SOLAR INDICES BULLETIN JULY 2012

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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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. 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.

JULY 2012 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	84	133	618	304	167	133	137	118	69	50	49
02	85	166	622	298	164	166	136	120	66	48	75
03	83	146	544	313	175	146	142	125	67	61	100
04	87	163	643	344	201	163	161	128	72	64	36
05	86	165	647	341	191	165	148	130	75	55	45
06	88	158	660	349	204	158	165	134	66	44	23
07	97	158	628	341	204	158	158	133	69	44	19
08	78	178	691	390	239	178	182	149	76	52	54
09	81	174	677	363	219	174	161	140	71	45	18
10	71	173	620	347	212	173	179	138	72	43	18
11	73	162	605	358	210	162	158	135	72	46	19
12	83	165	553	352	197	153 +	145	132	75	48	21
13	86	147	595	367	209	147	147	119	63	41	29
14	83	148	591	349	206	148	143	103	66	47	40
15	78	141	590	315	182	141	141	111	64	43	18
16	68	154	583	312	176	138	136	112	65	45	28
17	57	128	617	302	158	128	122	106	70	44	18
18	38	110	503	287	143	110	109	96	59	41	18
19	25	100	580	277	130	100	100	90	56	41	18
20	24	92	565	271	124	92	93	86	57	37	16
21	19	90	573	265	121	90	85	83	56	41	27
22	19	94	522	270	126	94	90	86	58	44	19
23	42	97	576	279	129	97	96	92	56	37	19
24	47	102	577	281	130	102	102	94	59	42	18
25	42	105	585	284	136	105	106	102	59	43	16
26	57	115	576	292	143	115	115	110	63	41	16
27	73	123	536	295	151	123	121	118	65	43	20
28	71	127	584	299	155	127	127	121	65	42	22
29	74	131	574	292	156	131	127	106	69	42	19
30	80	136	587	305	162	136	134	130	72	44	19
31	81	140	590	303	161	140	138	136	73	45	22
Mean	63	136	594	314	170	135	132	116	66	45	28

JUN 2012 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic (2800)
01	128.6	132.2
02	129.1	132.9
03	129.4	133.2
04	128.2	131.9
05	138.7	142.8
06	151.9	156.4
07	128.2	132.1
08	124.2	127.9
09	128.3	132.3
10	128.3	132.3
11	133.9	138.1
12	141.3	145.8
13	142.8	147.3
14	148.6	153.3
15	144.9	149.6
16	134.5	138.8
17	124	128
18	118	121.9
19	109.9	113.5
20	103.7	107.1
21	97.7	100.9
22	88.4	91.4
23	84	86.8
24	85.3	88.1
25	88.6	91.5
26	99.2	102.5
27	106.3	109.9
28	119.7	123.7
29	117.4	121.3
30	124	128.2
31		
Mean	120.9	124.7

♦ 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
1998	44	49	53	57	59	62	65	68	70	71	73	78	62
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	68	69	70	71	73	75	77	79	79	80	73
		(3)	(7)	(10)	(13)	(16)	(19)	(20)	(21)	(24)	(27)	(29)	(16)
2013	81	83	84	84	84	85	84	83	83	83	83	83	83
	(32)	(34)	(35)	(36)	(37)	(39)	(41)	(41)	(39)	(39)	(39)	(39)	(38)
2014	83	82	80	80	79	78	77	76	73	71	69	67	76
	(38)	(37)	(36)	(36)	(35)	(35)	(34)	(33)	(32)	(31)	(30)	(29)	(34)

♦ SUNSPOT NUMBER PREDICTIONS

For the end of Solar Cycle 23, and the beginning of Cycle 24, the table gives <u>smoothed</u> 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.

<u>The McNish-Lincoln prediction method generates useful estimates of smoothed, monthly mean sunspot numbers for no more than 12 months ahead.</u> 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.