Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

January 2023

Solar Activity

An increase in high level solar flare activity was observed during the month of January, with a period of increased flare activity over 6-15 January. A total of 42 solar flares of magnitude ASWAS R1 to R3 were observed during the month, which comprised of 36 R1 flares, three R2 flares and three R3 flares. The largest flare for the month was an R3 X1.9 on 9-Jan. Despite the high number of flares observed this month, none of the flares were associated with significant Earth-directed coronal mass ejections or solar proton events. The bulk of the month's flare activity was produced by solar regions AR3182, AR3184 and AR3186 during the interval 6-15 Jan.

Solar region AR3182 rotated over the eastern limb late on 4-Jan in the southeast quadrant and initially grew in size and magnetic complexity. The region immediately produced an R3 event on 6- Jan and R1 flares on 7, 12 and 14-Jan. Following this, the region did not produce significant flares and decayed significantly after crossing the central meridian.

AR3184 rotated onto the solar disk shortly after AR3182 on 8-Jan, also in the southeast quadrant.
The region produced a total of eight R1 flare events, one R2 event and a single R3 event over 8-11 Jan. The region showed some magnetic simplification before rotating over the western limb on 21-Jan.

AR3186 rotated onto the solar disk in the northeast quadrant on 10-Jan, appearing to be relatively simple magnetically. The region rapidly developed over 10-11 Jan and produced an R2 event on 11- Jan followed by a R3 flare later the same day. The region also produced six R1 level flare events and rotated over the western limb on 21-Jan.

More recently, solar regions AR3190 and AR3192 also contributed to the flare activity during the month, producing isolated minor R1 flare events over 25-26 Jan. Both regions have now rotated over the western limb.

The solar wind speed during Jan 2023 was elevated during the intervals 1-3, 5-9, 14-19, 21-24 and 25-31 Jan due to coronal hole high speed wind streams. Weak shocks were detected in the solar wind at 2041UT on 6-Jan and 2114UT on 17-Jan. A CME produced by a filament eruption observed on 20-Jan may have contributed to elevated solar wind conditions on 23-Jan.

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		FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
	CLASS M	CLASS X		
06 Jan 23		X1.2/2B	0057UT	0043-0107UT
07 Jan 23	M1.6/SF		0052UT	
08 Jan 23	M1.2		0854UT	
08 Jan 23	M1.4		0948UT	
08 Jan 23	M1.4		1507UT	
08 Jan 23	M1.0/SF		1911UT	
09 Jan 23	M1.1		0102UT	
09 Jan 23	M2.1/1N		0901UT	
09 Jan 23	M1.0		1322UT	
09 Jan 23		X1.9/3B	1850UT	1837-1857UT
10 Jan 23	M5.1/SF		0016UT	0009-0022UT
10 Jan 23	M1.0/SF		0216UT	
10 Jan 23	M2.6/2N		0241UT	
10 Jan 23	M1.0		1108UT	
10 Jan 23	M1.3		1728UT	
10 Jan 23	M1.2		1748UT	
10 Jan 23		X1.0/2B	2247UT	2239-2252UT
11 Jan 23	M2.4/1F		0059UT	
11 Jan 23	M5.6		0156UT	0149-0201UT
11 Jan 23	M1.3		0609UT	
11 Jan 23	M3.1		0833UT	0825-0837UT
12 Jan 23	M1.2/SF		1128UT	
12 Jan 23	M1.0		1457UT	
12 Jan 23	M1.0		1913UT	
13 Jan 23	M1.4/1N		0259UT	
13 Jan 23	M3.9/SN		1015UT	1005-1019UT
14 Jan 23	M1.3/SF		0209UT	
14 Jan 23	M3.5		2021UT	2006-2028UT
14 Jan 23	M4.6		2100UT	2037-2119UT
15 Jan 23	M6.0/SF		0342UT	0308-0408UT
15 Jan 23	M4.8/2B		1431UT	1416-1451UT
17 Jan 23	M1.8		2329UT	
18 Jan 23	M1.8		1035UT	
19 Jan 23	M1.1/SF		0403UT	
19 Jan 23	M1.7		1012UT	
19 Jan 23	M1.0/SF		1027UT	
22 Jan 23	M1.1		1226UT	
22 Jan 23	M1.6/1B		1702UT	
25 Jan 23	M4.6/SF		1011UT	0937-1049UT
25 Jan 23	M1.3/SF		1701UT	
25 Jan 23	M2.0		2235UT	
26 Jan 23	M2.8		1306UT	

FLARE ALERT	SWF ALERT
02 Jan 23	
06 Jan 23	0054 – 0156 UT
07 Jan 23	0051 – 0104 UT
08 Jan 23	
09 Jan 23	0057 – 0115 UT
10 Jan 23	0016 – 0033 UT, 0237 – 0307 UT, 2247 – 2300 UT
11 Jan 23	0054 – 0129 UT, 0152 – 0211 UT
12 Jan 23	
13 Jan 23	0254 – 0305 UT
14 Jan 23	0136 – 0253 UT
15 Jan 23	0319 – 0517 UT
17 Jan 23	
18 Jan 23	
19 Jan 23	
22 Jan 23	
24 Jan 23	
25 Jan 23	
26 Jan 23	

PROTON ALERT

BEGIN		END		ENERGY THRESHOLD
DATE	TIME	DATE	TIME	

None.

Ionospheric Activity

Mild to moderate ionospheric depressions observed during the month of January were all associated with mild geomagnetic activity induced by coronal hole high speed wind stream effects. Sporadic E was frequently observed across the Australian region, particularly during local night hours.

Shortwave fadeouts impacting lower HF frequencies were observed on 6/0054-6/0156UT (R3 X1.2), 7/0051-7/0104UT (M1.6), 9/0057-9/0115UT (M1.1), 10/0016-10/0033UT (M5.1), 10/0237-10/0307UT (M2.6), 10/2247-10/2300UT (X1.0), 11/0054-11/0129UT (M2.4), 11/0152-11/0211UT (M5.6), 13/0254-13/0305UT (M1.4), 14/0136-14/0253UT (M1.3) and 15/0319-15/0517UT (M6.0). Ionospheric scintillation was observed on 27/1029UT at Niue.

Aside from the depressed periods listed below, MUFs were near monthly predicted values to 25% enhanced in the Australian region during local day hours.

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

06 Jan 23: Northern region MUFs Depressed by 15%
Southern region MUFs Depressed by 15%
16 Jan 23: Southern region MUFs Depressed by 30%
22 Jan 23: Southern region MUFs Depressed by 15%

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END
05 Jan 23	01	06 Jan 23	08 Jan 23
05 Jan 23	02	06 Jan 23	06 Jan 23
06 Jan 23	03	06 Jan 23	08 Jan 23
08 Jan 23	04	08 Jan 23	10 Jan 23
10 Jan 23	05	11 Jan 23	13 Jan 23
13 Jan 23	06	13 Jan 23	15 Jan 23
14 Jan 23	07	16 Jan 23	18 Jan 23
15 Jan 23	08	16 Jan 23	16 Jan 23
18 Jan 23	09	18 Jan 23	20 Jan 23
20 Jan 23	10	21 Jan 23	21 Jan 23
22 Jan 23	11	23 Jan 23	24 Jan 23
25 Jan 23	12	25 Jan 23	26 Jan 23

Geomagnetic Activity

The regional geomagnetic field reached was at the G0 level for the entire month of January 2023 and there were no significant geomagnetic storm days. Mild disturbances were induced by coronal hole wind streams.

The strongest disturbance for the month was observed on 15-Jan with the planetary Ap index reaching 23. Other mildly disturbed conditions were observed on 4-Jan (Ap 16). These minor disturbances were due to coronal hole wind streams.

Two weak shocks were detected in the solar wind on 6-Jan and 17-Jan, although there was no significant geomagnetic activity as a result, with the Ap index reaching 3 and 6 on 6-7 Jan and 5 and 14 on the 17-18 Jan respectively.

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

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
15 Jan 23:	G0

GEOMAGNETIC WARNINGS AND ALERTS				
DATE	Nº.	BEGIN	END	ISSUED
31 Dec 23	61	04 Jan 23	05 Jan 23	Warning
20 Jan 23	01	20 Jan 23	24 Jan 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 Jan	153	10	112	17 Jan	222	6	125
02 Jan	146	5	120	18 Jan	220	12	143
03 Jan	149	4	119	19 Jan	219	3	147
04 Jan	151	13	124	20 Jan	218	4	111
05 Jan	154	8	88	21 Jan	209	10	125
06 Jan	172	3	65	22 Jan	199	6	130
07 Jan	179	5	104	23 Jan	189	8	124
08 Jan	184	5	120	24 Jan	180	4	143
09 Jan	191	4	118	25 Jan	172	6	142
10 Jan	193	5	126	26 Jan	151	8	132
11 Jan	195	9	118	27 Jan	145	7	109
12 Jan	212	7	123	28 Jan	138	7	114
13 Jan	209	11	105	29 Jan	137	4	115
14 Jan	228	6	132	30 Jan	136	4	119
15 Jan	234	19	120	31 Jan	137	6	112
16 Jan	228	11	92				

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
Feb 22	109.3	7.5	58.9	59.7	64.8	3
Mar 22	117.1	6.7	65.0	78.5	68.9	14
Apr 22	129.7	8.0	77.4	84.1	73.1	33
May 22	134.2	5.0	78.3	96.5	77.3	22
Jun 22	117.0	5.4	59.8	70.5	81.0	3
Jul 22	125.8	6.0	63.9	91.4	84.9	7
Aug 22	118.1	6.9	52.5	75.4	88.8	29
Sep 22	135.1	7.9	74.6	96.3	91.9	13
Oct 22	133.5	7.9	82.1	95.4	94.2	19
Nov 22	123.4	7.3	76.1	77.6	95.9	6
Dec 22	132.3	8.1	83.5	113.1	98.2	43
Jan 23	182.3	7.1	118.6	143.6	100.8	42
					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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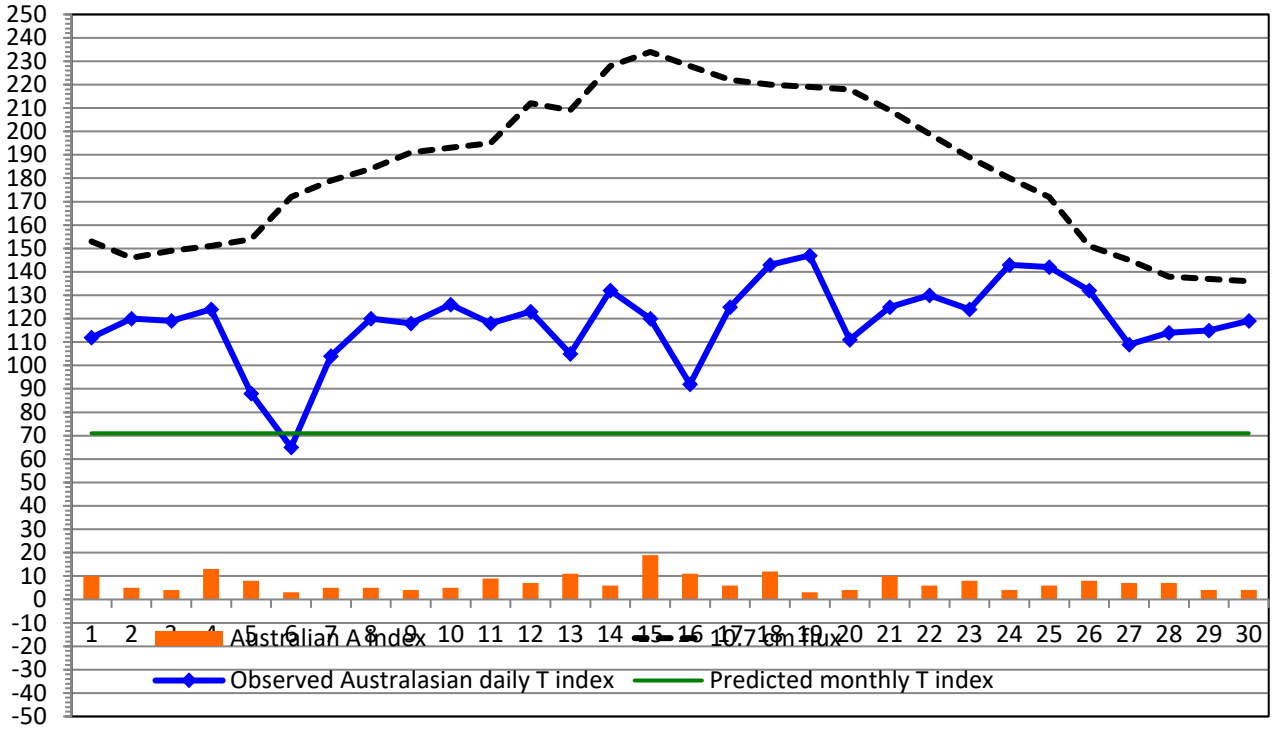
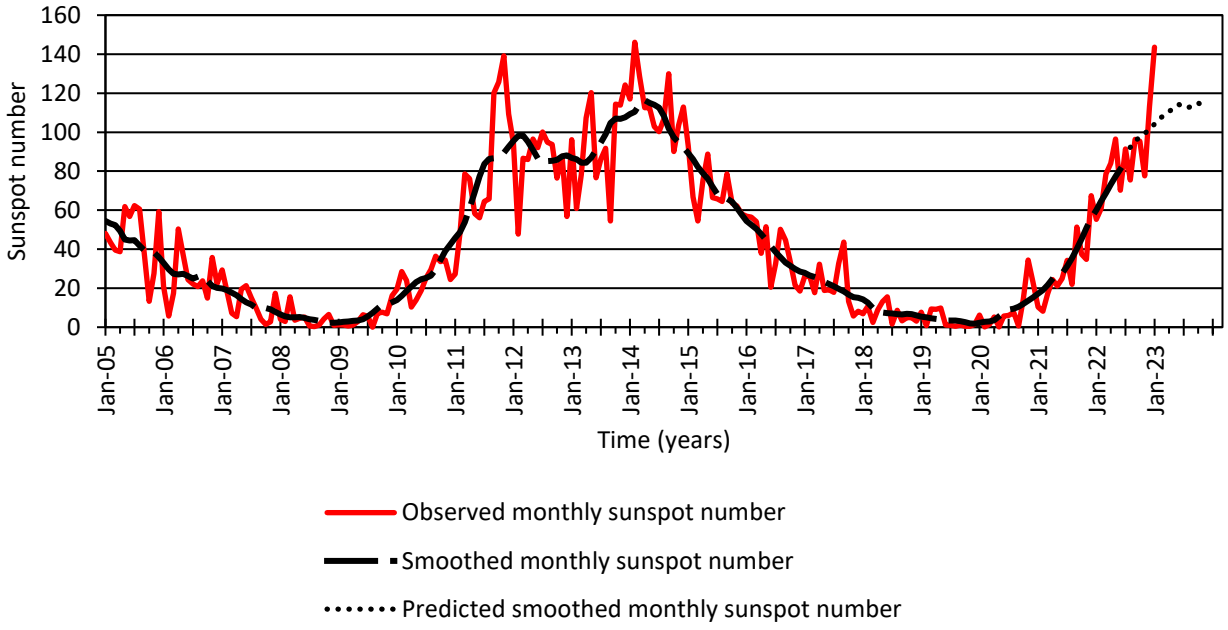
ASWFC WORLD T-INDICES

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*	75	76	76	77	78	77	76	77	78	79	79
		SWS predicted T-index			* New observed data. T-index value may have changed							

Solar and Geophysical Indices - January 2023



Solar Cycle



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