Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

April 2023

Solar Activity

Solar activity was entirely at R0-R1 levels over April, with R1 activity observed on 6, 8, 10-11, 14, 21, 27 and 30-Apr. The largest flare for the month was an M3.0 flare produced by AR3272 on the eastern limb. The M1.7 flare on 21-Apr was associated with a high velocity geoeffective halo CME. The M2.4 flare on 30-Apr was associated with an east-directed CME. AR3272 produced most of the M-class flares for the first half of the month, with AR3276 responsible for the M2.8 flare on 10-Apr. Both flares on 14-Apr were produced by AR3282. The final three flares for the month were produced by AR3283, AR3288 and AR3293 respectively. AR3272 began flaring soon after it rotated onto the solar disk on 06-Apr, but became quiet after 11-Apr when near the central meridian. AR3276, AR3282 and AR3293 also produced M-class flares as they rotated onto the solar disk. AR3283 produced little flaring for most of its transit, with the significant exception of the broad M1.7 flare in a geoeffective location at around S25W10. AR3288 has been producing several C-class flares during its time on the solar disk, with the M1.8 flare occurring at around S25E05. AR3282 was the only M-class flare producing region to rotate off the solar disk in a large and complex state. AR3288 is soon to rotate off the disk and has not decayed significantly. AR3282 may return after 06-May.

The solar wind speed during April was elevated at the beginning of the month due to coronal hole high speed wind stream effects. After declining the wind speed was elevated sharply by high speed wind stream effects from an equatorial coronal hole. A CME impact on 18-Apr produced another sharp rise in solar wind speed. A significant CME impact greatly increased solar wind speed on 23-Apr. The wind speed then remained elevated for the rest of the month, with two more rises on 26-Apr and 28-Apr due to equatorial coronal hole high speed wind streams. The solar wind is currently declining toward background levels. The majority of coronal holes observed this month were small or fragmented. The largest coronal hole appeared at the equator on the solar disk over 21-22 Apr and was responsible for the sustained period of high solar wind speed.

Two confirmed geoeffective CMEs were observed over the month, one glanced Earth on 18-Apr, the other was a full halo CME travelling at ~1800 km/s. This CME produced geomagnetic activity at the G4 level globally.

The proton flux was mostly quiet for April, with an enhancement of the >10MeV proton flux observed over 22-24 Apr. This enhancement produced a short period of S1 conditions from 23/1910UT to 23/2010UT. This enhanced period was due to the arrival of the aforementioned high speed halo CME.

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

DATE	FLARES CLASS M	CLASS X	FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
6 Apr 23	M3.0		0553UT	0536-0604UT
8 Apr 23	M2.9/1N		0146UT	
10 Apr 23	M2.8		0520UT	
11 Apr 23	M1.3/1N		1016UT	
14 Apr 23	M1.1		1618UT	
14 Apr 23	M1.5/1N		2327UT	
21 Apr 23	M1.7/2N		1812UT	
27 Apr 23	M1.8/SN		1114UT	
30 Apr 23	M2.4		2028UT	

Total Number of M-flares 9, X-flares 0
Total Number of flares for Apr was 9
The largest flare for the month was an M3.0 on Apr 06

FLARE ALERT	SWF ALERT
6 Apr 23	0543-0608 UT
8 Apr 23	0142-0151 UT
10 Apr 23	0519-0533 UT

PROTON ALERT

BEGIN DATE	BEGIN TIME	END DATE	END TIME	ENERGY THRESHOLD
23 04 2023	1800UT	23 04 2023	1900UT	10MeV (S1)

10MeV Maximum proton flux of 2.62E+01 PFU (S1) observed at 23 04 2023 1820UT.

Ionospheric Activity

The deepest ionospheric depression for the month was observed on 24-Apr following coronal mass ejection induced geomagnetic activity, with southern Australian regional Maximum Usable Frequencies (MUFs) depressed by up to 55% on this day. MUFs returned to near predicted monthly values to 20% enhanced on the following day in southern Australian regions. Northern Australian regional MUFs were mostly enhanced by 15-30% over the course of the month. Mild southern Australian regional MUF depressions of 15% were also observed on 30-Apr. Minor shortwave fadeouts affecting lower frequencies were observed on 06/0536-0604UT, 08/0142-08/0151UT and 10/0510-0528UT. Frequent brief periods of ionospheric scintillation were observed throughout the month at Darwin, Weipa and Niue Island. Southern Australia regional depressions were observed on the days below.

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

24 Apr 23	Southern region MUFs Depressed by 55%
30 Apr 23	Southern region MUFs Depressed by 15%

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END
6 Apr 23	34	6 Apr 23	8 Apr 23
10 Apr 23	35	10 Apr 23	12 Apr 23
14 Apr 23	36	14 Apr 23	16 Apr 23
16 Apr 23	37	17 Apr 23	19 Apr 23
22 Apr 23	38	23 Apr 23	24 Apr 23
24 Apr 23	39	24 Apr 23	24 Apr 23
28 Apr 23	40	28 Apr 23	30 Apr 23

Geomagnetic Activity

The strongest disturbance for the month was observed over 23-24 April with Australian regional conditions reaching G2 geomagnetic conditions. Isolated periods of G3 were observed at Hobart during the storm. Planetary geomagnetic conditions reached G4 levels. This geomagnetic activity was due to an Earth-directed full halo coronal mass ejection. The CME was launched on 21-Apr and was associated with a solar filament eruption and an M1.7 flare from AR3283. A strong shock was observed in the solar wind at 1700UT on 23-Apr. The CME contained a strongly sustained southward magnetic field orientation, contributing to the strong storm conditions observed. Auroral observations were reported from several Australian sites during this geomagnetic storm period. The resulting planetary daily Ap indices for 23 and 24-Apr were 72 and 82 respectively. Increased geomagnetic activity was observed on the days listed below. No other significant geomagnetic disturbances were observed this month. Disturbances with Australian A indices greater than or equal to 16 are reported below.

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

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
23 Apr 23	G3
24 Apr 23	G3
28 Apr 23	G0

GEOMAGNETIC WARNINGS AND ALERTS

DATE	Nº.	BEGIN	END	ISSUED
7 Apr 23	16	10 Apr 23	11 Apr 23	Warning
8 Apr 23	17	11 Apr 23	12 Apr 23	Warning
17 Apr 23	18	19 Apr 23	21 Apr 23	Warning
21 Apr 23	19	23 Apr 23	24 Apr 23	Warning
24 Apr 23	20	24 Apr 23	25 Apr 23	Warning
27 Apr 23	21	27 Apr 23	28 Apr 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
1-Apr	125	9	137	16-Apr	178	2	123
2-Apr	127	6	129	17-Apr	167	4	119
3-Apr	134	10	138	18-Apr	153	8	117
4-Apr	136	8	128	19-Apr	147	9	127
5-Apr	137	7	130	20-Apr	147	4	125
6-Apr	137	9	124	21-Apr	151	6	114
7-Apr	136	4	122	22-Apr	141	3	116
8-Apr	136	2	125	23-Apr	135	31	115
9-Apr	140	2	122	24-Apr	134	29	109
10-Apr	140	8	132	25-Apr	131	7	103
11-Apr	143	5	119	26-Apr	137	12	99
12-Apr	154	2	114	27-Apr	141	14	112
13-Apr	160	4	122	28-Apr	150	16	107
14-Apr	171	3	129	29-Apr	156	13	100
15-Apr	176	6	123	30-Apr	154	5	100
				16-Apr	178	2	123

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 22	134.2	5	78.3	96.5	77.3	22
Jun 22	117	5.4	59.8	70.5	81	3
Jul 22	125.8	6	63.9	91.4	84.9	7
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	100.8p	6
Dec 22	132.3	8.1	83.5	113.1	103.1p	43
Jan 23	182.3	7.1	118.6	143.6	105.7p	42
Feb 23	173.5	10.3	115	110.9	108.2p	51
Mar 23	157.2	9.3	131.5	122.6	110.5p	21
Apr 23	145.8	8.3	119.3	96.4	112.1p	9

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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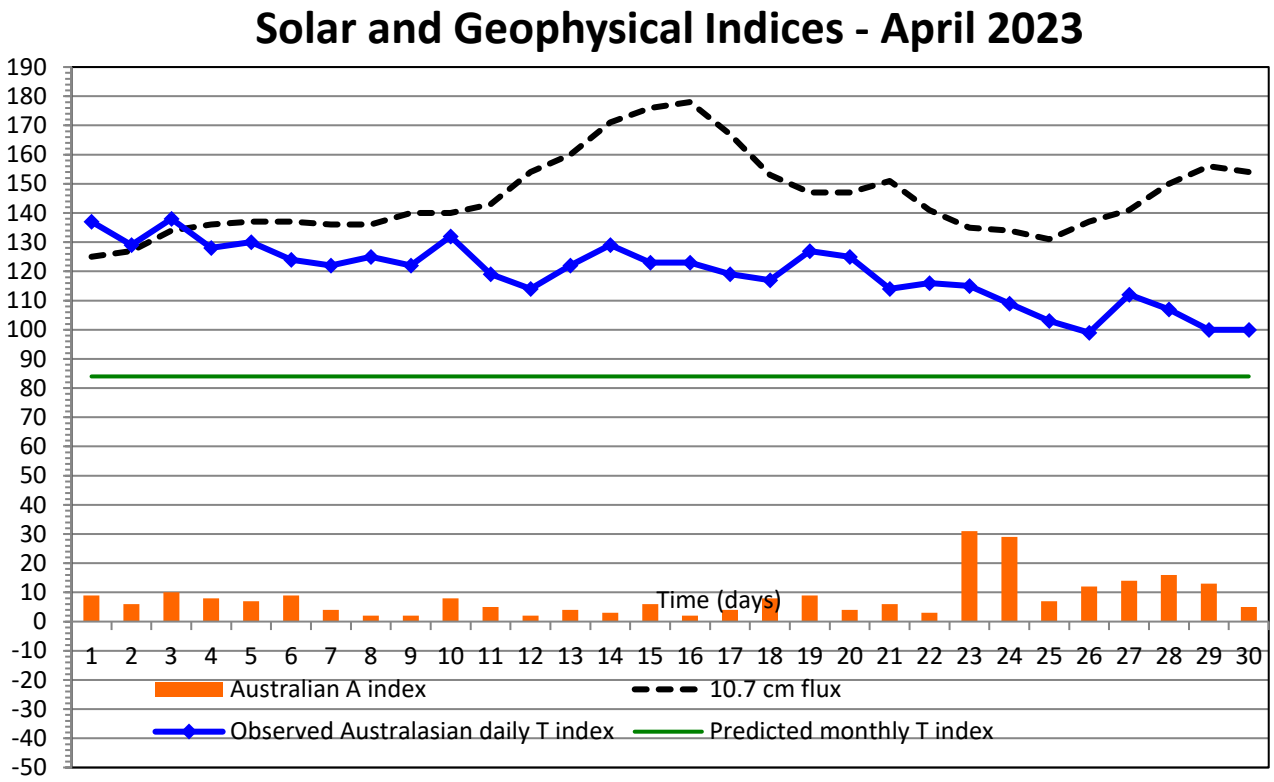
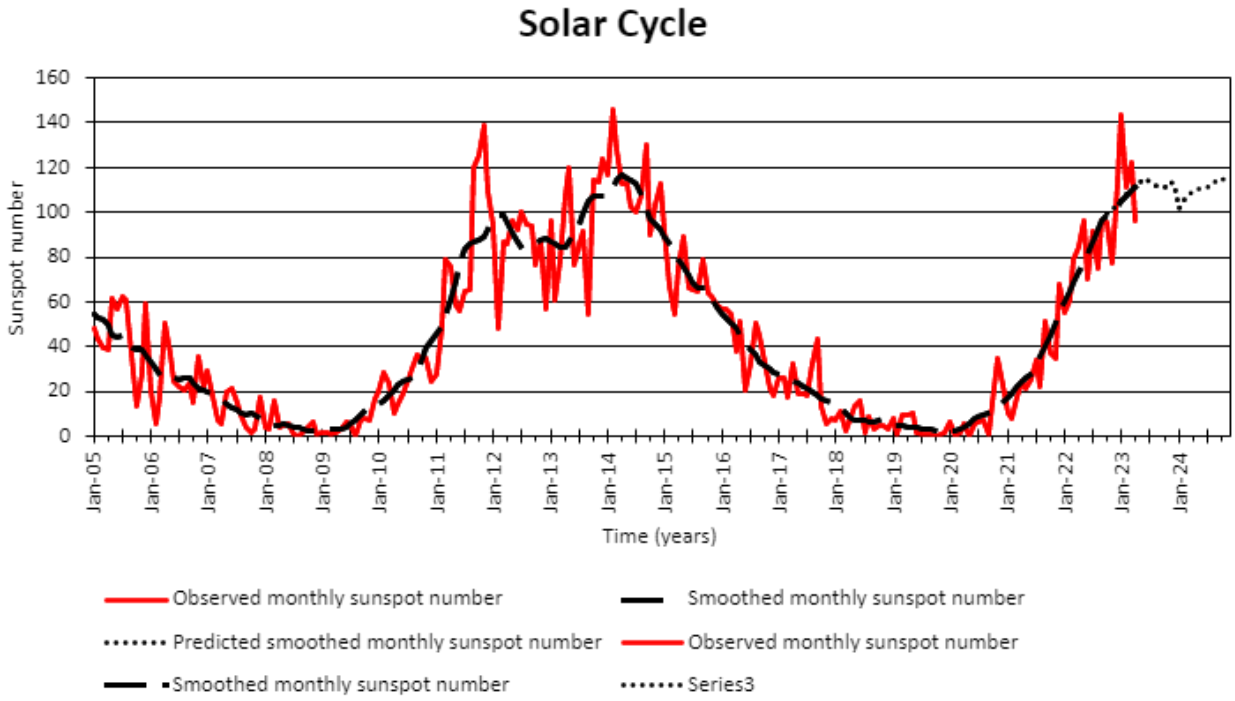
SWS WORLD T-INDICES

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*	84^	84^	85^	85^	82^	79^	78^	79^	80^

SWS predicted T-index

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


Solar and Geophysical Indices - April 2023
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
Time (days)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Australian A index
10.7 cm flux
Observed Australasian daily T index
Predicted monthly T index


Solar Cycle
Sunspot number
160
140
120
100
80
60
40
20
0
Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Jan-17 Jan-18 Jan-19 Jan-20 Jan-21 Jan-22 Jan-23 Jan-24
Time (years)
Observed monthly sunspot number
Smoothed monthly sunspot number
Predicted smoothed monthly sunspot number
Observed monthly sunspot number
Smoothed monthly sunspot number
Series3

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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