

STCE Newsletter

29 Apr 2024 - 5 May 2024



Published by the STCE - this issue : 8 May 2024. Available online at <https://www.stce.be/newsletter/>.

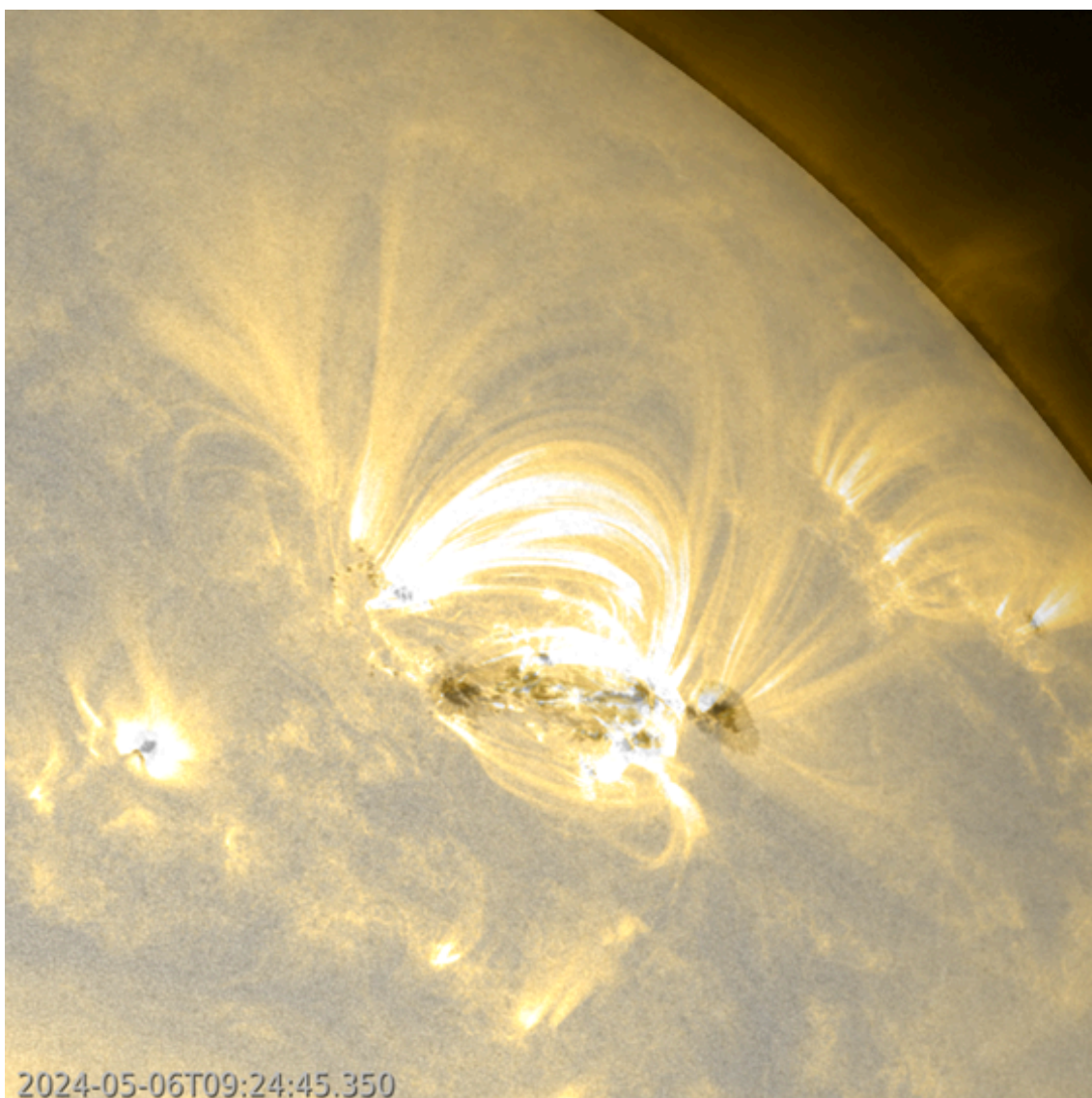
The Solar-Terrestrial Centre of Excellence (STCE) is a collaborative network of the Belgian Institute for Space Aeronomy, the Royal Observatory of Belgium and the Royal Meteorological Institute of Belgium.

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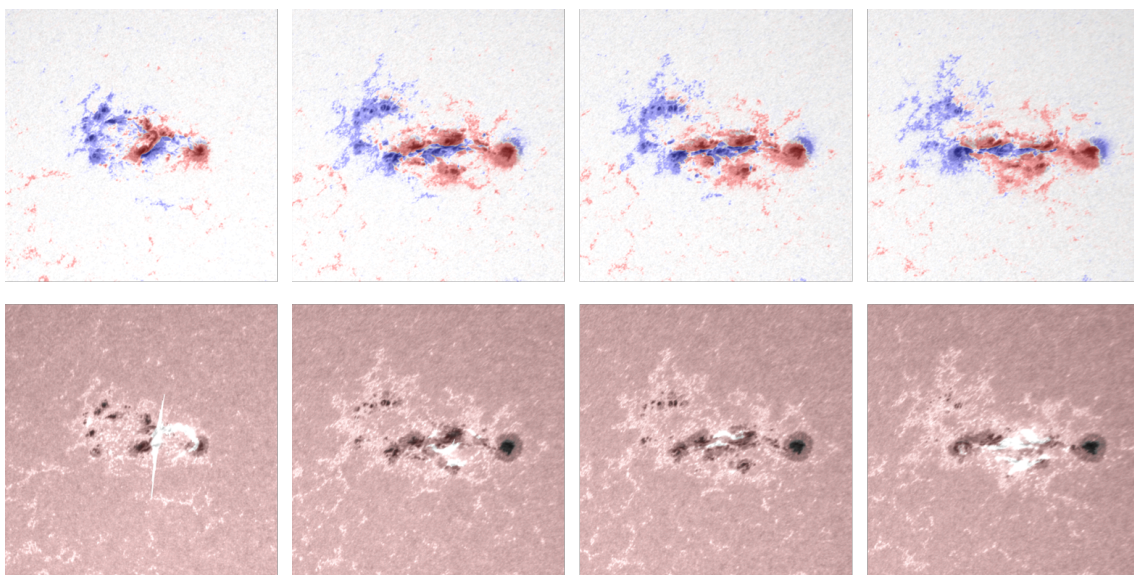
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1. The show continues!...

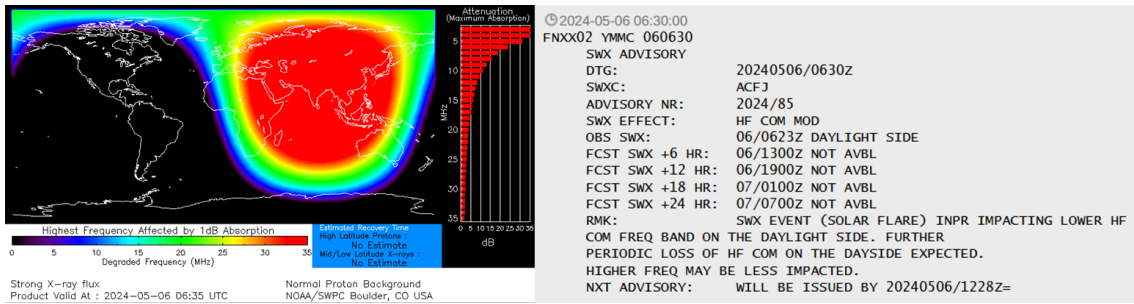
The strong solar flare activity from NOAA 3663 has been discussed in this STCE Newsflash (<https://www.stce.be/news/698/welcome.html>). On 6 May, the region produced its 4th and -so far- strongest X-class flare during its solar transit. The long-duration X4.5 flare peaked at 06:35UTC. It is the 3rd strongest flare so far this solar cycle (SC25), after the X6.3 flare from NOAA 3590 on 22 February this year (<https://www.stce.be/news/687/welcome.html>), and the X5.0 flare from NOAA 3536 on 31 December 2023 (<https://www.stce.be/news/675/welcome.html>). The imagery underneath combines semi-transparent extreme ultraviolet (EUV) pictures taken by SDO/AIA 171 (temperatures around 700.000 degrees ; <https://sdo.gsfc.nasa.gov/data/aiahmi/>) with white lights pictures. It shows the location of the X4 flare and the subsequent development of post-flare coronal loops. A clip is available in the online version at <https://www.stce.be/news/699/welcome.html> STEREO-A coronagraphic images show an associated coronal mass ejection (CME) of which the bulk is mostly directed northward. The SIDC forecaster (<https://www.sidc.be/index.php>) is further analyzing the images as they become available.



During the 1-5 May period, NOAA 3663 produced also 17 M-class flares ("medium"), some of which were flirting with the X-class level threshold. The fuel for all this solar flare frenzy came (is still coming...) from the strong and dynamic magnetic delta structure that NOAA 3663 developed. A sunspot group is said to contain a delta structure when there is at least one mature spot present in which umbrae of opposite polarities are separated by less than 2° and are situated within the common penumbra. Delta regions have a much higher flaring probability than the other regions. The top row in the imagery underneath shows a semi-transparent magnetogram overlaid on white light images of NOAA 3663. Red indicates positive magnetic polarity (field lines coming out of the Sun), blue represents negative magnetic polarity (field lines returning into the Sun). These images are about 10-30 minutes prior to each of the 4 X-class events. The bottom row then shows the location of the flare ribbons by overlaying AIA 1700 over the white light images close to the maximum of each X-class flare. AIA1700 shows the inner atmosphere of the Sun right above its surface, at temperatures near 5000 degrees. The ribbons are usually parallel to the magnetic inversion line, i.e. the line separating positive from negative magnetic polarities and near which flaring activity usually takes place. A clip showing the evolution of the magnetic delta in NOAA 3663 (2-6 May) can be found in the online version of this newsitem.



Similar to the X1.3 flare, this X4 event affected High Frequency (HF) communications over the western portion of Australia, Southeast Asia, China, Japan, Russia, India, the Arabian peninsula and East-Africa (D-RAP ; <https://www.swpc.noaa.gov/products/d-region-absorption-predictions-d-rap>). An advisory for disturbed HF Com has been sent by ACFJ (consortium of Australia, Canada, France and Japan) to the civil aviation through PECASUS (<https://pecasus.eu/>). Magnetometer stations in India and Asia (Intermagnet (BGS) - https://imag-data.bgs.ac.uk/GIN_V1/GINForms2) recorded a solar flare effect of 5-20 nT. Further strong flaring from NOAA 3663 can be expected as long as the potent magnetic delta structure remains present.



2. Science and Art - Solar Stasis

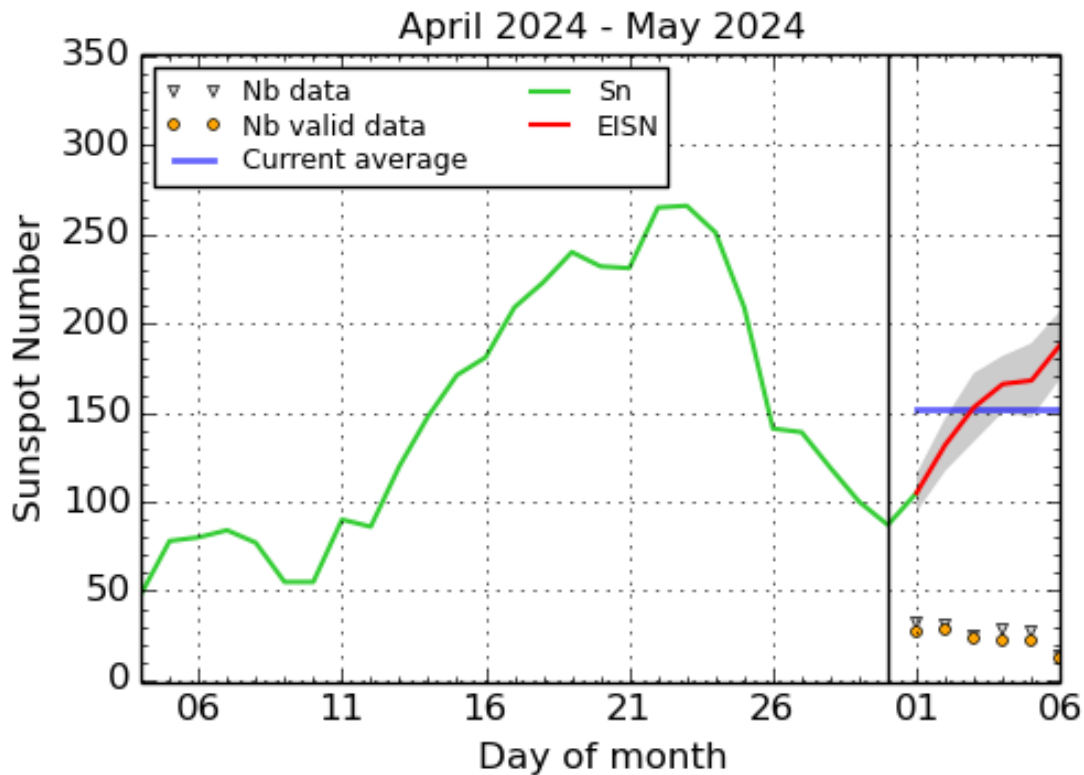
Pepa Ivanova got the PhD degree on May 6, 2024 for her research on the relation between solar science and art which resulted in the dissertation 'Solar Stasis'. An art installation supported the part 'An Echo of the Sun' that reflects on the evolution and coexistence between the Earth and the Sun.

Pepa: "In this practice-based Ph.D. research I examine the cultural values embodied in science and the aesthetics behind solar observations with emphasis on the sun-earth cohabitation. I investigate the phenomenological approach described in those fields and dive into the meaning-making processes essential for collaborative art-science practices. I look at how numerical, machine-generated knowledge production and a large amount of observational, scientific data have become an artifact in society and culture today. How algorithms have made their way from their technocentric habitat into the living, while scientific processes have become recipients of cultural and aesthetic values. I draw inspiration from contemporary philosophers such as Luciana Parisi and her "soft thought" and "autopoiesis" in algorithmic architecture. I discuss those two philosophical concepts, in relation to datasets and customized algorithms applied in the realization of the suNEARth interface, Picturing Earth's Light, and WARMTH installation.

My approach presupposes that scientific observations are an active agency in meaning-making in culture today. In this way, I build on Alexander Chizhevsky's hypothesis that the earth's ecosystem is echoing the sun's activity. For example, to highlight the sun-earth cohabitation I perform solar observational data with audio field recordings of the Earth (suNEARth interface). These concepts and the supporting artworks will be discussed during my phd defence along with presentation of WARMTH installation installed at the Observatory."



3. International Sunspot Number by SILSO



SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium, 2024 May 6

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.

4. Noticeable Solar Events

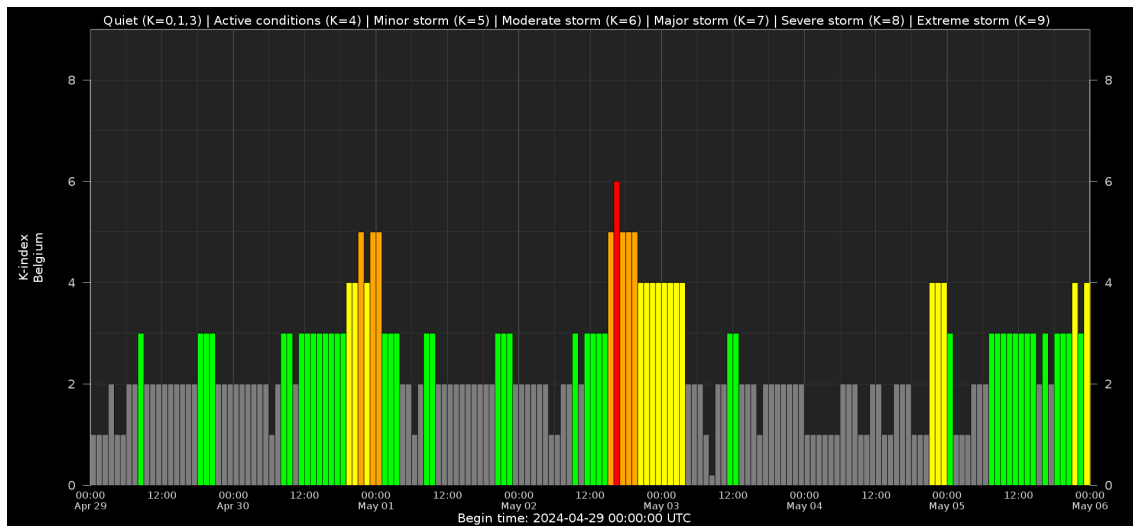
DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
29	0033	0048	0054	S8W40	M2.5	1N			74	3654
29	0054	0111	0120		M3.7				74	3654
30	0046	0114	0131	S6W50	M1.6	SF		VI/1	74	3654
30	1450	1511	1526	S7W60	M1.2	SF			74	3654
30	1611	1633	1647	S5W60	M1.3	SF		III/1	74	3654
30	2323	2346	2358	S5W63	M9.5	2B		III/2	74	3654
01	1417	1432	1437	S5W75	M1.8	SN		III/1	74	3654
01	1437	1444	1448	S8W75	M1.9	SN		III/1	74	3654
01	2226	2231	2237	N25E24	M1.8	SN		V/3III/2		3663
02	0207	0217	0224	N25E23	M1.0	1N		VI/1	84	3663

02	2052	2057	2101		M2.7		III/2	86	3664
03	0008	0015	0019	S21E59	M2.7	1N	III/3	86	3664
03	0211	0222	0227	N25E7	X1.6	1B	III/2VI/2II/2IV/4		3663
03	0805	0811	0816	N24E5	M4.4	SB	III/1	84	3663
03	2225	2247	2311	N26W6	M1.2	SF	III/3		3654
03	2311	2316	2320	N26W6	M1.0	SF	III/3	84	3663
03	2324	2330	2336	N26W6	M2.4	SN	III/2	84	3663
04	0026	0036	0044	N26W6	M1.6	SF		84	3663
04	0602	0619	0630	N26W8	M9.1	1B	III/3II/1IV/184		3663
04	0704	0707	0711		M1.5			84	3663
04	1810	1820	1825		M1.3			84	3663
04	2223	2237	2254		M3.2			84	3663
04	2328	2348	2355	N26W10	M9.0	1B	III/1	84	3663
05	0115	0127	0143	N26W10	M8.4	1B	VI/1	84	3663
05	0547	0601	0607	N26W10	X1.3	1B	III/3	84	3663
05	0807	0819	0824	N27W21	M1.3	SF		84	3663
05	0923	0938	0953	S20E22	M2.3	SN	III/1	86	3664
05	0953	1000	1019	N26W21	M7.4	1B	VI/1	84	3663
05	1141	1154	1216	N26W22	X1.2	1B		84	3663
05	1433	1447	1456	N25W25	M1.3	SF	VI/1	84	3663
05	1528	1538	1551	N24W26	M2.2	2N		84	3663
05	1655	1701	1706	S19E25	M1.3	1F	III/2	86	3664
05	1834	1840	1845	S19E25	M1.0	SF	III/1	86	3664
05	1944	1952	2006	N24W28	M1.3	2N	III/1	84	3663

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

5. 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/

6. PROBA2 Observations (29 Apr 2024 - 5 May 2024)

Solar Activity

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

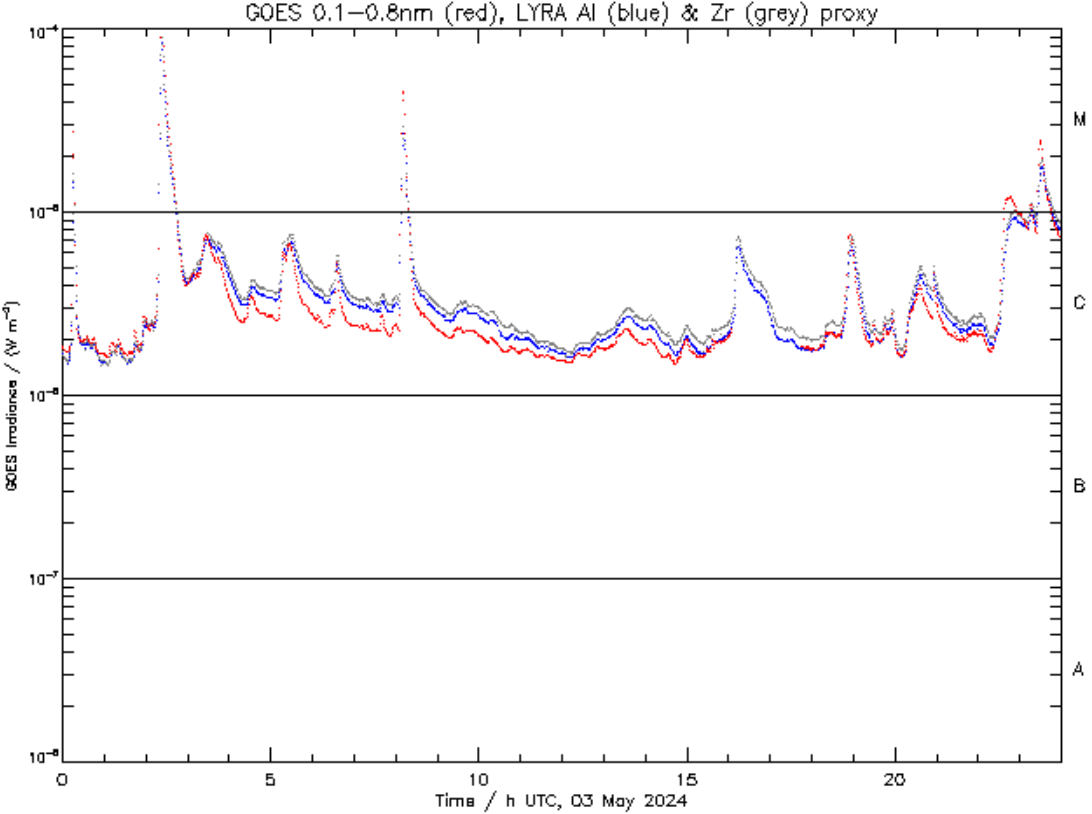
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: <https://proba2.oma.be/ssa>
This page also lists the recorded flaring events.

A weekly overview movie (SWAP week 736) can be found here: https://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2024_04_29.mp4.

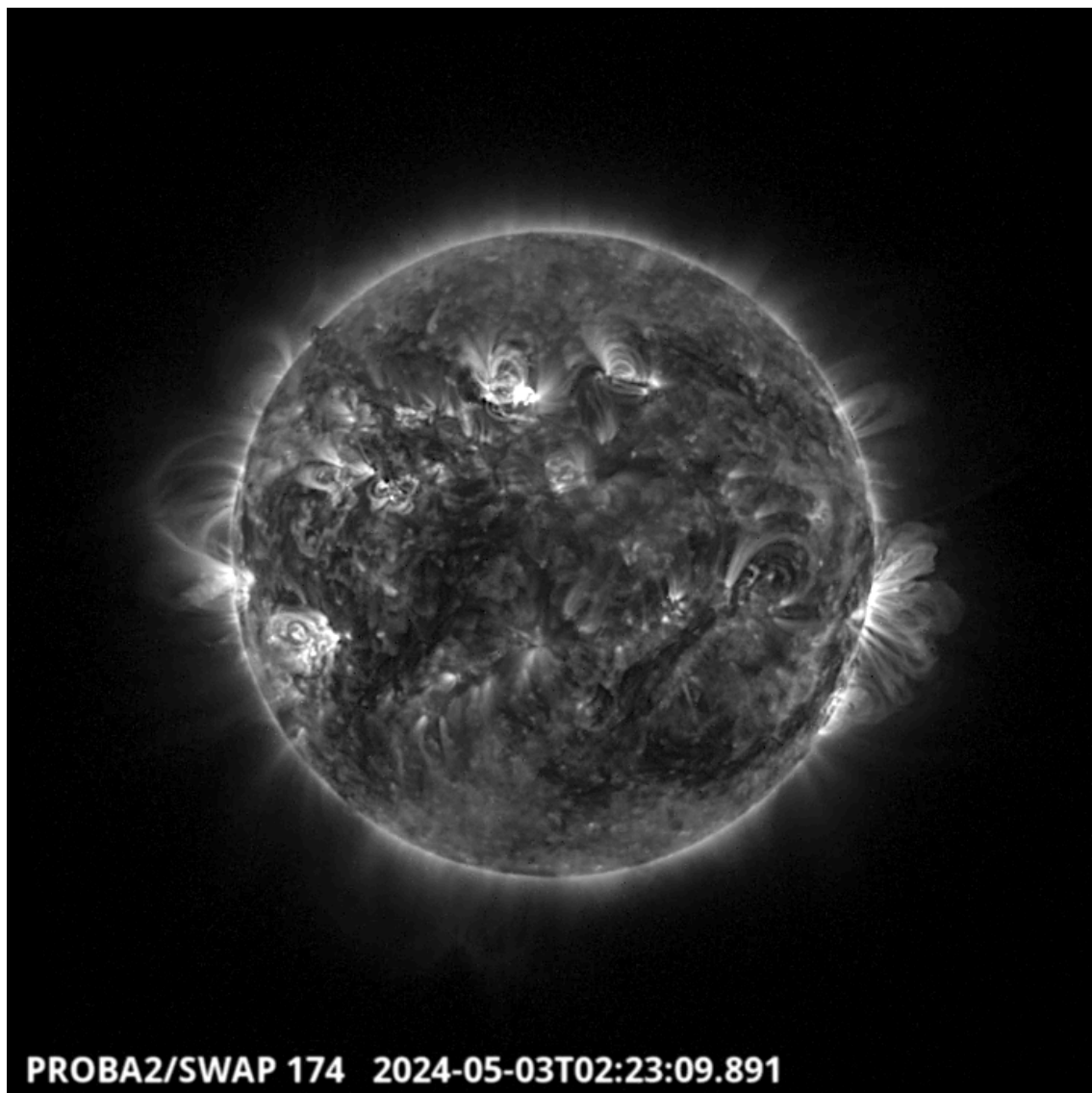
Details about some of this week's events can be found further below.

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/>.

Friday May 03



ROB/SIDC, Brussels, Belgium



The largest flare of this active week was an X1.6, and it was observed by LYRA (top panel) and SWAP (bottom panel). The flare peaked on 2024-May-03 at 02:22 UT. It occurred in the northern hemisphere close to the central meridian, and it originated from NOAA AR3663.

Find a SWAP movie of the event here: https://proba2.sidc.be/swap/movies/20240503_swap_movie.mp4.

7. The SIDC Space Weather Briefing

The SIDC briefing that gives an overview of space weather from April 28 to May 5: https://www.stce.be/briefings/20240506_SWbriefing.pdf

SIDC Space Weather Briefing

28 April 2024-05 May 2024

Vansintjan Robbe

& the SIDC forecaster team

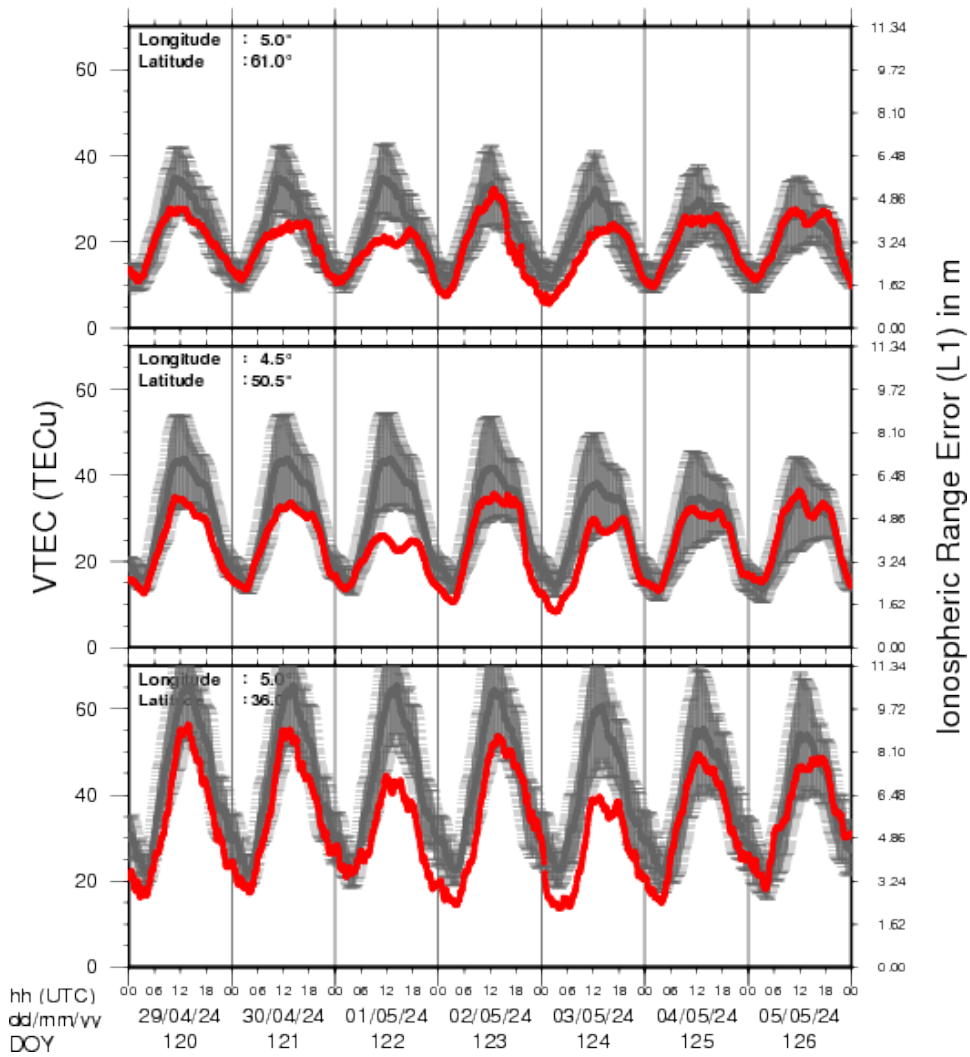


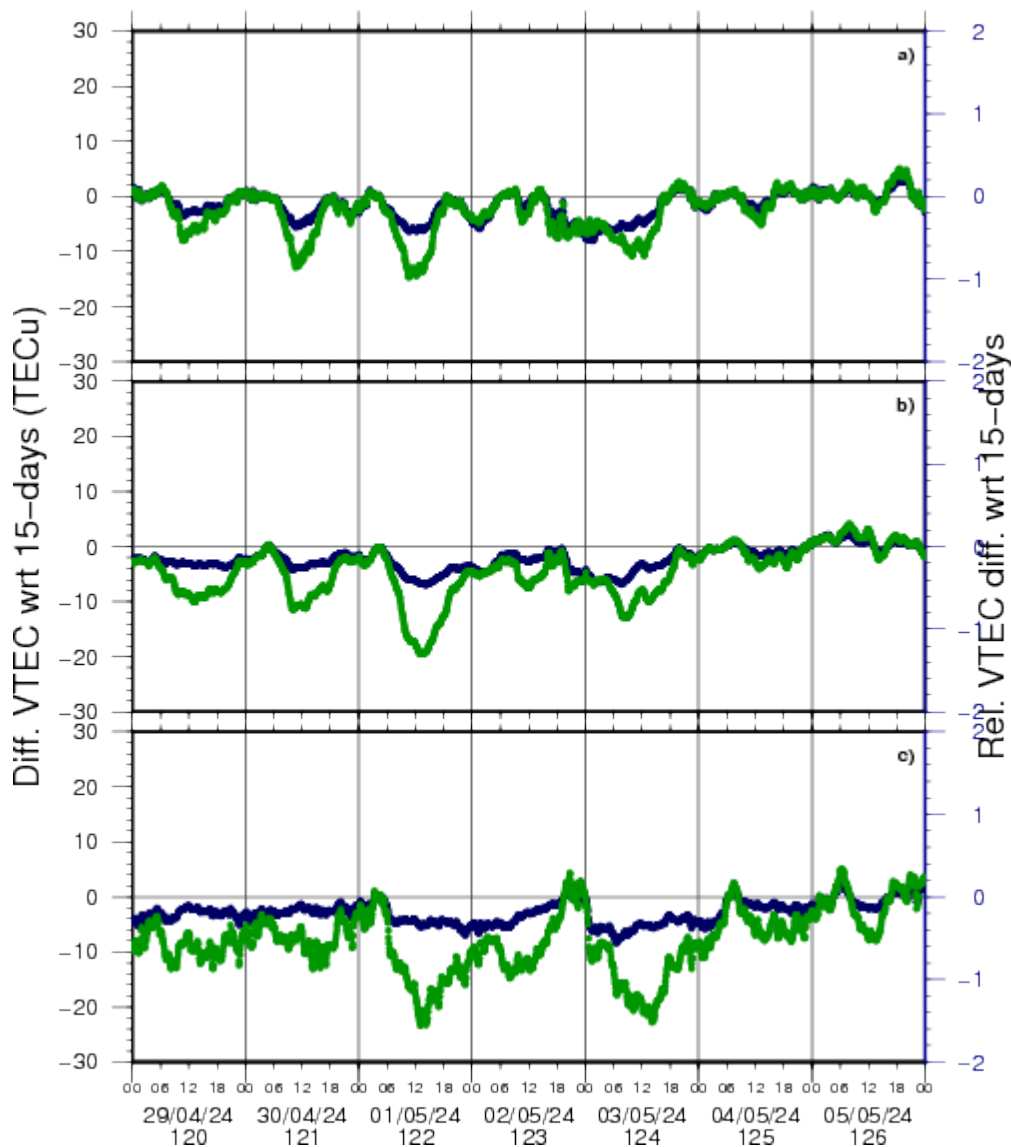
Solar Influences
Data analysis Centre
www.sidc.be

8. Review of Ionospheric Activity

NEW! The time series below illustrates (in green) the VTEC deviation from normal quiet behaviour.

VTEC Time Series





VTEC time series at 3 locations in Europe from 29 Apr 2024 till 5 May 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 $TECu=10^{16}$ 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. Courses and presentations

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

* May 13, lecture by the STCE, From physics to forecasting, ESA Space Weather Training Course 2024, Euro Space Center, Redu, Belgium

* May 14, STCE Seminar, Segmentation, grouping and classification of sunspots from ground-based observations using deep learning methods

* May 13 - 17, lectures by the STCE, solar and heliospheric weather; magnetosphere, ionosphere, aviation, and ground based impact, Course Operational Space Weather Fundamentals, L'Aquila, Italy

* May 18, Public presentation, The PROBA-3 Mission: Artificial Total Solar Eclipse in Space, FotonFest, Urania, Hove, Belgium

* May 28, Solar physics and Space Weather: Solar Orbiter Spacecraft, online course - Registrations are open

* June 7, STCE seminar, Ground level enhancements: probing conditions of the geospace environment

* June 9, Public presentation Total Eclipse of the Sun, Helios, Averbode, Belgium

* June 13, STCE seminar, Solar Prominence Eruptions: Insights from UV Imaging with EU/FSI

* June 25, Solar physics and Space Weather: predictions and services, online course - Registrations are open

* June 27, STCE annual meeting, Brussels, Belgium

* June 28, public presentation Help! Het stormt in de ruimte!?, Wetenschappelijke middagen, Brussels, Belgium

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](mailto:stce_coordination@stce.be) at stce.be

