SOLAR INDICES BULLETIN

JULY 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 $10^{-22}\ \mathrm{J/m^2 Hz\,sec}$. 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 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	97	152	609	331	220	152	158	113	74	58	62
02	105	169	628	333	222	169	177	131	76	57	45
03	121	178	629	337	230	178	174	129	77	53	31
04	124	188	623	348	248	188	198	145	84	53	23
05	140	193	624	351	248	193	199	150	84	64	28
06	134	201	638	354	265	201	206	151	87	53	21
07	142	198	622	367	271	198	205	153	86	57	22
08	132	201	634	384	269	201	193	151	89	57	44
09	117	198	641	350	251	198	196	151	81	52	35
10	116	177	643	351	251	177	189	132	91	90	68
11	104	166	636	336	226	166	169	126	81	66	29
12	86	145	632	257	203	145	148	125	78	51	21
13	62	127	619	298	177	127	129	103	67	45	19
14	45	109	589	281	156	109	104	85	76	40	22
15	15	101	596	272	147	101	103	87	63	41	22
16	7	92	585	267	139	92	94	80	61	41	19
17	0	89	580	262	135	89	88	74	54	40	18
18	11	89	590	261	136	89	91	72	56	39	18
19	25	86	586	260	135	86	88	71	57	37	19
20	25	87	549	248	131	87	85	68	52	43	20
21	12	90	561	256	136	90	86	70	52	40	20
22	28	93	578	261	140	93	91	72	54	39	17
23	47	99	578	267	143	99	101	78	56	40	20
24	45	104	597	277	151	104	107	86	63	39	18
25	46	107	600	280	156	107	106	81	62	42	18
26	42	117	605	280	162	117	117	95	69	42	19
27	59	121	604	270	163	121	120	102	66	44	20
28	79	132	612	294	180	132	127	109	66	46	22
29	99	142	576	292	185	142	137	111	69	43	17
30	88	152	615	305	189	152	148	125	77	49	22
31	95	156	620	308	194	156	155	125	80	49	20
Mean	74.7	137	606	301	189	128	138	108	71	49	26

JUNE 2014 FINAL FLUX

Day	Observed Pentic (2800)	Adjusted Pentic 2800)
01	103.3	106.2
02	105.3	108.3
03	107.0	110.1
04	105.4	108.5
05	110.5	113.8
06	133.0	136.9
07	136.7	140.8
08	148.6	153.1
09	161.2	166.1
10	166.2	171.3
11	168.4	173.6
12	174.5	179.9
13	152.7	157.5
14	143.5	148.0
15	130.2	134.3
16	116.8	120.5
17	114.3	118.0
18	110.8	114.4
19	111.1	114.7
20	102.2	105.5
21	101.2	104.5
22	94.2	97.3
23	92.6	95.6
24	93.5	96.6
25	97.0	100.2
26	100.0	103.3
27	104.2	107.6
28	114.6	118.4
29	125.7	129.9
30	140.5	145.2
31		
Mean	122.1	126.0

♦ 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
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	75	75	75	66
2014	76	75	75	74	74	73	72	71	69	67	66	64	71
	(3)	(7)	(11)	(14)	(16)	(18)	(19)	(19)	(19)	(19)	(20)	(20)	(15)
2015	62	60	59	59	57	55	53	51	50	49	48	47	54
	(19)	(17)	(14)	(12)	(12)	(13)	(13)	(14)	(15)	(15)	(16)	(18)	(15)
2016	46	45	43	41	39	39	38	37	37	35	33	32	39
	(19)	(21)	(23)	(24)	(25)	(25)	(25)	(24)	(24)	(24)	(25)	(26)	(24)

♦ 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.