# Solar Influences Data analysis Center

*Data Analysis Service supported by the FAGS*

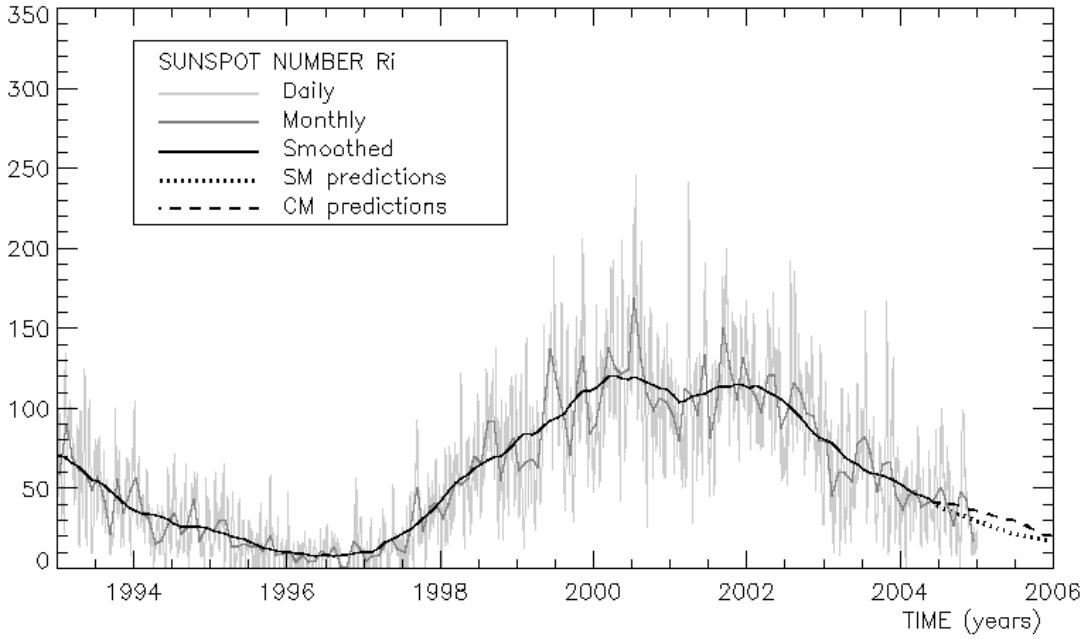
# *SUNSPOT BULLETIN*

**2004 n°12**

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

computed at the *Royal Observatory of Belgium* using observations from an international network with the *Locarno Specola Solare* as reference station.

| Date | $R'_I$ | $R'_N$ | $R'_S$ |
|---|---|---|---|
| 1 | 32 | 8 | 24 |
| 2 | 29 | 8 | 21 |
| 3 | 30 | 9 | 21 |
| 4 | 26 | 9 | 17 |
| 5 | 29 | 14 | 15 |
| 6 | 22 | 11 | 11 |
| 7 | 9 | 9 | 0 |
| 8 | 15 | 8 | 7 |
| 9 | 13 | 0 | 13 |
| 10 | 15 | 15 | 0 |
| 11 | 13 | 13 | 0 |
| 12 | 22 | 22 | 0 |
| 13 | 16 | 16 | 0 |
| 14 | 12 | 12 | 0 |
| 15 | 8 | 8 | 0 |
| 16 | 10 | 0 | 10 |
| 17 | 24 | 0 | 24 |
| 18 | 21 | 0 | 21 |
| 19 | 17 | 0 | 17 |
| 20 | 11 | 0 | 11 |
| 21 | 15 | 0 | 15 |
| 22 | 26 | 0 | 26 |
| 23 | 14 | 0 | 14 |
| 24 | 22 | 0 | 22 |
| 25 | 12 | 0 | 12 |
| 26 | 10 | 0 | 10 |
| 27 | 10 | 0 | 10 |
| 28 | 17 | 8 | 9 |
| 29 | 12 | 12 | 0 |
| 30 | 20 | 20 | 0 |
| 31 | 24 | 17 | 7 |
| **Monthly mean** | **17.9** | **7.1** | **10.8** |
| **Cooperating stations** | **41** | **34** | **34** |




**Predictions of the monthly smoothed Sunspot Number**
using the last provisional value, calculated for June 2004 : 41.7 (± 5%)

| | SM | CM | | SM | CM | | SM | CM |
|---|---|---|---|---|---|---|---|---|
| 2004 Jul | 42 | 42 | 2005 Jan | 34 | 36 | 2005 Jul | 26 | 30 |
| Aug | 41 | 41 | Feb | 33 | 35 | Aug | 24 | 28 |
| Sep | 40 | 41 | Mar | 31 | 34 | Sep | 23 | 26 |
| Oct | 39 | 40 | Apr | 30 | 33 | Oct | 22 | 24 |
| Nov | 37 | 38 | May | 28 | 32 | Nov | 21 | 22 |
| Dec | 36 | 37 | Jun | 27 | 31 | Dec | 20 | 21 |

**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, January 1, 2005 10:47 UT


Ed. Ronald Van der Linden, avenue Circulaire, 3 B-1180 BRUXELLES - BELGIUM
Fax 32-(0)2-373 02 24 Tel 32-(0)2-373 04 91
e-mail : arille@oma.be, ronald@oma.be
ftp anonymous : omaftp.oma.be, directory dist/astro/sidcdata
http://sidc.oma.be

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

| Date | $R'_i$ | PPSI | 600 | 2800 | COS | SFI | XI | Ak | SEA |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 32 | 74 | 43 | 111 | 908 | 0 | 0/0 | 23 | |
| 1 | 32 | 89 | 43 | 111 | 911 | 6 | 1/0 | 12 | |
| 2 | 29 | 123 | 41 | 106 | 914 | 0 | 1/0 | 3 | |
| 3 | 30 | 59 | 40 | 101 | 920 | 0 | 0/0 | 3 | |
| 4 | 26 | 28 | 40 | 97 | 922 | 0 | 0/0 | 0 | |
| 5 | 29 | 23 | 40 | 96 | 909 | 0 | 0/0 | 7 | |
| 6 | 22 | 17 | 39 | 93 | 890 | 0 | 0/0 | 26 | |
| 7 | 9 | 8 | 39 | 90 | 903 | 0 | 0/0 | 19 | |
| 8 | 15 | 5 | 37 | 81 | 906 | 1 | 0/0 | 14 | |
| 9 | 13 | 4 | – | 87 | 901 | 1 | 0/0 | 9 | |
| 10 | 15 | 5 | 36 | 85 | 903 | 0 | 0/0 | 11 | |
| 11 | 13 | 8 | 35 | 90 | 903 | 0 | 0/0 | 18 | |
| 12 | 22 | 16 | 36 | 91 | 901 | 0 | 0/0 | 29 | |
| 13 | 16 | 14 | 35 | 90 | 897 | 0 | 0/0 | 10 | |
| 14 | 12 | 8 | – | 89 | 895 | 0 | 0/0 | 8 | |
| 15 | 8 | 2 | 36 | 89 | 900 | 0 | 0/0 | 8 | |
| 16 | 10 | 2 | 36 | 90 | 909 | 0 | 0/0 | 21 | |
| 17 | 24 | 8 | 37 | 90 | 911 | 0 | 0/0 | 20 | |
| 18 | 21 | 8 | 37 | 91 | 905 | 0 | 0/0 | 12 | |
| 19 | 17 | 10 | 39 | 94 | 905 | 0 | 0/0 | 2 | |
| 20 | 11 | 21 | 42 | 94 | 907 | 0 | 0/0 | 5 | |
| 21 | 15 | 27 | 47 | 101 | 909 | 0 | 0/0 | 12 | |
| 22 | 26 | 50 | 44 | 99 | //// | 2 | 0/0 | 20 | |
| 23 | 14 | 43 | 40 | 96 | 905 | 0 | 0/0 | 10 | |
| 24 | 22 | 37 | 43 | 97 | 904 | 0 | 0/0 | 4 | |
| 25 | 12 | 22 | 41 | 93 | 987 | 0 | 0/0 | 16 | |
| 26 | 10 | 14 | 42 | 92 | 903 | 0 | 0/0 | 10 | |
| 27 | 10 | 10 | 42 | 97 | //// | 1 | 0/0 | 9 | |
| 28 | 17 | 6 | 40 | 105 | 887 | 15 | 0/0 | 23 | |
| 29 | 12 | 18 | 42 | 99 | 890 | 2 | 2/0 | 14 | |
| 30 | 20 | 28 | 41 | 100 | 898 | 114 | 2/0 | 18 | |
| 31 | 24 | 34 | 40 | 99 | //// | 4 | 1/0 | 8 | |

**$R'_i$** : provisional international sunspot numbers from the S.I.D.C.

**PPSI** : prompt photometric sunspot index from the S.I.D.C. in 10-5 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 x Sn+10 x "1"+100 x ">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 DECEMBER 2004

| DATE | UT | NUMBER OF GROUPS | NUMBER OF SPOTS | RELATIVE SUNSPOT NUMBERS TOTAL | NORTH | SOUTH | CENTRAL | PPSI 10-5 WM-2 | QUAL | OBS |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 900 | 3 | 10 | 40 | 11 | 29 | 22 | 63.7 | 3 | OB |
| 3 | 915 | 3 | 13 | 43 | 14 | 29 | 14 | 24.1 | 3 | OB |
| 4 | 1355 | 3 | 7 | 37 | 12 | 25 | 12 | 16.5 | 2 | FC |
| 8 | 1418 | 2 | 3 | 23 | 11 | 12 | 0 | 1.6 | 3 | OB |
| 9 | 1245 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 2 | OB |
| 14 | 1400 | 1 | 6 | 16 | 16 | 0 | 0 | 0.4 | 3 | OB |
| 15 | 940 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 1 | OB |
| 16 | 900 | 1 | 1 | 11 | 0 | 11 | 0 | 0.2 | 2 | OB |
| 18 | 949 | 2 | 5 | 25 | 0 | 25 | 0 | 2.7 | 2 | DB |
| 19 | 1042 | 1 | 2 | 12 | 0 | 12 | 0 | 3.0 | 2 | VI |
| 20 | 855 | 1 | 7 | 17 | 0 | 17 | 0 | 3.9 | 3 | OB |
| 21 | 915 | 2 | 7 | 27 | 0 | 27 | 16 | 5.3 | 3 | OB |
| 23 | 1015 | 1 | 13 | 23 | 0 | 23 | 23 | 23.1 | 2 | OB |
| 24 | 1000 | 1 | 7 | 17 | 0 | 17 | 17 | 22.2 | 2 | OB |
| 25 | 1200 | 1 | 8 | 18 | 0 | 18 | 0 | 18.3 | 2 | AZ |
| 26 | 1100 | 1 | 4 | 14 | 0 | 14 | 0 | 3.8 | 2 | AZ |
| 27 | 1050 | 3 | 4 | 34 | 0 | 34 | 22 | 3.1 | 2 | AZ |
| 28 | 1350 | 2 | 6 | 26 | 13 | 13 | 0 | 3.9 | 2 | DB |
| 29 | 1230 | 1 | 4 | 14 | 14 | 0 | 0 | 17.2 | 1 | FC |

The relative mean sunspot number is 20.9.

---

NORMALISED UCCLE OBSERVATIONAL SUNSPOT NUMBERS U'=K'U FOR DECEMBER 2004

K'= 0.868 (*)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *** | 7 | *** | 13 | *** | 19 | 10 | 25 | 16 |
| 2 | 35 | 8 | 20 | 14 | 14 | 20 | 15 | 26 | 12 |
| 3 | 37 | 9 | 0 | 15 | 0 | 21 | 23 | 27 | 30 |
| 4 | 32 | 10 | *** | 16 | 10 | 22 | *** | 28 | 23 |
| 5 | *** | 11 | *** | 17 | *** | 23 | 20 | 29 | 12 |
| 6 | *** | 12 | *** | 18 | 22 | 24 | 15 | 30 | *** |
| | | | | | | | | 31 | *** |

The normalised relative monthly mean sunspot number is 18.

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

---

The Sun has been observed 19 days on 31 possible.

---

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

| Uccle Nø | East Limb Date | Date and type 1st obs | CMP | Last obs | West Limb Date |
|---|---|---|---|---|---|
| 13-2023 | 11 23.4 | 24 C | 11 30.2 | 4 D | 12 6.9 |
| 1-2025 | 12 27.6 | 28 D | 1 3.3 | 29 E | 1 10.1 |

---

PROBABLE RETURN OF MAJOR GROUPS FOR JANUARY 2005

| Nø | New East Limb | New CMP | New West Limb |
|---|---|---|---|
| 13 | 12 20.4 | 12 27.2 | 1 2.9 |

## MONTHLY SUMMARY OF SOLAR AND GEOMAGNETIC ACTIVITY

## *I. Solar Activity*

*During most of December, solar activity was low. Some isolated M-flares with full halo CMEs occurred in the first few days in Catania sunspot group 79 (NOAA 0708). From Dec 03 to Dec 28 we saw only occasional bursts of C-flares. During the last 3 days of the month, Catania sunspot groups 90 (NOAA 0713) and 98 (NOAA 0715) were responsible for a small firework of flares, with as biggest event an M4.2 on Dec 30. All this was leading to a much larger X1.7 flare that happened just after the month finished.*

In the first few days of December, solar activity was moderate with two isolated long-duration M-flares on Dec 01 and 02. Both flares were produced by Catania sunspot group 79 (NOAA 0708), which was the dominant active region, although it consisted only of a single medium-size sunspot. Both flares had associated CMEs, of which the Dec 02 event was a fast full halo CME. The other active regions in existence at the time only produced occasional C flares. On Dec 03, Catania 79 stopped flaring and the sun became very, with only isolated B flares. By Dec 08, the solar X-ray background had dropped to the bottom of the B-level.

This period of very low activity was briefly interrupted by three C-flares on Dec 08-09. The largest of these was a C2.5, peaking at 19:59UT on Dec 08 and originating from sunspot group 84 (NOAA 0709) near the central meridian. A type II/1 radio burst was measured. A first part of a prominence located at the neutral line of the sunspot group erupted and was accompanied by a large EIT dimming and full halo CME. After these events, the sun became very quiet again; the X-ray background now sunk to the A-level. No more C-flares were observed until Dec 19. Only some small sunspot groups were visible during this period after Catania 79 had rotated over the west limb on Dec 09. A halo CME was observed by LASCO on Dec 15 at 17h36 UT, but it was determined to be backsided.

On Dec 16, Catania sunspot group 90 (NOAA 0713) appeared on the east limb. It became the dominant active region and broke the very quiet period with a C1.9 flare on Dec 19. During the next few days the group remained quiet, but it developed into a beta-gamma magnetic configuration on Dec 21 (until Dec 24). On Dec 22-23, it produced 4 C-flares, the strongest one being a C5.1. On Dec 24, prominence eruptions in the southeast and northwest quadrants (both from spotless plage areas) produced a very long duration C1.8 flare and spectacular CMEs. From Dec 24, Catania 90, which was the only noteworthy group, was in decay and the sun was therefore quiet again on Dec 25-27. However, on Dec 28 and 29, Catania 90 was re-activated, releasing a small firework of C-flares and finally an M1.4 flare before rotating over the edge. At the same time, Catania sunspot group 98 (NOAA 0715) appeared at the east limb. This group had a beta-gamma-delta magnetic classification and generated C-class flares from Dec 28 onwards. It soon make clear that despite its limited size it had even more in stock, producing a sequence of 4 M-class flares and finally an X1.7 in the first hour of the New Year. All of these flares were accompanied by CMEs, but these were mostly oriented to the east and did not reach the earth.

Low-latitude coronal holes passed the central meridian on Dec 01 (very elongated trans-equatorial hole), Dec 04 (small hole at the equator), Dec 12 (large hole in the north), Dec 20 (narrow coronal hole in the south) and on Dec 23 (in the north). The elongated trans-equatorial coronal hole returned near the central meridian on Dec 28; the equatorial hole on Dec 31.

No proton events were observed in December 2004, though there was a small enhancement of the >10MeV component on Dec 03.

## *II. Geomagnetic Activity*

*This month was mainly characterized by the influence of many coronal holes passing geo-effective position, although two small shocks also perturbed the geomagnetic field. In all, this lead to a mixture of quiet and active conditions with brief minor storms on Dec 6, 11-12 and 28.*

The month started quietly in the wake of a fast solar wind stream that had reached a maximum of 620km/s on Nov 30. The solar wind speed declined continuously to a minimum of 300km/s on Dec 04. The geomagnetic field was still unsettled on Dec 01 but it became very quiet from Dec 02 to Dec 04. On Dec 05, a shock was recorded by the ACE spacecraft at 07:04UTC, marking the arrival of the Dec 03 full halo CME. This disturbance initially had a weak geomagnetic impact and only produced a brief active period on Dec 05. Indeed, although the IMF reached 25nT, Bz remained strongly positive and the solar wind speed did not exceed 450km/s. But later, on Dec 06 and in the morning of Dec 07, we experienced active to minor storm conditions.

On Dec 11 and 12, we had another minor geomagnetic storm also caused by the arrival of a shock at 13:00UT on Dec 11. The shock was formed by the CME of Dec 08. On Dec 13, geomagnetic conditions turned quiet until Dec 16 when the first signatures of a co-rotating interaction region linked to the large northern hemisphere coronal hole were observed in the solar wind. The solar wind speed increased to values slightly above 600 km/s on Dec 17 and 18. The south component of the interplanetary magnetic field oscillated around zero with negative excursions down to almost -10 nT. This caused intermittent active geomagnetic conditions from late on Dec 16 late until noon on Dec 18. On Dec 19, the solar wind speed was decreasing again, indicating the end of the influence of this large recurrent coronal hole.

On Dec 21-22 the Earth passed again through an interaction region between fast and slow solar wind flows. This interplanetary disturbance contained relatively strong southward interplanetary magnetic field, so the estimated NOAA Kp index reached 5 twice (though the K-index in Niemegk and Wingst stayed at 4). The fast flow was produced by the narrow low-latitude coronal hole in the southern hemisphere. Another fast solar wind flow arrived on Dec 25. It contained intervals of southward interplanetary magnetic field, leading again to active conditions. This fast flow was produced by the low-latitude coronal hole in the northern hemisphere. The Bz component of the interplanetary magnetic field inside the fast flow was weak and oscillating near zero, so the geomagnetic conditions were quiet again on Dec 26 and 27.

On Dec 28-29 a persistent southward pointing interplanetary magnetic field induced active conditions (K=4) with a brief minor storm period, although the solar wind speed was low at 450km/s. On Dec 30 the solar wind speed increased to 550km/s, but now the IMF was no longer strongly southwards, so again only active conditions were observed, becoming quiet on Dec 31.

## ***III. Noticeable solar events***

| DAY | BEGIN | MAX | END | LOC | XRAY | OP | 10CM | RADIO TYPE | 600 (Humain) | Cat | NOAA | NOTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 0700 | 0720 | 0741 | N07E20 | M1.1 | SN | 130 | IV/1 | | 79 | 0708 | Halo CME |
| 02 | 2344 | 0006 | 0035 | N08W02 | M1.5 | | 520 | III/1,II/2,IV/2, III/3 | | 79 | 0708 | SXI-derived loc., Halo CME |
| 29 | 1557 | 1627 | 1638 | N04E62 | M2.3 | | 510 | III/2,II/1 | | 98 | 0715 | SXI-derived loc., CME |
| 29 | 1910 | 1920 | 1925 | S12W90 | M1.4 | | | | | 90 | 0713 | |
| 30 | 1034 | 1047 | 1057 | N03E53 | M2.2 | SF | 230 | III/1,II/1 | | 98 | 0715 | CME (EIT wave) |
| 30 | 2202 | 2218 | 2228 | N03E48 | M4.2 | 2N | 230 | II/1 | | 98 | 0715 | CME (EIT wave) |
| 31 | 1438 | 1445 | 1448 | N04E38 | M1.2 | | 36 | III/2 | | 98 | 0715 | SXI-derived loc., CME |

**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