Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

January 2024

Solar Activity

Solar activity in January occurred in three main clusters; over 01-04 Jan, 10-12 Jan and 22-24 Jan. During the first cluster 5 R1 level solar flares were observed, with the largest being M4.7 (R1). During the second cluster 6 M1 (R1) solar flares were observed. During the last cluster 18 solar flares were observed, with the largest being M5.1 (R2). An isolated M6.8 (R2) solar flare was observed on 29-Jan, which was the biggest event of the month. No X-class (R3) solar flares were observed during January.

The sunspot number was relatively high at the beginning of the month, before it decreased towards the end of the month. Many sunspots with a bipolar magnetic configuration were observed in January, however many regions were not observed to produce any activity.

Numerous coronal mass ejections (CMEs) were observed in January. Many CMEs were fast and halo/ partial halo shaped, although none were significantly Earth directed. There were numerous filament and prominence eruptions during January.

Two solar radiation storms were observed in January. The first was over 03-05 Jan, which initially began rising on 01-Jan due to an X5.1 (R3) solar flare that was observed on 31-Dec on the eastern solar limb. The maximum pfu reached over this period was 25 on 05-Jan. The second event occurred from the isolated M6 solar flare on 29-Jan, and S2 solar radiation storm conditions were observed on 29-Jan followed by S1 on 30-Jan. The maximum pfu reached by the 10 MeV protons during this event was 137.

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		
1-Jan-24	M2.3/1N		0854UT	
1-Jan-24	M4.7		1225UT	1154-1235 UT
2-Jan-24	M1.1		1830UT	
4-Jan-24	M1.1		0116UT	
4-Jan-24	M3.8/2N		0155UT	0122-1212 UT
10-Jan-24	M1.4		1255UT	
10-Jan-24	M1.9/SF		2328UT	
11-Jan-24	M1.3		1251UT	
11-Jan-24	M1.5		1725UT	
11-Jan-24	M1.2		1923UT	
12-Jan-24	M2.0/SN		0258UT	
22-Jan-24	M1.5/1N		0622UT	
22-Jan-24	M1.2		1932UT	
22-Jan-24	M2.0/1F		1947UT	
22-Jan-24	M3.4		2121UT	2114-2132 UT
22-Jan-24	M1.6		2143UT	
22-Jan-24	M2.1		2222UT	
23-Jan-24	M5.1		0331UT	0309-0338 UT
23-Jan-24	M2.4		0811UT	
23-Jan-24	M2.3/1F		0822UT	
23-Jan-24	M1.0		1308UT	
23-Jan-24	M1.3		1459UT	
23-Jan-24	M4.3		1640UT	1636-1647 UT
23-Jan-24	M1.1		1844UT	
23-Jan-24	M1.0		2001UT	
24-Jan-24	M1.0		0038UT	
24.Jan-24	M2.6/SF		0140UT	
24-Jan-24	M1.4		0543UT	
24-Jan-24	M1.3		2058UT	
29-Jan-24	M1.2/SF		0140UT	
29-Jan-24	M6.8		0438UT	0354-0515 UT

FLARE ALERT	SWF ALERT
1-Dec-23	
2-Dec-23	
4-Dec-23	0113-0120 UT, 0123-0232 UT
10-Dec-23	
11-Dec-23	
12-Dec-23	0256-0259 UT
14-Dec-23	
22-Dec-23	
23-Dec-23	0315-0352 UT
24-Dec-23	0057-0118 UT, 0134-0203 UT, 0530-0558 UT
26-Dec-23	
29-Dec-23	0136-0149 UT, 0412-0654 UT

PROTON ALERT

BEGIN DATE	BEGIN TIME	END DATE	END TIME	ENERGY THRESHOLD	ASWAS S class
03-01-2024	1955UT	03-01-2024	2205 UT	10MeV	S1 (>10PFU)
03-01-2024	2250 UT	04-01-2024	2155 UT	10MeV	S1 (>10PFU)
04-01-2024	2225 UT	05-01-2024	0125 UT	10MeV	S1 (>10PFU)
29-01-2024	0605 UT	30-01-2024	0405 UT	10MeV	S1 (>10PFU)
29-01-2024	1725 UT	29-01-2024	1850 UT	10MeV	S2 (>100PFU)

Ionospheric Activity

Ionospheric conditions for HF radio communications were generally good for most of January. Some minor degradations were observed during local night hours at high and low latitudes, but otherwise daytime conditions were good. Maximum usable frequencies (MUFs) were either near predicted monthly values or enhanced every day in January, except for on 31-Jan where 20% depressions were observed. Enhancements of 25-30% were common, however enhancements up to 45% were observed. As no significant geomagnetic activity was observed in January, no significant depressions to MUFs were observed. Sporadic-E was observed over the east coast of Australian most days during local night and dawn hours.

Several brief shortwave fadeouts were observed in the Australian region in January. Two were observed on 04-Jan, one on 12-Jan, one on 23-Jan, three on 24-Jan and two on 29-Jan. In general these shortwave fadeouts were minor. The most significant one was due to an M6 (R2) solar flare on 29-Jan that lasted several hours.

Transpolar HF circuits may have experienced increased absorption over 03-05 Jan and 29-30 Jan due to S1 and S2 solar radiation storm conditions on these days. January 1, 2, 6, 7, 22 and 23 also observed an enhanced S conditions but remained under S0; increased absorption may have also been experienced on these days.

Ionospheric scintillation was common over South America and Africa, but rarely affected the Australian region. A brief scintillation event was observed in Weipa on 22-Jan.

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

No MUF depressions were observed.

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END

No HF radio depression warnings were issued.

Geomagnetic Activity

There were no geomagnetic storms at G1 or above during the month of January. CMEs were observed on most days during January, however only few of them had any Earth-directed components. On 03-Jan a glancing blow was observed from a CME that was associated with an X5 flare (R3) on 31-Dec. On 22, 25 and 26 Jan weak CME impacts were also observed. None of these events were associated with any significant geomagnetic activity. Coronal holes caused an increase to solar wind speeds on 2, 3, 8, 16, 30 and 31 Jan. Solar wind data for the first half of the month was not reliable, as the ACE satellite experienced frequent outages and the DSCOVR satellite was providing suspect data.
The instruments on these satellites began providing better data by the end of the month.

The maximum planetary A index observed during January was 9 on 31-Jan and the maximum Australian A index observed was 10 on 03-Jan.

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
No geomagnetic disturbances were observed in the Australian region.	

GEOMAGNETIC WARNINGS AND ALERTS

DATE	Nº.	BEGIN	END	ISSUED
20-Dec-23	1	22-Jan-24	23-Jan-24	Warning
22-Dec-23	2	22-Jan-24	24-Jan-24	Warning
23-Dec-23	3	25-Jan-24	26-Jan-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
1-Jan	136	8	109	17-Jan	174	3	178
2-Jan	142	7	104	18-Jan	162	5	165
3-Jan	140	10	134	19-Jan	157	5	157
4-Jan	126	2	119	20-Jan	166	5	154
5-Jan	153	3	144	21-Jan	179	4	153
6-Jan	159	1	140	22-Jan	196	8	135
7-Jan	167	1	137	23-Jan	180	5	144
8-Jan	176	3	165	24-Jan	172	7	145
9-Jan	176	5	150	25-Jan	161	6	149
10-Jan	186	8	160	26-Jan	157	6	133
11-Jan	193	5	138	27-Jan	148	4	128
12-Jan	186	3	156	28-Jan	141	8	140
13-Jan	185	1	162	29-Jan	140	8	128
14-Jan	188	6	163	30-Jan	135	5	137
15-Jan	183	6	132	31-Jan	136	4	114
16-Jan	180	5	154				

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
Jan-23	182.3	7.1	118.6	143.6	113.3	42
Feb-23	173.5	10.3	115	110.9	117.9	51
Mar-23	157.2	9.3	131.5	122.6	121.2	21
Apr-23	145.8	8.3	119.3	96.4	123.4	9
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	125.4	27
Sep-23	154.5	9.8	104.3	133.6	126.1	33
Oct-23	142.6	6.1	130.3	99.4	127.2	7
Nov-23	153.9	8.7	113.9	105.4	127.6	17
Dec-23	151.3	8.4	110.9	114.2	125.2	25
Jan-24	163.9	5.1	142.8	123.0	120.6	31

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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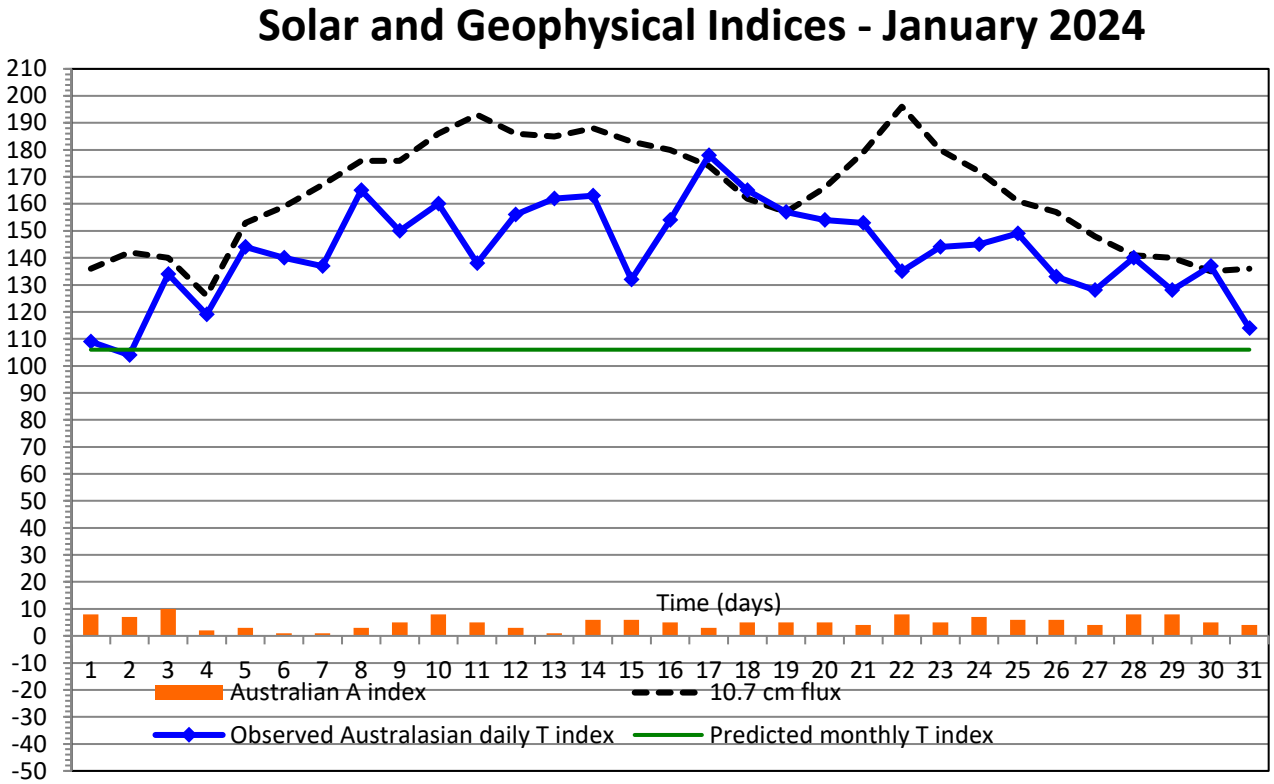
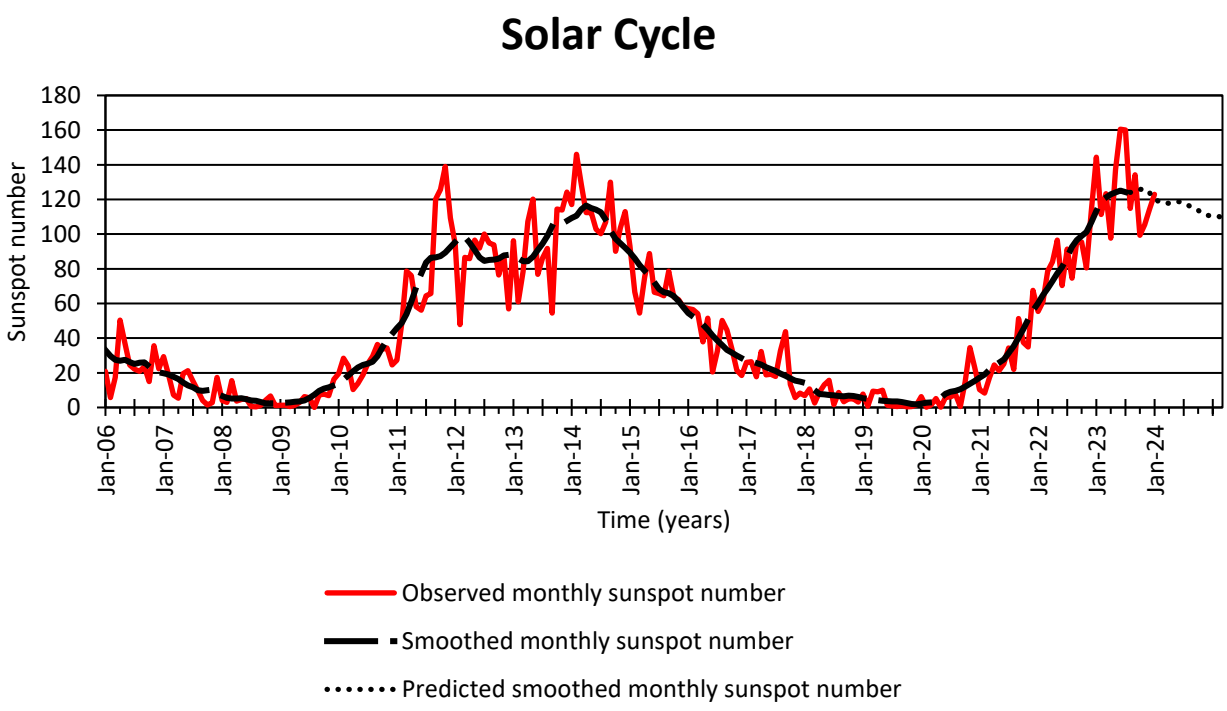
SWS WORLD T-INDICES

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	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	118	118	107	113	97	95
2024	106*	105	105	104	104	104	106	105	104	102	101	99
2025	98	95	93	91	90	89	88	87	86	84	83	82
2026	81	81	80	79	77	75	73	71	68	65	62	59

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





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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