

**Space Weather Highlights**  
**23-29 March 1998**

Solar activity was low to moderate. There were three M-class X-ray bursts: an optically unassociated M2 at 23/0309UT, an M1/2B flare at 26/1259UT, and a long-duration M2/3N flare at 27/2227UT. The latter two flares were produced by Region 8185 (S25, L = 233, class/area Fkc/650 on 24 March), a moderately complex group that was in slow decline during the period. The long-duration M2/3N flare was notable in that it was associated with a Type II radio sweep and a halo-type coronal mass ejection (CME). A 27-degree filament disappeared from the northwest quadrant beginning 28/1826UT. There was evidence of continuing activity from old Region 8179, now nine days behind the southwest limb. CMEs observed on 25 and 29 March were associated with old Region 8179 based upon space-based X-ray and coronal images. A few optically unassociated Types II and IV radio sweeps may have been produced by the region as well.

Solar wind data were available from the ACE and WIND spacecraft during most of the period (no magnetic field data were available). Velocities decreased from 550 - 350 km/sec during 23 - 24 March, then gradually increased during the remainder of the period, ranging from 390 - 530 km/sec.

Solar wind particle densities were in the 03 - 10 p/cc range most of the time, but briefly peaked at 15 p/cc late on 25 March.

There were no significant proton enhancements observed at geosynchronous altitude.

The greater than 2 MeV electron flux at geosynchronous altitude was at normal to moderate levels, then increased to high levels late on 29 March.

The geomagnetic field was mostly quiet through 24 March. Activity was highly variable during the remainder of the period with quiet to active levels recorded at all latitudes and brief minor to major storm intervals at higher latitudes.

**Space Weather Forecast**  
**01 April 1998 - 27 April 1998**

Solar activity is expected to range from low to moderate. Old Region 8179 returns to the visible disk during 03 - 17 April and is expected to produce M-class flares.

No significant proton enhancements are expected at geosynchronous altitude.

The greater than 2 MeV electron flux at geosynchronous altitude is expected to be at moderate to high levels through 12 April. Thereafter, mostly normal fluxes are expected.

The geomagnetic field is expected to be at quiet to unsettled levels during most of the period. However, unsettled to minor storm levels are expected through 03 April, and again during 06 - 07 April. In addition, unsettled to active levels are expected around 18 April.



### *Daily Solar Data*

Date	Radio Flux	Sun spot	Sunspot Area	X-ray Background	X-ray Flux			Flares				
	10.7 cm	No. (10 <sup>6</sup> hemi.)			C	M	X	S	1	2	3	4
23 March	122	72	650	C1.2	0	1	0	1	0	0	0	0
24 March	121	83	890	B5.6	5	0	0	6	0	0	0	0
25 March	115	79	770	B4.3	2	0	0	5	0	0	0	0
26 March	110	77	720	B3.6	0	1	0	1	0	1	0	0
27 March	108	80	620	B3.8	3	1	0	3	0	0	1	0
28 March	104	81	580	B5.6	2	0	0	3	0	0	0	0
29 March	100	82	650	B2.5	0	0	0	0	0	0	0	0

### *Daily Particle Data*

Date	Proton Fluence (protons/cm <sup>2</sup> -day-sr)			Electron Fluence (electrons/cm <sup>2</sup> -day-sr)		
	>1MeV	>10MeV	>100MeV	>.6MeV	>2MeV	>4MeV
23 March	1.4E+6	1.7E+4	3.6E+3		2.1E+7	
24 March	1.0E+6	1.8E+4	3.8E+3		1.7E+7	
25 March	4.1E+5	1.6E+4	3.4E+3		3.6E+6	
26 March	3.2E+5	1.6E+4	3.4E+3		2.3E+6	
27 March	3.4E+5	1.7E+4	4.0E+3		3.5E+6	
28 March	1.9E+5	1.7E+4	4.2E+3		2.3E+6	
29 March	1.6E+6	1.7E+4	4.3E+3		2.2E+7	

### *Daily Geomagnetic Data*

Date	Middle Latitude Fredericksburg		High Latitude College		Estimated Planetary	
	A	K-indices	A	K-indices	A	K-indices
23 March	4	2-3-1-0-1-0-0-2	3	1-1-0-2-1-0-1-1	5	2-3-1-1-1-2-2-2
24 March	5	1-1-2-1-2-1-2-2	11	1-1-3-3-4-2-2-2	7	0-0-3-2-3-2-2-3
25 March	8	3-3-1-2-2-3-1-1	28	2-1-1-4-6-6-3-1	16	3-3-1-4-4-4-2-2
26 March	9	1-2-0-2-3-3-2-3	21	0-1-0-2-6-5-3-3	10	1-1-0-2-4-4-3-3
27 March	9	3-2-3-2-2-2-2-2	20	3-2-4-4-4-4-2-2	13	3-2-3-3-3-3-3-3
28 March	10	2-3-1-3-1-0-2-4	17	1-2-1-6-4-1-2-1	14	2-3-2-4-4-3-2-3
29 March	10	4-3-1-1-2-2-2-2	37	3-3-1-2-4-6-7-2	17	4-3-2-2-3-4-4-3

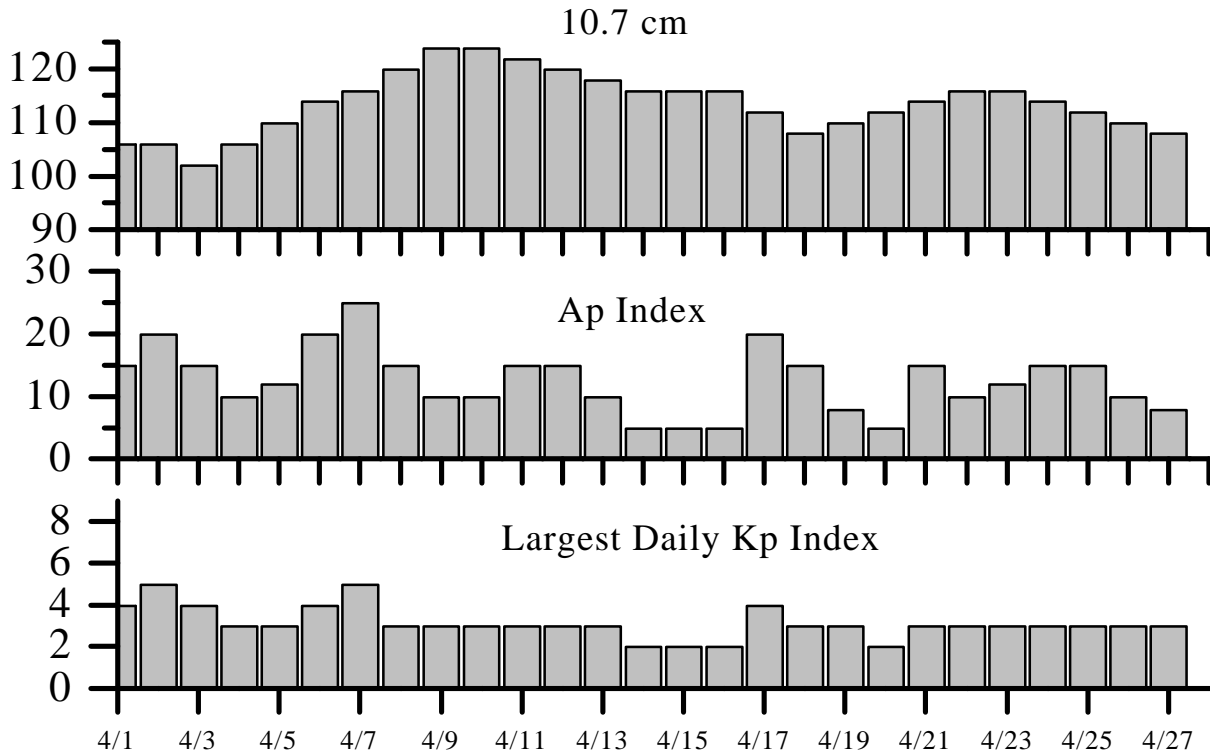


*Alerts and Warnings Issued*

Date and Time of Issue (UT)	Type of Alert or Warning	Date and Time of Event (UT)
24 Mar 2256	Type IV Radio Emission	24 Mar 2207
25 Mar 1507	K= 4 observed	25 Mar 12-15
26 Mar 1810	K= 4 observed	26 Mar 15-18
26 Mar 2358	Type IV Radio Emission	26 Mar 2315
27 Mar 0100	Type II Radio Emission	27 Mar 0042
28 Mar 0010	4-245 MHz Radio Bursts	27 Mar
28 Mar 0010	245 MHz Radio Noise Storm	27 Mar
28 Mar 1200	K= 4 observed	28 Mar 09-12
29 Mar 0008	245 MHz Radio Noise Storm	28 Mar
29 Mar 0258	K= 4 observed	29 Mar 00-03
29 Mar 0358	Type II Radio Emission	29 Mar 0245
29 Mar 0303	Type IV Radio Emission	29 Mar 0302
29 Mar 1810	K= 4 observed	29 Mar 15-18
29 Mar 1900	>2MeV Electron Event $\geq 1000$ pfu	29 Mar 1830
30 Mar 0010	2-245 MHz Radio Bursts	29 Mar



Twenty-seven Day Outlook



Date	Radio Flux 10.7 cm	Planetary A Index	Largest Kp Index	Date	Radio Flux 10.7 cm	Planetary A Index	Largest Kp Index
01 Apr	106	15	4	15	116	5	2
02	106	20	5	16	116	5	2
03	102	15	4	17	112	20	4
04	106	10	3	18	108	15	3
05	110	12	3	19	110	8	3
06	114	20	4	20	112	5	2
07	116	25	5	21	114	15	3
08	120	15	3	22	116	10	3
09	124	10	3	23	116	12	3
10	124	10	3	24	114	15	3
11	122	15	3	25	112	15	3
12	120	15	3	26	110	10	3
13	118	10	3	27	108	8	3
14	116	5	2				



***Energetic Events***

Date	Time (UT)			X-ray		Optical Information			Peak		Sweep Freq		
	Begin	Max	$\frac{1}{2}$	Class	Integ	Imp	Location		Rgn	Radio Flux		Intensity	
			Max		Flux		Brtns	Lat		CMD	#	245	2695
23 Mar	0239	0309	0329	M2.3	.050								
26 Mar	1246	1259	1340	M1.8	.039	2B	S26E19		8185				
27 Mar	2149	2227	2317	M2.4	.068	3N	S24W03		8185	42			

***Flare List***

Date	Time			X-ray Class.	Imp / Brtns	Optical Location Lat CMD	Rgn #
	Begin	Max	End				
23 March	0239	0309	0329	M2.3			
	0832	0833	0844		SF	N21E01	8183
24 March	0145	0153	0203	C2.3			
	0433	0447	0459	C4.3			
	0650	0705	0719	C1.3			
	0745	0750	0755	C1.5			
	1022	1114	1217	C8.0			
	1531	1532	1534		SF	S27E42	8185
	1559	1600	1603		SF	N21W18	8183
	1803	1804	1811		SF	N22W19	8183
25 March	1835	1837	1846	B9.6	SF	S27E41	8185
	1913	1916	1925		SF	S27E41	8185
	1926	1927	1929		SF	S27E41	8185
	B1146	U1148	A1151	C1.2	SF	S29E38	8185
	1231	1325	1434	C5.3			
	1617	1623	1633		SF	N19W23	8183
	1713	1715	1725		SF	S25E24	8185
	1843	1844	1846		SF	S25E24	8185
26 March	2245	2247	2250		SF	S30E33	8185
	0002	0004	A0021	B7.6	SF	S26E22	8185
	0249	0255	0304	B5.7			
27 March	1247	1254	1348	M1.8	2B	S26E19	8185
	0036	0046	0127	C1.0			
	0545	0553	0607	B8.1			
	1310	1319	1355	C1.3	SF	S25W11	
	1559	1600	1612	C1.0	SF	S28W03	8185
	2153	2225	0030	M2.4	3N	S24W03	8185
	B2319	2341	0029		SF	S28W05	8185



**Flare List – continued.**

Date	Time			X-ray Class.	Imp / Brtns	Optical	Rgn #
	Begin	Max	End			Location Lat CMD	
28 March	0450	0453	0455	B5.4			
	0513	0514	0519		SF	N23W61	8183
	0713	0714	0735	C4.9	SF	N23W63	8183
	0853	0902	0907	B4.4			
	0925	0930	0937	B7.3			
	B1131	U1137	A1150	B5.7	SF	S26W26	8189
	1500	1504	1509	B3.9			
	1612	1616	1620	B3.7			
	1829	1835	1841	B5.2			
	1950	1957	2002	C1.3			
	2233	2237	2244	B3.4			
29 March	0635	0638	0643	B3.4			
	1226	1231	1235	B4.0			
	1721	1730	1738	B8.3			

**Region Summary**

Date	Location		Sunspot Characteristics					Flares							
	( ° Lat ° CMD)	Helio	Area (10 <sup>-6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray		Optical					
		Lon						C	M	X	S	1	2	3	4
<i>Region 8178</i>															
10 Mar	S15E72	022	0100	04	HSX	001	A								
11 Mar	S16E59	022	0140	01	HSX	001	A								
12 Mar	S17E47	021	0100	01	HSX	001	A								
13 Mar	S16E34	020	0110	02	HSX	001	A								
14 Mar	S17E20	021	0110	02	HSX	001	A								
15 Mar	S16E07	021	0130	02	HSX	001	A								
16 Mar	S16W06	021	0130	03	HSX	002	A								
17 Mar	S16W19	021	0100	03	HAX	002	A								
18 Mar	S16W32	021	0080	02	HAX	002	A								
19 Mar	S17W45	020	0050	02	HAX	001	A								
20 Mar	S17W54	016	0060	02	HSX	001	A								
21 Mar	S17W71	020	0040	02	HSX	001	A								
22 Mar	S15W83	019	0030	02	HSX	001	A								
								0	0	0	0	0	0	0	0

Crossed West Limb.

Absolute heliographic longitude: 021



**Region Summary – continued.**

Date	Location		Sunspot Characteristics					Flares															
	( ° Lat ° CMD)	Helio	Area (10 <sup>6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray			Optical												
		Lon						C	M	X	S	1	2	3	4								
<i>Region 8180</i>																							
12 Mar	S29E42	026	0010	05	BXO	005	B																
13 Mar	S27E29	025	0010	07	BXO	006	B						1										
14 Mar	S30E19	022	0010	03	BXO	003	B																
15 Mar	S30E07	021	0000	00	AXX	001	A																
16 Mar	S30W06	021																					
17 Mar	S30W19	021																					
18 Mar	S30W32	021																					
19 Mar	S30W45	021																					
20 Mar	S30W58	021																					
21 Mar	S29W71	020	0010	04	BXO	004	B																
													0	0	0	1	0	0	0	0	0	0	

Crossed West Limb.

Absolute heliographic longitude: 21

<i>Region 8181</i>																							
12 Mar	S20E48	020	0000	04	BXO	002	B																
13 Mar	S20E35	020																					
15 Mar	S20E09	020																					
16 Mar	S20W04	020																					
17 Mar	S20W17	020																					
18 Mar	S20W30	020																					
19 Mar	S20W43	020																					
20 Mar	S20W56	020																					
21 Mar	S20W69	020																					
													0	0	0	0	0	0	0	0	0	0	

Died on Disk.

Absolute heliographic longitude: 020



*Region Summary – continued.*

Date	Location		Sunspot Characteristics				Flares														
	( ° Lat ° CMD)	Helio	Area (10 <sup>6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray			Optical										
		Lon						C	M	X	S	1	2	3	4						
<i>Region 8183</i>																					
18 Mar	N22E58	291	0050	03	CRO	003	B					1									
19 Mar	N22E44	291	0080	08	CRO	006	B	4	1			4	3								
20 Mar	N23E30	292	0020	08	BXO	013	B														
21 Mar	N23E18	291	0050	09	BXO	011	B														
22 Mar	N22E06	290	0040	08	DRO	010	B	1				1									
23 Mar	N22W07	290	0090	08	DSO	008	B					1									
24 Mar	N22W21	290	0220	09	DSO	016	B					2									
25 Mar	N22W33	289	0190	09	DSO	010	B					1									
26 Mar	N21W48	291	0180	05	DAO	009	B														
27 Mar	N22W62	292	0130	09	CAO	003	B														
28 Mar	N22W73	290	0110	05	CSO	005	B	1				2									
29 Mar	N21W86	289	0050	01	HSX	001	A														
												6	1	0	12	3	0	0	0		

Still on Disk.

Absolute heliographic longitude: 290

<i>Region 8184</i>																					
20 Mar	S18E46	276	0050	04	CSO	003	B														
21 Mar	S19E33	276	0040	06	DSO	003	B														
22 Mar	S20E20	276	0040	07	DSO	004	B														
23 Mar	S20E06	277	0040	08	DSO	004	B														
24 Mar	S20W06	275	0020	08	BXO	005	B														
25 Mar	S21W17	273	0000	00	AXX	001	A														
26 Mar	S21W30	273																			
27 Mar	S21W43	273																			
28 Mar	S21W56	273																			
29 Mar	S21W69	273																			
												0	0	0	0	0	0	0	0		

Still on Disk.

Absolute heliographic longitude: 277





*Region Summary – continued.*

Date	Location		Sunspot Characteristics				Flares												
	( ° Lat ° CMD)	Helio	Area (10 <sup>6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray			Optical								
		Lon						C	M	X	S	1	2	3	4				
<i>Region 8185</i>																			
20 Mar	S24E64	258	0000	00	AXX	001	A												
21 Mar	S24E71	238	0080	12	CSO	006	B					1							
22 Mar	S24E63	233	0350	16	FKI	015	B	1	1			5	1						
23 Mar	S25E50	233	0510	18	FKC	018	BG												
24 Mar	S24E37	232	0650	19	FKC	021	BG					4							
25 Mar	S25E24	232	0580	20	FKC	027	BG	1				4							
26 Mar	S25E12	231	0530	22	FHC	037	BG		1			1		1					
27 Mar	S24W03	233	0480	25	FKC	031	BG	1	1			2						1	
28 Mar	S26W15	232	0430	20	FKI	024	BG												
29 Mar	S25W27	230	0450	20	FKO	018	BG												
								3	3	0		17	1	1	1	1	0		

Still on Disk.

Absolute heliographic longitude: 233

*Region 8186*

22 Mar	N09W24	320	0010	01	BXO	002	B												
23 Mar	N09W37	320																	
24 Mar	N09W50	320																	
25 Mar	N09W63	320																	
26 Mar	N09W76	320																	
27 Mar	N09W89	320																	
								0	0	0		0	0	0	0	0	0	0	

Crossed West Limb.

Absolute heliographic longitude: 320

*Region 8187*

23 Mar	S23W75	358	0010	03	BXO	002	B												
24 Mar	S23W87	356	0000	00	AXX	001	A												
								0	0	0		0	0	0	0	0	0	0	

Crossed West Limb.

Absolute heliographic longitude: 358

*Region 8188*

25 Mar	N29E56	200	0000	00	AXX	001	A												
26 Mar	N30E41	202	0010	00	AXX	001	A												
27 Mar	N30E30	200	0000	00	AXX	001	A												
28 Mar	N30E19	198	0010	05	BXO	005	B												
29 Mar	N30E06	197	0020	05	BXO	003	B												
								0	0	0		0	0	0	0	0	0	0	

Still on Disk.

Absolute heliographic longitude: 197



Date	Location		Sunspot Characteristics				Flares											
	( ° Lat ° CMD)	Helio	Area (10 <sup>6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray			Optical							
		Lon						C	M	X	S	1	2	3	4			
<i>Region 8189</i>																		
27 Mar	S26W17	247	0010	04	BXO	005	B											
28 Mar	S26W30	247	0030	07	CSO	007	B					1						
29 Mar	S26W43	246	0040	09	CSO	006	B											
								0	0	0	1	0	0	0	0	0	0	0
Still on Disk.																		
Absolute heliographic longitude: 247																		
<i>Region 8190</i>																		
29 Mar	S20E66	137	0090	08	DSO	004	B											
								0	0	0	0	0	0	0	0	0	0	0
Still on Disk.																		
Absolute heliographic longitude: 137																		



**Recent Solar Indices (preliminary)  
of the observed monthly mean values**

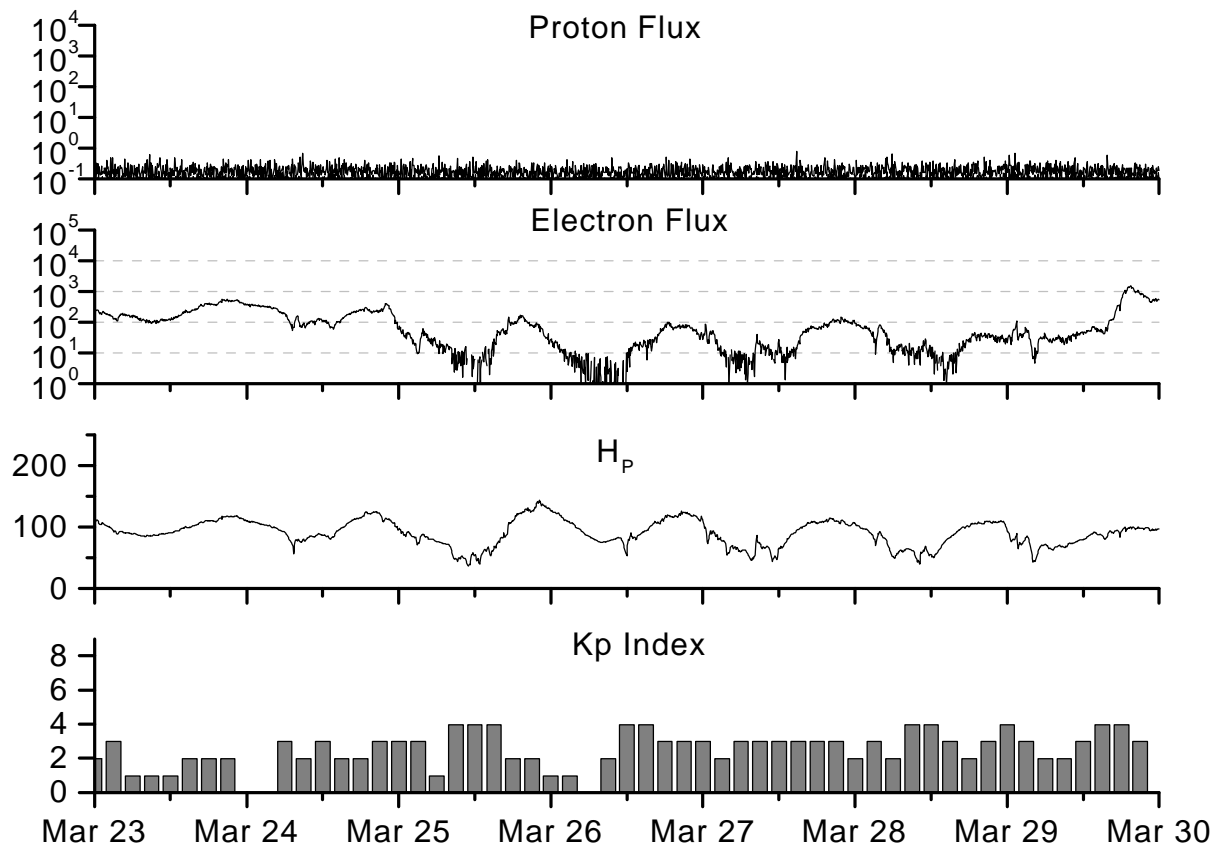
Month	Sunspot Numbers					Radio Flux		Geomagnetic	
	Observed SWO	values RI	Ratio RI/SWO	Smooth SWO	values RI	**Penticton 10.7 cm	Smooth Value	Planetary Ap	Smooth Value
<b>1996</b>									
March	12.1	09.2	0.76	15.4	09.7	72.7	72.1	11	09.9
April	08.5	04.8	0.56	13.6	08.5	69.3	71.6	11	09.7
May	11.8	05.5	0.47	12.9	08.0	72.1	71.4	07	09.5
June	18.8	11.8	0.63	13.5	08.5	69.6	71.8	05	09.4
July	13.2	08.2	0.62	13.4	08.4	71.2	72.0	07	09.3
August	20.5	14.4	0.70	13.1	08.3	72.4	72.1	09	09.4
September	02.9	01.6	0.55	13.3	08.4	69.4	72.3	15	09.3
October	02.3	00.9	0.39	14.0	08.8	69.2	72.6	13	09.1
November	26.7	17.9	0.67	15.4	09.8	78.7	73.0	08	09.1
December	21.1	13.3	0.63	16.2	10.4	77.8	73.3	07	09.3
<b>1997</b>									
January	09.0	05.7	0.63	16.5	10.5*	74.0	73.4	09	09.3*
February	11.3	07.6	0.67	17.4	11.0*	73.8	73.7	11	09.2*
March	14.4	08.7	0.60	20.4	13.5*	73.5	75.1*	08	09.0*
April	24.5	15.5	0.63	24.0	16.5*	74.5	76.8*	10	08.6*
May	28.6	18.5	0.65	26.4	18.4*	74.6	78.4*	08	08.6*
June	22.1	12.7	0.57	29.0	20.4*	71.7	80.1*	07	08.6*
July	17.0	10.5*	0.62*	32.4	22.7*	71.1	81.8*	06*	08.4*
August	36.7	24.7*	0.67*	35.9	25.2*	79.0	83.4*	08*	08.2*
September	52.8	51.3*	0.88*			96.2*		10*	
October	33.6	23.3*	0.69*			85.0*		10*	
November	53.5	39.3*	0.73*			99.5*		10*	
December	57.9	41.5*	0.72*			98.8*		05*	
<b>1998</b>									
January	51.8	32.3*	0.62*			93.5*		07*	
February	54.4	40.7*	0.75*			93.6*		07*	

\*Preliminary estimates.

The lowest smoothed sunspot indices number for Cycle 22, RI = 8.0, occurred in May 1996. The highest smoothed sunspot number for Cycle 22, RI=158.5, occurred July 1989.

\*\* From June 1991 onward, the 10.7 cm radio flux data source is Penticton, B.C. Canada. Prior to that, it was Ottawa.





*Weekly Geosynchronous Satellite Environment Summary*  
*Week Beginning 23 March 1998*

*Protons* plot contains the five-minute averaged integral proton flux (protons/  $\text{cm}^2$ -sec-sr) as measured by GOES-9 (W135) for each of three energy thresholds: greater than 10, 50, and 100 MeV.

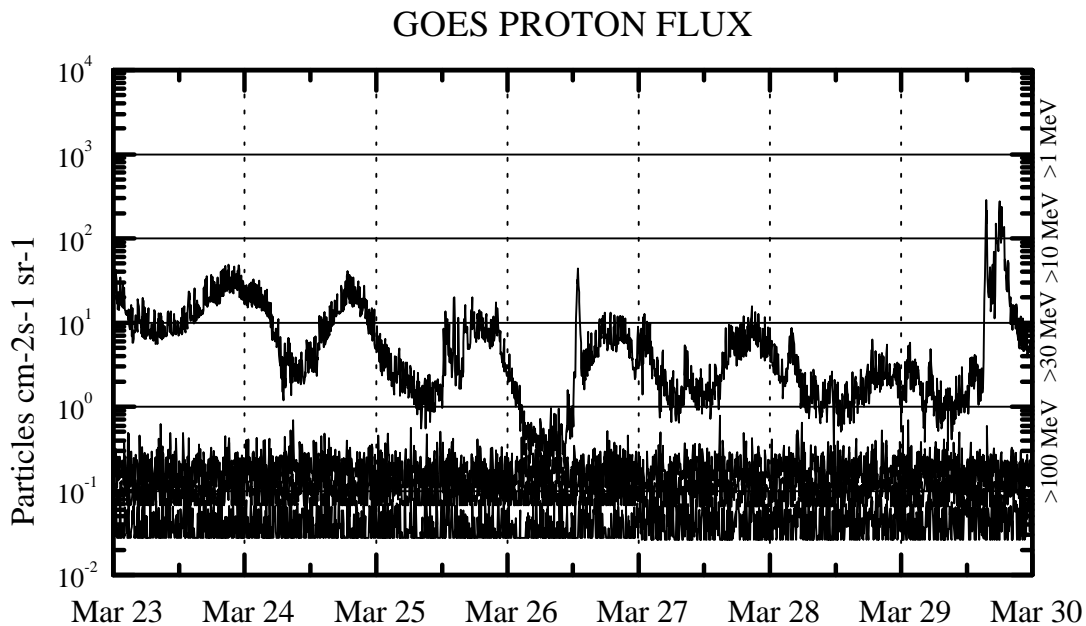
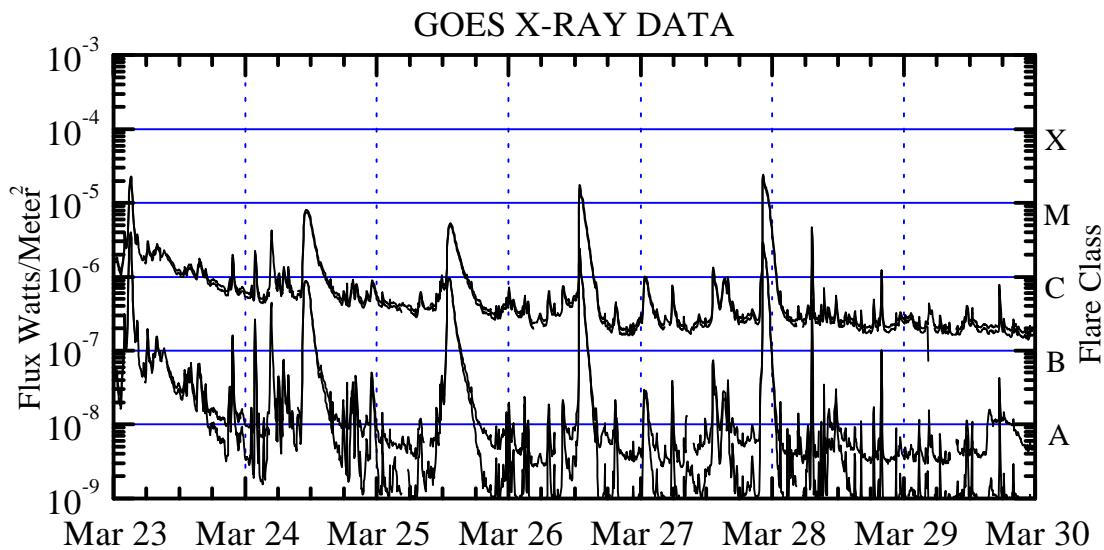
*Electrons* plot contains the five-minute averaged integral electron flux (electrons/  $\text{cm}^2$ -sec-sr) with energies greater than 2 MeV at GOES-9.

*H<sub>p</sub>* plot contains the five minute averaged magnetic field H component in nanoteslas (nT) as measured by GOES-9. The H component is parallel to the spin axis of the satellite, which is nearly parallel to the Earth's rotation axis.

*K<sub>p</sub>* plot contains the estimated planetary 3-hour K-index (derived by the USAF 55<sup>th</sup> Space Weather Squadron) in real time from magnetometers at Meanook, Canada; Sitka, AK; Glenlea, Canada; St. Johns, Canada; Ottawa, Canada; Newport, WA; Fredericksburg, VA; Boulder, CO; Fresno, CA and Heartland, UK. These data are made available through cooperation from the Geological Survey of Canada (GSC) and the US Geological Survey. These may differ from the final K<sub>p</sub> values derived from a more extensive network of magnetometers.

The data included here are those now available in real time at the SWO and are incomplete in that they do not include the full set of parameters and energy ranges known to cause satellite operating anomalies. The proton and electron fluxes and K<sub>p</sub> are "global" parameters that are applicable to a first order approximation over large areas. H<sub>parallel</sub> is subject to a more localized phenomena and the measurements generally are applicable to within a few degrees of longitude of the measuring satellite.





*Weekly GOES Satellite X-ray and Proton Plots*

Proton plot contains the five minute averaged integral proton flux ( $\text{protons}/\text{cm}^2\text{-sec-sr}$ ) as measured by GOES-9 (W135) for each of the energy thresholds:  $>1$ ,  $>10$ ,  $>30$  and  $>100$  MeV. P10 event threshold is 10 pfu ( $\text{protons}/\text{cm}^2\text{-sec-sr}$ ) at greater than 10 MeV.

X-ray plot contains five minute averaged x-ray flux ( $\text{watts}/\text{m}^2$ ) as measured by GOES 8 and 9 in two wavelength bands, .05 - .4 and .1 - .8 nm. The letters A, B, C, M and X refer to x-ray event levels for the .1 - .8 nm band.

