

## Center

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**SUNSPOT BULLETIN**

2004

n° 4

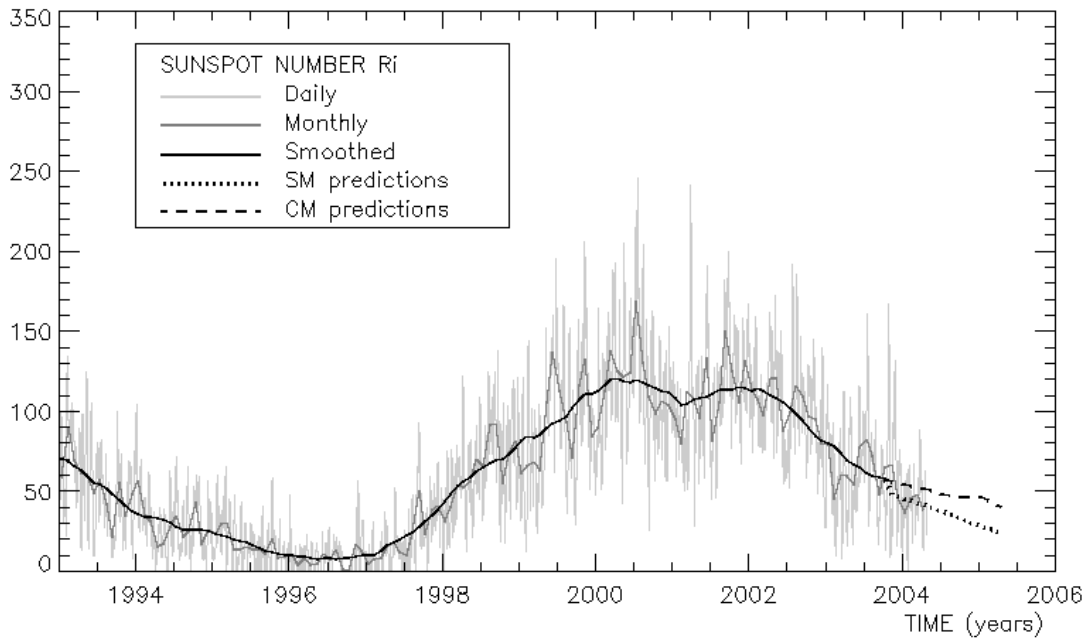
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**Provisional international and normalized hemispheric daily sunspot numbers for April 2004**


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computed at the *Observatoire Royal de Belgique* using observations from an international network with the *Locarno Specola Solare* as reference station.

Date	R' <sub>I</sub>	R' <sub>N</sub>	R' <sub>S</sub>
1	55	20	35
2	51	14	37
3	47	10	37
4	55	16	39
5	57	17	40
6	40	8	32
7	39	0	39
8	27	0	27
9	15	0	15
10	13	0	13
11	13	0	13
12	25	0	25
13	35	0	35
14	42	8	34
15	34	9	25
16	31	10	21
17	50	9	41
18	58	9	49
19	63	9	54
20	59	7	52
21	59	0	59
22	57	0	57
23	43	0	43
24	38	11	27
25	31	18	13
26	34	24	10
27	26	15	11
28	23	14	9
29	24	10	14
30	34	9	25
<b>Monthly mean</b>	<b>39.3</b>	<b>8.2</b>	<b>31.1</b>
<b>Cooperating stations</b>	<b>45</b>	<b>39</b>	<b>39</b>



**Predictions of the monthly smoothed Sunspot Number**  
 using the last provisional value, calculated for October 2003 : 58.1 ( $\pm 5\%$ )

	<b>SM</b>	<b>CM</b>		<b>SM</b>	<b>CM</b>		<b>SM</b>	<b>CM</b>			
2003	Nov	57	57	2004	May	45	51	2004	Nov	36	47
	Dec	52	56		Jun	43	50		Dec	35	47
2004	Jan	50	55		Jul	42	49	2005	Jan	33	47
	Feb	49	54		Aug	41	48		Feb	32	45
	Mar	47	53		Sep	39	47		Mar	30	43
	Apr	46	52		Oct	38	47		Apr	29	41

**SM : SIDC classical method** : based on an interpolation of Waldmeier's standard curves; the estimated error ranges from 7% (first month) to 35% (last month)

**CM : Combined method** : the combined method is a regression technique coupling a dynamo-based estimator with Waldmeier's idea of standard curves, due to K. Denkmayr.

ref. : **K. Denkmayr, P. Cugnon**, 1997 : "About Sunspot Number Medium-Term Predictions", in "Solar-Terrestrial Prediction Workshop V", eds G. Heckman et al., Hiraiso Solar Terrestrial Research Center, Japan, 103

Brussels, May 1, 2004 08:44 UT

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## S.I.D.C. SUMMARY OF THE URSIGRAMS

Date	R' <sub>i</sub>	PPSI	600	2800	COS	SFI	XI	Ak	SEA
31	56	106	50	121	////	15	0/0	12	
1	55	91	44	113	////	0	0/0	4	
2	51	75	41	108	////	0	0/0	4	
3	47	58	41	107	////	0	0/0	35	
4	55	57	41	109	////	0	0/0	18	
5	57	63	43	109	////	10	1/0	26	
6	40	31	44	101	////	3	1/0	29	
7	39	32	42	98	////	0	0/0	16	
8	27	28	43	94	////	1	0/0	13	
9	15	21	42	90	////	1	0/0	14	
10	13	16	41	88	////	0	0/0	12	
11	13	8	41	90	////	10	0/0	14	
12	25	9	40	91	////	1	0/0	10	
13	35	13	41	93	////	0	0/0	8	
14	42	19	41	95	////	1	0/0	5	
15	34	19	41	97	////	1	1/0	9	
16	31	15	39	97	////	0	0/0	16	
17	50	13	41	98	////	0	0/0	8	
18	58	30	43	109	////	0	0/0	10	
19	63	47	45	113	////	2	0/0	8	
20	59	63	46	111	////	1	0/0	6	
21	59	71	43	113	////	5	0/0	8	
22	57	82	45	117	////	36	1/0	8	
23	43	69	44	115	////	12	2/0	18	
24	38	60	43	112	////	2	0/0	10	
25	31	52	42	107	////	16	1/0	13	
26	34	57	41	100	////	2	0/0	6	
27	26	36	41	95	////	0	0/0	7	
28	23	28	39	90	////	0	0/0	12	
29	24	18	39	89	////	0	0/0	6	
30	34	15	38	89	////	0	0/0	21	

- R'<sub>i</sub>** : provisional international sunspot numbers from the S.I.D.C.
- PPSI** : prompt photometric sunspot index from the S.I.D.C. in  $10^{-5} \text{ w/m}^2$  : the quantity to be subtracted from the mean solar constant to account for the sunspot contribution.
- 600** : 600 Mhz solar flux from the station at Humain (Belgium).
- 2800** : 2800 Mhz solar flux from Ottawa (origin : Ursigrams - UGEOI). The 10.7cm Flux data are a service of the National Research Council of Canada.
- COS** : thousands of the cosmic ray counts (origin : Ursigrams - UCOSE Terre Adélie).
- SFI** : From October 1992, Solar Flare Index from the S.I.D.C. (origin : Ursigrams – UGEOR, evaluation :  $1 \times \text{Sn} + 10 \times "1" + 100 \times ">1"$ ).
- XI** : X-flares index from the Ursigrams (M-flares/X-flares) (origin : Ursigrams – UGEOR, UGEOI).
- Ak** : geomagnetic index from Wingst, Germany (origin : Ursigrams).
- SEA** : sudden enhancements of atmospherics from Uccle & Humain (Royal Observatory, Belgium).

**Note that due to problems of interferences saturating our receivers, no SEA could be detected this month.**

SOLAR PHYSICS DEPARTMENT

UCCLE DAILY PROVISIONAL RELATIVE SUNSPOT NUMBERS FOR APRIL 2004

DATE	UT	NUMBER		RELATIVE SUNSPOT NUMBERS			PPSI 10-3	QUAL	OBS	
		OF GROUPS	OF SPOTS	TOTAL	NORTH	SOUTH				CENTRAL
1	845	3	24	54	23	31	54	53.2	2	DC
2	934	4	20	60	18	42	20	34.6	1	DC
3	1025	4	21	61	12	49	25	47.1	2	ER
4	1000	4	35	75	11	64	35	41.1	2	ER
5	933	5	17	67	23	44	18	15.8	2	DC
6	1400	3	25	55	11	44	19	10.3	3	OB
7	905	3	15	45	0	45	18	7.2	2	DC
8	813	2	9	29	0	29	18	6.2	1	DC
9	1015	1	4	14	0	14	14	5.7	1	DC
11	945	1	5	15	0	15	0	3.7	2	IT
12	830	2	6	26	0	26	12	2.8	2	ST
14	715	4	18	58	11	47	22	7.0	4	DC
15	737	3	10	40	11	29	0	6.0	3	VI
16	719	3	5	35	11	24	11	5.3	3	VI
17	701	4	6	46	12	34	11	4.9	2	VI
19	915	5	26	76	11	65	37	11.9	3	DC
20	714	4	24	64	0	64	17	23.3	4	DC
21	1315	6	21	81	0	81	57	28.1	2	DC
22	730	5	25	75	0	75	52	23.7	3	DC
23	711	4	22	62	0	62	50	25.5	4	DC
25	855	2	23	43	24	19	19	24.1	3	OB
26	735	3	10	40	28	12	28	23.2	2	DC
27	745	2	9	29	16	13	16	23.7	2	DC
28	820	3	10	40	28	12	28	23.2	3	OB
29	1002	1	2	12	12	0	12	19.6	1	OB
30	940	3	18	48	11	37	21	8.5	3	OB

The relative mean sunspot number is 48.1.

NORMALISED UCCLE OBSERVATIONAL SUNSPOT NUMBERS  $U'=K'U$  FOR APRIL 2004

$K' = 0.784$  (\*)

1	42	7	35	13	***	19	60	25	34
2	47	8	23	14	45	20	50	26	31
3	48	9	11	15	31	21	64	27	23
4	59	10	***	16	27	22	59	28	31
5	53	11	12	17	36	23	49	29	9
6	43	12	20	18	***	24	***	30	38

The normalised relative monthly mean sunspot number is 38.

(\*)  $K'$  is the mean of the monthly  $K'$  for the last five years.

The Sun has been observed 26 days on 30 possible.

UCCLE OBSERVATIONAL MAJOR SUNSPOT GROUPS FOR APRIL 2004  
E AND F BRUNNER'S TYPE GROUPS

Uccle Nø	East Limb Date	Date and type			West Limb Date
		1st obs	CMP	Last obs	
13-2014	3 24.4	25 C	3 31.2	5 C	4 6.9

PROBABLE RETURN OF MAJOR GROUPS FOR MAY 2004

Nø	New East Limb	New CMP	New West Limb
13	4 20.3	4 27.1	5 3.8

## MONTHLY SUMMARY OF SOLAR AND GEOMAGNETIC ACTIVITY

### I. Solar Activity

Solar activity varied from low to moderate during the month, with a number of M-flares recorded, as well as some significant CME activity. The largest flare of the month, an M2.4, occurred on Apr 06 and was accompanied by a full halo CME. On Apr 11, a small proton event was observed.

The month started very quiet. Catania sunspot group 93 (NOAA 0582), which had produced more than 20 C-flares at the end of March, was in its decay phase and generated just one more C-class flare on Apr 01. During the next few days only B-class flares were observed, but from Apr 04 onwards, the close neighbours Catania sunspot groups 96 and 97 (NOAA 0588) became active. Catania 96 consisted mainly of one big sunspot, and Catania 97 was producing most of the activity. On Apr 05 and 06 the region produced two *M-flares*, followed by several C-flares during the week thereafter, including a C9.6 flare peaking at 04:19 on Apr 11. As this sunspot group passed from the eastern hemisphere on Apr 05 to the western hemisphere on Apr 11, it produced several *halo CMEs*. The first one, a partial halo registered by the SOHO/LASCO C2 coronagraph at 06:06 UT on Apr 05, had a plane-of-the-sky speed of 573 km/s and accompanied the M1.7 flare. On Apr 06 at 13:31 UT, LASCO C2 registered the start of a full halo CME with a speed of 1075 km/s and associated with the M2.4 flare. On Apr 08 at 10:30 UT LASCO observed another full halo CME starting at 10:30 UT; it had a speed of 915 km/s and was associated with a C7.4 flare. A CME first observed by LASCO C2 at 04:30 UT on Apr 11 and associated with the C9.6 flare was not a halo CME, but produced a *proton event* that started shortly after and finished late on Apr 11. A partial halo CME at 13:31UT on Apr 11 was most probably backside, since GOES-12/SXI showed no apparent activity at the time of the event.

On Apr 12, Catania groups 96/97, now close to the west limb, ended their active period and solar activity became much lower. An isolated short-duration M1.2 flare was produced by Catania sunspot group 02 (NOAA 0591) on Apr 15, but this was the only significant event from this group. Solar activity remained at mostly B-class level with occasional C-class flares until Apr 21. Four M-flares were then produced by the 3 active regions that one after the other dominated space weather. The beginning of the period was dominated by Catania sunspot group 08 (NOAA 0596), culminating in an M1.2 flare on Apr 22. After that Catania sunspot group 12 (NOAA 0597), already at the west limb at that time, started an impressive firework of more than 10 C-flares, an M1.5 flare (11h50 UT) and an M1.1 flare (21h12 UT) on Apr 24. By the time Catania 12 rotated over the west limb, Catania 15 (NOAA AR 0599) took the lead with an M2.2 flare on Apr 25 (05h37 UT). On Apr 26 and 27, Catania 15 (NOAA 0599) remained the most active group, although not spectacular: the strongest flare was a C3.1, which was accompanied by a type II radio burst. The accompanying CME is likely to have been full halo, but since LASCO was not operating, no visual CME observations were available. On Apr 28 and 29, solar activity remained very low, but on Apr 29, a sunspot group labeled with number 18 (NOAA 0601) suddenly popped up from nowhere and developed really fast to a beta-configuration, producing a first C-flare on Apr 30.

### II. Geomagnetic Activity

After a quiet start, geomagnetic conditions reached minor geomagnetic storm level in the period 03-06 April, and then remained mostly quiet ( $K < 4$  in Wingst) with occasional periods of active conditions ( $K = 4$  in Wingst) until the end of the month. On Apr 30, minor geomagnetic storm conditions were again observed in Wingst.

The beginning of the month was characterised by a low solar wind speed and an interplanetary magnetic field close to zero, resulting in quiet geomagnetic conditions. This changed drastically on Apr 03 with the arrival of a disturbance in the solar wind, which increased stepwise in speed from 380 to 500 km/s, while the solar wind density increased by an order of magnitude. The z-component of the interplanetary magnetic field made southward excursions down to  $-10$ nT. This disturbance was probably related to the halo CME accompanying a long duration flare on Mar 31. As a consequence, geomagnetic storm conditions were recorded on with K-values reaching  $K = 5$  in Dourbes (Belgium)

and K=6 in Izmiran and Wingst, while the NOAA estimated Kp index reached 5. These conditions lasted until early on Apr 04; then the geomagnetic field became quiet again.

In the evening of Apr 05 the Earth entered the fast flow from a low-latitude coronal hole. The interaction region between the fast and slow solar wind flows contained southward interplanetary magnetic field, leading to minor storm conditions on Apr 05 and 06.

The geomagnetic activity during the following days was influenced by the arrival of interplanetary disturbances produced by the halo CMEs listed above. CME-driven shock waves were registered by the ACE spacecraft on Apr 09 at 01:47 UT, on Apr 10 at 19:25 UT and on Apr 12 around 04:25 UT. On Apr 09 the interplanetary magnetic field was southwards and the estimated Kp index rose briefly to 5 (though the local K-index in Wingst stayed at 4). The other days had mostly northward interplanetary magnetic field, so the geomagnetic conditions remained at quiet to active level.

The rest of the month was a long period with mostly quiet geomagnetic conditions. The K-index in Wingst was mostly 2 with occasional values of 3 or 4. Occasional small perturbations were due to the influence of small coronal holes. A larger deviation was seen on Apr 23 with Kp up to 5 (but the Wingst K-index was still 4). On Apr 30, finally, at a moment of strong negative Bz (-10nT), the local K index in Wingst increased to 5, while the estimated Kp index stayed at 4.

### III. Noticeable solar events

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	RADIO	TYPE	600 (Humain)	Cat	NOAA	NOTE
05	0537	0555	0613	S18E35	M1.7	1F	110	III/3,	II/2	0540,0546	97	0588	partial halo CME
										0554			
06	1230	1328	1346	S18E15	M2.4	SF	690			1308,1320	97	0588	full halo CME
										1344,1355			
15	1637	1644	1648	S15W38	M1.2	SF	70	III/1		1642	02	0591	
22	0203	0219	0224	S09E19	M1.2	1N					08	0596	
23	1141	1150	1152	S08W90	M1.5					1148,1149	12	0597	
23	2102	2112	2114	S08W83	M1.1	SF	150				12	0597	
25	0502	0537	0542	N15E36	M2.2	1N					15	0599	

**loc:** approximate heliographic location

**Xray:** X-ray flare class

**op:** optical flare class

**10 cm:** 10 cm radio flux

**type:** type of radio burst

**600:** peak time (UT) of 600 Mhz radio bursts in Humain

**Cat:** Catania sunspot group identification

**NOAA:** NOAA active region identification

**p:** proton event

**CME:** Coronal Mass Ejection