Solar Influences Data analysis Center

Data Analysis Service supported by the FAGS

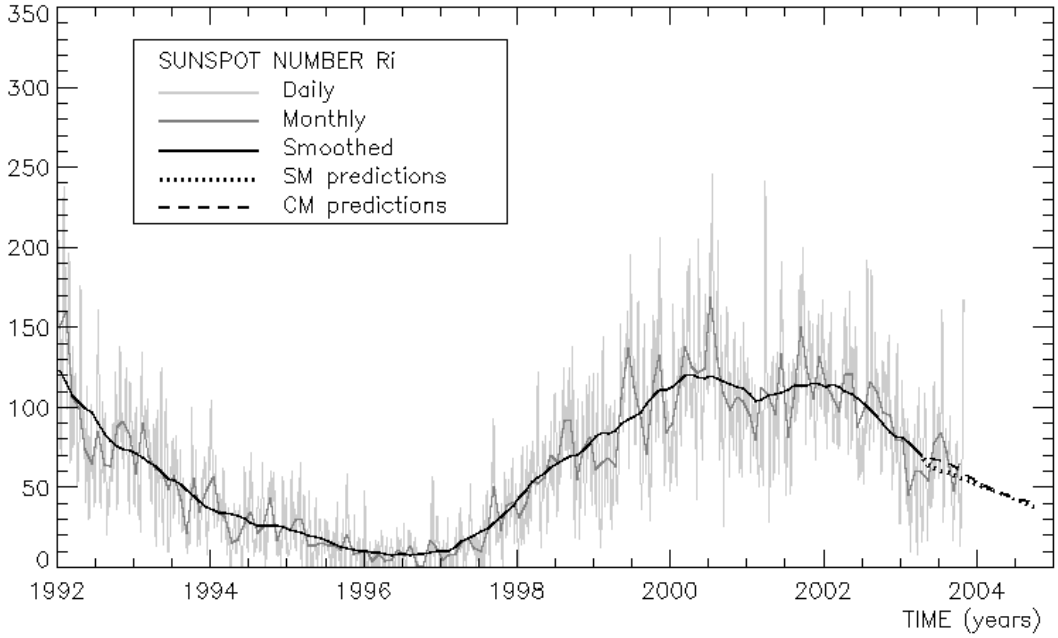
SUNSPOT BULLETIN

2003 n°10

Provisional international and normalized hemispheric daily sunspot numbers for October 2003

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

Date	R'_I	R'_N	R'_S
1	76	17	59
2	68	15	53
3	62	8	54
4	49	0	49
5	57	0	57
6	41	0	41
7	41	0	41
8	43	0	43
9	47	10	37
10	45	13	32
11	41	15	26
12	25	9	16
13	13	0	13
14	13	0	13
15	13	13	0
16	19	10	9
17	30	16	14
18	41	25	16
19	41	34	7
20	47	38	9
21	59	38	21
22	58	37	21
23	61	36	25
24	75	46	29
25	88	48	40
26	89	45	44
27	133	61	72
28	165	71	94
29	167	66	101
30	167	50	117
31	160	54	106
Monthly mean	**65.6**	**25.0**	**40.6**
Cooperating stations	**40**	**36**	**36**



Predictions of the monthly smoothed Sunspot Number
using the last provisional value, calculated for April 2003 : 70.3 (± 5%)

	SM	CM		SM	CM		SM	CM
2003 May	66	70	2003 Nov	60	58	2004 May	51	46
Jun	64	68	Dec	58	56	Jun	49	45
Jul	67	67	2004 Jan	57	53	Jul	48	43
Aug	65	66	Feb	55	51	Aug	46	42
Sep	63	64	Mar	54	49	Sep	45	41
Oct	61	61	Apr	52	48	Oct	43	40

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, November 1, 2003 10:04 UT

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

Date	R'_i	PPSI	600	2800	COS	SFI	XI	Ak	SEA
30	66	81	49	133	////	15	0/0	6	
1	76	80	49	137	////	13	1/0	17	
2	68	65	46	125	////	13	0/0	10	
3	62	60	44	120	////	2	0/0	17	
4	49	66	43	119	////	1	1/0	7	
5	57	69	43	110	////	3	0/0	8	
6	41	61	45	112	////	0	0/0	10	
7	41	73	43	112	////	0	0/0	18	
8	43	81	46	113	////	0	0/0	8	
9	47	36	44	111	////	0	0/0	8	
10	45	30	43	112	////	0	0/0	3	
11	41	25	44	106	////	0	0/0	3	
12	25	9	43	98	////	0	0/0	6	
13	13	4	42	94	////	0	0/0	23	
14	13	3	41	92	////	0	0/0	56	
15	13	4	41	96	////	1	0/0	39	
16	19	7	41	95	////	1	0/0	32	
17	30	6	42	99	////	0	0/0	26	
18	41	22	43	109	////	28	0/0	26	
19	41	46	45	120	////	29	2/1	40	
20	47	132	49	135	////	17	1/0	38	
21	59	271	53	152	////	8	1/0	48	
22	58	254	53	154	////	17	7/0	35	
23	61	283	52	183	////	36	3/2	5	
24	75	233	56	191	////	39	4/0	40	
25	88	390	62	222	////	108	3/0	20	
26	89	474	66	298	////	213	2/2	14	
27	133	467	-	257	////	130	5/0	12	
28	165	595	-	274	////	268	0/1	28	
29	167	601	-	279	////	131	2/1	22	
30	167	831	-	271	////	21	2/0	85	
31	160	616	61	249	////	12	2/0	40	

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 OCTOBER 2003

DATE	UT	NUMBER OF GROUPS	NUMBER OF SPOTS	RELATIVE SUNSPOT NUMBERS TOTAL	NORTH	SOUTH	CENTRAL	PPSI 10-3 WM-2	QUAL	OBS
2	1410	6	44	104	11	93	34	64.5	3	OB
4	930	5	52	102	0	102	72	89.4	3	OB
5	800	5	60	110	0	110	88	94.9	3	OB
7	1235	4	48	88	0	88	62	98.7	3	OB
8	830	4	32	72	11	61	35	93.7	2	OB
10	1400	4	26	66	11	55	14	50.0	2	OB
11	915	5	27	77	23	54	15	29.0	2	DB
12	830	3	6	36	11	25	12	2.6	2	DB
13	915	2	3	23	11	12	12	2.2	3	OB
14	930	1	2	12	0	12	0	1.8	3	OB
15	930	1	5	15	15	0	15	0.4	3	OB
16	816	2	4	24	12	12	0	0.5	3	ST
17	817	3	6	36	13	23	12	0.5	3	VI
18	1010	3	22	52	36	16	16	21.0	1	ST
19	935	3	35	65	54	11	0	13.0	2	ST
20	930	3	27	57	44	13	12	48.9	3	OB
22	915	3	76	106	79	27	93	66.7	3	OB
23	930	3	89	119	85	34	100	82.6	2	OB
24	1340	2	63	83	50	33	50	90.2	3	OB
25	1000	3	89	119	71	48	57	96.2	2	OB
27	1020	6	167	227	102	125	74	175.1	3	OB
28	940	7	225	295	112	183	215	201.3	3	OB
29	844	8	175	255	96	159	201	251.3	3	VI

The relative mean sunspot number is 93.2.

NORMALISED UCCLE OBSERVATIONAL SUNSPOT NUMBERS U'=K'U FOR OCTOBER 2003

K'= 0.831 (*)

1	***	7	73	13	19	19	54	25	99
2	86	8	60	14	10	20	47	26	***
3	***	9	***	15	12	21	***	27	189
4	85	10	55	16	20	22	88	28	245
5	91	11	64	17	30	23	99	29	212
6	***	12	30	18	43	24	69	30	***
								31	***

The normalised relative monthly mean sunspot number is 77.

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

The Sun has been observed 23 days on 31 possible.

UCCLE OBSERVATIONAL MAJOR SUNSPOT GROUPS FOR OCTOBER 2003

E AND F BRUNNER'S TYPE GROUPS

Uccle Nø	East Limb Date	Date and type 1st obs	CMP	Last obs	West Limb Date
19-2007	9 19.4	20 C	9 26.1	2 G	10 2.9
8-2008	9 29.7	2 E	10 6.5	12 J	10 13.2
1-2009	10 17.1	18 E	10 23.8	29 E	10 30.6
3-2009	10 22.0	23 E	10 28.8	29 E	11 4.5
4-2009	10 24.6	25 B	10 31.4	29 E	11 7.1
6-2009	10 21.8	27 E	10 28.6	29 F	11 4.3

PROBABLE RETURN OF MAJOR GROUPS FOR NOVEMBER 2003

Nø	New East Limb	New CMP	New West Limb
19	10 17.2	10 23.9	10 30.7
8	10 26.7	11 2.5	11 9.2
1	11 13.2	11 19.9	11 26.7
3	11 18.4	11 25.1	12 1.9
6	11 17.9	11 24.7	12 1.4

MONTHLY SUMMARY OF SOLAR AND GEOMAGNETIC ACTIVITY

I. Solar Activity

Solar activity varied over the full spectrum during October, ranging from very low activity in the beginning of the month to extremely high activity levels during the last 10 days. Many M-class and 7 X-class X-ray flares were observed, the largest being an X17 from Catania sunspot group 70 (NOAA 0486) on Oct 28, one of the largest flares on record. Several very large sunspot groups transited the solar disk. Catania sunspot groups 41 (NOAA 0464), 65 (NOAA 0484), 70 (NOAA 0486) and 75 (NOAA 0488) all grew to more than 0.1% of the solar disk. The largest of these, and also the largest sunspot group observed in the current solar cycle, was group 70, which grew to more than 0.25% of the solar disk.

Things were fairly quiet at the start of the month. Many C-class flares occurred, but the largest activity consisted of only two small M-flares. *Catania sunspot group 41 (NOAA 0464)* produced an M1.4 on Oct 01 and was the dominant source of solar activity during the first few days. When it rotated over the west limb on Oct 03, attention shifted to Catania sunspot group 52 (NOAA 0471), which had appeared at the east limb on September 30. Also this group had a beta-gamma magnetic classification (with McIntosh type E), but was only about half the size of group 41. It generated about 10 C-flares and an M1 flare (on Oct 04).

From Oct 10 until Oct 17, solar activity was reduced to almost nothing: some small ripples superposed on a background X-ray flux situated at the bottom of the B-range. Starting on Oct 18, solar activity increased gradually due to the apparition of *Catania sunspot group 65 (NOAA 0484)* at the east limb (its position on the solar disk more or less coinciding with the magnetic complex housing the former group 41). This group, with a gamma-beta-delta configuration, started its major flaring sequence on Oct 19 with an M1.9 flare at 06:26UT, an X1.1 flare at 16:50UT and an M1.0 flare at 19:26 UT, the start of a period of extreme solar and space weather activity. This sunspot group covered at its maximum extent 0.14 % of the total disk area. It produced a total of 16 M-flares and 2 X-flares before rotating off disk on Oct 30.

A second big sunspot group, *Catania 70 (NOAA 0486)* appeared at the eastern limb of the solar disk on Oct 23. This group quickly grew to become the largest group of the current solar cycle (measuring more than 0.25% of the solar disk), and produced several of the largest flares on record. An extremely strong X17.2 flare occurred in this group on October 28 peaking at 11:10 UT. At the time this was the third-largest flare on record, but it was overtaken by an even larger flare from this group in November. Many of the flares occurred near the center of the solar disk and generated fast earth-directed CMEs, causing severe space weather conditions. These CME events and their consequences are described in the second section of this report.

Late on 26 Oct a proton event started at about 18 UT, due to an X1.2 flare from group 65. The >10 MeV proton flux exceeded the event threshold, while the >50 MeV proton flux nearly reached the threshold. At about 17 UT on 27 Oct this event ended. The next day however, the X17.2 flare from group 70 generated a severe particle storm: all the proton fluxes exceeded the threshold; by 00:00 UT on Oct 29 the >10 MeV proton flux exceeded 10000. On Oct 29 Catania 70 produced an X10.1 flare peaking at 20:49 UT. The proton fluxes increased again, thus prolongating the proton storm. Several subsequent M-flares maintained the >10 MeV proton flux above the threshold until the end of the month.

II. Geomagnetic Activity

At the start of the month, geomagnetic activity was mostly quiet, with a few brief periods of active conditions. On Oct 01 both Wingst and Izmiran reported K-indices of 5, but the estimated Kp index at SEC NOAA did not exceed 3 on this day. The solar wind speed remained below 400 km/s until Oct 02. It then gradually rose under the influence of a trans-equatorial coronal hole, reached 500km/s early

on Oct 03 and remained at this value until late on Oct 04, when it started to decrease again. The interplanetary magnetic field was mostly northwards during these days, and the enhanced solar wind speed only led to short spells of active conditions late on Oct 03 and late on Oct 05. On Oct 06 the solar wind speed started to increase to a maximum of 700 km/s just before midnight and remained high until Oct 09. In this period, the interplanetary magnetic field carried by the solar wind was strongly fluctuating from positive to negative values. This led to occasional active conditions (K-indices of 4 in Wingst and Izmiran) from Oct 06 until Oct 09. Thereafter the solar wind speed decreased to 300km/s (by Oct 12) and geomagnetic conditions became quiet.

Thereafter, the solar wind speed was dominated by two coronal holes. A first small equatorial coronal hole made the solar wind speed increase from Oct 13 onwards. On Oct 14 the influence from a large hole with 2 imbedded weak loop systems was visible. The combination of the increased speed and an IMF that was strongly pointing southward led to strong geomagnetic perturbations. Wingst reported a peak K-index of 7 late on Oct 14. Minor storm conditions persisted until Oct 17, followed by active conditions until Oct 19. Late on Oct 19, geomagnetic activity increased again to minor storm conditions, still under the influence of the trans-equatorial coronal hole. Also on Oct 20-21, active to minor storm conditions were observed. On 22 Oct the coronal hole left its geo-effective position, but on the same day, the earth experienced a minor geomagnetic storm following the arrival of the CME which had left the Sun on Oct 19. During the rest of the month, many more earth-directed CMEs were observed. The most relevant ones are listed below:

1) A partial halo CME on Oct 19 was first seen in the north-east quadrant of LASCO/C2 at 17:08 UT. It was probably associated with the X1.1 flare from Catania sunspot group 65. Both an EIT wave and coronal dimming were observed in conjunction with this event. This halo CME resulted in a minor geomagnetic storm on Oct 22.
2) A full halo CME on Oct 21 was first visible in the SE from 03:54 UT. It wasn't clear whether this event was front- or back-sided, but in any case it didn't generate any geomagnetic perturbation.
3) On Oct 22 a partial (almost full) halo CME was reported by LASCO, starting at 07:54 UT. It was probably related to the flaring activity (at C and M levels) in and around sunspot group 65, and therefore was regarded as front sided. This CME was probably overtaken by the fast one following it.
4) A full halo CME on Oct 23 was first observed in LASCO/C2 at 08:54 UT. The mean plane-of-sky speed for this event was 1110 km/s. The CME was probably associated with the X5.4 flare from Catania sunspot group 70. A very large EIT wave and coronal dimming were observed in association with this event. This event caused a major geomagnetic storm after the arrival of a shock on Oct 24.
5) On Oct 26 a CME was visible in LASCO/C2 at about 01:31 UT. It was most likely related to a large prominence eruption clearly visible in all EIT images. The prominence was situated to the southwest of Catania 70.
6) On Oct 26, while the previous CME was still in progress, a fast partial halo CME developed at the West limb. It was first seen in LASCO/C2 at 06:54 UT and was probably related to the X1.2 X-ray burst in Catania 70 (NOAA 0486). The shock registered by the ACE spacecraft around 03:00 UT on Oct 28 was probably due to this CME.
7) On Oct 26 at the end of the UT day a third CME was visible in LASCO, this time at the East limb. It was first visible in LASCO/C2 at 17:54 UT and had developed into a full halo by 18:36 UT. This CME escaped just after the X1.2 flare in Catania 65 (NOAA 0484) with peak emission at 18:36.
8) The X17.2 flare from Catania 70 on Oct 28 was accompanied by strong coronal dimmings and an EIT wave indicating the onset of a CME. This full halo CME was first seen in LASCO/C2 at 10:54 UT and had an estimated plane-of-the-sky speed of about 2125 km/s. As the CME was extremely fast, the shock arrived to the earth around 06:00 UT on Oct 29. The ACE/SWEPAM data were not available at this moment (due to the particle storm), but the magnetic field measurements showed the strong jump of the magnetic field at the arrival of the

shock. The Bz component of the magnetic field reached about -50 nT, thus producing a ***severe magnetic storm*** with the Kp index reaching 9 on Oct 29-30.

9) On Oct 29 Catania 70 produced an X10.1 flare peaking at 20:49 UT. Again, EIT wave and coronal dimmings were observed, and the full halo CME appeared in the LASCO C2 field of view at 20:54 UT with an estimated plane-of-the-sky speed of about 1950 km/s. The shock arrived around 16:00 UT on Oct 30. A severe geomagnetic storm started right after the arrival of the shock (Kp reached 9 again) and continued on Oct 31.

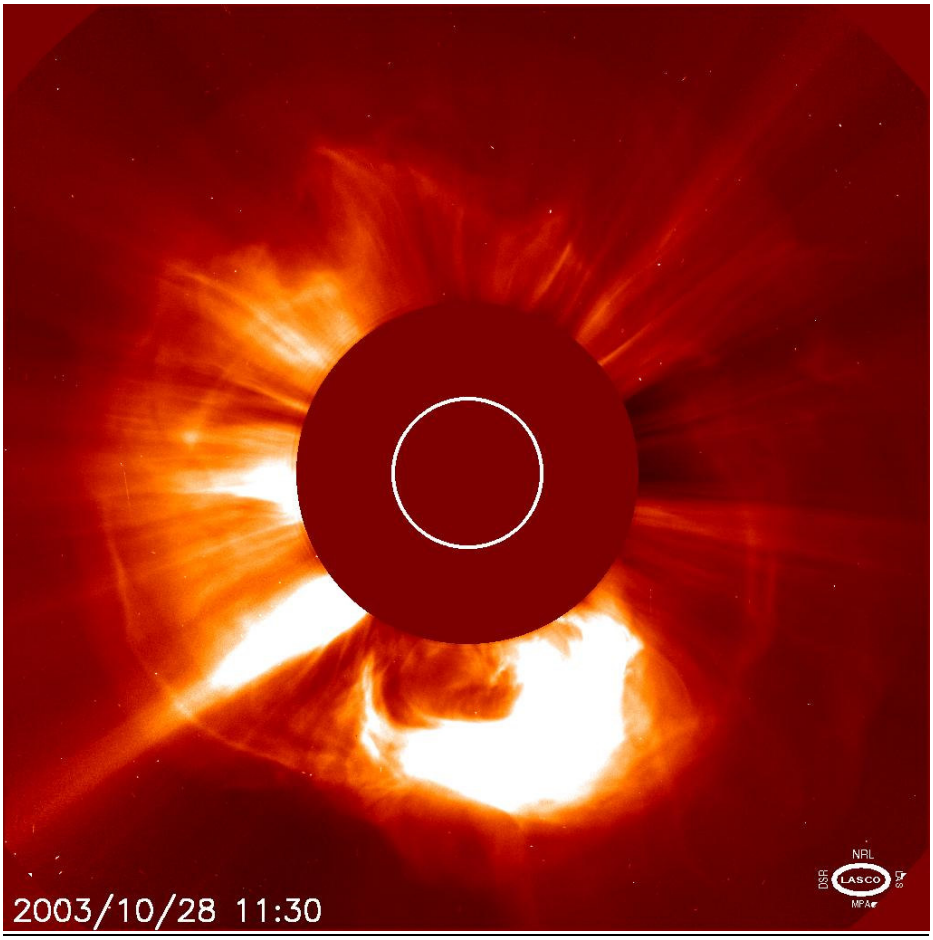
III. Noticeable solar events

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	RADIO TYPE	600 (Humain)	Cat	NOAA	NOTE
01	0444	0451	0459	N05W57	M1.4	1F				41	0464	
04	1542	1547	1549	S10E29	M1.0	SF	22			52	0471	
19	0608	0626	0641	N07E65	M1.9	1F	37	III/2		65	0484	EIT derived loc
19	1629	1650	1704	N08E56	X1.1	1N	510	II/1,CTM/1		65	0484	CME
19	1921	1926	1930	N05E54	M1.0	SF				65	0484	
20	0644	0722	0800	NO6E48	M1.9	1N				65	0484	EIT derived loc
21	0823	0827	0833	N02E34	M1.0	SF	35			65	0484	EIT derived loc
21	1922	2330	0305	S18E87	M2.4					70	0486	EIT derived loc
22	0328	0351	0521	S13E88	M3.7	SF	320	III/3		70	0486	EIT derived loc
22	0830	0844	0853	S16E88	M1.7					70	0486	EIT derived loc
22	0937	0956	0959	S18E88	M1.7			II/1		70	0486	EIT derived loc
22	1506	1511	1513	N05E22	M1.4	SN		III/2	1509	65	0484	
22	1557	1601	1604	N03E17	M1.2	SN		III/3		65	0484	
22	1947	2007	2028	S18E78	M9.9	SF	240			70	0486	
22	2156	2204	2217	S16E88	M2.1					70	0486	EIT derived loc
23	0235	0241	0244	N03E15	M2.4	SN	54	III/3		65	0484	
23	0704	0708	0711	N04E13	M3.2	1N	150	III/3	0706	65	0484	EIT derived loc
23	0808	0835	0900	S18E87	X5.4	1B	1500	II/3	0827	70	0486	EIT der. loc, halo CME
23	1049	1053	1055	N04E10	M2.7		130	III/2		65	0484	EIT derived loc
23	1549	1622	1640	S17E82	M1.0					70	0486	EIT derived loc
23	1950	2004	2014	S17E84	X1.1	1N	77			70	0486	
24	0223	0253	0320	S18E80	M7.6	1N	73	IV/2		70	0486	EIT derived loc
24	0504	0510	0518	S22E78	M4.2	1F	91			70	0486	EIT derived loc
24	1842	1856	1905	S19E68	M1.3					70	0486	EIT derived loc
24	2135	2140	2145	N05W09	M1.0	1N		III/3		65	0484	
25	0417	0446	0528	S14E45	M1.2	2N	64	III/1		70	0486	EIT derived loc
25	0544	0553	0625	N00W15	M1.7	SF	130	III/2,II/1		70	0486	EIT derived loc
25	1027	1035	1051	N03W20	M1.5	SF	220		1029	65	0484	
26	0555	0654	0733	S15E43	X1.2	3B	4000	CTM/1,VI/3 III/3,II/3	0733,0842	70	0486	EIT derived loc
26	1415	1420	1424	N05W33	M1.0	SF				65	0484	
26	1721	1819	1921	N02W38	X1.2	1N	2000	CTM/1,II/2		65	0484	
26	2134	2140	2148	N01W38	M7.6	2N	57	III/2		65	0484	
27	0412	0439	0508	N00W44	M1.2	SF				65	0484	
27	0750	0833	0924	N00W48	M2.7	2F	1100	III/3,IV/1	0806, 0825,0848	65	0484	EIT derived loc
27	0922	0927	0937	S16E26	M5.0	SF	65	III/1		70	0486	EIT derived loc
27	1227	1243	1252	S17E25	M6.7	SF	59	III/2		70	0486	
27	2146	2151	2205	N08E09	M1.9	SN		III/3		75	0488	
28	1018	1110	1145	S18E20	X17	4B	13000	IV/3, II/3	1044, 1117,1153	70	0486	EIT der. loc, halo CME
29	0026	0151	0208	S16E10	M1.1	1F	63			70	0486	
29	0408	0511	0554	S17E06	M3.7	SN	610	IV/1		70	0486	EIT derived loc
29	2037	2049	2101	S15W02	X10	2B	2500	II/3,III/3,IV/2		70	0486	halo CME
30	0156	0207	0229	N06W20	M1.6	1F				75	0488	EIT derived loc
30	1515	1528	1537	S15W18	M1.5		29			70	0486	EIT derived loc
31	0427	0433	0440	N06W89	M2.0		67	III/3		65	0484	EIT derived loc
31	0604	0616	0632	N07W30	M1.1	SF		III/1		75	0488	EIT derived loc

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 UT time of 600 Mhz radio bursts in Humain
Cat: Catania sunspot group identification
NOAA: NOAA active region identification
p: proton event
CME: Coronal Mass Ejection

IV Picture of the month



A LASCO/C2 image of the full halo CME accompanying the large X17.2 flare on Oct 28. LASCO is an instrument onboard the joint ESA/NASA mission SOHO.