



Sunspot Index and Long-term Solar Observations

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SUNSPOT BULLETIN

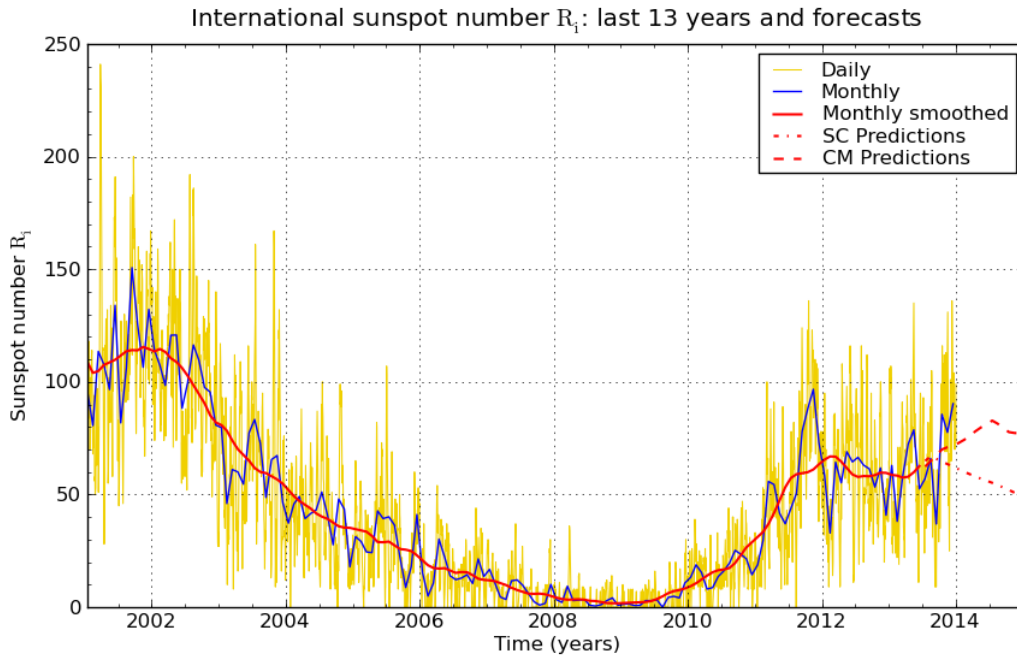
2013

n° 12

Provisional international and normalized hemispheric daily sunspot numbers for December 2013

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 | 90 | 18 | 72 |
| 2 | 101 | 16 | 85 |
| 3 | 80 | 0 | 80 |
| 4 | 85 | 0 | 85 |
| 5 | 80 | 0 | 80 |
| 6 | 71 | 0 | 71 |
| 7 | 65 | 0 | 65 |
| 8 | 69 | 0 | 69 |
| 9 | 103 | 30 | 73 |
| 10 | 136 | 45 | 91 |
| 11 | 128 | 46 | 82 |
| 12 | 110 | 43 | 67 |
| 13 | 105 | 50 | 55 |
| 14 | 98 | 50 | 48 |
| 15 | 98 | 47 | 51 |
| 16 | 83 | 28 | 55 |
| 17 | 88 | 19 | 69 |
| 18 | 102 | 18 | 84 |
| 19 | 102 | 27 | 75 |
| 20 | 104 | 24 | 80 |
| 21 | 102 | 22 | 80 |
| 22 | 83 | 8 | 75 |
| 23 | 81 | 0 | 81 |
| 24 | 79 | 0 | 79 |
| 25 | 70 | 0 | 70 |
| 26 | 75 | 0 | 75 |
| 27 | 77 | 0 | 77 |
| 28 | 73 | 0 | 73 |
| 29 | 90 | 8 | 82 |
| 30 | 73 | 0 | 73 |
| 31 | 99 | 8 | 91 |
| Monthly mean | 90.3 | 16.4 | 73.9 |
| Cooperating stations | 67 | 60 | 60 |



SILSO graphics (<http://sidc.be>) Royal Observatory of Belgium 01/01/2014

Predictions of the monthly smoothed Sunspot Number
using the last provisional value, calculated for June 2013: 62.6 ($\pm 5\%$)

| | | SM | CM | | | SM | CM | | | SM | CM |
|------|-----|----|----|------|-----|----|----|------|-----|----|----|
| 2013 | Jul | 65 | 62 | 2014 | Jan | 61 | 73 | 2014 | Jul | 55 | 83 |
| | Aug | 67 | 65 | | Feb | 60 | 74 | | Aug | 54 | 81 |
| | Sep | 66 | 67 | | Mar | 59 | 76 | | Sep | 53 | 79 |
| | Oct | 65 | 70 | | Apr | 58 | 78 | | Oct | 52 | 78 |
| | Nov | 64 | 71 | | May | 57 | 80 | | Nov | 51 | 77 |
| | Dec | 62 | 72 | | Jun | 56 | 81 | | Dec | 50 | 77 |

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 method 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

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Editor: Frédéric Clette
3, avenue Circulaire, B-1180 Bruxelles, Belgium
Fax: +32(0)2/374.98.22 Tel: +32(0)2/373.02.33 E-mail: arille@oma.be frederic.clette@oma.be

Web: <http://sidc.oma.be/silso>
FTP anonymous : [omaftp.oma.be](ftp://omaftp.oma.be), directory: dist/astro/sidcdata

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

| Date | R' _i | PPSI | 600 | 2800 | COS | SFI | XI | Ak | SEA |
|------|-----------------|------|-----|------|------|-----|-----|-------|-----|
| 30 | 65 | 74 | - | /// | //// | /// | /// | (///) | |
| 1 | 90 | 92 | - | 131 | //// | 0 | 0/0 | 9 | |
| 2 | 101 | 82 | - | 134 | //// | 0 | 0/0 | 0 | |
| 3 | 80 | 59 | - | 136 | //// | 0 | 0/0 | 12 | |
| 4 | 85 | 64 | - | 138 | //// | 1 | 0/0 | 5 | |
| 5 | 80 | 56 | - | 150 | //// | 2 | 0/0 | 4 | |
| 6 | 71 | 71 | - | 151 | //// | 4 | 0/0 | 4 | |
| 7 | 65 | 59 | - | 157 | //// | 12 | 1/0 | 8 | |
| 8 | 69 | 51 | - | 166 | //// | 2 | 0/0 | 27 | |
| 9 | 103 | 69 | - | 168 | //// | 1 | 0/0 | 5 | |
| 10 | 136 | 91 | - | 175 | //// | 3 | 0/0 | 3 | |
| 11 | 128 | 122 | - | 171 | //// | 4 | 0/0 | 4 | |
| 12 | 110 | 114 | - | 165 | //// | 3 | 0/0 | 1 | |
| 13 | 105 | 145 | - | 163 | //// | 3 | 0/0 | 3 | |
| 14 | 98 | 157 | - | 164 | //// | 6 | 0/0 | 20 | |
| 15 | 98 | 185 | - | 156 | //// | 2 | 0/0 | 6 | |
| 16 | 83 | 108 | - | 154 | //// | 2 | 0/0 | 6 | |
| 17 | 88 | 102 | - | 159 | //// | 2 | 0/0 | 5 | |
| 18 | 102 | 99 | - | 156 | //// | 1 | 0/0 | 3 | |
| 19 | 102 | 115 | - | 153 | //// | 2 | 0/0 | 6 | |
| 20 | 104 | 115 | - | 149 | //// | 1 | 1/0 | 7 | |
| 21 | 102 | 123 | - | 144 | //// | 12 | 0/0 | 2 | |
| 22 | 83 | 98 | - | 138 | //// | 39 | 6/0 | 0 | |
| 23 | 81 | 99 | - | 136 | //// | 23 | 1/0 | 2 | |
| 24 | 79 | 98 | - | 128 | //// | 0 | 0/0 | 2 | |
| 25 | 70 | 63 | - | 123 | //// | 2 | 0/0 | 6 | |
| 26 | 75 | 76 | - | 125 | //// | 1 | 0/0 | 2 | |
| 27 | 77 | 73 | - | 131 | //// | 5 | 0/0 | 2 | |
| 28 | 73 | 73 | - | 135 | //// | 8 | 0/0 | 2 | |
| 29 | 90 | 58 | - | 137 | //// | 21 | 1/0 | 5 | |
| 30 | 73 | 49 | - | 143 | //// | 3 | 0/0 | 2 | |
| 31 | 99 | 74 | - | 145 | //// | 106 | 1/0 | 6 | |

- 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 : $1 \times \text{Sn} + 10 \times "1" + 100 \times ">1"$).
- 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 DECEMBER 2013

| DATE | UT | NUMBER | | RELATIVE SUNSPOT NUMBERS | | | PPSI 10-5 | QUAL | OBS | |
|------|------|-----------|----------|--------------------------|-------|-------|-----------|-------|-----|---------|
| | | OF GROUPS | OF SPOTS | TOTAL | NORTH | SOUTH | | | | CENTRAL |
| 1 | 930 | 7 | 53 | 123 | 27 | 96 | 70 | 77.5 | 3 | OL |
| 2 | 945 | 7 | 34 | 104 | 13 | 91 | 66 | 45.2 | 2 | OB |
| 3 | 910 | 5 | 20 | 70 | 0 | 70 | 31 | 28.4 | 3 | OB |
| 6 | 1130 | 6 | 40 | 100 | 0 | 100 | 41 | 41.4 | 2 | LL |
| 8 | 1225 | 5 | 30 | 80 | 0 | 80 | 11 | 28.3 | 1 | LL |
| 9 | 1030 | 11 | 30 | 140 | 47 | 93 | 46 | 37.1 | 2 | AE |
| 10 | 920 | 11 | 38 | 148 | 61 | 87 | 26 | 58.1 | 2 | OL |
| 11 | 900 | 10 | 28 | 128 | 49 | 79 | 41 | 76.1 | 2 | AE |
| 12 | 1200 | 9 | 30 | 120 | 52 | 68 | 40 | 55.7 | 2 | AE |
| 13 | 930 | 9 | 39 | 129 | 56 | 73 | 93 | 87.5 | 2 | AE |
| 14 | 1030 | 9 | 39 | 129 | 65 | 64 | 106 | 75.0 | 2 | OB |
| 16 | 1000 | 6 | 12 | 72 | 23 | 49 | 34 | 40.3 | 1 | OB |
| 18 | 1145 | 10 | 42 | 142 | 23 | 119 | 47 | 59.1 | 2 | OL |
| 19 | 1205 | 9 | 46 | 136 | 35 | 101 | 69 | 115.6 | 3 | OL |
| 20 | 950 | 9 | 55 | 145 | 34 | 111 | 69 | 122.0 | 2 | OL |
| 23 | 1000 | 5 | 16 | 66 | 0 | 66 | 24 | 72.1 | 1 | AE |
| 25 | 940 | 6 | 21 | 81 | 0 | 81 | 44 | 15.3 | 2 | OL |
| 29 | 1215 | 6 | 37 | 97 | 11 | 86 | 30 | 12.1 | 3 | AE |
| 30 | 945 | 5 | 41 | 91 | 0 | 91 | 59 | 33.5 | 2 | OL |
| 31 | 1130 | 8 | 48 | 128 | 11 | 117 | 38 | 88.9 | 3 | OL |

The relative mean sunspot number is 111.4.

NORMALISED UCCLE OBSERVATIONAL SUNSPOT NUMBERS $U'=K'U$ FOR DECEMBER 2013

$$K' = 0.868 (*)$$

| | | | | | | | | | |
|---|-----|----|-----|----|-----|----|-----|----|-----|
| 1 | 107 | 7 | *** | 13 | 112 | 19 | 118 | 25 | 70 |
| 2 | 90 | 8 | 69 | 14 | 112 | 20 | 126 | 26 | *** |
| 3 | 61 | 9 | 122 | 15 | *** | 21 | *** | 27 | *** |
| 4 | *** | 10 | 128 | 16 | 62 | 22 | *** | 28 | *** |
| 5 | *** | 11 | 111 | 17 | *** | 23 | 57 | 29 | 84 |
| 6 | 87 | 12 | 104 | 18 | 123 | 24 | *** | 30 | 79 |
| | | | | | | | | 31 | 111 |

The normalised relative monthly mean sunspot number is 97.

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

The Sun has been observed 20 days on 31 possible.