

**Space Weather Highlights  
21-27 December 1998**

Solar activity ranged from low to moderate. The week began with activity at low levels due to isolated subflares from a couple of decaying regions. Activity increased to moderate on 23 December with an M2 X-ray flare from the northeast limb at 23/0816UT with associated Types II and IV radio sweeps and a loop prominence system. This active area appeared to be the return of old active Region 8395 (which had a history of major flare production) and was numbered as 8421 (N27, L = 171, class/area Eac/360 on 28 December). Activity remained at moderate levels through 25 December as Region 8421 produced isolated low-level M-class flares. Region 8421 was moderate in size and magnetic complexity at the end of the period. Activity dropped to low levels during 26 - 27 December with Regions 8421 and 8419 (N27, L = 224, class/area Eai/540 on 28 December) producing C-class subflares. Region 8419 entered a rapid growth phase on 27 December and had developed into a large, magnetically complex spot group by the end of the day.

Real-time solar wind data were available from the Advanced Composition Explorer (ACE) spacecraft during most of the period. There were a few significant changes in the solar wind flow during 25 - 26 December including a velocity increase from 330 - 620 km/sec and increased southward IMF Bz (maximum southerly deflection minus 14 nT (GSM) on 25 December). These changes may have been due to a coronal hole wind stream.

No significant proton flux enhancements were detected at geosynchronous altitude.

The greater than 2 MeV electron flux at geosynchronous altitude was at normal levels during most of the period.

The geomagnetic field was quiet to unsettled during most of the period. However, the field was mildly disturbed during 25 - 26 December with brief active to minor storm periods detected at all latitudes.

**Space Weather Forecast  
30 December 1998 - 25 January 1999**

Solar activity is expected to be low to moderate during the first week with M-class flares possible from Regions 8419 and 8421. Solar activity is expected to be low for the remainder of the period.

No significant proton enhancements are expected at geosynchronous altitude. However, Regions 8419 and 8421 provide an increased chance for a proton event during the first week of the forecast period.

The greater than 2 MeV electron flux at geosynchronous altitude is expected to be at normal to moderate levels during most of the period.

The geomagnetic field is expected to be unsettled during the first two days with a chance for active periods due to possible coronal hole effects. Quiet to unsettled conditions are expected during the remainder of the period, barring any Earth-directed CMEs.



**Daily Solar Data**

Date	Radio Flux 10.7 cm	Sun spot No. (10 <sup>6</sup> hemi.)	Sunspot Area (10 <sup>6</sup> hemi.)	X-ray Background	Flares							
					X-ray Flux			Optical				
					C	M	X	S	1	2	3	4
21 December	135	72	270	B6.3	3	0	0	6	0	0	0	0
22 December	129	56	200	B5.9	3	0	0	4	0	0	0	0
23 December	140	78	250	B6.5	3	2	0	4	0	0	0	0
24 December	139	93	290	C1.8	3	1	0	7	1	0	0	0
25 December	144	84	370	B6.7	6	1	0	6	0	0	0	0
26 December	145	100	550	B8.0	10	0	0	16	1	0	0	0
27 December	167	156	800	B9.2	12	0	0	16	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
21 December	4.2E+5	1.9E+4	3.7E+3		4.9E+6	
22 December	7.0E+5	1.8E+4	4.0E+3		3.8E+6	
23 December	3.6E+5	1.7E+4	3.9E+3		1.4E+6	
24 December	7.8E+5	1.7E+4	3.9E+3		8.5E+5	
25 December	9.0E+5	1.7E+4	3.7E+3		1.3E+5	
26 December	8.3E+5	1.6E+4	3.7E+3		1.8E+5	
27 December	3.9E+5	1.6E+4	3.6E+3		3.5E+5	

**Daily Geomagnetic Data**

Date	Middle Latitude		High Latitude		Estimated	
	Fredericksburg		College		Planetary	
	A	K-indices	A	K-indices	A	K-indices
21 December	3	1-0-0-3-0-1-1-1	3	0-0-1-1-3-1-1-0	3	0-0-1-1-1-2-1-1
22 December	2	1-1-1-0-0-1-2-0	2	0-0-0-0-2-0-2-0	5	1-1-1-0-1-2-3-2
23 December	3	1-0-2-2-1-0-1-1	10	0-0-1-4-4-3-2-0	8	1-0-3-2-3-3-3-1
24 December	*	1-1-*-*-*-*-*	*	0-0-0-*-*-*-*1*	3	1-1-0-2-2-1-1-1
25 December	*	*-*-*3-*-*2-2	12	1-0-2-5-3-3-2-2	11	2-1-3-4-2-2-2-3
26 December	13	2-4-3-2-4-1-2-2	23	1-4-4-4-6-2-1-2	16	1-4-4-3-4-2-2-3
27 December	1	2-0-0-0-1-0-0-0	2	2-1-1-0-1-1-0-0	3	2-0-0-0-1-2-1-1

*Note:* Missing values from Fredericksburg, VA due to weather outage.

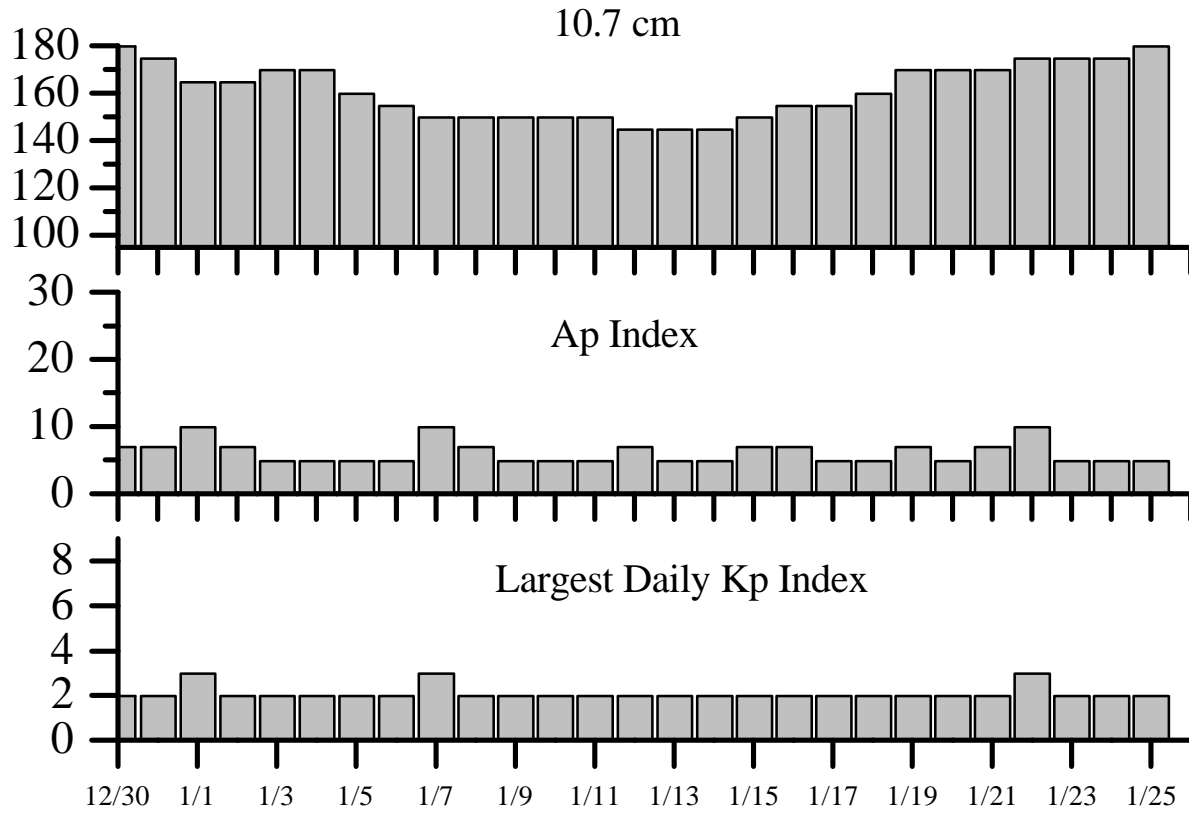


*Alerts and Warnings Issued*

Date and Time of Issue (UT)	Type of Alert or Warning	Date and Time of Event (UT)
21 Dec 1250	Stratwarm Alert EXISTS	Stratwarm Monday
22 Dec 1344	Stratwarm Alert EXISTS	Stratwarm Tuesday
23 Dec 0030	2 - 245 MHz Bursts	22 Dec
23 Dec 0728	Type II Radio Emission	23 Dec 0615
23 Dec 0728	Type IV Radio Emission	23 Dec 0633
24 Dec 0010	1 - 245 MHz Burst	23 Dec
25 Dec 0032	2 - 245 MHz Bursts	24 Dec
26 Dec 0021	5 - 245 MHz Bursts	25 Dec
26 Dec 0858	K= 4 Observed	26 Dec 06-09
26 Dec 1322	K= 4 Warning valid	26 Dec 13-21
26 Dec 1339	K= 5 Warning valid	26 Dec 13-21
26 Dec 1344	A $\geq$ 20 Watch	26 Dec
26 Dec 1508	K= 5 Observed	26 Dec 12-15



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
30 Dec	180	7	2	13 Jan	145	5	2
31	175	7	2	14	145	5	2
01 Jan	165	10	3	15	150	7	2
02	165	7	2	16	155	7	2
03	170	5	2	17	155	5	2
04	170	5	2	18	160	5	2
05	160	5	2	19	170	7	2
06	155	5	2	20	170	5	2
07	150	10	3	21	170	7	2
08	150	7	2	22	175	10	3
09	150	5	2	23	175	5	2
10	150	5	2	24	175	5	2
11	150	5	2	25	180	5	2
12	145	7	2				



### *Energetic Events*

Date	Time (UT)			X-ray		Optical Information			Peak		Sweep Freq	
	Begin	Max	Max	Class	Flux	Imp Brtns	Location Lat CMD	Rgn #	Radio Flux		Intensity	
									245	2695	II	IV
23 Dec 98	0513	0659	0743	M2.3	.110						2	2
23 Dec 98	0813	0816	0821	M1.1	.005							
24 Dec 98	1129	1145	1214	M1.7	.030	SF	N28E73	8421				
25 Dec 98	0531	0634	0727	M1.2	.050	SF	N30E66	8421				

### *Flare List*

Date	Time			X-ray Class	Imp / Brtns	Optical Location Lat CMD	Rgn #
	Begin	Max	End				
21 December	0417	0429	0440	C5.6			
	1057	1100	1103	B7.7			
	1122	1127	1138	B8.5			
	1333	1333	1343	C2.0	SF	N19E63	8416
	1533	1543	1552		SF	N20E61	8416
	1621	1624	1626		SF	N20E61	8416
	B1836	U1837	A1850		SF	N20E62	8416
	B1942	U1942	A2015	C1.4	SF	N21E26	8415
	2114	2118	2122	B9.4			
	B2123	U2125	A2127		SF	N18E20	8415
22 December	0912	0915	0920		SF	N16E48	8416
	1512	1517	1522	B6.2			
	1532	1533	1538	B6.9	SF	N18E11	8415
	1705	1720	1807	B8.9			
	1825	1834	1843	C1.2	SF	N19E58	8416
	2111	2114	2119	C1.3	SF	N19E10	8415
	2345	2351	2355	C6.9			
23 December	0230	0231	0252	C2.2	SF	N26W23	8414
	0308	0309	0314		SF	N26W23	8414
	0326	0332	0350	C2.2			
	0513	0659	0743	M2.3			
	0813	0816	0821	M1.1			
	1157	1206	1213	C5.0			
	1800	1800	1813		SF	N28E86	8421
	2000	2002	2007		SF	N26E30	8419
24 December	0040	0054	0107	C5.0			
	0122	0126	0156	C6.2	SF	N19E32	8416
	0437	0441	0444		SF	N17E31	8416
	0813	0822	0831		SF	N17E29	8416
	0820	0823	0826		SF	N28E73	8421
	1140	U1148	A1229		SF	N29E79	8421
	B1143	U1147	A1213	M1.7	SF	N28E73	8421
	1840	1843	1845	B9.8			



*Flare List-continued*

Date	Time			X-ray	Optical		Rgn Lat CMD	#
	Begin	Max	End		Imp / Class	Location Brtns		
24 December	1904	1910	1922		SF	N17E22	8416	
	2048	2122	2216	C1.8	1F	N28E62	8421	
25 December	0031	0031	0040	C2.2	SF	N28E60	8421	
	0337	0414	0449	C2.9				
	0614	0630	0705	M1.2	SF	N30E66	8421	
	1803	1804	1809	C1.0	SF	N30E58	8421	
	1833	1833	1836		SF	N25E01	8419	
	2005	2006	2013	C1.3	SF	N29E57	8421	
	2017	2020	2023	C1.1				
	2050	2051	2058	C1.2	SF	N29E59	8421	
26 December	0044	0047	0049	C1.3				
	0137	0137	0149	C2.0	SF	N29E56	8421	
	0337	0337	0341		SF	N29E54	8421	
	0510	0511	0520	C2.4	SF	N28E52	8421	
	0558	0558	0602	C7.8	SF	S21E64	8422	
	0707	0731	0803	C1.7				
	0922	0924	0929	C2.9	SF	N27E53	8421	
	1447	1457	1559	C4.4	1F	N25E46	8421	
	1619	1619	1623		SF	N32E53	8421	
	1628	1634	1645		SF	N27W08	8419	
	1634	1635	1639		SF	N26E42	8421	
	1705	1710	1716		SF	N28E44	8421	
	1712	1713	1716		SF	N21W36	8415	
	1721	1721	1727		SF	N21W09	8416	
	1823	1827	1853	C3.5	SF	N26W10	8419	
	1921	1924	1930		SF	N28E47	8421	
	1936	1940	1948		SF	N28E46	8421	
	2031	2040	2119	C2.4	SF	N27W10	8419	
	2338	2344	0003	C7.8	SF	N26W11	8419	
	27 December	0117	0117	0124	C2.0	SF	N26W11	8419
0131		0134	0140	C3.0	SF	N26W14	8419	
0310		0312	0322	C3.3	SF	N26E37	8421	
0420		0421	0430		SF	N26W15	8419	
0459		0507	0510		SF	N28E37	8421	
0522		0524	0527		SF	N28E37	8421	
0555		0556	0601	C2.2	SF	N28E37	8421	
0650		0652	0700		SF	N26E38	8421	
0703		0708	0715	C2.2				
0916		0920	0936	C2.3	SF	N28E35	8421	
1542		1542	1546		SF	S24E39	8422	
1759	U1801	A1805		SF	N15W90			



**Flare List-continued**

Date	Begin	Time			X-ray Brtns	Optical		Rgn
		Max	End	Class		Imp / Lat CMD	Location #	
27 December	1808	1810	1815			SF	S25E38	8422
	1824	1836	1846	C2.0				
	2015	2018	2033	C3.4	SF		N30E33	8421
	2117	2123	2129	C1.4				
	2153	2153	2157	C1.4	SF		N21W19	8416
	2340	2342	2346	C2.7	SF		N21W30	8423
	2355	2358	0019	C3.6	SF		N18W19	8416

**Region Summary**

Date	Location		Sunspot Characteristics					Flares						
	( ° Lat ° CMD)	Helio Lon	Area (10 <sup>6</sup> hemi)	Extent (helio)	Spot Class	Spot Count	Mag Class	X-ray			Optical			
								C	M	X	S	1	2	3

*Region 8410*

11 Dec	N23E77	332	0080	04	HSX	001	A										
12 Dec	N23E61	334	0070	01	HSX	001	A										
13 Dec	N24E48	334	0060	02	HSX	001	A										
14 Dec	N26E37	332	0070	15	CSO	004	B										
15 Dec	N25E22	333	0090	02	HSX	001	A										
16 Dec	N23E09	333	0060	04	CSO	002	B	1				1					
17 Dec	N24W04	333	0050	02	HAX	002	A										
18 Dec	N24W17	333	0050	03	CAO	006	B										
19 Dec	N24W29	332	0030	04	CSO	005	B										
20 Dec	N24W42	331	0010	00	AXX	002	A						2				
21 Dec	N24W55	331	0010	02	AXX	002	A										
22 Dec	N24W68	331															
								1	0	0	3	0	0	0	0	0	0

Died on Disk.

Absolute heliographic longitude: 333



**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

*Region 8414*

16 Dec	N21E49	293	0010	04	BXO	004	B												
17 Dec	N25E34	295	0000	00	AXX	001	A												
18 Dec	N25E21	295																	1
19 Dec	N27E13	290	0000	04	BXO	003	B												
20 Dec	N26E02	287	0000	01	AXX	001	A												
21 Dec	N26W11	287																	
22 Dec	N26W24	287																	
23 Dec	N26W37	287							1				2						
24 Dec	N26W50	287																	
25 Dec	N26W63	287																	
26 Dec	N26W76	287																	
27 Dec	N26W89	287																	
										1	0	0	2	1	0	0	0	0	

Still on Disk.

Absolute heliographic longitude: 287

*Region 8415*

17 Dec	N19E72	257	0010	06	BXO	005	B	2				7	2						
18 Dec	N19E61	255	0190	11	EAI	011	B	6	1			15		1					
19 Dec	N20E49	254	0270	13	EAI	018	B	2				3							
20 Dec	N20E36	253	0170	13	EAI	016	BG	2	1			2	1						
21 Dec	N20E23	253	0130	13	EAO	017	BG	1				2							
22 Dec	N20E11	252	0070	14	CAO	016	B	1				2							
23 Dec	N22W02	252	0040	13	CRO	011	B												
24 Dec	N23W12	249	0010	06	BXO	005	B												
25 Dec	N23W25	249																	
26 Dec	N20W40	250	0000	01	AXX	001	A												1
27 Dec	N16W49	246	0000	00	AXX	001	A												
										14	2	0	32	3	1	0	0	0	

Still on Disk.

Absolute heliographic longitude: 252







**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

*Region 8420*

23 Dec	N18E64	186	0010	01	AXX	001	A												
24 Dec	N18E52	185	0010	01	AXX	002	A												
25 Dec	N17E40	184	0000	01	AXX	001	A												
26 Dec	N20E24	186	0010	03	BXO	003	B												
27 Dec	N20E12	185	0010	04	BXO	003	B												
												0	0	0	0	0	0	0	0

Still on Disk.

Absolute heliographic longitude: 185

*Region 8421*

23 Dec	N29E80	170	0090	03	HAX	002	A												1
24 Dec	N27E64	173	0120	05	DAO	006	B	1	1			3	1						
25 Dec	N27E52	172	0170	08	DAO	010	B	4	1			5							
26 Dec	N26E40	170	0270	09	DAI	011	B	4				9	1						
27 Dec	N27E26	171	0290	11	EAI	032	BG	4				7							
												13	2	0	25	2	0	0	0

Still on Disk.

Absolute heliographic longitude: 171

*Region 8422*

24 Dec	S23E75	162	0070	10	CAO	005	B												
25 Dec	S26E68	156	0130	09	DSO	004	B												
26 Dec	S23E51	159	0160	07	DSO	008	B	1				1							
27 Dec	S23E38	159	0190	07	DAO	016	B					2							
												1	0	0	3	0	0	0	0

Still on Disk.

Absolute heliographic longitude: 159

*Region 8423*

27 Dec	N23W28	225	0010	04	BXO	006	B	1				1							
								1	0	0	1	0	0	0	0	0	0	0	0

Still on Disk.

Absolute heliographic longitude: 225



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

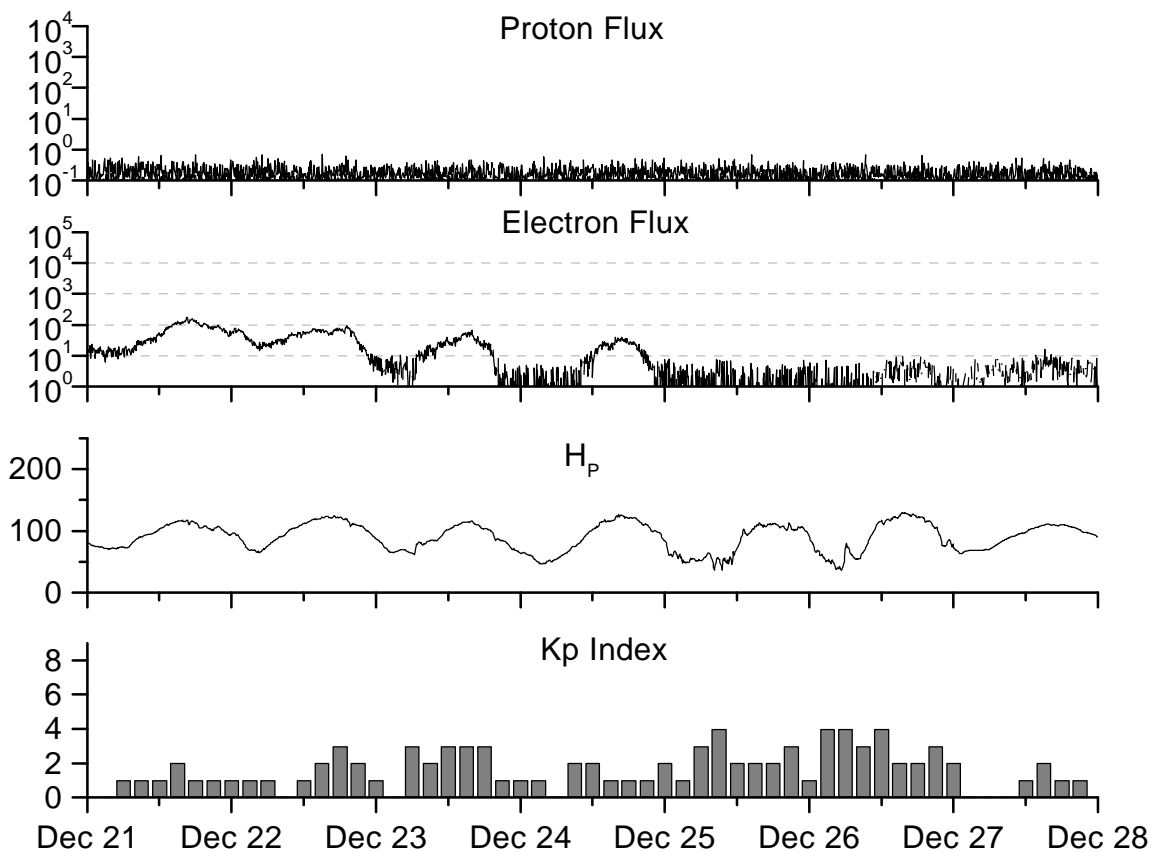
Month	Sunspot Numbers			Smooth values		Radio Flux	Smooth	Geomagnetic	
	Observed values SWO	RI	Ratio RI/SWO	SWO	RI	**Penticton 10.7 cm	Value	Planetary Ap	Smooth Value
<b>1996</b>									
December	21.1	13.3	0.63	16.2	10.4	77.8	73.3	07	09.3
<b>1997</b>									
January	09.0	05.7	0.63	16.5	10.5	74.0	73.4	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	08.9
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	18.3	74.6	78.4	08	08.6
June	22.1	12.7	0.57	29.0	20.3	71.7	80.1	07	08.6
July	17.0	10.4	0.61	32.4	22.6	71.1	81.8	06	08.5
August	36.7	24.4	0.66	35.9	25.0	79.0	83.4	07	08.3
September	52.8	51.3	0.88	40.5	28.3	96.2	85.7	10	08.4
October	33.6	22.8	0.68	45.4	31.8	84.9	88.6	11	08.6
November	53.5	39.0	0.73	49.3	35.0	99.5	91.3	11	09.0
December	57.9	41.2	0.71	54.2	39.0*	98.8	94.2*	05	09.5
<b>1998</b>									
January	51.8	31.9	0.62	60.6	43.7*	93.4	97.5*	08	09.9*
February	54.4	40.3	0.74	67.4	48.8*	93.4	101.7*	08	10.5*
March	81.8	54.8	0.67	73.3	53.4*	109.1	105.8*	13	11.2*
April	73.6	53.4	0.73	77.7	56.5*	108.3	109.1*	10	11.4*
May	74.3	56.3	0.76			106.7		18	
June	93.6	70.7*	0.76*			108.4*		10	
July	98.3	66.2*	0.67*			114.0*		11*	
August	118.6	91.7*	0.77*			136.0*		18*	
September	119.0	92.9*	0.78*			138.4*		14*	
October	77.0	55.6*	0.72*			121.9*		13*	
November	99.5	73.6*	0.74*			140.2*		16*	

\*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 21 December 1998*

*Protons* plot contains the five-minute averaged integral proton flux (protons/  $\text{cm}^2$ -sec-sr) as measured by GOES-8 (W75) for each of three energy thresholds: greater than 10, 50, and 100 MeV.

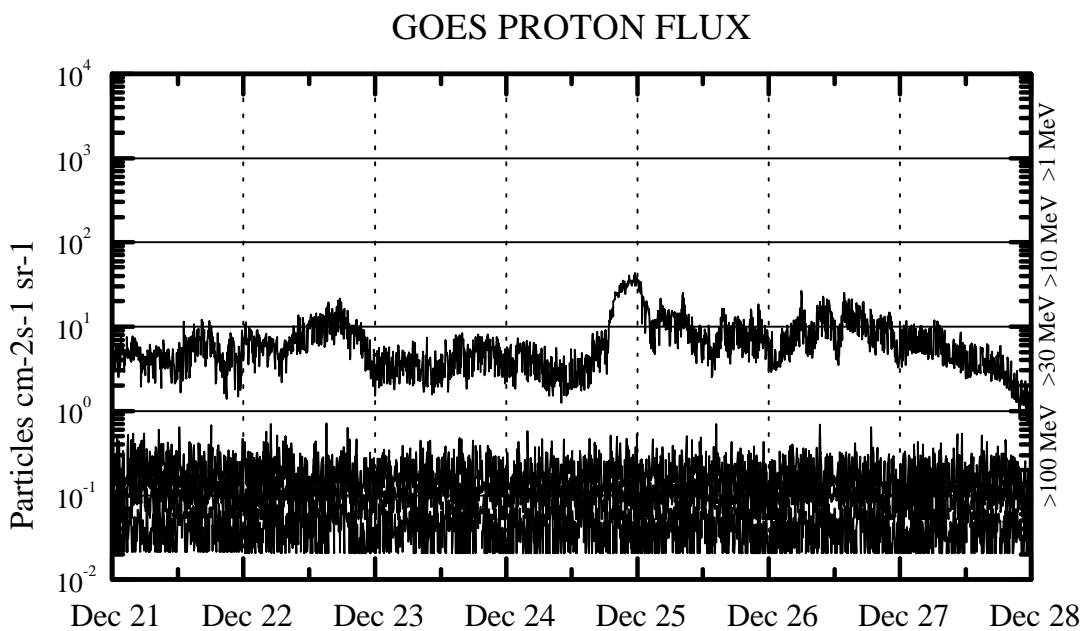
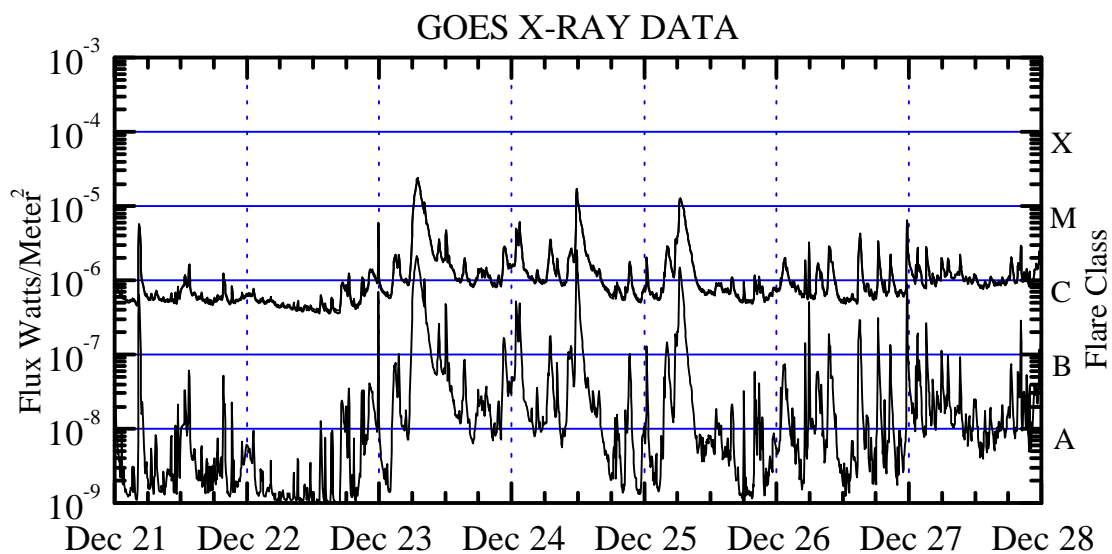
*Electrons* plot contains the five-minute averaged integral electron flux (electrons/  $\text{cm}^2$ -sec-sr) with energies greater than 2 MeV at GOES-8.

*H<sub>p</sub>* plot contains the five minute averaged magnetic field H component in nanoteslas (nT) as measured by GOES-8. 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>p</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*

X-ray plot contains five minute averaged x-ray flux (watts/m<sup>2</sup>) as measured by GOES 8 and 10 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.

Proton plot contains the five minute averaged integral proton flux (protons/cm<sup>2</sup>-sec-sr) as measured by GOES-8 (W75) for each of the energy thresholds: >1, >10, >30 and >100 MeV. P10 event threshold is 10 pfu (protons/cm<sup>2</sup>-sec-sr) at greater than 10 MeV.

