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High Energetic Solar Proton Flares on 26 and 28 October 2003

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Abstract. During the period from 19 October to 4 November 2003, there was a sudden and high Solar activity. During this period the sunspot area increased from 1110 10E-6 Hemisphere on 19 October to 5690 10E-6 Hemisphere on 30 October, then decreased to 1110 10 E-6 Hemisphere at 4 November 2003. Also, the radio flux of 10.7 cm increased from 120 sfu on 19 October to 298 sfu on 26 October, then decrease to 168 sfu on 4 November 2003. There were two eruptive solar proton flares released on 26 and 28 October 2003, where the last one is the most eruptive flare recorded since 1976 with importance X17/4B. The proton event affecting the Earth's environment, with energy ¿10 MeV is 29500 particle flux units, on 29 October 2003 as recorded by spacecraft SOHO, due to the solar flares of 28 October. The peak of the Solar cycle 21 was at 1979, but high energetic Solar flares, or secondary peaks, occurred at the declining phase in 1981, 1982, and 1984 before the solar activity minimum in 1986. Also, the peak of the solar cycle 22 was at 1989 but high energetic solar flares occurred at the declining phase in 1991, 1992, and 1994, before the solar activity minimum in 1996. Then the secondary peaks were occurred during 2 to 3 years after the first peak, as deduced from the last five solar cycles. The period of 19 Oct. to 4 Nov. 2003 is the second peak of the solar cycle 23, where the main peak of the solar cycle 23 was at 2001. There are many terrestrial influences, due to the solar activity during Oct.-Nov. 2003. These influences are studied in details, especially the geomagnetic storms and their effects on humankind daily activity.

1. Introduction

Recently, the observations has revealed the solar energetic particles (SEPs) and coronal mass ejection's (CMEs), with different origins, based on magnetic changes of the active region, see for example, Reames, D.V (1995), and Michaleket et al (2004). These events led to severe effects on the Earth, such as power blackouts, disruption of communications, and damage of satellites (A. Hady and Shaltout, 2004). The analytical studies of solar cycle 23 peak, have been studied by using the solar indices to find the associated periodicity's (A. Hady. 2002). Some recent researches dealing with solar proton events during the last three solar cycles, and its declining phase, see for example Pontieri, et al (2003), and Mininni (2000). The Study of eruptive solar proton flares is particularly challenge because, until now, there are no adequate theoretical model for the production of such high energies, Robert (2004), Schatten, and Pesnell (1993). The aim of present work is, to study the different indices of solar activity since 1976 until the most eruptive end energetic flares during Oct. 2003. In particular we highlight our study on 25 Oct. to 19 Nov. 2003, during releasing the high energetic flare. Investigate of the existence a second peak during decline phase of the cycles 21, 22, and 23. And to study the reasons of release the Eruptive flares on Oct. - Nov. 2003

	Proton flux		Flares			
Start Date/UT	Max. Date/UT	Proton (>10 MeV)	Flux Date/UT	Fl.Max. X-ray/Opt.	Higher Loc.	Region No.
Peak of cycle 21						
19780923/1035	0924/0400	2200	0923/1023	X1/3B	N35W50	1294
Decline of cycle 21						
19811008/1235	1013/2247	2000	1007/2308	X3/1B	S19E88	3390
19820711/0700	0713/1615	2900	0709/0742	X9/3B	N17E73	3804
19821208/0010	1208/1000	1000	1207/2354	X2/0B	S14W81	4007
19840425/1330	0426/1420	2500	0425/0005	X13/3B	S12E43	4474
Peak of cycle 22						
19890308/1735	03 3/0645	3500	0306/1405	X15/3B	N35E69	5395
19890317/1855	0318/0920	2000	0317/1744	X6/2B	N33W60	5395
19890812/1600	0813/0710	9200	0812/1427	X2/2B	S16W37	5629
19890929/1205	0930/0210	4500	0929/1133	X9/EPL	S26W90	5698
19891019/1305	1020/1600	40000	1019/1258	X13/4B	S27E10	5747
19891130/1345	1201/1340	7300	1130/1229	X2/3B	N26W59	5800
Decline of cycle 22						
19910323/0820	0324/0350	43000	0322/2247	X9/3B	S26E28	6555
19910604/0820	0611/1420	3000	0604/0352	X12/3B	N30E70	6659
19910614/2340	0615/1950	1400	0615/0821	X12/3B	N33W69	6659
19910707/0455	0708/1645	2300	0707/0223	X1/2B	N26E03	6703
19940220/0300	0221/0900	10000	0220/0141	M4/3B	N09W02	7671
Peak of cycle 23						
20000714/1045	0715/1230	24000	0714/1024	X5/3B	N22/W07	9077
						9213
20001108/2350	1109/1600	14800	1108/2328	M7/mult	N00-10	9213
					W75-80	9684
20011122/2320	1124/0555	18900	1122/2330	M9/2N	S15W34	9704
Decline of cycle 23						
20020421/0225	0421/2320	2520	0421/0151	X1/1F	S14W8	9906
20031028/1215	1029/0615	29500	1028/1110	X17/4B	S16E08	10486
20031102/1105	1103/0815	1570				
20031104/2225	1105/0600	353	1104/1915	X28/3B	S19W83	10486

2. Data analysis and Discussion

A disturbances in Cycle 23 have been relatively rare compared with previous cycle, but a large peak in the occurrence during the declining phase of the cycle 23. Table (1) shows the data of proton flux, x-ray and optical flares, the active regions and its location on the sun disk, for the most eruptive events during the peaks and decline phase of solar cycles 21, 22 and 23. The selected proton flux, that which more than 1000 pfu, for x-ray flares the selected one which has class of x1 and more. Table (1): Eruptive solar proton events, and eruptive Flares affecting the Earth environment, During the Peaks and declining phases of the solar cycles 21,22 and 23. From the table (1), we can note that the decline of the current solar cycle 23, there are sudden arises with the solar activates. During the period from 28 Oct. to 4 Nov. 2003, there was a sudden and high Solar activity in the active region Number 10486, and produced one of the most eruptive flare recorded since 1976. During the period from 28 October to 4 November 2003, the proton flux reaches 29500 pfu. The x-ray flare to X17 and reaches X28 in 4 November 2003. While optical flares is 4B and reached 3B at 4 November 2003. The x -ray sensors on-board the GOES spacecraft are not capable of registering x-ray intensities up to level of class. It appears

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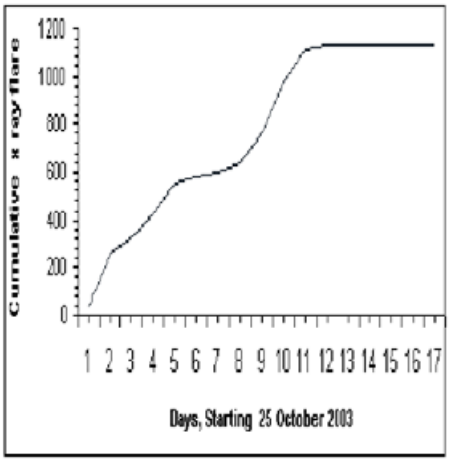

Figure 1. Daily cumulative Summation curve of x-rays Flares during 17 days starting 25 Oct.2003 to 10 Nov. 2003

that this x-ray flare peaked somewhere between the X30 and X40 class level. During the decline phase of the solar cycles 21, 22 and 23 a high energetic eruptive flares were recorded. Some of them, are more than the peaks of the solar cycle, as shown in solar cycle 23 (19 Oct. to 4 Nov. 2003). Its can be named as a second peak of the solar cycle during its decline phase. Daily solar data of Mg II core-to wings ratio of the eruptive days during the Peak and declining phase of solar cycle 23 in table (2). Column 2contains the radio Flux 10.7 cm (2800 MHz), full Sun radio, Column 3 contains the Sunspot Numbers, The SESC sunspot number is computed according to the Wolf Sunspot Number. The sunspot area in column 4 is the Sum of the corrected area of all observed sunspots, in units of millionths of the solar hemisphere. X-ray Background Flux is given in column 5. The total number of x-ray flares observed during the day for x-ray flare class B, C, M and X were given in column 6. The data at decline phase (Oct.- Nov. 2003) for x-ray Background, In column 7. Taking the ratio of the h and k lines of the solar Mg II feature at 280 nm to the background or wings at 278 nm and 282 nm derives the Mg II core-to-wing ratio. The h and k lines are variable chromospheric emissions while the background emissions are more stable. This ratio has been shown to be a good measure of solar UV and EUV emissions. The source of Mg II Core-to wing ratio data was given in column 8. The data of Mg II Core-to wing ratio did not recorded dramatic change during Oct.-Nov. 2003. More details were given, Viereck and Puga (2001). Table(2): Daily Solar Data of Most robust eruptive days during the Peak and declining phase of Solar cycle 23.

Daily cumulative Summation curves of x-ray flare parameters, has been given in Figure 1, from 25 Oct. to 10 Nov. 2003. The change in daily cumulative Summation curves of x-ray has been appeared. The sudden increase at 26 October give's indication for prediction by 2-3 days before the occurrence of the eruptive flares, which started at 28 October 2003.

3. Conclusion

We can conclude the following: during the decline phase of the last three solar cycles (21,22 and 23) high energetic eruptive flares were recorded. Some of them, are more than that occurred during the peaks of the cycles. While in the decline phase of the present solar cycle 23 (28 Oct.-4 Nov. 2003) the highest energetic proton flares was recorded since

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Date	Radio Flux	SESC Sunspot Number	Sunspot Area 10E-6 Hemis.	GOES8 X-Ray Bkgd Flux	X-Ray Flares B C M X	Mg II Core-to-W-R	Mg II Source
20000715	213	229	1120	C2.6	8 1 0 28	——	No data
20001108	173	171	910	C1.1	8 3 0 6	0.2780	GOME
20001109	166	149	730	M1.1	1 3 0 3	0.2786	GOME
20010924	279	315	3160	C1.8	8 0 1 0	0.2841	NOAA 16
20010925	275	320	2860	C2.5	3 3 0 0	0.2844	NOAA 16
20011104	227	186	1820	C1.7	5 0 1 12	0.2806	NOAA 16
20011122	190	143	1310	B8.1	6 3 0 7	0.2821	NOAA 16
20011123	177	144	1120	M1.5	4 0 0 4	0.2823	NOAA 16
20020421	173	160	1030	C1.3	4 0 1 2	0.2803	NOAA 16
20020422	170	155	980	C1.0	8 0 0 5	0.2795	NOAA 16
20031028	274	230	4520	C3.2	5 0 1 31	0.2802	NOAA 16
20031029	279	330	5160	C3.3	4 2 1 16	0.2811	NOAA 16
20031030	271	293	5690	C2.8	6 2 0 2	0.2816	NOAA 16
20031031	249	266	4420	C1.8	7 2 0 12	0.2810	NOAA 16
20031101	210	277	4170	C1.8	9 3 0 10	0.2801	NOAA 16
20031102	190	174	4050	C1.9	1 2 1 9	0.2801	NOAA 16
20031103	167	76	2830	C3.2	3 1 2 6	0.2774	NOAA 16
20031104	168	79	1100	C2.3	3 3 1 1	0.2752	NOAA 16

1976. Before and during the eruptive solar flares occurrence, It is noticed that the Mg II (core-to wing ratio) is increased before and during the eruptive solar flares occurrence. There is very notable increasing in the magnetic flux in the near space of the earth as measured by GEOS-11 monitor, after high energetic solar flares. Three is valuable increase in the belt indices of relative intensities of NOAA/POES energetic particle after the releasing this high energetic flare by 1-2 days. From this analysis we can conclude that the release of the Eruptive flares at Oct. - Nov. 2003, are due to: The a large active region area (AR 10498, 10488), and due to , the higher solar magnetic field during that time, and the high peak in geomagnetic disturbances. More theoretical treatment of theory for solar activities, which can be correlate, the solar interiors with its atmosphere are very important now. Especially, after the appearance of second peaks during the declining phase of the solar cycles, and the appearance of high energetic storms during that time.

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