Solar Influences Data analysis Center

Data Analysis Service supported by the FAGS

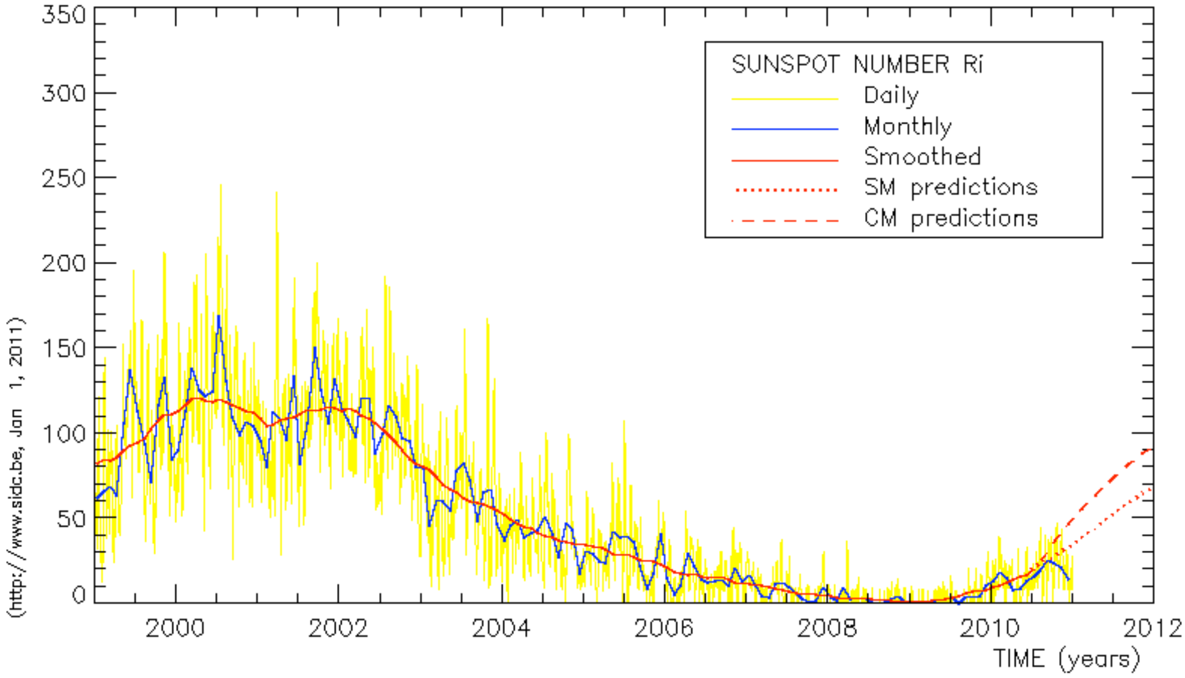
SUNSPOT BULLETIN

2010 n°12

Provisional international and normalized hemispheric daily sunspot numbers for December 2010

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	19	19	0
2	21	21	0
3	24	24	0
4	31	31	0
5	26	26	0
6	17	17	0
7	18	18	0
8	18	18	0
9	17	17	0
10	21	21	0
11	16	16	0
12	16	16	0
13	28	28	0
14	16	16	0
15	8	8	0
16	14	14	0
17	7	7	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	10	0	10
23	10	0	10
24	8	0	8
25	15	8	7
26	20	12	8
27	10	10	0
28	13	13	0
29	11	11	0
30	8	8	0
31	27	27	0
Monthly mean	**14.5**	**13.1**	**1.4**
Cooperating stations	**67**	**60**	**60**



Predictions of the monthly smoothed Sunspot Number
using the last provisional value, calculated for June 2010: 16. (± 5%)

	SM	CM		SM	CM		SM	CM
2010 Jul	17	20	2011 Jan	29	52	2011 Jul	45	75
Aug	17	26	Feb	31	56	Aug	48	79
Sep	20	31	Mar	34	60	Sep	51	82
Oct	22	37	Apr	37	64	Oct	54	85
Nov	24	42	May	39	68	Nov	57	88
Dec	26	47	Jun	42	72	Dec	60	91

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, 2011 15:43 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	15	35	-	86	////	0	0/0	4	
1	19	28	-	87	////	0	0/0	4	
2	21	27	-	87	////	0	0/0	4	
3	24	30	-	87	////	0	0/0	1	
4	31	38	-	87	////	0	0/0	2	
5	26	49	-	88	////	0	0/0	2	
6	17	51	-	89	////	0	0/0	3	
7	18	81	-	87	////	0	0/0	6	
8	18	63	-	87	////	0	0/0	11	
9	17	59	-	87	////	0	0/0	2	
10	21	60	-	88	////	0	0/0	0	
11	16	46	-	87	////	///	///	2	
12	16	29	-	89	////	0	0/0	5	
13	28	23	-	88	////	0	0/0	10	
14	16	9	-	90	////	1	0/0	19	
15	8	2	-	87	////	0	0/0	10	
16	14	3	-	84	////	0	0/0	8	
17	7	1	-	82	////	0	0/0	6	
18	0	1	-	81	////	0	0/0	3	
19	0	///	-	81	////	0	0/0	4	
20	0	1	-	78	////	0	0/0	10	
21	0	4	-	78	////	0	0/0	3	
22	10	2	-	78	////	0	0/0	///	
23	10	1	-	80	////	0	0/0	1	
24	8	2	-	79	////	0	0/0	3	
25	15	1	-	79	////	0	0/0	6	
26	20	4	-	81	////	0	0/0	4	
27	10	8	-	80	////	0	0/0	2	
28	13	8	-	81	////	0	0/0	10	
29	11	6	-	83	////	0	0/0	5	
30	8	2	-	83	////	0	0/0	5	
31	27	8	-	91	////	0	0/0	4	

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 2010

DATE	UT	NUMBER OF GROUPS	NUMBER OF SPOTS	RELATIVE SUNSPOT NUMBERS TOTAL	NORTH	SOUTH	CENTRAL	PPSI 10-5 WM-2	QUAL	OBS
1	1245	1	7	17	17	0	0	4.5	1	OB
3	1045	3	4	34	34	0	0	1.8	2	OB
6	1145	2	2	22	22	0	0	24.3	1	SV
9	1155	2	2	22	22	0	11	26.2	2	SV
12	1200	2	2	22	22	0	0	13.3	1	SV
13	900	3	7	37	37	0	0	11.6	2	OL
14	910	2	2	22	22	0	0	5.3	2	OL
17	930	1	1	11	11	0	11	0.4	1	AE
18	1000	1	1	11	11	0	11	0.4	3	AE
20	1120	0	0	0	0	0	0	0.0	3	SV
25	1230	1	1	11	11	0	0	0.3	1	SV

The relative mean sunspot number is 19.0.

NORMALISED UCCLE OBSERVATIONAL SUNSPOT NUMBERS U'=K'U FOR DECEMBER 2010

K'= 0.868 (*)

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

The normalised relative monthly mean sunspot number is 16.

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

The Sun has been observed 11 days on 31 possible.

UCCLE OBSERVATIONAL MAJOR SUNSPOT GROUPS FOR DECEMBER 2010
E AND F BRUNNER'S TYPE GROUPS

NONE

PROBABLE RETURN OF MAJOR GROUPS FOR JANUARY 2011
NONE

MONTHLY SUMMARY OF SOLAR AND GEOMAGNETIC ACTIVITY

I. Solar Activity

Solar activity was largely dominated by plasma eruptions this month.

On Dec 06, a large filament in the eastern part of the southern hemisphere erupted. The event shows very nicely in PROBA2/SWAP and SDO/AIA 192/304 images. The filament is relatively stable at first. Around 14:00UT, one part lights up. By 16:00UT, the southern part rises. The massive plasma loop opens up by 18:00UT and the plasma is ejected into the heliosphere, below the ecliptic and therefore of no threat for the Earth.

On Dec 07, we see an Earth-directed CME in STEREO/COR2 images. CACTus calculated the speed to be 250 km/s in STEREO B images and 238 km/s from STEREO A. There is no signature of a plasma eruption on the solar disk. GOES recorded a small increase in the X-ray radiation. The increase in radiation was not labeled as a flare. According to STEREO A/EUVI 195 images, the large filament eruption of Dec 06 seems to affect the magnetic loops near the equator/limb and triggers a slow motion away from the Sun. Around 04:00UT, a loop front comes into view of STEREO COR1. Only 9 hours later, the loop front reached the boundary of the STEREO A/COR1 image. The event is particularly interesting since STEREO EUVI, COR1 and COR2 movies show a very slow expanding magnetic loop high above the solar surface. With a speed of 250 km/s, the plasma cloud should arrive near Earth after about 6.9 days. But, on Dec 14, we were under the influence of a fast coronal hole wind stream of more than 600 km/s. The fast solar wind leaving the Sun later than Dec 07, probably caught up with the relatively slow plasma structure and overtook it.

A long duration B-flare of Dec 08 was also linked with a plasma eruption. This increase of radiation was again not labeled as a flare by SWPC, nor was it mentioned in the SolarSoft Events list. The speed of the CME was 337 km/s according to CACTus running on STEREO A COR2 images and 379 km/s when calculated with STEREO B COR2 images. The CME was directed above the ecliptic.

The plasma eruptions of Dec 12 were spectacular. In STEREO A-B/COR2, one sees a mixture of 3 CMEs. The global picture is one clear halo CME and one CME directed upwards. SOHO/LASCO gives us the possibility to split the dual structure into three constituting pieces: 1- a NE directed CME coming slightly into the direction of Earth, 2 - a CME directed east, slightly under the ecliptic in the plane of view and 3 - an equatorial westward-directed CME. The NE CME – 1, shows up as a clear CME, relatively well propagating in the plane of view of STEREO A/COR2. The E CME – 2 and the W CME - 3 show up as halo CMEs in STEREO/COR2 movies. The E CME is directed to STEREO B, away from STEREO A, while the equatorial W CME is directed towards STEREO A, away from STEREO B. All 3 CME's were separate events. The STEREO side views and the LASCO front view help to cut the global view into the constituting pieces. The equatorial W CME is associated with a long duration B-flare for which the post-flare loops are nicely seen in SDO/AIA 192.

According to the source region of the long duration event, LDE, we can argue that the equatorial W CME propagated slightly out of the plane of view of LASCO into the direction of the Earth.
Check these websites:
http://secchi.nrl.navy.mil/cactus/index.php?p=SECCHI-A/2010/12/out/CME0021/CME.html
http://secchi.nrl.navy.mil/cactus/index.php?p=SECCHI-B/2010/12/out/CME0025/CME.html
http://sidc.oma.be/cactus/catalog/LASCO/2_5_0/qkl/2010/12/CME0041/CME.html

The Dec 15 event is particular interesting. The forecaster on duty saw on Dec 19 a cloud signature in solar wind data. Counting back in time, based on the cloud speed, the cloud could be associated to an event occurring on Dec 15. There was no on-disk signature that day, no flares, no filament eruptions, but STEREO COR2 images captured a CME leaving only from the very high corona. SOHO/LASCO showed a very weak signature of a non-halo cloud. Such CMEs are so-called 'stealth CMEs' with no clear observable on-disk features.

On Dec 23, STEREO A-B/COR2 show an Earth directed CME with a propagation speed of around 320 km/s. Using this as a proxy to calculate the time the CME needs to arrive at Earth, we have 5.4 days. On Dec 24 and 25, STEREO A-B/COR2 captured also two Earth-directed CMEs. Their speeds were however too slow compared with the ambient solar wind. Those CMEs were overtaken by the solar wind. The CME was seen in radio data of Humain, see III.

Only one coronal hole (CH) with a geomagnetic relevance passed the scene. The CH was large and situated at the equator-northern hemisphere, above the region with the filament channel erupting on Dec 06. The CH reached the central meridian (CM) on Dec 07.

II. Geomagnetic Activity

We had a mixture of two sorts of geomagnetic influences: fast solar wind linked with a coronal hole and CME-arrival. The magnetic disturbances were limited in size and time.

On Dec 12, a co-rotating interaction region arrived. This solar wind structure is linked with the second CH. The solar wind speed reached values up to almost 700 km/s. The Bz component fluctuated strongly between positive and negative values. On Dec 12, NOAA estimated one period with unsettled conditions, on Dec 14, Kp became 4 times 3, on Dec 15, Kp became once 4.

The shock leading the plasma cloud that was ejected on Dec 15 reached the ACE spacecraft on Dec 19. The cloud itself passed ACE on Dec 20. The cloud is recognized by the slowly varying magnetic field components. This was a schoolbook example of a magnetic cloud, but the influence on the Earth's magnetic field was very limited due to the small Bz component. Only unsettled conditions were measured on Dec 20.

The CME of Dec 23 arrived on Dec 28. The cloud was preceded by a shock. The Bz component turned from a small positive value to a large negative value: -12nT after which it became again positive. The period during which Bz was negative led to a short minor storm with Kp equal to 5.

III. Humain event list

DAY	BEGIN	END	TYPE	DESCRIPTION	BRIGHTNESS	STARTFREQ	STOPFREQ
15	1439	1447	1915	H	3	79	45X

Type: I=storm bursts
II slow drift bursts
III fast drift bursts
IV prolonged continuum
V brief continuum

Brightness: 1: weak – 3: bright/very bright

Frequency:MHz
X: 45 MHz is the lower limit, burst goes probably below

IV. News: looking back on esww7

European space weather is quickly growing in professionalism and maturity. This has been particularly noticeable at the annual European Space Weather Week, ESWW. Whereas in the past years we still had many hand-waving discussions of the popular kind, these days we discuss deep core developments, services and new insights. Something is clearly changing.

*S*pace Weather research and operations got a boost thanks to the significant investments for example by the EU's 7th framework program and by the Space Situational Awareness (SSA) program of ESA. The European community working in the field of space weather has a natural focus on the Space Weather Element of the SSA. This ESA program supports new and existing initiatives that meet the requirements of a broad group of users of space weather applications and products. At the ESWW it became clear that SSA is an opportunity for Europe to strengthen its skills and play an important role in the field.

From this increasing number of space weather programs, one could conclude that space weather is overall getting ‘worse’. It's not, but our vulnerability is increasing as our technology is getting more advanced. In this regard, space weather effects on spacecraft and its environment are a hot issue. Post-analysis of space weather radiation events causing hazardous effects in spacecraft, offer a way to handle future events. It becomes more and more critical for spacecraft engineers to be one step ahead of the Sun. More in-depth research, modelling and forecasting can help. Data input is crucial for performing this task.

The ESWW showed again clearly and loudly that we are at the beginning of a new era, with enormous data flows coming in, e.g. from the NASA SDO mission or from dedicated space weather monitors such as PROBA2. To handle all that data we need new machinery such as virtual observatories, online quicklook viewers and automatically generated data catalogs. Space weather products and services, following naturally as the output of research and modelling activities evolve rapidly.

We are progressing to more mature, worldwide application centres. But there are limitations to our space weather capabilities, including the sparseness of certain experiments, e.g. coronagraphs. Efforts are done, however, to assimilate data into models and implement these models into a usable platform. Bridging the gap between models and applications is an issue relevant for all physical layers, from the Sun and the corona, through the heliosphere and the magnetosphere, across the radiation belts, over the earth poles, the ionosphere, to the Earth's surface. This diversity of scales and processes is difficult to control, but several groups try.

Beside these issues, other side-events were also on the ESWW-menu contributing to a lively and dynamic conference. The space weather tutorial served as an ice-breaker and helped the people in the field to get into the subject. The keynote lecture dragged us into the world of Birkeland and auroras. The style could -how do we phrase it- cause some controversy, but was perceived as 'more than excellent' by others. Birkeland's life teaches us the need to communicate with non-experts and to build a firm bridge between pure science and applications. The debate put the question about space exploration on the foreground: 'What is the rationale behind the decision to send humans to space?' It's in the human nature to explore, how small or grown up you are. Children's biggest fantasies are about dinosaurs and ... space, the past and the future. Further, the possibilities of a scientific market were explored during a fair: the Matroshka phantom drew our attention to the received radiation dose while traveling through space, the aurora and the Sun were visible in 3D, a huge radio receiver was mounted in the exhibition hall and Jean Lilensten’s Planeterrella experiment was also demonstrated. And of course, the students did their best to deliver a nice oral or poster presentation. Two nominees left home with a small but nice present in their bags.

The European Space Weather Week offers the platform to meet in a formal and informal environment, during the plenary sessions, the numerous splinters and a whole bunch of side events like the tutorial, the space weather fair, the debate-evening. Many scientists, engineers, space weather product developers, students, national delegates, ... take this opportunity. These are exciting space weather times, whether we are in a solar minimum or heading towards a solar maximum. There are many new aspects of space weather to discover and to deal with. Join us next time for the 8th European Space Weather Week!