SOLAR INDICES BULLETIN APRIL 2014

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♦ SOLAR RADIO EMISSIONS

The quiet Sun emits radio energy with a slowly varying intensity. These radio fluxes, which stem from atmospheric layers high in the chromosphere and low in the corona, change gradually from day-to-day, in response to the number and size of spot groups on the solar disk. The table below gives daily measurements of this slowly varying emission at selected wavelengths between about 1 and 100 centimeters. Many observatories record quiet-sun radio fluxes at the same local time each day and correct them to within a few percent for factors such as antenna gain, bursts in progress, atmospheric absorption, and sky background temperature. At 2800 megahertz (10.7 centimeters) flux observations summed over the Sun's disk have been made continuously since February 1947.

♦ SOLAR FLUX TABLE

Numbers in parentheses in the column headings below denote frequencies in megahertz. Each entry is given in solar flux units--a measure of energy received per unit time, per unit area, per unit frequency interval. One solar flux unit equals $10^{-22}\ J/m^2 Hz\,sec$. During periods of low solar activity, the flux never falls to zero, because the Sun emits at all wavelengths with or without the presence of spots. The lowest daily Ottawa flux since 1947 occurred on November 3, 1954. On that day the observed noon value dropped to 62.6 units; the highest observed value of 457.0 occurred on April 7, 1947.

The preliminary observed and adjusted Penticton fluxes tabulated here are the "Series C" values reported by Canada's Dominion Radio Astrophysical Observatory in Penticton, British Columbia. Observed numbers are less refined, since they contain fluctuations as large as ±7% from the continuously changing sun-earth distance. Adjusted fluxes have this variation removed; they show the energy received at the mean distance between the Sun and Earth. Gaps in the Palehua, Hawaii (PALE), data reflect equipment problems. Fluxes measured either at Sagamore Hill, Massachusetts, or at San Vito, Italy, will be substituted for frequencies at which many Palehua values are missing.

APRIL 2014 PRELIMINARY SUNSPOT NUMBERS AND SOLAR RADIO FLUX

Day	Sunspot Number Intl	Obs Flux Pentic (2800)	Solar Flux Adjusted to 1 Astronomical Unit RSTN (15400)	RSTN (8800)	RSTN (4995)	Pentic (2800)	RSTN (2695)	RSTN (1415)	RSTN (610)	RSTN (410)	RSTN (245)
01	72	153	578	297	190	153	138	117	79	53	48
02	86	155	586	301	193	155	149	121	76	52	57
03	100	153	595	300	194	153	142	118	73	51	41
04	119	157	592	293	190	157	145	118	64	41	16
05	102	142	592	287	175	142	135	113	71	46	22
06	91	141	592	294	174	141	131	114	64	38	14
07	86	140	578	298	180	140	134	111	70	39	16
08	88	132	441	282	174	132	122	107	96	81	23
09	71	131	586	295	169	131	127	103	65	45	20
10	49	137	599	298	176	137	130	108	80	59	78
11	46	138	586	257	178	138	129	105	75	46	22
12	55	136	589	298	177	136	130	105	73	47	19
13	60	137	510	283	175	137	130	106	69	41	19
14	79	150	586	301	186	150	143	116	68	45	19
15	109	162	594	309	200	162	154	120	75	52	22
16	141	184	600	311	215	184	164	128	81	51	21
17	150	179	597	319	228	179	177	138	79	56	24
18	134	172	586	309	208	172	159	129	76	53	25
19	134	169	590	305	199	169	158	126	78	52	38
20	130	163	591	299	191	163	156	125	84	50	20
21	113	159	597	308	195	159	149	119	76	46	18
22	93	145	575	307	185	145	144	114	72	44	20
23	64	136	573	293	173	136	133	106	69	45	17
24	54	130	583	291	171	130	123	101	68	48	21
25	43	125	582	283	163	125	119	99	69	47	20
26	34	121	579	279	160	121	115	94	68	47	21
27	58	118	418	184	121	118	96	92	64	45	36
28	60	121	597	285	163	121	114	97	78	48	22
29	58	120	579	288	166	120	118	95	66	50	26
30	62	124	573	282	165	124	121	95	62	47	28
31											
Mean	75.1	144	574	291	181	144	136	111	73	49	26

MARCH 2014 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	164.6	161.6
02	161.3	158.5
03	161.0	158.3
04	158.0	155.4
05	149.1	146.7
06	148.8	146.5
07	148.2	146.0
08	141.6	139.5
09	145.9	143.8
10	151.5	149.5
11	164.6	162.5
12	147.6	145.8
13	147.7	145.9
14	143.8	142.1
15	139.0	137.5
16	135.6	134.2
17	136.4	135.1
18	138.3	137.0
19	149.2	147.9
20	151.3	150.1
21	152.6	151.4
22	154.9	153.8
23	157.0	156.0
24	158.6	157.7
25	152.8	152.0
26	153.2	152.5
27	144.8	144.2
28	146.4	145.9
29	142.7	142.3
30	148.4	148.1
31	152.4	152.1
Mean	149.9	148.3

♦ SUNSPOT COUNTS

In 1848 the Swiss astronomer Johann Rudolf Wolf introduced a daily measurement of sunspot number. His method, which is still used today, counts the total number of spots visible on the face of the Sun and the number of groups into which they cluster, because neither quantity alone satisfactorily measures the level of sunspot activity.

An observer computes a daily sunspot number by multiplying his estimated number of groups by ten and then adding this product to his total count of individual spots. Results, however, vary greatly, since the measurement strongly depends on observer interpretation and experience and on the stability of the Earth's atmosphere above the observing site. Moreover, the use of Earth as a platform from which to record these numbers contributes to their variability, too, because the Sun rotates and the evolving spot groups are distributed unevenly across solar longitudes. To compensate for these limitations, each daily international number is computed as a weighted average of measurements made from a network of cooperating observatories. The international sunspot numbers tabulated on page 1 are provisional values taken from a bulletin prepared monthly by the SOLAR INFLUENCE DATA CENTER, RINGLAAN 3, 1180 BRUSSELS, BELGIUM. (http://sidc.oma.be)

♦ HISTORICAL SUNSPOT COUNTS

How do sunspot numbers in the table on page 1 compare to the largest values ever recorded? The highest daily count on record occurred December 24-25, 1957. On each of those days the sunspot number totaled 355. In contrast, during years near the spot cycle minimum, the count can fall to zero. Today, much more sophisticated measurements of solar activity are made routinely, but none has the link with the past that sunspot numbers have. Our archives, for example, include reconstructed daily values from January 8, 1818; monthly means from January 1749; and yearly means beginning in 1700.

SMOOTHED (OBSERVED AND PREDICTED) SUNSPOT NUMBERS: CYCLES 23 AND 24

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1999	83	85	84	86	91	93	94	98	102	108	111	111	95
2000	113	117	120	121	119	119	120	119	116	115	113	112	117
2001	109	104	105	108	109	110	112	114	114	114	116	115	111
2002	114	115	113	111	109	106	103	99	95	91	85	82	102
2003	81	79	74	70	68	65	62	60	60	58	57	55	66
2004	52	49	47	46	44	42	40	39	38	36	35	35	42
2005	35	34	34	32	29	29	29	27	26	26	25	23	29
2006	21	19	17	17	17	16	15	16	16	14	13	12	16
2007	12	12	11	10	9	8	7	6	6	6	6	5	8
2008	4	4	3	3	4	3	3	3	2	2	2	2	3
2009	2	2	2	2	2	3	4	5	6	7	8	8	4
2010	9	11	12	14	16	16	17	17	20	23	27	29	18
2011	31	33	37	42	48	53	57	59	60	60	61	63	50
2012	66	67	67	65	62	59	58	58	58	59	60	61	61
2013	59	58	58	58	60	63	66	69	73	73	74	74	65
										(5)	(9)	(11)	(2)
2014	73	73	72	72	72	71	70	69	67	65	63	62	69
	(12)	(13)	(14)	(16)	(18)	(20)	(20)	(20)	(19)	(19)	(18)	(18)	(17)
2015	60	59	58	57	56	54	52	50	49	48	48	47	53
	(18)	(15)	(13)	(12)	(12)	(13)	(14)	(15)	(16)	(16)	(17)	(18)	(15)

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, the table gives smoothed sunspot numbers up to the one calculated that first uses the most recently measured monthly mean. These smoothed, observed values are based on final, unsmoothed monthly means through June 2010 and on provisional ones thereafter. We compute a smoothed monthly mean by forming the arithmetic average of two sequential 12-month running means of monthly means.

Table entries with numbers in parentheses below them denote predictions by the McNish-Lincoln method. This method estimates future numbers by adding a correction to the mean of all cycles that is proportional to the departure of earlier values of the current cycle from the mean cycle. (See page 9 in the July 1987 supplement to *Solar-Geophysical Data*). We use and predict only smoothed monthly means, because we believe the errors are too great to estimate any values more precisely. In the table above, adding the number in parentheses to the predicted value generates the upper limit of the 90% confidence interval; subtracting the number from the predicted value generates the lower limit. Consider, for example, the August 2011 prediction. There exists a 90% chance that in August 2011, the actual smoothed sunspot number will fall somewhere between 18 and 62.

The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead. Beyond a year these predictions regress rapidly toward the mean of all 14 cycles used in the computation. Moreover, the method is very sensitive to the date defined as the beginning of the current sunspot cycle, that is, to the date of the most recent sunspot minimum.