Australian Government

Bureau of Meteorology

SPACE WEATHER SERVICES

SOLAR

AND

GEOPHYSICAL

SUMMARY

April 2022

Solar Activity

Solar activity was below the ASWAS R1 (minor) level in the first half of the month, apart from 2 April when neighbouring sunspot regions 2975 and 2976, nearing the northwest limb, produced a total of three M-class flares resulting in the ASWAS R1 (minor) level that day. A 10 MeV proton/PCA event exceeding the ASWAS S1 (minor) threshold was associated with one of the flares (M3.9 at 02/1344 UT from AR 2976). The S1 event commenced at 1425 UT and ended at 2235 UT 2 April, peaking at 32.2 pfu at 1600 UT.

There were many flares in the second half of the month, reaching the ASWAS R3 (strong) level on 17 April (X1.1 from region 2994), 20 April with the month's largest flare (X2.2 from region 2992 just over the southwest limb), and 30 April with a parting X1.1 from 2994 just over the northwest limb. On 17, 20 and 30 April, there were also a number of M-class flare events.

The ASWAS R2 (moderate) level occurred on 21 April due to an M9.6 flare from region 2993, a neighbour of region 2994. The ASWAS R1 (minor) level was observed on 15, 16, 18, 19, 22, 25 and 29 April due to activity from regions 2987 and 2992 to 2996. Less than the ASWAS R1 level was observed on 23-24 and 26-28 April.

There was an increase in the 10 MeV proton flux on 29 April following the M1.2 flare at 29/0730 UT from region 2996. The increase was well below the ASWAS S1 level and began around 1310 UT, ending near the end of the UT day with a peak of 4.2 pfu.

There were enhancements in the solar wind over April due to many weak coronal mass ejections (CMEs) and some coronal hole wind streams. Earth directed coronal mass ejections from 28 March influenced the solar wind from late March to 3 April along with the effects of a coronal hole stream. Further CME impacts and coronal hole effects were observed on 7 and 9 to 10 April. A halo CME on 11 April from a filament eruption near the centre of the visible solar disc arrived around the start of 14 April and persisted into the first half of 15 April. The interplanetary magnetic field (IMF) during April was most disturbed on 10 and 14 April. There was an unexpected mild CME disturbance on 27 April. Weak CMEs that occurred on 27 to 28 April likely mildly disturbed the IMF on 30 April as it was settling from coronal hole influences.

Total Number of M-flares 30, X-flares 3
Total Number of flares for Apr was 33
The largest flare for the month was an X2.2 on Apr 20

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

ASWAS SCALE DESCRIPTION: https://bit.ly/3lmaMBx

DATE	FLARES		FLARE MAX	FADEOUT POSSIBLE ON DAYLIGHT CIRCUIT
	CLASS M	CLASS X		
02 Apr 22	M2.9		0255UT	
02 Apr 22	M3.9/SN		1355UT	1256-1444UT
02 Apr 22	M4.3/1N		1744UT	1734-1751UT
15 Apr 22	M1.2		1101UT	
15 Apr 22	M1.9		1359UT	
16 Apr 22	M1.0		1456UT	
17 Apr 22	M1.9		0211UT	
17 Apr 22	M1.8		0211UT	
17 Apr 22		X1.1	0334UT	0317-0351UT
17 Apr 22	M1.5/SF		2002UT	
17 Apr 22	M4.4/SF		2234UT	2228-2240UT
18 Apr 22	M1.3/SF		0748UT	
18 Apr 22	M1.1		1027UT	
18 Apr 22	M1.9/SF		1724UT	
19 Apr 22	M1.0		0450UT	
19 Apr 22	M3.7		2049UT	2039-2058UT
19 Apr 22	M1.6/SN		2113UT	
20 Apr 22	M1.2/1N		0114UT	
20 Apr 22	M7.2		0136UT	0120-0144UT
20 Apr 22		X2.2	0357UT	0341-0404UT
20 Apr 22	M1.9/SF		1253UT	
21 Apr 22	M9.6		0159UT	0147-0205UT
22 Apr 22	M1.1		0514UT	
22 Apr 22	M3.4/2B		1325UT	1316-1330UT
25 Apr 22	M1.2/SF		0201UT	
25 Apr 22	M1.1/SF		0402UT	
29 Apr 22	M1.2/1F		0730UT	
29 Apr 22	M1.2/SF		1810UT	
30 Apr 22	M2.6		0501UT	
30 Apr 22	M1.4		0534UT	
30 Apr 22	M4.8		0958UT	0948-1005UT
30 Apr 22		X1.1	1347UT	1337-1352UT
30 Apr 22	M1.9		1947UT	

FLARE ALERT (number issued)		SWF ALERT
02 Apr 22	(3)	0250-0311 UT
15 Apr 22	(1)	
16 Apr 22	(1)	
17 Apr 22	(4)	0324-0515 UT
18 Apr 22	(3)	
19 Apr 22	(3)	
20 Apr 22	(4)	0122-0159 UT
		0354-0418 UT
21 Apr 22	(1)	0156-0216 UT
22 Apr 22	(2)	
25 Apr 22	(2)	
29 Apr 22	(2)	
30 Apr 22	(5)	0459-0511 UT

PROTON ALERT

BEGIN DATE	BEGIN TIME	END DATE	END TIME	ENERGY THRESHOLD
02 04 2022	1425UT	02 04 2022	2235UT	10MeV

Ionospheric Activity

Solar flux above predicted levels resulted in enhanced maximum usable frequencies compared to April predicted monthly values in the Australian region, although frequencies were closer to predicted monthly values at the mid and higher latitudes. Maximum usable frequencies were nearer predicted monthly values on 15 April due to the geomagnetic disturbance over 14-15 April. Depressions related to geomagnetic activity were observed at mid and higher latitudes from the second half of 1 April to 3 April, from late 10 to 11 April and late 14 to 16 April.

Short-wave fadeouts affecting lower frequencies in the Australian region may have occurred on 2, 17, 20, 22, 25 and 30 April. Higher frequencies were impacted by fadeouts in the Australian region on 17, 20 and 21 April.

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

IONOSPHERIC DISTURBANCES (MUFs for the Australian region)

02 Apr 22	Southern region MUFs Depressed by 30%
03 Apr 22	Southern region MUFs Depressed by 25%
08 Apr 22	Southern region MUFs Depressed by 15%
11 Apr 22	Southern region MUFs Depressed by 25%
15 Apr 22	Southern region MUFs Depressed by 40%

RADIO COMMUNICATIONS WARNINGS

DATE	Nº.	BEGIN	END
02 Apr 22	31	03 Apr 22	05 Apr 22
06 Apr 22	32	06 Apr 22	06 Apr 22
12 Apr 22	33	13 Apr 22	15 Apr 22
14 Apr 22	34	15 Apr 22	15 Apr 22
16 Apr 22	35	16 Apr 22	18 Apr 22
18 Apr 22	36	19 Apr 22	21 Apr 22
21 Apr 22	37	22 Apr 22	24 Apr 22
24 Apr 22	38	25 Apr 22	27 Apr 22
30 Apr 22	39	30 Apr 22	02 May 22

Geomagnetic Activity

Globally, the most geomagnetically disturbed days were 10 and 14 April with planetary A indices of 29 and 34, respectively. On 10 April, there was one period of ASWAS G3 (strong) conditions and one period of G2 (moderate) level on 14 April.

The Australian region A index reached 21 and 20 respectively on 14 and 15 April, with isolated periods of ASWAS G1 (minor) conditions in the Australian region. This disturbance was caused by a coronal mass ejection that left the Sun on 11 April.

An isolated period of G1 (minor) conditions also occurred on 10 and 27 April in the Australian region, with local A index of 14 and 13, respectively. Weak coronal hole and coronal mass ejection effects were the cause of the mild disturbance on 10 April and an expected weak CME impact on 27 April. On other days, conditions were at less than G1 levels in the Australian region.

Weak sudden impulses in the Australian region geomagnetic field were observed on 1, 10, 12 and 15 April.

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

ASWAS SCALE DESCRIPTION: https://bit.ly/3lmaMBx

DATE	GEOMAGNETIC DISTURBANCES (for the Australian region)
14 Apr 22:	G0 to G1 (minor)
15 Apr 22:	G0 to G1 (minor)

GEOMAGNETIC WARNINGS AND ALERTS

DATE	Nº.	BEGIN	END	ISSUED
03 Apr 22	17	04 Apr 22	05 Apr 22	Warning
05 Apr 22	18	05 Apr 22	07 Apr 22	Warning
07 Apr 22	19	07 Apr 22	08 Apr 22	Warning
10 Apr 22	20	10 Apr 22	11 Apr 22	Warning
10 Apr 22				Alert
11 Apr 22	21	13 Apr 22	14 Apr 22	Warning
14 Apr 22	22	14 Apr 22	15 Apr 22	Warning
14 Apr 22				Alert
14 Apr 22	23	16 Apr 22	17 Apr 22	Warning
27 Apr 22				Alert
28 Apr 22	24	28 Apr 22	30 Apr 22	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	147	14	88	16 Apr	122	5	59
02 Apr	143	13	69	17 Apr	135	6	66
03 Apr	140	4	77	18 Apr	135	5	75
04 Apr	128	6	95	19 Apr	135	5	70
05 Apr	122	4	88	20 Apr	160	4	77
06 Apr	117	4	89	21 Apr	164	8	76
07 Apr	111	11	94	22 Apr	163	5	79
08 Apr	109	5	74	23 Apr	160	7	88
09 Apr	107	13	83	24 Apr	159	2	79
10 Apr	101	14	78	25 Apr	157	2	83
11 Apr	99	7	63	26 Apr	150	1	76
12 Apr	96	8	61	27 Apr	142	13	84
13 Apr	99	4	66	28 Apr	132	11	94
14 Apr	103	21	65	29 Apr	124	10	92
15 Apr	110	20	45	30 Apr	120	8	88

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 21	75.5	3.9	12.9	21.2	25.9	4
Jun 21	79.2	2.7	13.5	25.4	27.8	0
Jul 21	81.1	3.5	17.3	34.4	31.4	4
Aug 21	77.8	3.9	14.6	22.4	35.3	1
Sep 21	87.3	4.9	24.1	51.5	40	2
Oct 21	89.2	5.6	18.3	38.1	45	7
Nov 21	86.2	6.9	3	35	49.9p	3
Dec 21	103	5.6	34.6	67.6	54.5p	8
Jan 22	103.9	6.4	47.3	54	58.9p	7
Feb 22	109.3	7.5	58.9	59.7	63.7p	3
Mar 22	117.1	6.7	65	78.5	68.1p	14
Apr 22	129.7	8	77.4	84.1	72.1p	33
					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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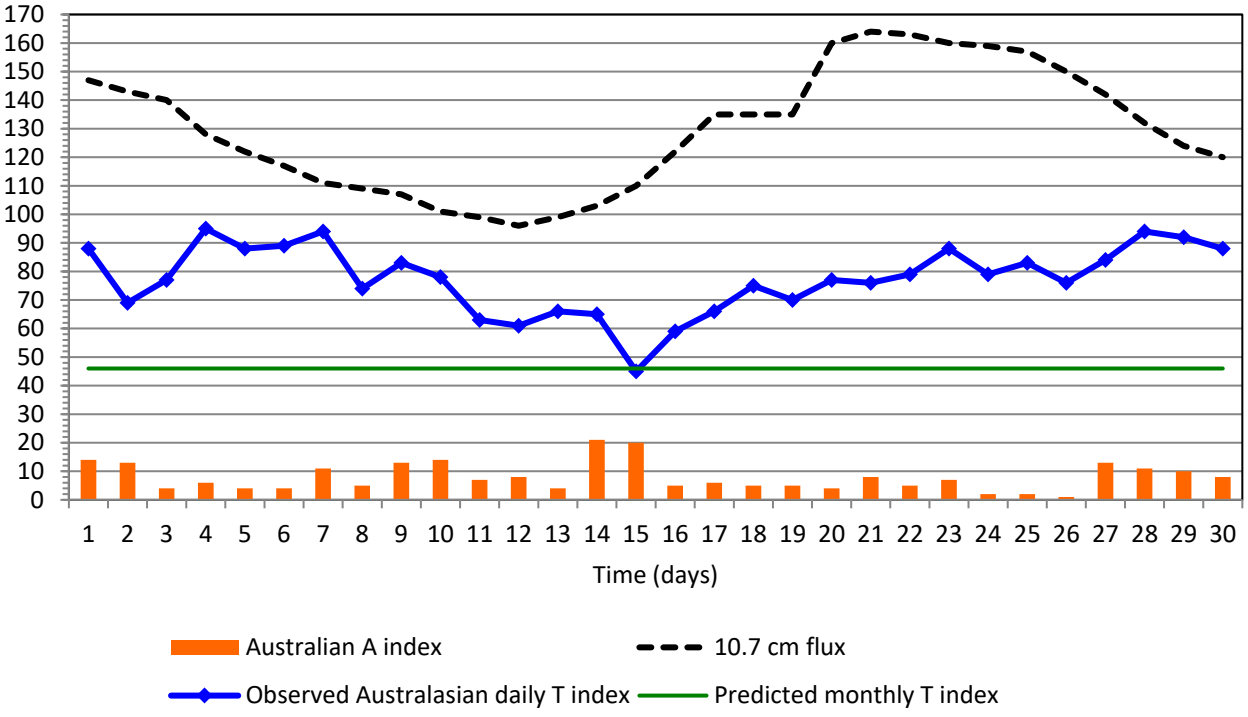
SWS WORLD T-INDICES

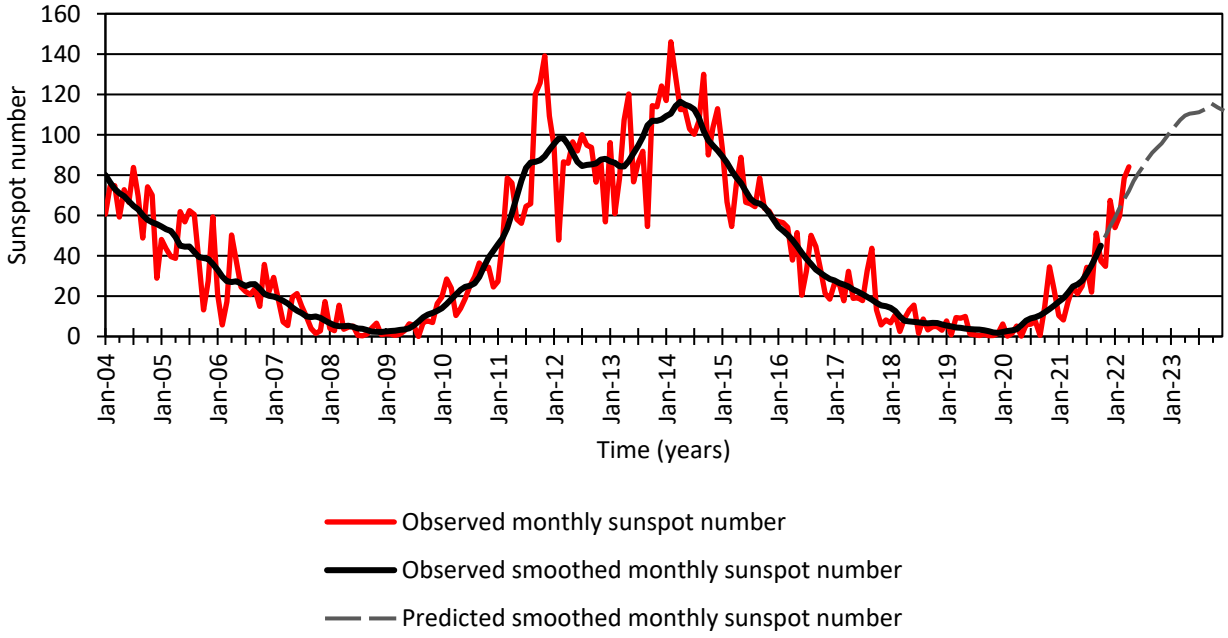
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	14	19	11	8	2	2	0	3	16	13	5	6
2018	8	2	3	-2	-6	-3	-3	-8	-6	-10	-15	-9
2019	-5	-3	-4	-4	-9	-14	-11	-14	-11	-14	-16	-12
2020	-2	-5	2	-1	-7	-7	-9	-2	-6	-6	7	12
2021	12	4	10	6	6	12	21	12	23	23	17	28
2022	41	52	63	71*	51	54	56	57	57	57	57	58
2023	59	60	61	62	63	63	64	65	66	67	68	69

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

Solar and Geophysical Indices - April 2022



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.

j. ASWAS scale description: https://bit.ly/3lmaMBx

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