Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

April 2024

Solar Activity

Solar activity was generally R0 for the first half of the month, then mostly R1 for the second half of the month with some isolated R2 level solar flares. In total there were 46 R1 level solar flares and 2 R2 level solar flares. No X class flares were observed during April. The largest flare of the month was M9.4 which was observed on 30-Apr.

A notable group of sunspots developed on 17-Apr near S10 and grew rapidly in complexity. This complex group of sunspots crossed the disk at approximately S10 and left the disk on 27-Apr, but despite their complexity they only produced low level M class flares.

Many CMEs were observed during April, with several being Earth directed. Most of the Earth directed CMEs were faint and weak, although G1-G3 level geomagnetic conditions did arise. CME impacts were observed on 16, 19, 26 and 30 April.

Several small coronal holes were observed in April, and contributed to enhanced solar wind speed on 2-3, 10-12, 19-23, 26-28 April

No solar energetic particle events were observed in April.

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DATE	FLARES CLASS M	CLASS X	FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
1-Apr-24	M3.9/SF		0132UT	0113-0157UT
11-Apr-24	M5.4		1706UT	1652-1711UT
13-Apr-24	M2.4/SF		0502UT	
14-Apr-24	M4.3/1F		0232UT	0224-0236UT
15-Apr-24	M1.7/SF		0118UT	
15-Apr-24	M1.0/1F		0732UT	
15-Apr-24	M2.3/1B		0842UT	
15-Apr-24	M1.2/SF		0932UT	
15-Apr-24	M1.1/1F		1358UT	
15-Apr-24	M1.4/SN		1404UT	
15-Apr-24	M2.2		1417UT	
15-Apr-24	M4.0/1N		1932UT	1925-1939UT
16-Apr-24	M1.1/SN		1802UT	
17-Apr-24	M1.6/2N		2208UT	
18-Apr-24	M2.2/SF		0248UT	
18-Apr-24	M2.4		0737UT	
18-Apr-24	M1.3/SF		2016UT	
19-Apr-24	M2.1/SF		0453UT	
19-Apr-24	M1.0		1306UT	
21-Apr-24	M1.0/1F		1259UT	
21-Apr-24	M2.2/SF		1514UT	
21-Apr-24	M3.4/SF		2152UT	2144-2157UT
22-Apr-24	M1.0/SF		0813UT	
22-Apr-24	M1.6/1N		1335UT	
22-Apr-24	M1.1		1455UT	
22-Mar-24	M2.8		1550UT	
22-Apr-24	M1.1		1630UT	
22-Apr-24	M1.5/1N		2116UT	
23-Apr-24	M3.6		0319UT	0306-0335UT
23-Apr-24	M3.0/1B		0821UT	0807-0829UT
23-Apr-24	M1.0		1651UT	
23-Apr-24	M2.9/SF		1744UT	
24-Apr-24	M1.7/SF		0029UT	
24-Apr-24	M1.8		0239UT	
24-Apr-24	M1.4		1214UT	
24-Apr-24	M1.1		2259UT	
24-Apr-24	M2.0		2250UT	
25-Apr-24	M1.0		0149UT	
25-Apr-24	M1.0		1321UT	
25-Apr-24	M1.3		1712UT	
27-Apr-24	M1.9		1235UT	
27-Apr-24	M2.1/SN		2140UT	2129-2149UT
29-Apr-24	M2.5/1N		0048UT	
29-Apr-24	M3.7		0111UT	0054-0120UT
30-Apr-24	M1.6		0114UT	
30-Apr-24	M1.2		0511UT	
30-Apr-24	M1.3		1633UT	
30-Apr-24	M9.4		2348UT	2340-0019UT

FLARE ALERT	SWF ALERT
01 Apr 24	(0124-0210 UT)
11 Apr 24	
13 Apr 24	(0500-0504 UT)
14 Apr 24	(0230-0239 UT)
15 Apr 24	
16 Apr 24	
17 Apr 24	
18 Apr 24	(0243-0254 UT)
19 Apr 24	(0448-0505 UT)
21 Apr 24	
22 Apr 24	
23 Apr 24	(0313-0349 UT)
24 Apr 24	
25 Apr 24	
27 Apr 24	
29 Apr 24	(0043-0137 UT)
30 Apr 24	

PROTON ALERT
No proton alerts during April.

Ionospheric Activity

The deepest ionospheric depression for the month was observed on 20-Apr following a planetary G3 geomagnetic storm. While the Australian region remained at G0 geomagnetic conditions during this event, the southern regions of Australia became briefly depressed to 30%. Maximum usable frequencies (MUFs) mostly recovered by the following day. Some southern Australian sites saw some mild MUF depressions towards the end of the month during local night time hours.

Brief MUF enhancements were also observed between 18-28 April in the Australian region. Otherwise, MUFs were mostly near predicted monthly values for most days in April

Shortwave fadeouts were observed in the Australian region on 1, 13, 14, 18, 19, 23, 29 and 30 April. In general these fadeouts were mostly minor, although a major fadeout was observed on 30-Apr in association with an M9 level solar flare.

Ionospheric conditions were not affected by polar/ auroral absorption on any day of April.

Equatorial scintillation was common towards the end of April after local midnight hours. This affected ionospheric conditions at low latitudes and was occasionally associated with spread F at these times.

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

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

20-Apr-24	Southern region MUFs Depressed by 30%

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END
11 Apr 24	35	12 Apr 24	14 Apr 24
14 Apr 24	36	15 Apr 24	17 Apr 24
18 Apr 24	37	18 Apr 24	20 Apr 24
19 Apr 24	38	19 Apr 24	21 Apr 24
19 Apr 24	39	20 Apr 24	22 Apr 24
21 Apr 24	40	22 Apr 24	24 Apr 24
25 Apr 24	41	25 Apr 24	26 Apr 24
27 Apr 24	42	28 Apr 24	30 Apr 24
30 Apr 24	43	01 May 24	02 May 24

Geomagnetic Activity

The strongest magnetic disturbance for the month was observed on 19-Apr with when a period of planetary G3 was observed. This activity was associated with a weak CME combined with a coronal hole wind stream. In the 12-14 hours leading up to the G3, the solar wind parameter Bz was predominantly oriented southward. During this event, the Australian region remained at G0 geomagnetic conditions. Despite this, vivid aurorae were reported as far north as south Australia during this event. During this event the Australian A index reached 16 and the planetary A index reached 46.

Other disturbances were also observed on 16 and 26-Apr, although these were only associated with planetary G1 activity and Australian region
G0 activity. The source for these disturbances were weak CMEs combined with coronal hole high speed wind streams.

Several small coronal holes were observed in April. Many coronal holes were patchy, with several being long and thin. The result of this was that coronal hole enhancements were generally not significant or long-lasting.

A weak shock to the solar wind was observed on 30-Apr, although its source is unknown. Potential candidates could be a co-rotating interaction region from a coronal hole, else a weak CME from 26-Apr. No significant geomagnetic activity arose from this, despite several periods of prolonged southward Bz.

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

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
19-Apr-24	G0 (G3 planetary)

GEOMAGNETIC WARNINGS AND ALERTS				
DATE	Nº.	BEGIN	END	ISSUED
14 Apr 24	13	14 Apr 24	15 Apr 24	Warning
19 Apr 24	14	19 Apr 24	20 Apr 24	Warning
19 Apr 24	15	19 Apr 24	20 Apr 24	Warning
21 Apr 24	16	21 Apr 24	24 Apr 24	Warning
26 Apr 24	17	26 Apr 24	27 Apr 24	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 Apr	125	7	118	16 Apr	199	15	143
02 Apr	113	5	119	17 Apr	217	4	127
03 Apr	112	3	108	18 Apr	227	2	133
04 Apr	114	9	104	19 Apr	213	19	132
05 Apr	121	10	115	20 Apr	210	7	130
06 Apr	123	7	115	21 Apr	217	15	138
07 Apr	125	5	114	22 Apr	227	5	138
08 Apr	125	3	111	23 Apr	214	5	142
09 Apr	124	5	111	24 Apr	199	1	147
10 Apr	131	5	117	25 Apr	167	1	144
11 Apr	144	2	117	26 Apr	153	10	152
12 Apr	152	3	125	27 Apr	153	6	134
13 Apr	161	2	116	28 Apr	140	2	127
14 Apr	178	3	118	29 Apr	138	3	119
15 Apr	192	5	119	30 Apr	130	9	103

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
May 23	156	6.5	97.7	137.9	124.9	60
Jun 23	161.7	5.5	97.5	163.4	125.6	21
Jul 23	177.1	4.9	103.5	159.1	124.4	52
Aug 23	153.7	4.6	114.5	114.9	124	27
Sep 23	154.5	9.8	104.3	133.6	123.8	33
Oct 23	142.6	6.1	130.3	99.4	124.8	7
Nov 23	153.9	8.7	113.9	105.4	125.7	17
Dec 23	151.3	8.4	110.9	114.2	123.3	25
Jan 24	163.9	5.1	142.8	123	119.8	31
Feb 24	173.3	4.5	137.4	124.6	118.2	51
Mar 24	155.2	7.7	120.1	104.9	117.4	51
Apr 24	161.5	5.9	124.5	136.5	117.2	48

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: www.sidc.be/silso/home). 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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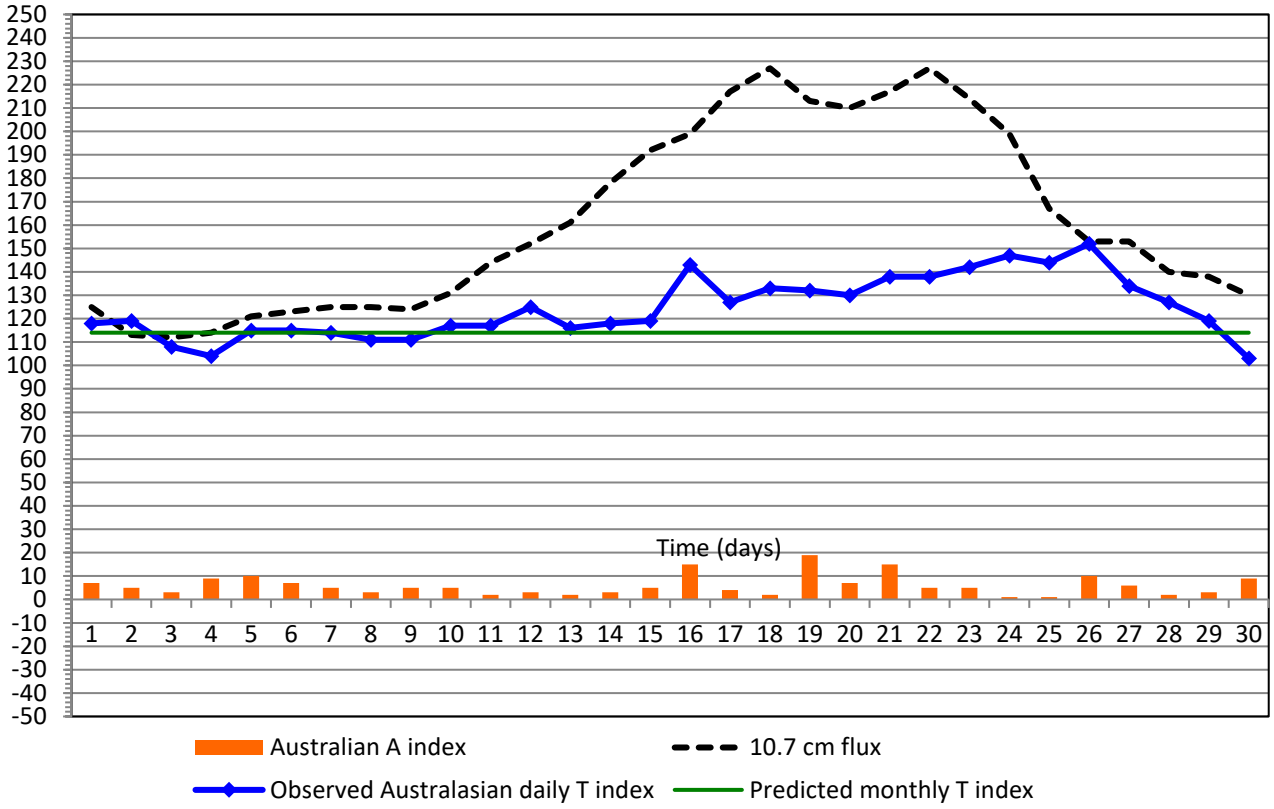
SWS WORLD T-INDICES

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	-5	-3	-4	-4	-9	-14	-11	-14	-11	-14	-16	-12
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	116	117	116	116	115	118	117
2025	116	114	113	111	110	108	105	103	100	99	98	97

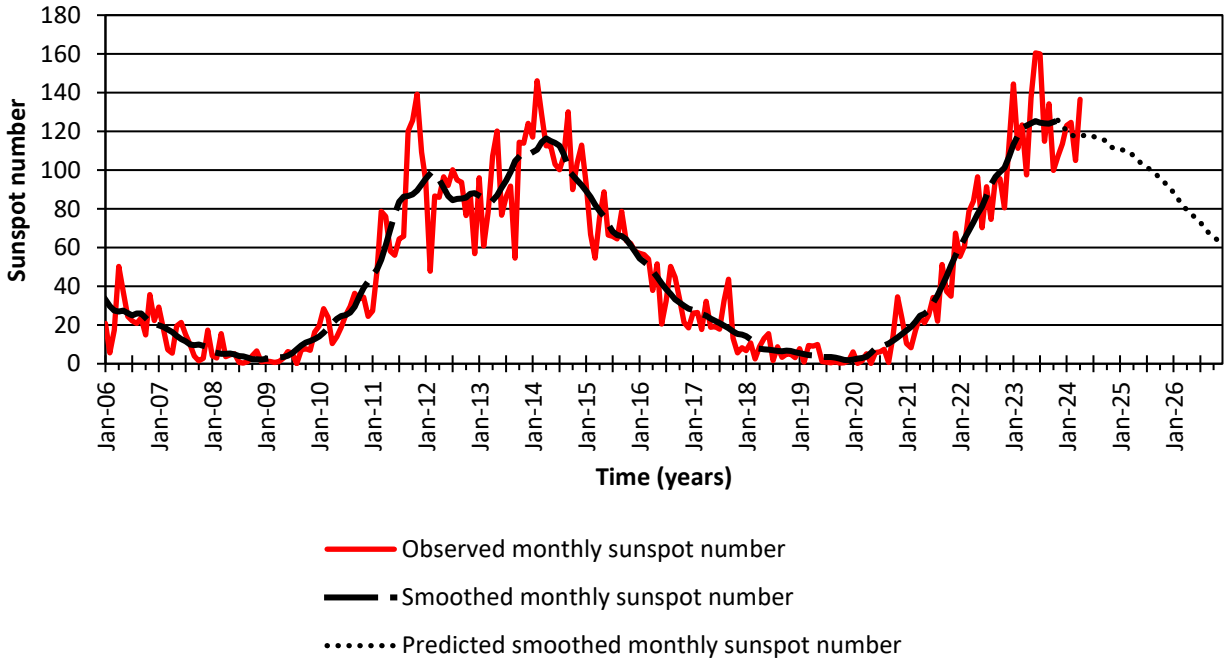
SWS predicted T-index

* New observed data. T-index value may have changed

Solar and Geophysical Indices - April 2024



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.

SPACE WEATHER SERVICES
PO BOX 1386, HAYMARKET NSW 1240
AUSTRALIA

GENERAL ENQUIRIES: +61 2 9213 8000

DUTY FORECASTER: +61 2 9213 8010

FACSIMILE: +61 2 9213 8060

E-mail**:** asfc@bom.gov.au

Web**:** www.sws.bom.gov.au

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