

STCE Newsletter

15 Jul 2024 - 21 Jul 2024



Published by the STCE - this issue : 25 Jul 2024. Available online at <https://www.stce.be/newsletter/>.

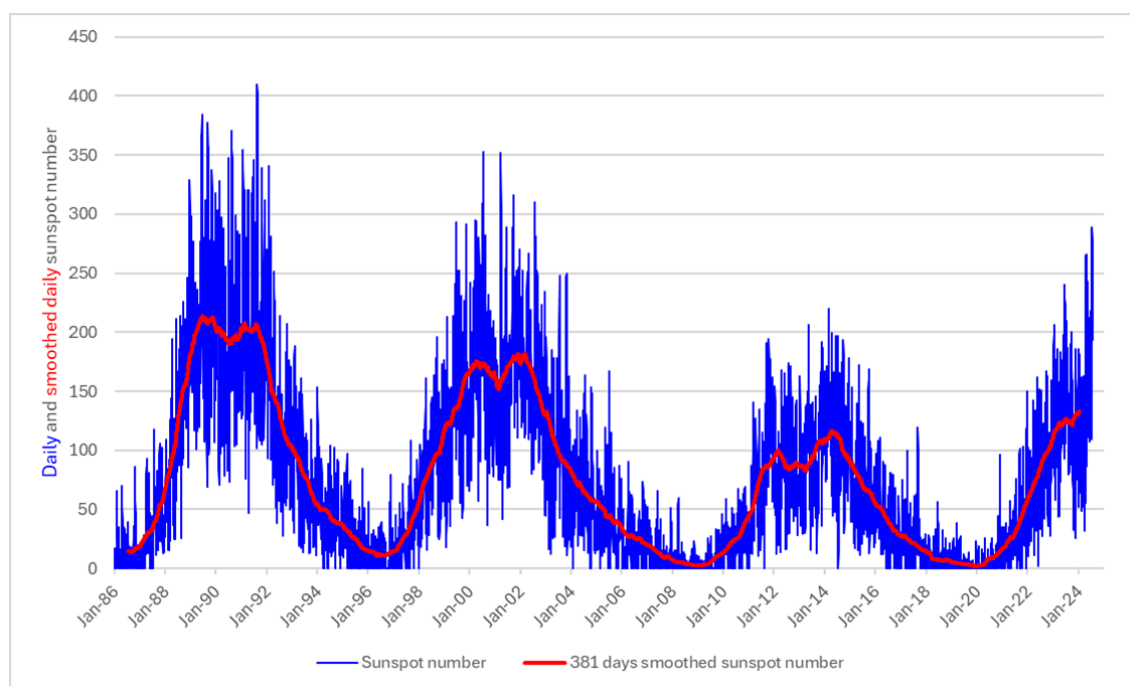
The Solar-Terrestrial Centre of Excellence (STCE) is a collaborative network of the Belgian Institute for Space Aeronomy, the Royal Observatory of Belgium and the Royal Meteorological Institute of Belgium.

Content	Page
1. High sunspot numbers	2
2. Review of space weather	4
3. Noticeable Solar Events	5
4. International Sunspot Number by SILSO	6
5. PROBA2 Observations (15 Jul 2024 - 21 Jul 2024)	7
6. Geomagnetic Observations in Belgium	9
7. The SIDC Space Weather Briefing	9
8. Review of Ionospheric Activity	11
9. Lectures and courses	13

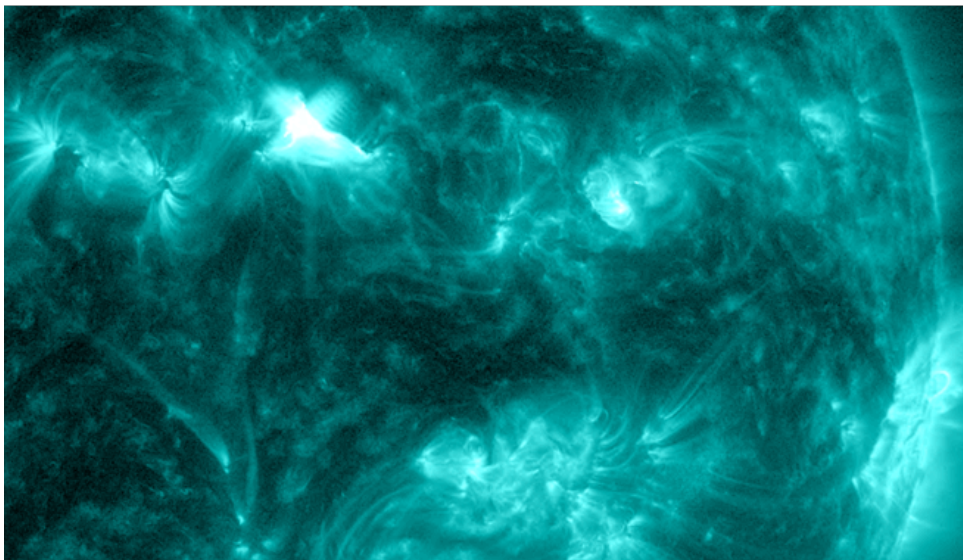
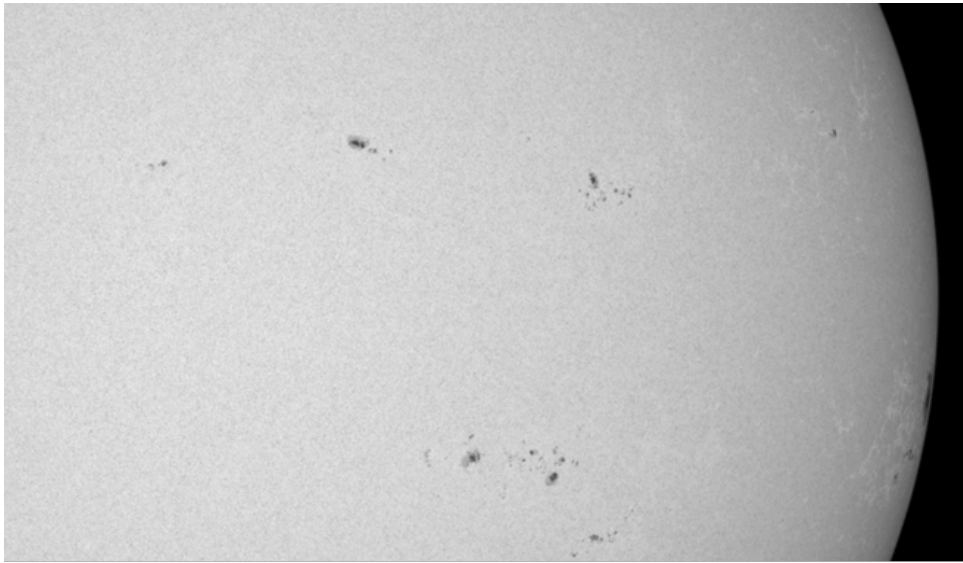
Final Editor : Petra Vanlommel
Contact : R. Van der Linden, General Coordinator STCE,
Ringlaan - 3 - Avenue Circulaire, 1180 Brussels,
Belgium

1. High sunspot numbers

Last week's sunspot numbers were the highest so far during solar cycle 25 (SC25). The preliminary sunspot number reached values around 285 from 16 till 18 July. We have to go back to July 2002 to find higher values, when sunspot numbers varied between 290 and 310 (SILSO - <https://www.sidc.be/SILSO/home>). The graph underneath shows the daily and smoothed daily sunspot number from 1986 (SC22) onwards. The 381 days smoothed value is simply the average value of 381 days of sunspot numbers, with 381 days corresponding to 14 solar rotations or about 12.5 months, showing the overall evolution of the solar cycle. Of note is the very low sunspot activity during the previous SC24, when sunspot numbers exceeded the 200-level on only a handful of days. The graph makes it also clear that sunspot numbers can reach much higher values, such as e.g. on 21 and 22 August 1991 when the sunspot number S_n was above 400. Since the start of the daily archiving by SILSO (1818 - present), the highest sunspot numbers recorded were in August 1870 (528 on the 26th) and in December 1957 (503 on 24-25th). In more than 200 years of near-continuous observations, only 5 days had a sunspot number in excess of 500. So far, the highest daily sunspot number during the 21st century was on 27 March 2001 (352).



The mostly sunny weather in Belgium during July allowed the solar observers of the SIDC (<https://www.sidc.be/>) to monitor the Sun almost every day with their solar telescopes (USET, Uccle Solar Equatorial Table - <https://www.sidc.be/uset/>). Underneath are an image and a drawing (side reversed) made by the SIDC observers on 18 July, when the preliminary S_n was at its highest (289). The image and the drawing reveal 16 sunspot groups, and the observer penciled 119 dark spots, good for a total sunspot number of 279 ($= 10 \times 16 + 119$). It's a coincidence that the USET sunspot number and the preliminary S_n correspond so well for this day, as S_n is of course an average of several observers (31 for that day) who use different telescopes and different observing methods rescaled to the reference observer (S_n version 2.0: <https://www.sidc.be/SILSO/newdataset>).



2. Review of space weather

Solar Active Regions (ARs) and flares

Last week's solar flaring activity was at moderate levels except on 16 July when high levels were registered. The only X-class flare of the week was an X1.9 on 16 July at 13:26 UTC associated with NOAA AR 3738 (magnetic type Beta-Gamma-Delta, Catania sunspot group 85). The strongest M-class flare of the week, an M5.0, was produced by NOAA AR 3743 on 17 July at 06:39 UTC. NOAA AR 3744 (magnetic type Beta, Catania sunspot group 96) was the source of five M-class flares, the first being an M1.4 on 16 July at 03:01 UTC and the last an M3.2 on 21 July at 23:28 UTC. M-class flares were also emitted by NOAA AR 3751 (magnetic type Beta until 18 July, Beta-Gamma-Delta since, Catania sunspot group 12), NOAA AR 3753 (magnetic type Beta, Catania sunspot group 8), NOAA AR 3757 (magnetic type Beta, Catania sunspot group 20), and NOAA AR 3758 (magnetic type Beta, Catania sunspot group 93).

Coronal mass ejections

No earth-directed, halo or partial halo, coronal mass ejections (CME) were observed during the period.

Coronal holes

A northern coronal hole (CH) with negative polarity crossed the central meridian between 15 and 18 July.

Proton flux levels

The greater than 10 MeV proton flux was at nominal levels over the last week.

Electron fluxes at GEO

The greater than 2 MeV electron flux, as measured by the GOES-16 satellite, was at nominal levels during the last week. The 24h electron fluence was at very low levels throughout last week.

Solar wind at L1

During the last week, the solar wind (SW) conditions were typical of the slow SW regime, with the exception of a glancing blow from a coronal mass ejection (CME) that lasted from 16 to 17 July. For the 15 July, the SW speed was between 270 and 330 km/s, the total interplanetary magnetic field (Bt) ranged between 1 and 10 nT, the North-South magnetic component (Bz) fluctuated between -5 and 6 nT, while the interplanetary magnetic field (IMF) phi angle was directed away and towards the Sun for an almost equal length of time. The disturbance caused an increase of SW speed to 420 km/s, a rise of Bt to 18 nT, a variation of Bz between -10 and 13 nT, and the IMF phi angle to be predominantly directed away from the Sun. The SW conditions returned to the slow SW regime on 18 July. The Bt ranged between 1 and 7 nT, Bz between -5 and 6 nT, and the IMF phi angle was predominantly directed away from the Sun for the rest of the period.

Geomagnetism

Global geomagnetic conditions were quiet (NOAA Kp 1- to 2+) last week with the exception of 16 July when unsettled levels (NOAA Kp 3+) were recorded. This was the result of the arrival of a glancing blow associated with a CME. The local geomagnetic conditions started last week at unsettled levels (K BEL 3) and increased to active levels (K BEL 4) as a result of the glancing blow on 16 July. They returned to active levels (K BEL 3) for the rest of the week.

3. Noticeable Solar Events

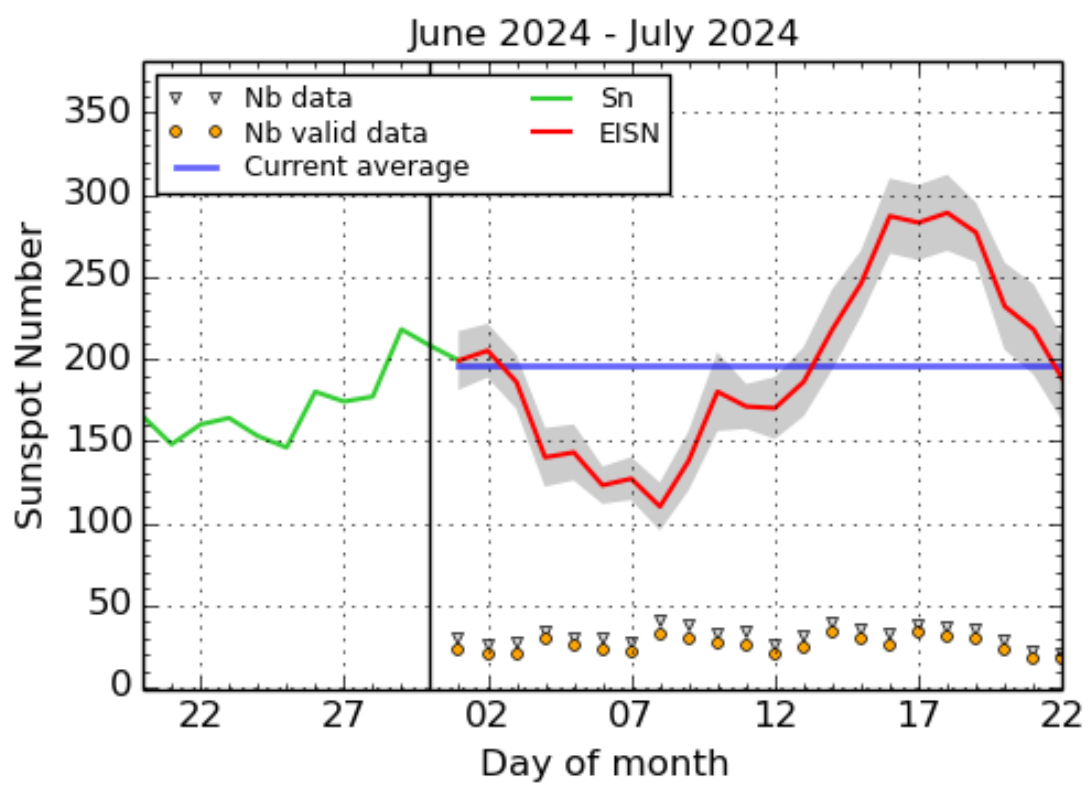
DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
15	0329	0345	0355		M1.2	F			85	3738
15	0921	0937	1008	S7W66	M2.7	SN		III/1VI/1	85	3738
15	1008	1013	1019	S8W64	M1.9	SF			85	3738
16	0249	0301	0322	N16E2	M1.4	1N			96	3744
16	0724	0737	0750	N11W27	M3.6	1B		III/1	8	3753
16	1311	1326	1336	S6W85	X1.9	1B		III/1II/3IV/25	85	3738
16	2106	2124	2136	N11W34	M1.6	1N			8	3753
16	2146	2206	2217	N18W10	M1.9	1N		III/2II/2	96	3744
17	0626	0639	0701	S10W31	M5.0	2B		III/1II/1	93	3743
17	0701	0708	0713	N9W39	M3.4	SF		VI/2II/1IV/193		3743
17	0926	0945	1010	S10W83	M1.2	SF				3738
17	1940	1951	1953	N11W46	M1.2	1N			8	3753
17	1953	1958	2004		M2.0				8	3753
18	1004	1014	1020	S7E24	M2.2	SN			12	3751
18	1020	1027	1031		M2.0				12	3751
19	0813	0823	0830	N11W67	M3.2	1F		III/1	8	3753

19	1753	1806	1825	S10E3	M2.0	2N		12	3751
19	2244	2251	2306		M1.0			93	3758
20	0710	0720	0724	S7W3	M1.8	SF		12	3751
20	1836	1849	1902	N12W68	M1.5	1N	VI/1	96	3744
21	0346	0355	0359		M1.4		VI/2	96	3744
21	0828	0834	0841		M1.5			12	3751
21	1618	1631	1659		M1.0		III/2II/2	20	3757
21	2321	2328	2334	N15W86	M3.2	SF		96	3744

LOC: approximate heliographic location
 XRAY: X-ray flare class
 OP: optical flare class
 10CM: peak 10 cm radio flux

TYPE: radio burst type
 Cat: Catania sunspot group number
 NOAA: NOAA active region number

4. International Sunspot Number by SILSO



SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium, 2024 July 22

The daily Estimated International Sunspot Number (EISN, red curve with shaded error) derived by a simplified method from real-time data from the worldwide SILSO network. It extends the official Sunspot Number from the full processing of the preceding month (green line), a few days more than one solar rotation. The horizontal blue line shows the current monthly average. The yellow dots give the number of stations that provided valid data. Valid data are used to calculate the EISN. The triangle gives the number of stations providing data. When a triangle and a yellow dot coincide, it means that all the data is used to calculate the EISN of that day.

5. PROBA2 Observations (15 Jul 2024 - 21 Jul 2024)

Solar Activity

Solar flare activity fluctuated from moderate to high during the week.

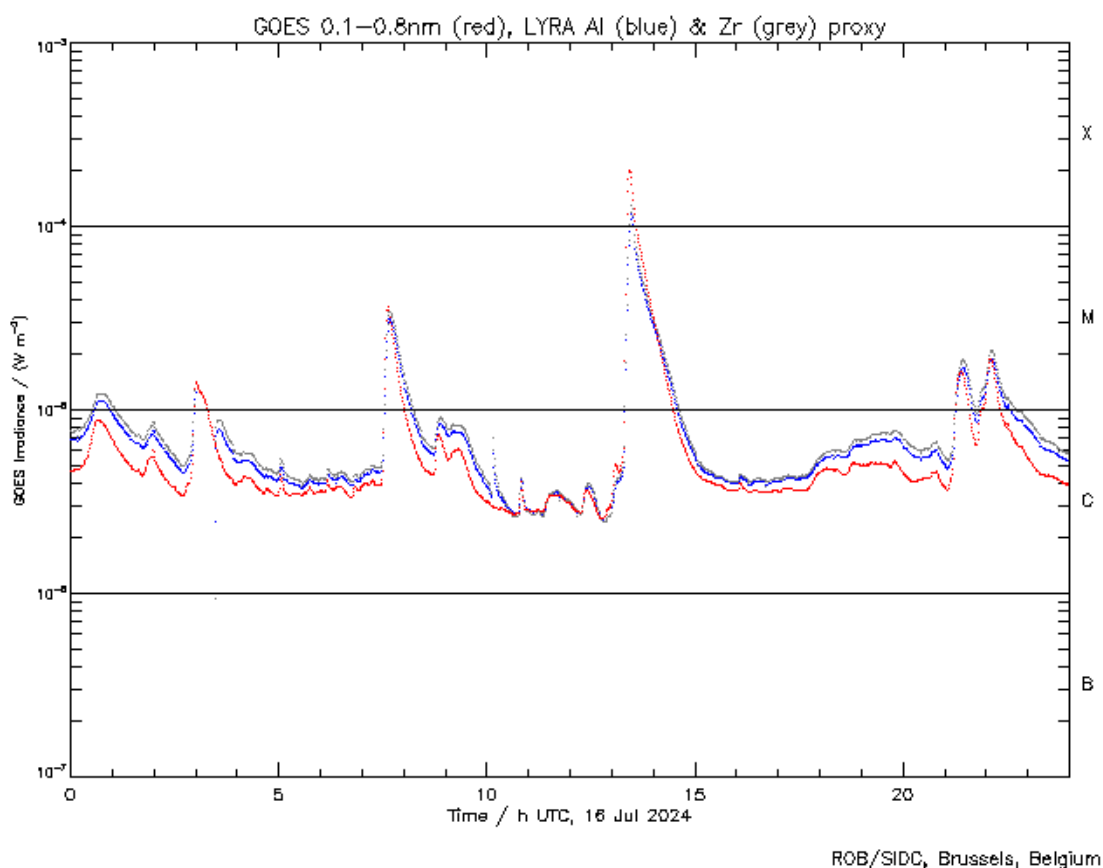
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: <https://proba2.oma.be/ssa>
This page also lists the recorded flaring events.

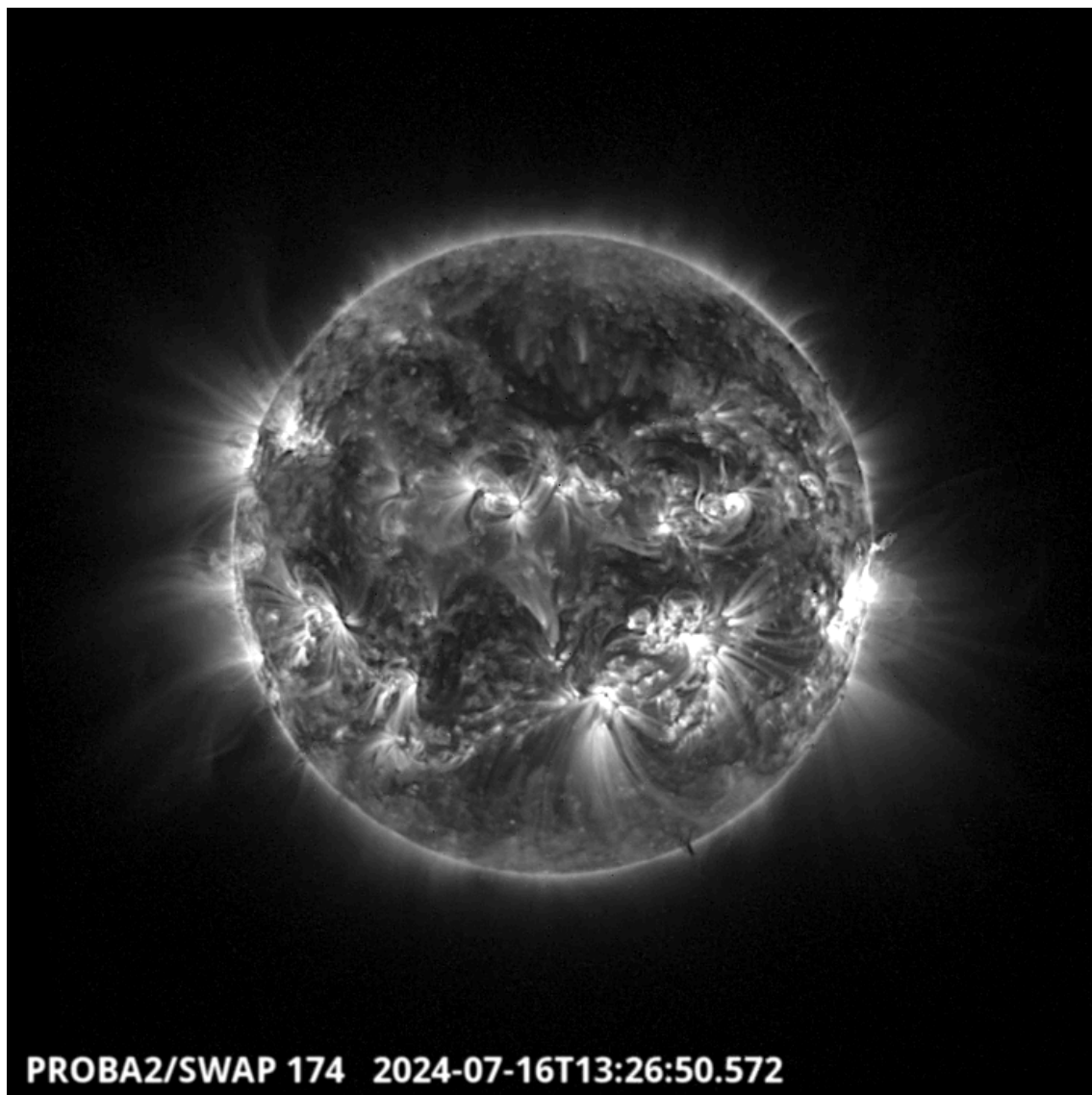
A weekly overview movie (SWAP week 747) can be found here: https://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2024_07_15.mp4.

Details about some of this week's events can be found further below.

If any of the linked movies are unavailable they can be found in the P2SC movie repository here: <https://proba2.oma.be/swap/data/mpg/movies/>.

Tuesday July 16

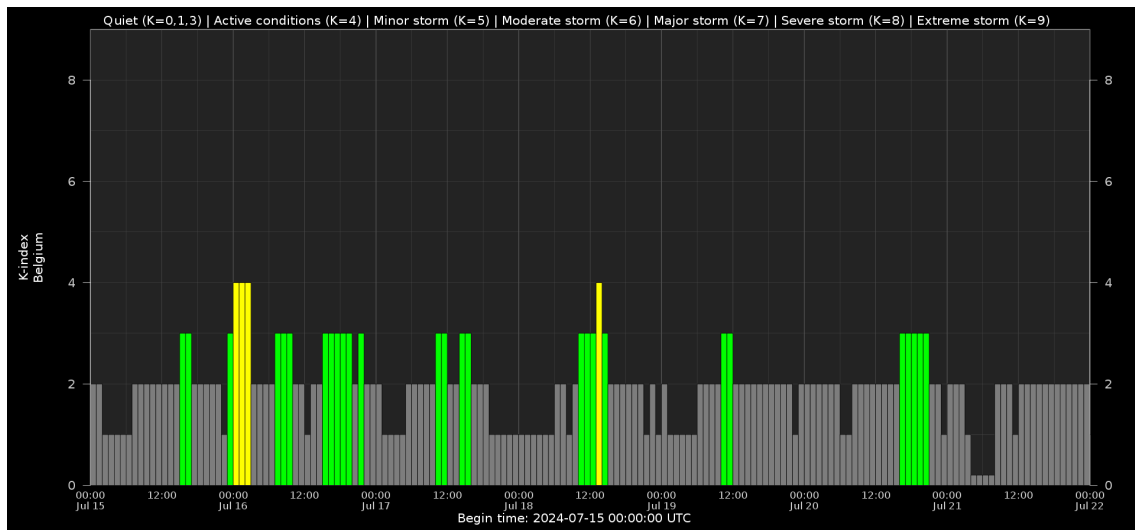




The largest flare of this week was an X1.9, and it was observed by LYRA (top panel) and SWAP (bottom panel). The flare peaked on 2024-Jul-16 at 13:26 UT. It occurred at the western limb of the Sun close to the equator, originating from NOAA AR3738.

Find a SWAP movie of the event here: https://proba2.sidc.be/swap/movies/20240716_swap_movie.mp4.

6. Geomagnetic Observations in Belgium



Local K-type magnetic activity index for Belgium based on data from Dourbes (DOU) and Manhay (MAB). Comparing the data from both measurement stations allows to reliably remove outliers from the magnetic data. At the same time the operational service availability is improved: whenever data from one observatory is not available, the single-station index obtained from the other can be used as a fallback system.

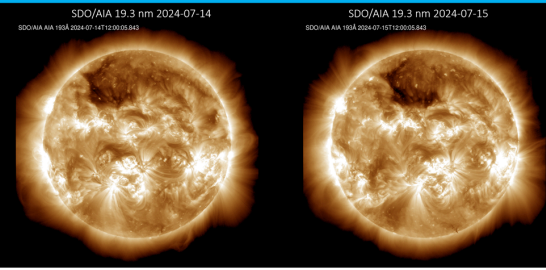
Both the two-station index and the single station indices are available here: http://ionosphere.meteo.be/geomagnetism/K_BEL/

7. The SIDC Space Weather Briefing

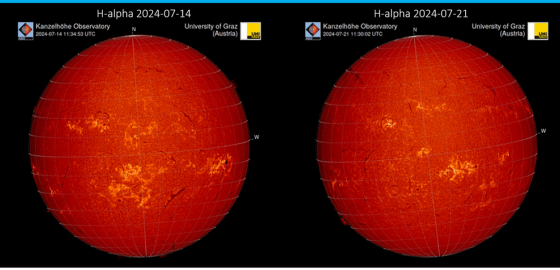
The forecaster on duty presented the SIDC briefing that gives an overview of space weather from July 14 to July 21.

The pdf of the presentation can be found here: https://www.stce.be/briefings/20240722_SWbriefing.pdf

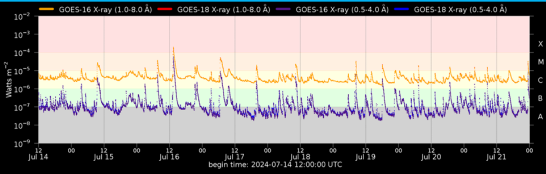
Coronal holes



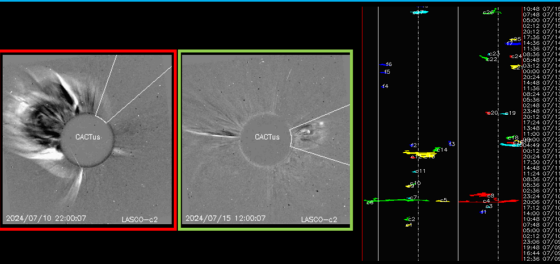
Filaments & Filament eruptions



Flaring activity



Coronal Mass Ejections

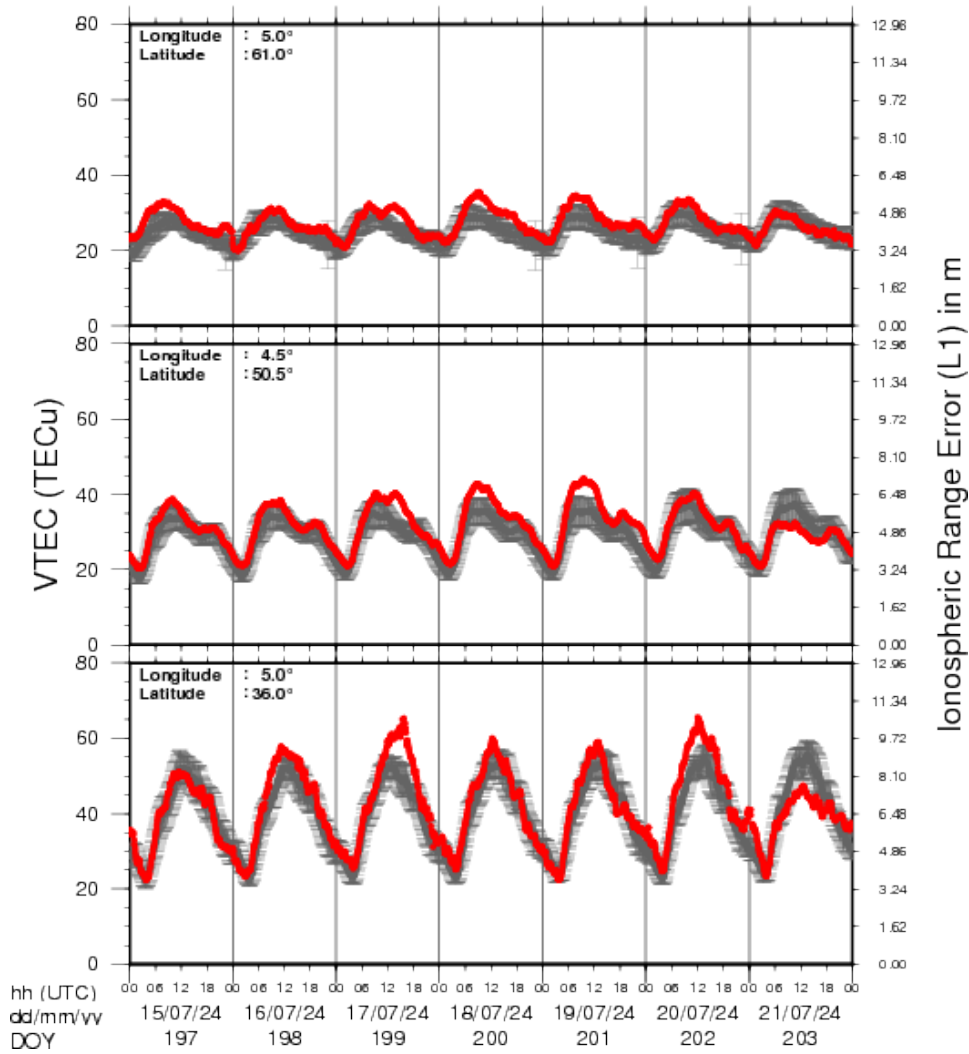


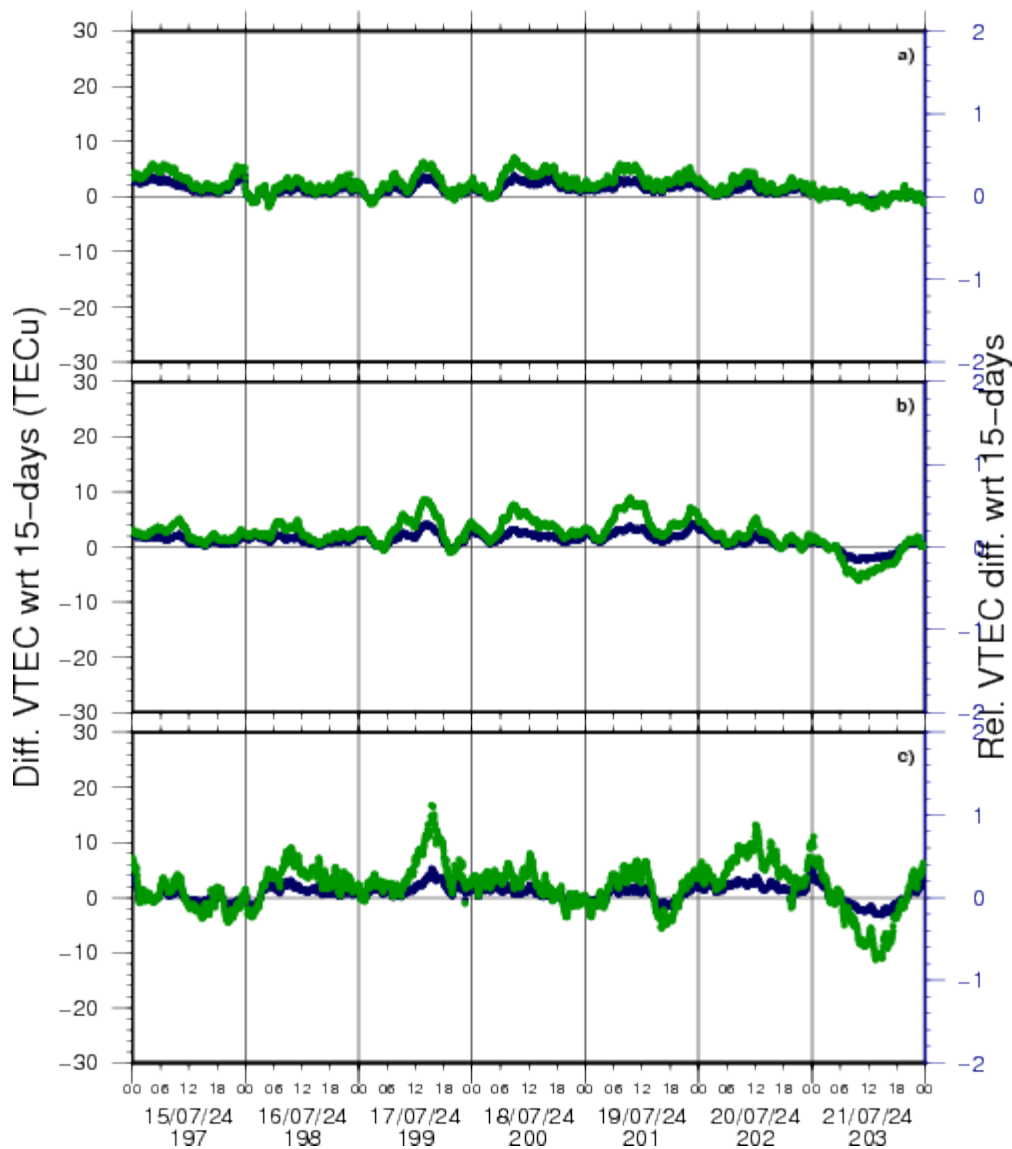
Probabilities (%) and occurrences (#) of C/M/X flares daily from noon to noon:

Issue date	2024-07-14	2024-07-15	2024-07-16	2024-07-17	2024-07-18	2024-07-19	2024-07-20	2024-07-21
Probability (%)	99 80 30	99 85 15	99 85 10	99 90 20	99 75 25	99 65 10	99 75 35	99 70 15
Observed (#)	09 02 00	03 02 00	02 03 01	04 02 00	05 01 00	06 03 00	10 03 00	06 02 00

8. Review of Ionospheric Activity

VTEC Time Series





VTEC time series at 3 locations in Europe from 15 Jul 2024 till 21 Jul 2024

The top figure shows the time evolution of the Vertical Total Electron Content (VTEC) (in red) during the last week at three locations:

- a) in the northern part of Europe(N 61deg E 5deg)
- b) above Brussels(N 50.5deg, E 4.5 deg)
- c) in the southern part of Europe(N 36 deg, E 5deg)

This top figure also shows (in grey) the normal ionospheric behaviour expected based on the median VTEC from the 15 previous days.

The time series below shows the VTEC difference (in green) and relative difference (in blue) with respect to the median of the last 15 days in the North, Mid (above Brussels) and South of Europe. It thus illustrates the VTEC deviation from normal quiet behaviour.

The VTEC is expressed in TECu (with $1\text{TECu}=10^{16}$ electrons per square meter) and is directly related to the signal propagation delay due to the ionosphere (in figure: delay on GPS L1 frequency).

The Sun's radiation ionizes the Earth's upper atmosphere, the ionosphere, located from about 60km to 1000km above the Earth's surface. The ionization process in the ionosphere produces ions and free electrons. These electrons perturb the propagation of the GNSS (Global Navigation Satellite System) signals by inducing a so-called ionospheric delay.

See http://stce.be/newsletter/GNSS_final.pdf for some more explanations; for more information, see <https://gnss.be/SpaceWeather>

9. Lectures and courses

Courses and presentations with the Sun-Space-Earth system and Space Weather as the main theme. We provide occasions to get submerged in our world through educational, informative and instructive activities.

* Sep 27, STCE at the Wisenight Science festival in the Planetarium, Brussel, <https://wisenight.eu/>

* Sep 30 - Oct 3, STCE Space Weather Introductory Course, Brussels, Belgium - Registrations are open <https://events.spacepole.be/event/204/>

* Nov 25 - 27, STCE course: Space Weather impacts on ionospheric wave propagation, focus on GNSS and HF, Brussels, Belgium - Registrations are open, <https://events.spacepole.be/event/206/>

* Dec 5-6, STCE Course Space Weather impacts on aviation, Brussels, Belgium - Registrations are open, <https://events.spacepole.be/event/205/>

To register for a course or lecture, check the page of the STCE Space Weather Education Center: <https://www.stce.be/SWEC>

If you want your event in the STCE newsletter, contact us: [stce_coordination at stce.be](mailto:stce_coordination@stce.be)

