Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

July 2023

Solar Activity

Solar activity was predominately at the R1 or higher level for 25 of the 31 days this month, with R3 level flaring observed on 2-Jul, R2 level flaring observed on 11-12 and 17-18 Jul and R1 level flaring observed on 1-7, 10-19, 22, and 25-31 Jul. Overall 51 M-class flares (R1-R2) and 1 X-class flare (R3) were observed over the month of July. Some of these flares caused HF radio fadeouts in the Australian region. The largest flare for the month was an X1.0 flare at 2/2314UT produced by AR3354.

The most active sunspot regions for the month of July were AR3363, AR3372 and AR3376. These regions produced 7, 11 and 7 of the M-class flares of the month respectively. AR3363 arrived on the solar disk on 7-Jul and rotated off on 19-Jul. AR3372 arrived on 12-Jul and rotated off on 25-Jul. AR3376 appeared on the disk on 18-Jul and rotated off on 28-Jul. These regions are due to return on 2-Aug, 7-Aug and 9-Aug respectively.

Three elevated proton flux events were observed over the month of July.
An S1 event beginning at 16/0750UT and ending at 16/1010UT was observed and was likely due to a far side CME event. An S2 event was observed, beginning at the S1 level at 18/0220UT crossing the S2 threshold at 18/0259UT crossing back to S1 level at 18/1540UT and ending at 20/0450UT. This event was due to a long duration M5.7 flare on 18/0006UT. An S2 event was observed, beginning at the S1 level at 29/0145UT, crossing the S2 threshold at 29/0630UT, crossing back to the S1 level at 29/1259UT and ending at 30/1725UT.
This event was likely due to an M4.1 flare at 28/1558UT.

The solar wind speed was variable throughout the month. Increases from background levels were observed over 06-07 Jul; 15-18 Jul; 25-27 Jul and 30-31 Jul.
Most of these increases were due to CME impacts, with only minor coronal hole influences.
The peak interplanetary magnetic field strength was 15 nT, observed on 14-Jul due to a CME impact.

Significant flare activity was observed on the days listed below.
M and X class flares for the month are listed below.

Please see our homepage https://www.sws.bom.gov.au for a link to an explanation of the Australian Space Weather Alert System (ASWAS) scales.

DATE	FLARES CLASS M	CLASS X	FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
01 July 23	M1.1/SN		2223UT	
02 July 23	M2.0		0235UT	
02 July 23		X1.0	2314UT	2254-2358UT
03 July 23	M1.3		0653UT	
04 July 23	M1.4/SF		1235UT	
05 July 23	M1.0/SF		1858UT	
06 July 23	M1.0/SF		1049UT	
07 July 23	M4.0/2B		0629UT	0617-0638UT
10 July 23	M2.3/2N		0355UT	
10 July 23	M1.4/1N		2218UT	
11 July 23	M2.0		1435UT	
11 July 23	M1.1		1612UT	
11 July 23	M6.8/SF		1808UT	1751-1816UT
11 July 23	M1.0/SF		1929UT	
11 July 23	M5.8		2215UT	2204-2224UT
11 July 23	M1.2		2337UT	
12 July 23	M1.4/SF		0031UT	
12 July 23	M1.3		0445UT	
12 July 23	M1.3		0514UT	
12 July 23	M6.9/1N		0855UT	0849-0900UT
13 July 23	M2.1/1N		1920UT	
14 July 23	M1.0/SF		0936UT	
15 July 23	M2.9/2B		0741UT	
15 July 23	M1.0/SF		0953UT	
15 July 23	M2.2/1N		1010UT	
16 July 23	M1.0		0826UT	
16 July 23	M1.7/1B		1508UT	
16 July 23	M4.0/2B		1746UT	1736-1859UT
17 July 23	M2.7		2254UT	
17 July 23	M5.7		0006UT	2337-0023UT
18 July 23	M1.5		0656UT	
18 July 23	M1.3		1948UT	
18 July 23	M1.4		2005UT	
18 July 23	M2.1		2027UT	
18 July 23	M5.7		0006UT	2337-0023UT
19 July 23	M1.4/SF		1057UT	
19 July 23	M3.8		1725UT	1704-1743UT
19 July 23	M2.1/SF		2027UT	
22 July 23	M3.1/2N		0337UT	0312-0355UT
22 July 23	M1.0/1F		0416UT	
25 July 23	M1.52N		0203UT	
25 July 23	M1.6/SF		2116UT	
26 July 23	M1.2		0428UT	
26 July 23	M4.6		1037UT	1017-1048UT

26 July 23	M2.6/1N	1559UT	
27 July 23	M1.9/SF	0951UT	
27 July 23	M1.7/SF	2234UT	
28 July 23	M4.1	1558UT	1539-1613UT
29 July 23	M1.4/1N	1624UT	
30 July 23	M1.8/1F	0814UT	
30 July 23	M1.8	0822UT	
31 July 23	M1.6/2F	0900UT	

Total Number of M-flares 51, X-flares 1
Total Number of flares for Jul was 52
The largest flare for the month was an X1.0 on Jul 02

FLARE ALERT	SWF ALERT
01 July 23	
02 July 23	
03 July 23	
04 July 23	
05 July 23	
06 July 23	
07 July 23	
10 July 23	
11 July 23	
12 July 23	
13 July 23	
14 July 23	
15 July 23	
16 July 23	
17 July 23	
18 July 23	
19 July 23	
20 July 23	
22 July 23	
23 July 23	
24 July 23	
25 July 23	
26 July 23	
27 July 23	
28 July 23	
29 July 23	
30 July 23	
31 July 23	

PROTON ALERT

BEGIN		END		ENERGY THRESHOLD
DATE	TIME	DATE	TIME	
16 07 2023	0625UT	16 07 2023	0855UT	10MeV (S1)
18 07 2023	0145UT	18 07 2023	1425UT	10MeV (S2)
18 07 2023	0105UT	20 07 2023	0335UT	10MeV (S1)
29 07 2023	0035UT	30 07 2023	1615UT	10MeV (S1)
29 07 2023	0520UT	29 07 2023	1150UT	10MeV (S2)

Ionospheric Activity

Mild ionospheric depressions up to 15% were observed on 05, 09, 10 and 18, but no significant depressions were observed. Depressions on 05-Jul are not attributed to any significant space weather. Depressions over 09-10 may be due to a mild geomagnetic disturbance from a coronal hole on 07-Jul, although geomagnetic indices remained at G0 on this occasion. Depressions on 18-Jul were due to geomagnetic activity from a CME impact. In general, ionospheric frequencies of support were normal for the first half of the month and enhanced over the second half of the month. Transpolar HF circuits may have experienced increased absorption on 16, 17, 18, 20, 29 and 30 July.

Absorption may have been strongest on 18 and 29 July, when S2 conditions were observed.
The regional monthly T-index for July was 103. Mild depressions to maximum usable frequencies (MUFs) were observed during local night hours. Spread-F was observed at high and mid-latitudes during local night and dawn hours. ionospheric scintillation was observed at Niue island on 04, 17,21, 30 and 31 July. 12 shortwave fadeouts occurred to the Australian region over the month of July. Most of these fadeouts were short in duration and affected lower frequencies only.

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

05 Jul 23: Northern region MUFs Depressed by 15%
09 Jul 23: Southern region MUFs Depressed by 15%
10 Jul 23: Northern region MUFs Depressed by 15%
18 Jul 23: Southern region MUFs Depressed by 15%

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END
02 July 23	61	02 July 23	04 July 23
07 July 23	62	07 July 23	09 July 23
10 July 23	63	10 July 23	12 July 23
12 July 23	64	12 July 23	14 July 23
14 July 23	65	14 July 23	16 July 23
17 July 23	66	17 July 23	19 July 23
19 July 23	67	19 July 23	21 July 23
22 July 23	68	22 July 23	23 July 23
22 July 23	69	23 July 23	25 July 23
26 July 23	70	26 July 23	28 July 23
29 July 23	71	29 July 23	31 July 23
29 July 23	72	28 July 23	30 July 23

Geomagnetic Activity

The strongest disturbance for the month was observed on 17-Jul with a local Australian A index of 16 reached, and although the Australian A index did not indicate any significant activity, the planetary A index reached 24 on 26-Jul. Overall, the Australian regional K-index (Kaus) remained at G0 levels throughout the entire month. The planetary K-index (Kp) reached G1 geomagnetic conditions on 16-18 Jul and 25-26 Jul due to CME impacts. Weak shocks were detected in the solar wind on 14/1525UT and 20/1608UT and strong shocks were detected on 15/1026UT and 25/2154UT all due to CME impacts. The sole drivers of geomagnetic activity this month were CME impacts on 14, 16, 20-21 and 25-26 Jul.

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

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
17 Jul 23	G0

GEOMAGNETIC WARNINGS AND ALERTS

DATE	Nº.	BEGIN	END	ISSUED
04 July 23	35	07 July 23	07 July 23	Warning
11 July 23	36	13 July 23	13 July 23	Warning
13 July 23	37	13 July 23	15 July 23	Warning
16 July 23	38	17 July 23	17 July 23	Warning
18 July 23	39	19 July 23	21 July 23	Warning
19 July 23	40	20 July 23	21 July 23	Warning
26 July 23	41	26 July 23	26 July 23	Warning
30 July 23	42	01 August 23	02 August 23	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 Jul	166	1	91	16 Jul	184	3	117
02 Jul	170	3	92	17 Jul	180	16	118
03 Jul	173	1	87	18 Jul	219	8	113
04 Jul	167	1	96	19 Jul	189	2	105
05 Jul	154	3	81	20 Jul	184	5	105
06 Jul	158	7	88	21 Jul	173	6	116
07 Jul	161	13	96	22 Jul	174	4	124
08 Jul	161	2	85	23 Jul	173	4	114
09 Jul	179	1	82	24 Jul	165	3	115
10 Jul	191	3	82	25 Jul	169	7	108
11 Jul	203	3	86	26 Jul	167	12	126
12 Jul	181	3	96	27 Jul	165	5	111
13 Jul	179	4	100	28 Jul	168	4	101
14 Jul	184	8	110	29 Jul	179	6	111
15 Jul	179	5	117	30 Jul	174	5	122
				31 Jul	177	3	112

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
Aug 22	118.1	6.9	52.5	75.4	92.2	29
Sep 22	135.1	7.9	74.6	96.3	96.2	13
Oct 22	133.5	7.9	82.1	95.4	99.1	19
Nov 22	123.4	7.3	76.1	77.6	101	6
Dec 22	132.3	8.1	83.5	113.1	104.5	43
Jan 23	182.3	7.1	118.6	143.6	113.3	42
Feb 23	173.5	10.3	115	110.9	117.7	51
Mar 23	157.2	9.3	131.5	122.6	120.1	21
Apr 23	145.8	8.3	119.3	96.4	121.1	9
May 23	156.0	6.5	97.7	137.9	123.8	60
Jun 23	161.7	5.5	97.5	163.4	125.2	21
Jul 23	177.1	4.9	103.5	159.1	123.8	52
					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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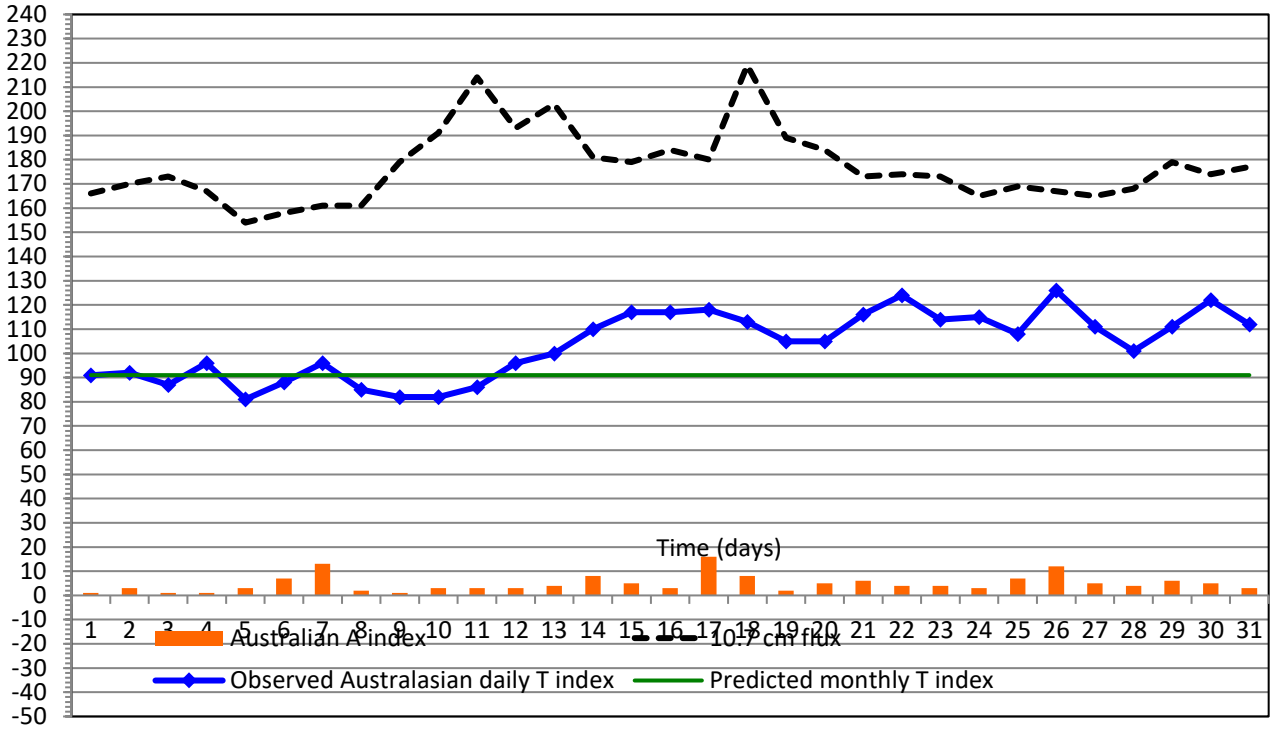
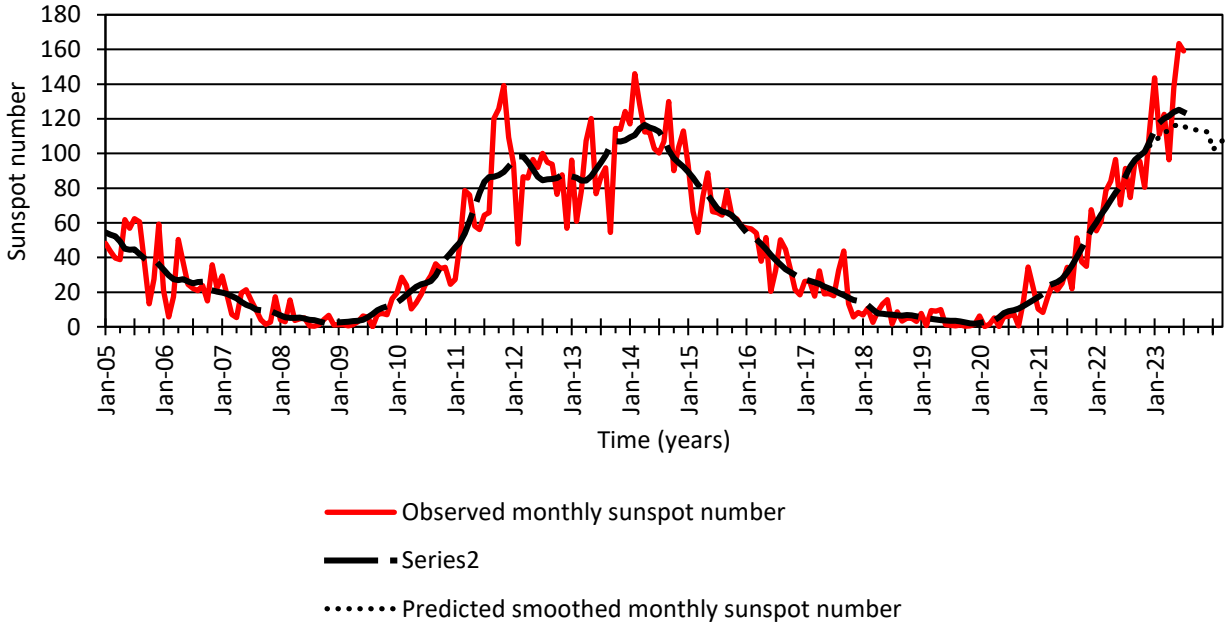
SWS WORLD T-INDICES

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	8	2	3	-2	-6	-3	-3	-8	-6	-10	-15	-9
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	10	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	91	88	84	81	78	75
	SWS predicted T-index				* New observed data. T-index value may have changed							

Solar and Geophysical Indices - July 2023



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