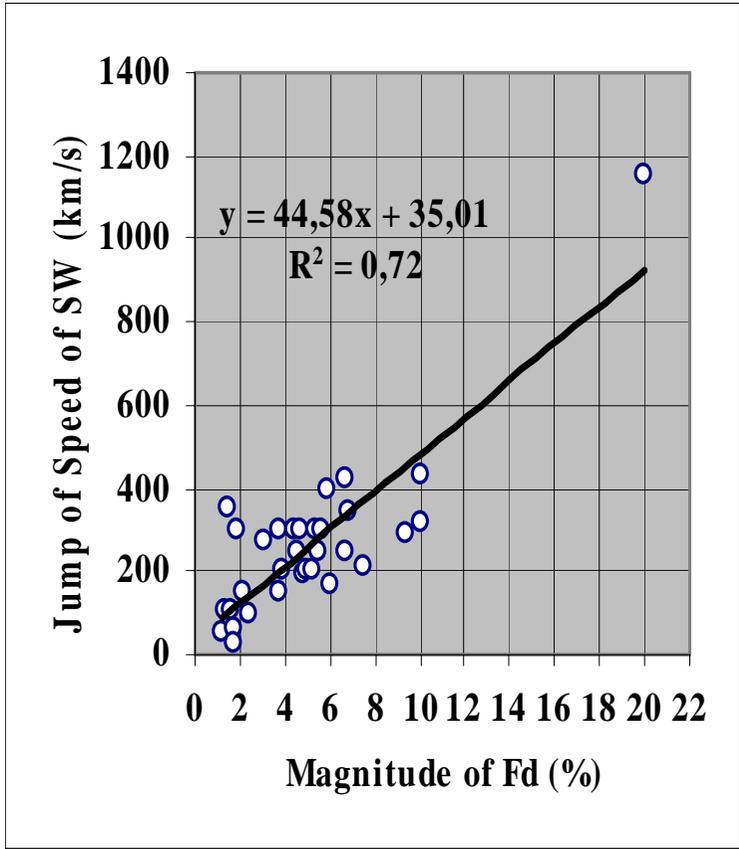
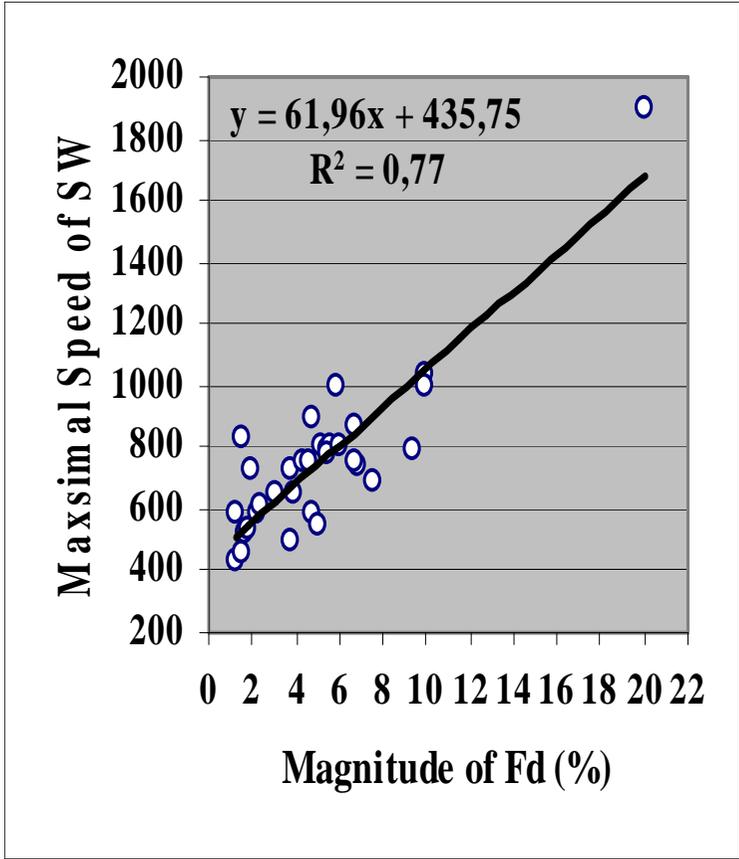
15 May, 2005	Median energies of primary (GeV)	Most probable energies of primary protons (GeV)	Magnitude of Fd (%)
Mosvow NM	10		7.3
ANM	15	7	6.7
Charged ANI	24	11	3.8
URAGAN	23		3.3
TEMP	28		2.8
DÉCOR	50		2.2
AMMM	60	37	1.34



In the top figure dependence between magnitude of Fd and median energies of primary particles by data of MEPhI and ASEC is presented (look the table).

The Black points are our data

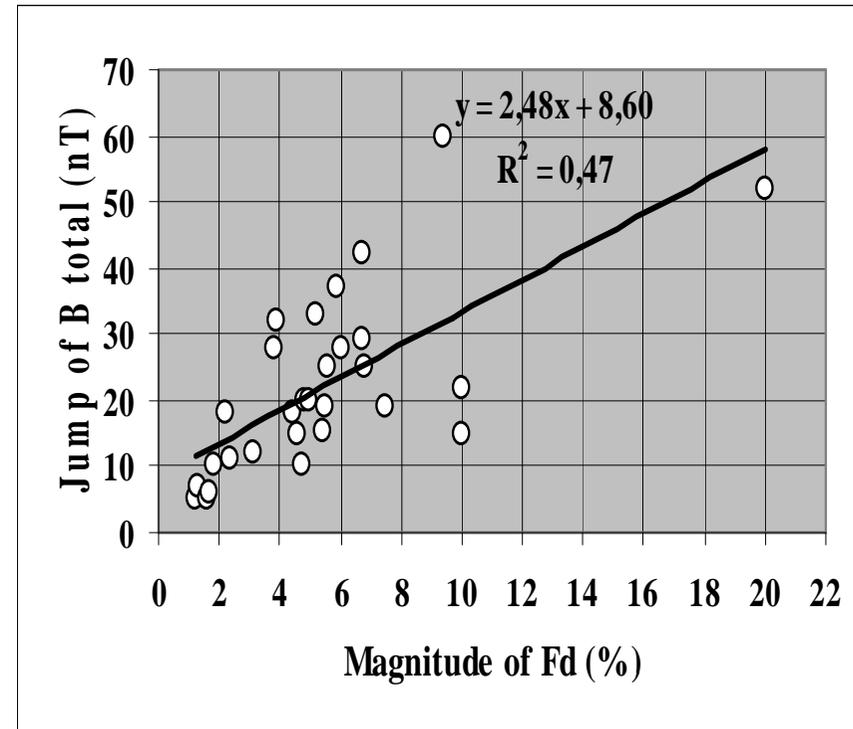
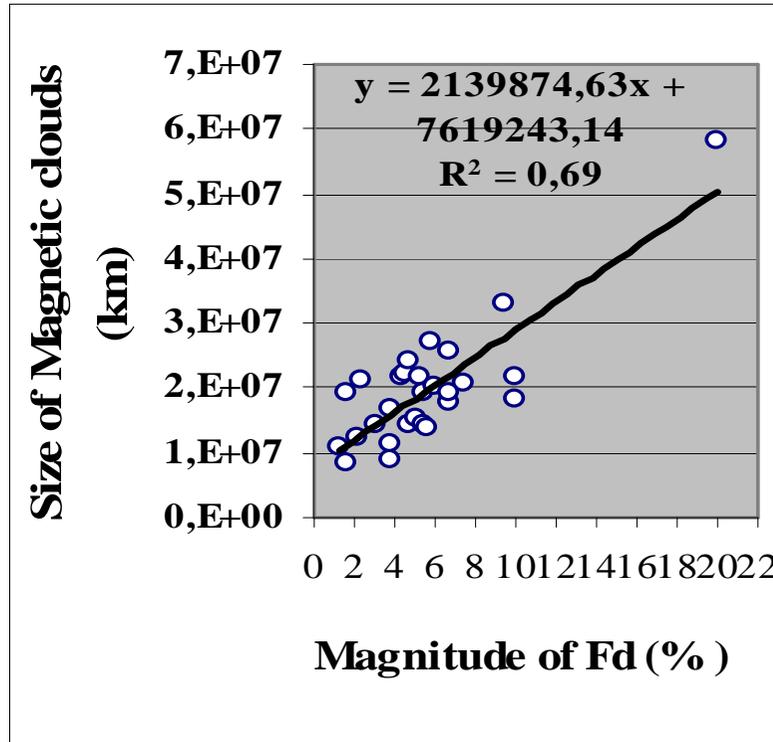
In left figure flux attenuation of different secondary cosmic ray species (neutrons, charged particles and muons >5 GeV) by ASEC was approximated by the power function



Dependence of the magnitude of Forbush decrease on the Max solar wind speed

Dependence magnitude of Fd on the Jump of solar wind

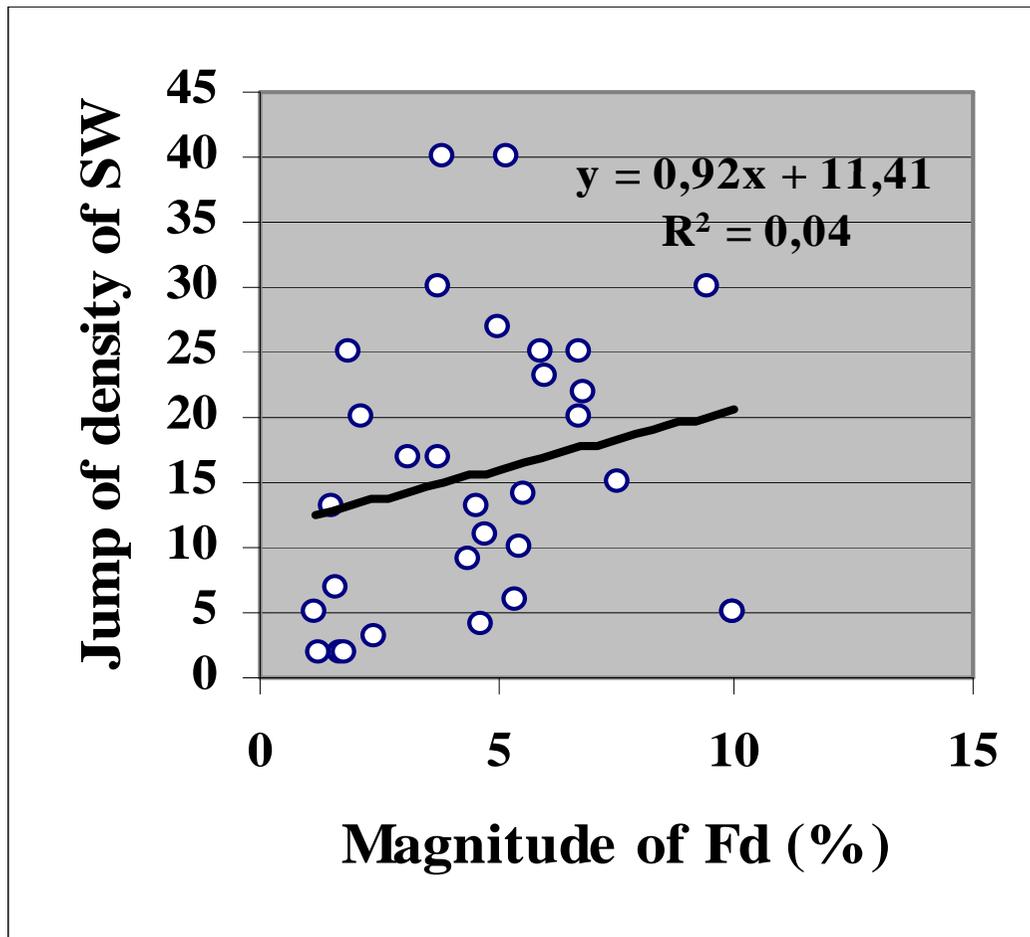
Dependence of the magnitude of Forbush decrease on the size of the magnetic clouds and on the B total.



We see that there is significant correlation between size of Magnetic cloud and magnitude of Fd.

The magnitude of Forbush decrease show weaker correlation on B total in ICME

Dependence the magnitude of Forbush decrease on the density



There is no correlation between magnitude of FD and density of ICME

Conclusion

- The magnitude of F_d for different secondary particles reverse proportional to the most probable energy of primary;
- Significant correlation observed between the magnitude of F_d and speed of ICME , size of the ICME and the magnetic field (B_{total});
- No correlation between density of ICME and magnitude of F_d is observed;
- Obtained correlations can be used for developing of the operational models of interaction of ICME and GCR.