Australian Government
Bureau of Meteorology

AUSTRALIAN SPACE WEATHER FORECASTING CENTRE

SOLAR

AND

GEOPHYSICAL

SUMMARY

March 2025

Solar Activity

Solar flare activity was less frequent this month, with a total of 22 solar flares observed during the month of March. Solar flare activity was relatively isolated, with flare activity increasing during 28-30 Mar. Most of these flares were the lowest R1-Minor class with the largest flare for the month a single isolated R3 X1.1 observed at 28/1522UT. This event was associated with a very large eastward (mostly non-Earth directed) CME and an associated solar proton event, with S1-Minor solar radiation storm conditions observed from 31/1450UT, increasing to S2-Moderate early in the UT day on 01-Apr. The R3 flare was produced by solar region AR4046 at the time of the flare event located near the northeast solar limb of the Sun. This region which predominately consisted of a large single spot then produced only isolated R1-Minor flare activity during the month. However, it did produce an M5.6 R2 flare on 01-Apr. Around the middle of the month the daily sunspot number was reasonably high in the 170-200 range, due to the presence of many smaller sized regions on the solar disk, though they produced little flare activity. Toward the end of the month solar regions AR4043, AR4045 and AR4048 also contributed to this month's flare activity. Region AR4048 was responsible for a large proportion of this month's flare activity and continued to grow in complexity at the end of the month. It is currently the largest on disk solar region.

There were no significant CME arrivals during the month of March. The solar wind speed was frequently elevated due to coronal hole high speed wind streams during the month. Elevated solar wind speeds were observed over 01-Mar,09-Mar,12-15 Mar, 19-Mar, 21-22 Mar, and 26-28 Mar. A very minor CME shock was observed at 21/0142UT with only a brief minor increase to the solar wind speed and no significant following interplanetary magnetic field (IMF) enhancement. Three periods of enhanced interplanetary magnetic field (IMF) conditions were observed during the month. The Earth entered a coronal hole wind stream on 08-Mar and over 08-09 Mar the IMF was mildly enhanced with a peak total IMF Bt strength of 16nT and the minimum north-south IMF Bz component falling to -13nT. On 21-Mar the IMF became very enhanced late in the UT day possibly due to both coronal hole wind stream entry and an indistinct CME signature. The solar wind speed peaked at 500km/sec over 21-22-Mar. The peak total IMF Bt strength was 40 nT and the north-south IMF component range (Bz) was 33 to -20 nT. This disturbance was the largest increase/disturbance to the IMF for the month. On 26-Mar the Earth entered a wind stream from a large coronal hole located in the southern solar hemisphere with the solar wind peaking at 800km/sec on 27-Mar, with the peak total interplanetary field strength (IMF, Bt) reaching 24 nT and the north-south IMF component range (Bz) was +19 to -21 nT, and the IMF Bz component frequently oriented southwards during the interval 26/1024-1330UT. Over 27-Mar the IMF Bt slowly declined, and whilst the solar wind speed remained strong (over 600km/sec) by 28-Mar, the IMF was quite small in magnitude and had decreased to around 5nt by the end of the UT day. A very minor solar wind discontinuity and weak enhancement was observed from 31/1017UT, possibly a very weak signature from the 28-Mar eastward X1/CME. Solar wind conditions then slowly declined. Daily electron fluence at geosynchronous orbit altitudes as measured by the GOES satellites reached the moderate fluence level during the intervals 15-17 Mar and 29-31 Mar and was normal on other days of the month.

M and X class flares for the month are listed below.

DATE	FLARES CLASS M	FLARES CLASS X	FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
05 Mar 25	M1.7/SF		1150UT	
07 Mar 25	M1.6/SN		2100UT	
11 Mar 25	M1.1		1304UT	
14 Mar 25	M1.1		2221UT	
17 Mar 25	M1.0		1933UT	
19 Mar 25	M1.5/1N		2040UT	
21 Mar 25	M1.2/1N		1558UT	
26 Mar 25	M1.0		0809UT	
27 Mar 25	M2.0		0037UT	
28 Mar 25		X1.1	1521UT	1503-1542UT
28 Mar 25	M1.0/SF		1801UT	
28 Mar 25	M1.1		1926UT	
28 Mar 25	M1.7		2339UT	
29 Mar 25	M1.4		2138UT	
29 Mar 25	M1.9		2300UT	
30 Mar 25	M1.5		0148UT	
30 Mar 25	M1.6		1642UT	
30 Mar 25	M1.4		1707UT	
30 Mar 25	M1.4		2250UT	
30 Mar 25	M1.5		2319UT	
30 Mar 25	M1.0		2348UT	
31 Mar 25	M1.2		1024UT	

FLARE ALERT	SWF ALERT
01 Mar 25	
05 Mar 25	
07 Mar 25	
11 Mar 25	
14 Mar 25	
17 Mar 25	
19 Mar 25	
21 Mar 25	
25 Mar 25	
26 Mar 25	
27 Mar 25	(0027-0053 UT)
28 Mar 25	
29 Mar 25	
30 Mar 25	
31 Mar 25	

PROTON ALERT

BEGIN DATE	BEGIN TIME	END DATE	END TIME	ENERGY THRESHOLD
31 Mar 25	1425UT	in progress		S1
01 Apr 25	0200UT	01 Apr 2025	0850UT	S2

Ionospheric Activity

Frequent periods of mild(15%) to moderate(30%) depressions in ionospheric maximum usable frequencies (MUFs) were observed for the southern Australian region during the month, generally in association with coronal hole induced geomagnetic activity. The strongest ionospheric frequency depressions for the southern Australian region were observed on 09-Mar and 12-13 Mar.

A minor shortwave fadeout impacting only the lower HF frequencies was observed during the interval 27/0027-0053UT. Regional equatorial scintillation was observed at at times during the midnight to dawn period on 07-08 Mar, 10-12 Mar, 20-21 Mar and
30-31 Mar.

Ionospheric depressions listed below are calculated using foF2 data from the SWS ionosonde network.

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

01 Mar 25	Northern region MUFs depressed -17%
	Southern region MUFs depressed -15%
02 Mar 25	Southern region MUFs depressed -21%
09 Mar 25	Southern region MUFs depressed -32%
11 Mar 25	Southern region MUFs depressed -15%
12 Mar 25	Southern region MUFs depressed -28%
13 Mar 25	Southern region MUFs depressed -35%
20 Mar 25	Southern region MUFs depressed -17%
26 Mar 25	Southern region MUFs depressed -20%

RADIO COMMUNICATIONS WARNINGS			
DATE	Nº.	BEGIN	END
09 Mar 25	28	09 Mar 25	10 Mar 25
12 Mar 25	29	12 Mar 25	14 Mar 25
23 Mar 25	30	23 Mar 25	24 Mar 25
26 Mar 25	31	27 Mar 25	27 Mar 25
29 Mar 25	32	29 Mar 25	31 Mar 25
31 Mar 25	33	01 Apr 25	03 Apr 25

Geomagnetic Activity

The strongest disturbance for the month was observed on 26-Mar with planetary conditions reaching G2. Planetary G2 geomagnetic storm conditions were observed on 9-Mar, 14-Mar, 22-Mar and 26-Mar. Planetary G1 conditions were observed on 8-Mar, 12-13 Mar, 19-Mar, 21-Mar and 27-Mar. Australian regional G1 geomagnetic storm conditions were observed 09-Mar, 13-Mar, 21-Mar, 25-Mar and 26-Mar. Most of the geomagnetic storm days were due to coronal hole wind streams. The G1-G2 geomagnetic storm conditions over 21-22 Mar were due to both coronal hole wind stream and an indistinct CME arrival.

The planetary Ap index reached 46 on 26-Mar, 42 on 13-Mar, 35 on 9-Mar, 33 on 22-Mar and 27-Mar and 25 on 14-Mar and 21-Mar and 21 on 8-Mar. The Australian Aaus index reached 24 on 26-Mar and 20 on 09-Mar and 13-Mar. Auroral sightings were reported on 26-Mar.

Disturbances with Australian A indices greater than or equal to 16 are reported below.

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)	
	Regional	Planetary
08 Mar 25:	G0	G1
09 Mar 25:	G1	G2
12 Mar 25:	G0	G1
13 Mar 25:	G1	G1
14 Mar 25:	G0	G2
19 Mar 25:	G0	G1
21 Mar 25:	G1	G1
22 Mar 25:	G0	G2
26 Mar 25:	G1	G2
27 Mar 25:	G0	G1

GEOMAGNETIC WARNINGS AND ALERTS

DATE	Nº.	BEGIN	END	ISSUED
07 Mar 25	13	09 Mar 25	10 Mar 25	Warning
08 Mar 25	14	08 Mar 25	10 Mar 25	Warning
09 Mar 25	15	09 Mar 25	11 Mar 25	Warning
09 Mar 25				Alert
12 Mar 25	16	12 Mar 25	14 Mar 25	Warning
13 Mar 25				Alert
14 Mar 25	17	14 Mar 25	15 Mar 25	Warning
19 Mar 25	18	19 Mar 25	20 Mar 25	Warning
21 Mar 25				Alert
22 Mar 25	19	22 Mar 25	22 Mar 25	Warning
22 Mar 25	20	23 Mar 25	23 Mar 25	Warning
23 Mar 25	21	25 Mar 25	27 Mar 25	Warning
25 Mar 25				Alert
26 Mar 25	22	27 Mar 25	28 Mar 25	Warning
26 Mar 25				Alert
30 Mar 25	23	30 Mar 25	31 Mar 25	Warning

Solar And Geophysical Indices

DATE	10cm FLUX	AUSTRALIAN A-INDEX	AUSTRALIAN T-INDEX	DATE	10 cm FLUX	AUSTRALIAN A-INDEX	AUSTRALIAN T-INDEX
01 Mar	145	11	103	16 Mar	186	7	141
02 Mar	140	4	103	17 Mar	204	9	126
03 Mar	145	3	122	18 Mar	184	7	141
04 Mar	160	6	129	19 Mar	180	13	145
05 Mar	157	6	137	20 Mar	170	3	135
06 Mar	150	5	138	21 Mar	165	16	151
07 Mar	147	8	145	22 Mar	178	16	152
08 Mar	148	16	141	23 Mar	168	5	133
09 Mar	148	19	64	24 Mar	156	12	148
10 Mar	149	6	104	25 Mar	156	15	130
11 Mar	161	5	104	26 Mar	152	23	113
12 Mar	160	19	99	27 Mar	153	18	120
13 Mar	175	19	88	28 Mar	160	9	131
14 Mar	180	13	109	29 Mar	157	4	143
15 Mar	178	10	142	30 Mar	171	4	136
				31 Mar	172	4	150

DATE	10cm FLUX	AUSTRALIAN A-INDEX	AUSTRALIAN T-INDEX	SUNSPOT NUMBER		FLARES
	Monthly Average	Monthly Average	Monthly Average	Monthly Average	13-month smoothed	>M1.0
Apr 24	161.5	5.9	124.5	136.5	142.9	48
May 24	187.8	12.1	121.3	171.7	148.2	143
Jun 24	184.2	5.2	120.6	164.2	152	56
Jul 24	197.4	4.2	131	196.5	154.9	97
Aug 24	247.4	8.6	158.5	215.5	156.7	125
Sep 24	196.2	9	147.5	141.4	159.3	68
Oct 24	222.2	11.5	139.3	166.4	159.8	79
Nov 24	201.4	7.4	127.5	152.5	156.7	82
Dec 24	197.7	7.7	132.1	154.5	152.2	91
Jan 25	189.4	10.8	125.4	137	146.2	44
Feb 25	184.3	10	126.3	154.6	137.8	50
Mar 25	163.1	10.2	126.5	134.2	131.4	22
					Predicted sunspot numbers	

SPECIAL NOTE
In June 2015, WDC-SILSO, Royal Observatory of Belgium, Brussels, adjusted their original observed sunspot numbers (Version 1.0) to a Version 2.0 series in which the sunspot numbers are higher. In the Version 1.0 data series, some of the sunspot numbers were weighted. The new (Version 2.0) sunspot numbers are unweighted sunspot number counts (for more information see:). The Bureau of Meteorology SWS solar cycle prediction is now based on the Version 2.0 values. As a result of this recalibration, the observed monthly and observed and predicted smoothed sunspot numbers are higher in the monthly table and solar cycle graph.

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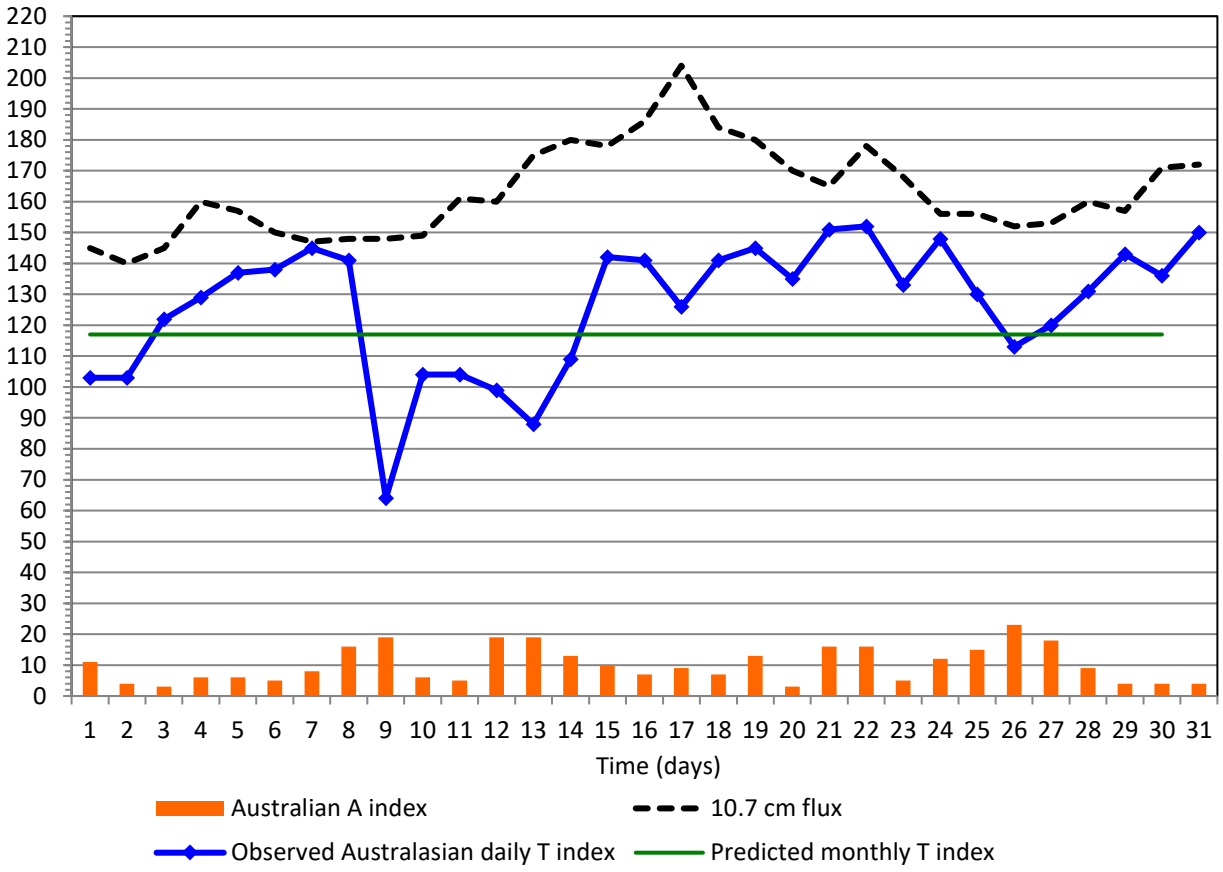
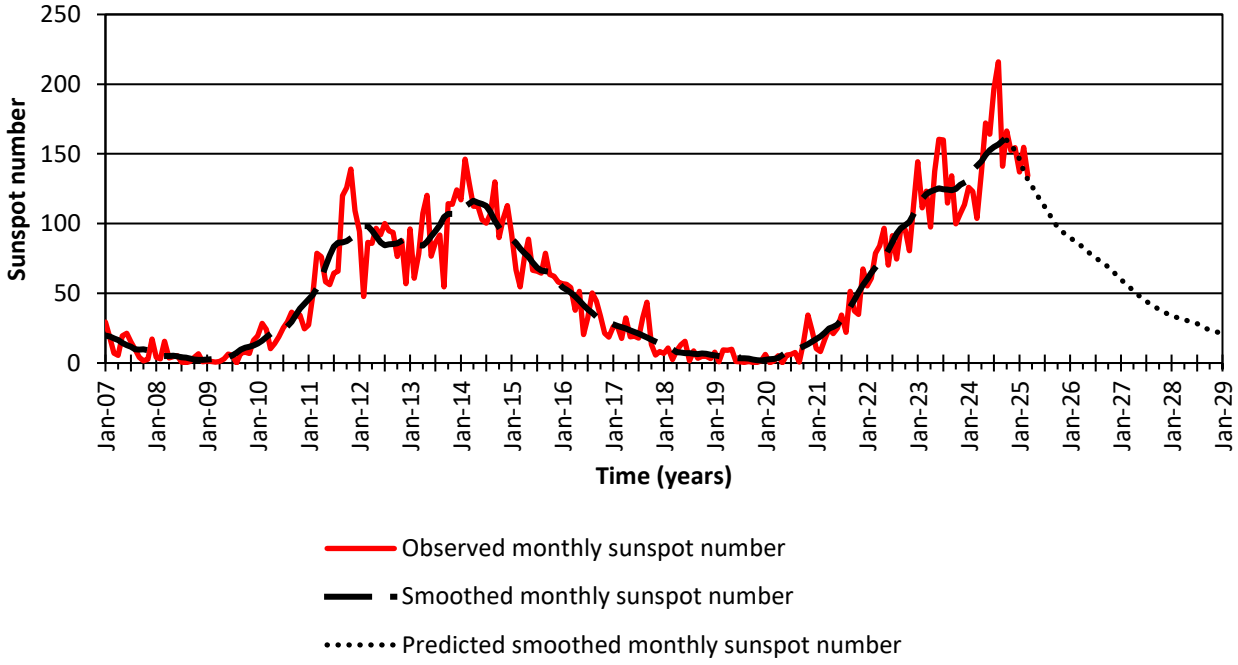
SWS WORLD T-INDICES

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	-2	-5	2	-1	-7	-7	-9	-2	-6	-6	7	12
2021	12	4	9	6	6	12	21	12	23	23	17	28
2022	41	52	63	71	81	65	67	56	72	75	65	71
2023	107	114	119	105	101	110	118	118	107	113	97	95
2024	122	123	117	113	114	126	141	143	137	133	122	117
2025	124	124	118*	115	113	112	110	108	106	104	103	101
2026	100	99	97	96	95	94	93	92	90	88	85	82
2027	79	75	72	68	64	61	58	55	52	49	47	45
2028	43	42	40	40	38	37	35	33	32	30	29	28
	SWS predicted T-index			* New observed data. T-index value may have changed								

Solar and Geophysical Indices - March 2025



Solar Cycle



Observed monthly sunspot numbers courtesy of WDC-SILSO, Royal Observatory of Belgium, Brussels (www.sidc.be/silso/home)

NOTES - notes - NOTES - notes - NOTES - notes

a. Times quoted in this publication are all Universal Time (UT).

b. The values of all indices are provisional. Final values are not available for several months.

c. M or X class flares refer to the X-ray classification system for solar flares. In this system, X class flares are more energetic than M class flares.

FLARE CLASS	X-RAY FLUX DENSITY	
	Ergs/cm^2/sec	W/m^2
M	0.01-0.1	10^{-5} to 10^{-4}
X	>0.1	> 10^{-4}

d. Class M flares, particularly the less energetic ones, are likely to cause a fadeout on only the lowest frequencies. Class X flares are likely to cause a fadeout over the entire HF spectrum. It should be noted that a fadeout will only occur on those circuits having a reflection point in the daylight hemisphere of the earth. Circuits having only night hemisphere reflection points will not be affected no matter the energy of the solar flares.

e. The 10cm flux is the radio power of the sun at a frequency of 2800 MHz (wavelength 10.7 cm). This flux is a good indicator of solar activity and is widely used in place of the sunspot number. The values are measured by the Penticton radio observatory, Canada. Unlike the sunspot number, the 10cm flux never drops to zero even during solar minimum. With no sunspots visible on the solar disk, the 10cm flux will still have a value of around 67. The table below gives a (statistical) comparison between 10cm flux and sunspot number. The 10cm flux is measured in solar flux units (10^{-22} W m^{-2} Hz^{-1}).

SUNSPOT No.	10 cm FLUX
0	67
20	78
40	93
60	110
100	147
150	195
200	243

f. Ionospheric disturbances refer to measurements made across Australia, but are generally applicable to mid-latitude Southern Hemisphere conditions. Spread F conditions indicate tilts in the ionosphere, which may result in multipath fading on some HF circuits.

g. The magnetic A-indices are for the Australian region. Large values for the A index correspond to disturbed conditions. Levels of magnetic disturbances are described in the following terms.

A INDEX VALUE	DESCRIPTION
0 up to 7	Quiet
8 up to 15	Unsettled
16 up to 24	Active
25 up to 35	Minor Storm
36 and above	Major Storm

h. The Australian daily T-index is a measure of the average of the ionospheric critical frequencies available on a particular day - the higher the value of the T-index, the higher the ionospheric critical frequencies (and Maximum Usable Frequencies on HF circuits) for that day. The T-index is based on data from Australian ionospheric stations and so is most applicable to HF circuits with reflection points in the Australian region.

i. The SWS monthly observed T-index is derived from the observed monthly median values of foF2 for each hour from ionospheric stations worldwide.

The predicted smoothed monthly T-indices are computed by using a statistical analysis of the observed monthly T-indices for all solar cycles since 1938.

The SWS T-indices may not be updated each month but only when sufficient new data becomes available.

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