STCE Newsletter

18 Aug 2025 - 24 Aug 2025

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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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1. A Blizzard of Solar Campfires

Solar Orbiter's Closest Look Reveals Myriad Tiny Flares

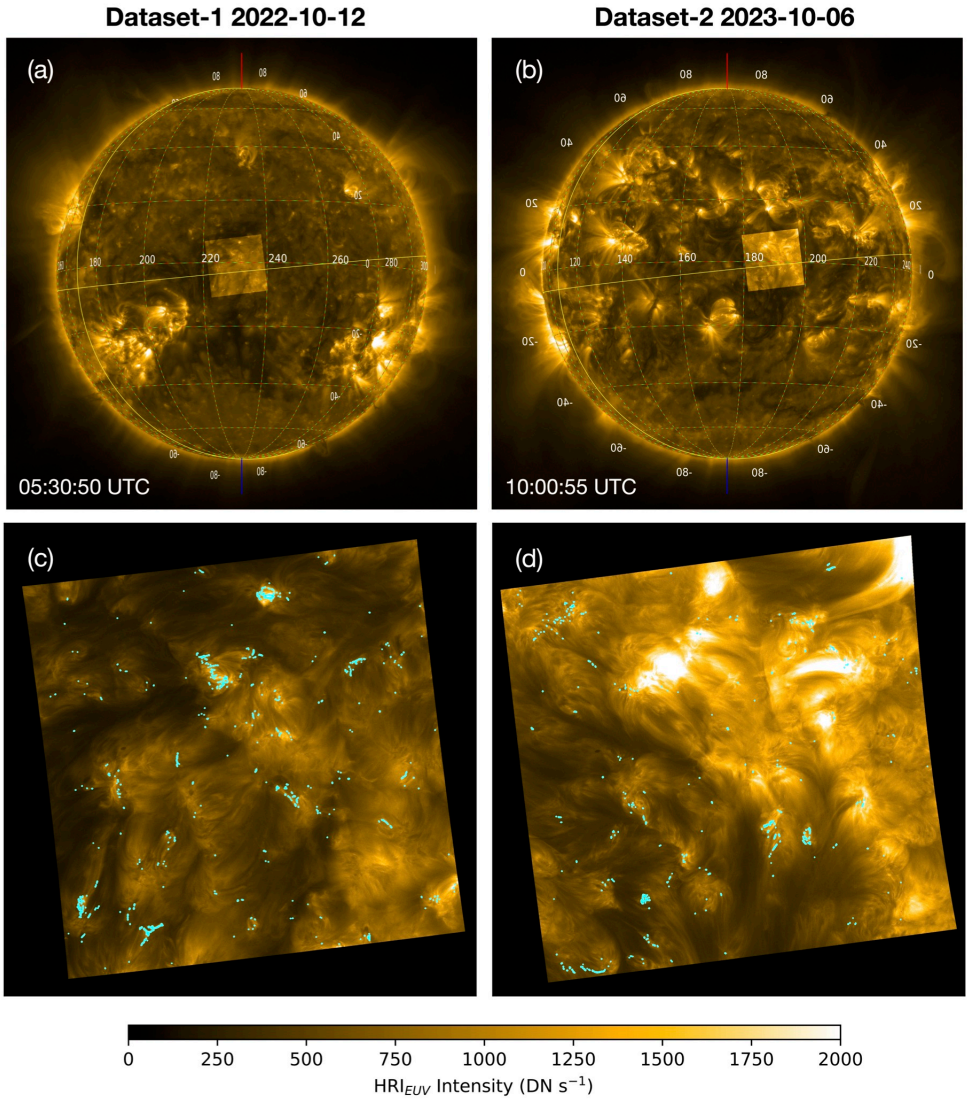
One of the most enduring mysteries in solar physics is the coronal heating problem: why is the Sun's outer atmosphere, the corona, hundreds of times hotter than its visible surface? One leading theory suggests that the corona is heated by a constant storm of tiny, impulsive energy releases, often called 'nanoflares'.

A new study published in the Astronomy And Astrophysics led by Dr. Nancy Narang from the STCE, provides compelling new evidence to support this theory, thanks to unprecedented observations from the Solar Orbiter spacecraft.

The Closest View Ever

Using the High Resolution EUV Imager (HRIEUV) of the Extreme Ultraviolet Imager (EUI) onboard Solar Orbiter spacecraft, scientists took advantage of Solar Orbiter's closest perihelion passes in 2022 and 2023. From a distance of just 0.293 AU (less than one-third of the distance from the Sun to Earth), EUI captured the highest-resolution images of the quiet solar corona ever obtained.

These unique observations had an image scale of just 105 km per pixel and were taken at a rapid cadence of 3 seconds, revealing the solar atmosphere in stunning, fine detail.



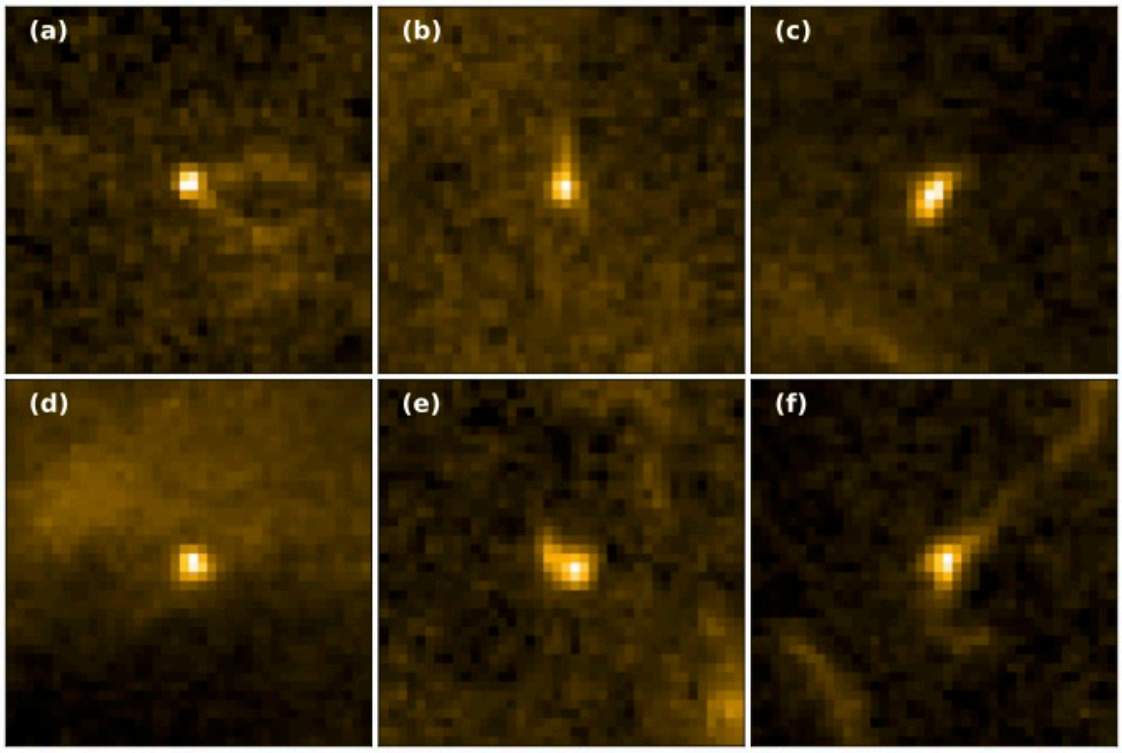
Top Panels: EUI/FSI (Full-Sun Imager aboard EUI) images of the full Sun with the HRIEUV field-of-view overlaid. Bottom Panels: Detailed HRIEUV observations with detected EUV brightenings marked in cyan. The animations are available as movie1(https://cloud-as.oma.be/index.php/s/2y2NjicCiPBrACG) and movie2(https://cloud-as.oma.be/index.php/s/JDwzxsKb8bazgs8). Courtesy: Narang et al. 2025

Unprecedented Findings

The STCE researchers used a sophisticated wavelet-based algorithm to automatically detect and characterize thousands of transient EUV brightenings, often called "campfires," in the HRIEUV data obtained at the closest-perihelion of Solar Orbiter. The results were staggering:

* Record-Breaking Detections: The study reports the detection of the smallest and shortest-lived EUV brightenings to date. These events were observed with sizes down to 10000 km² and lifetimes as short as 3 seconds—the very limit of the instrument's detection capability.
* A Staggering Occurrence Rate: The analysis revealed that these tiny events are far more numerous than previously thought. The team estimates that, on average, about 3600 EUV brightenings appear per second across the entire surface of the Sun. This rate is more than an order of magnitude higher than previously reported values.

* The Small Dominate: The statistical analysis showed a clear power-law distribution, confirming that smaller and shorter-lived events are vastly more common than their larger, and longer-lived counterparts.



Close-up view of tiniest EUV brightenings. Courtesy: Narang et al. 2025

Heating of the Solar Corona

This incredibly high number of tiny, ubiquitous energy releases provides strong support for the nanoflare heating model. While the energy contributed by each individual EUV brightening is small, their collective effect across the entire Sun could be a significant source of the energy required to maintain the million-degree corona (Narang et al. 2025).

The study concludes that these EUV brightenings observed by the HRIEUV are the most prevalent, localized, and finest-scale transient events ever detected in the quiet solar corona.

While these results are a major step forward, the researchers at STCE note that the next crucial step is to determine the thermal energy of this newly-discovered population of tiny events. Active research is being performed at STCE to explore the thermal nature of these tiniest EUV brightenings, that will put another step forward to fully understand their contribution in solving the coronal heating mystery.

The research that led to these results was subsidized by the Belgian Federal Science Policy Office through the contract B2/223/P1/CLOSE-UP.

Based on the paper: Narang, N., Verbeeck, C., Mierla, M., Berghmans, D., Auchère, F., Shestov, S., Delouille, V., Chitta, L. P., Priest, E., Lim, D., Dolla, L. R., and Kraaikamp, E. (2025). Extreme-ultraviolet transient brightenings in the quiet-Sun corona. Astronomy And Astrophysics, 699, A138. https://doi.org/10.1051/0004-6361/202554650

2. Review of space weather

Solar Active Regions (ARs) and flares

Solar flaring activity was low to moderate during the week. A total of 14 C-class flares and 3 M-class flares were observed. The largest flare was a M1.9 flare (SIDC Flare 5195) peaking on August 23 at 20:06 UTC from on the east-limb. Fourteen (14) active regions were observed on the visible solar disk.

Coronal mass ejections

No CME (Coronal Mass Ejection) with an Earth directed component was observed. The partial halo CME that was observed on August 21 08:24 UTC was backsided.

Coronal Holes

A small polar negative polarity equatorial Coronal Hole (CH) crossed the central meridian on the August 22, and a negative polarity mid-latitude CH crossed the central meridian on August 22-23.

Proton flux levels

The greater than 10 MeV GOES proton flux started to rise on August 22 12:UTC but remained below the 10pfu threshold.

Electron fluxes at GEO

The greater than 2 MeV electron flux was mainly above the 1000 pfu threshold throughout the entire week, but with minimal crossings of the threshold.

Solar wind

At the start of the week, the solar wind near Earth was slow. On August 19 the solar wind became fast due to the arrival of the high speed stream of SIDC CH 116 near Earth, and returned gradually to slow solar wind conditions on August 23. The solar wind ranged between 330 and 680 km/s and the interplanetary magnetic field was between 0.85 and 16 nT, and with the Bz reaching a minimum value of -6 nT.

Geomagnetism

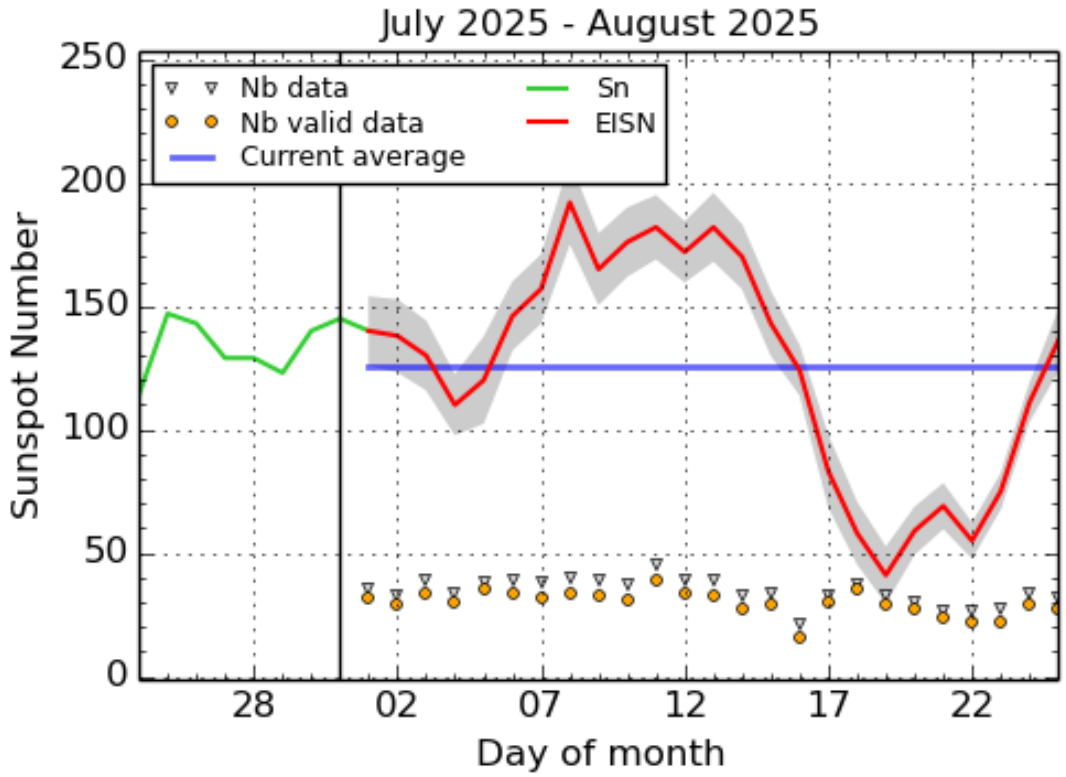
Geomagnetic conditions reached active conditions (Kp4) on August 19-20, with an isolated period of minor storm on August 19 (Kp 5), and have since then returned to quiet conditions.

3. Noticeable Solar Events

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
19	0351	0439	0507		M1.1					
22	1756	1851	1902	N12E61	M1.7	SF		II/2		
22	1855	1859	1902		M1.7			II/2		
23	1953	2006	2016		M1.9					
24	0826	0836	0842		M1.3					

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

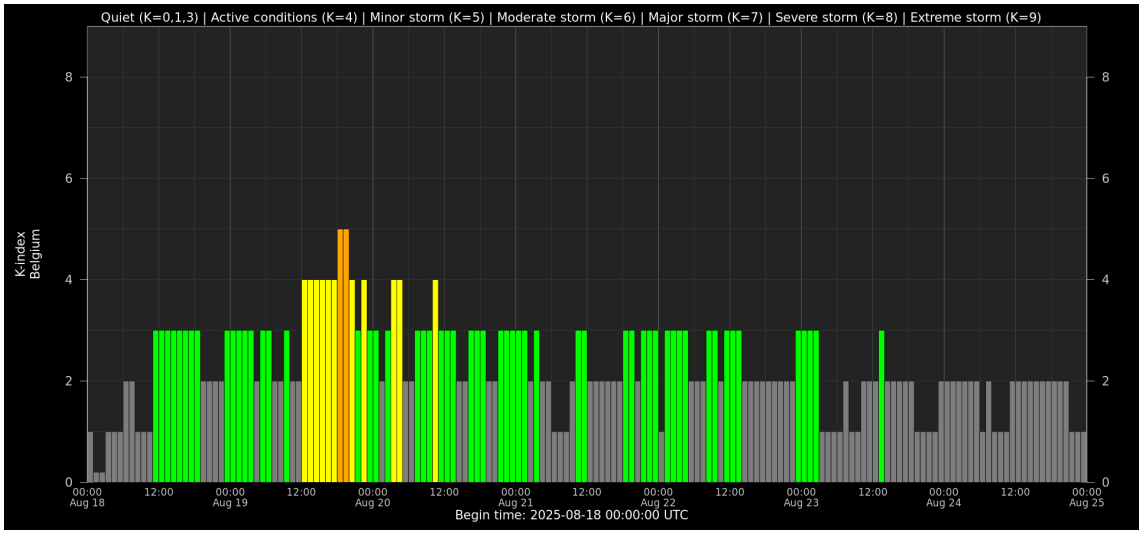
4. International Sunspot Number by SILSO



SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium, 2025 August 25

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. 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. The SIDC Space Weather Briefing

The forecaster on duty presented the SIDC briefing that gives an overview of space weather from Aug 18 to 24.
The pdf of the presentation: https://www.stce.be/briefings/20250825_SWbriefing.pdf

SIDC Space Weather Briefing

18 August 2025-24 August 2025

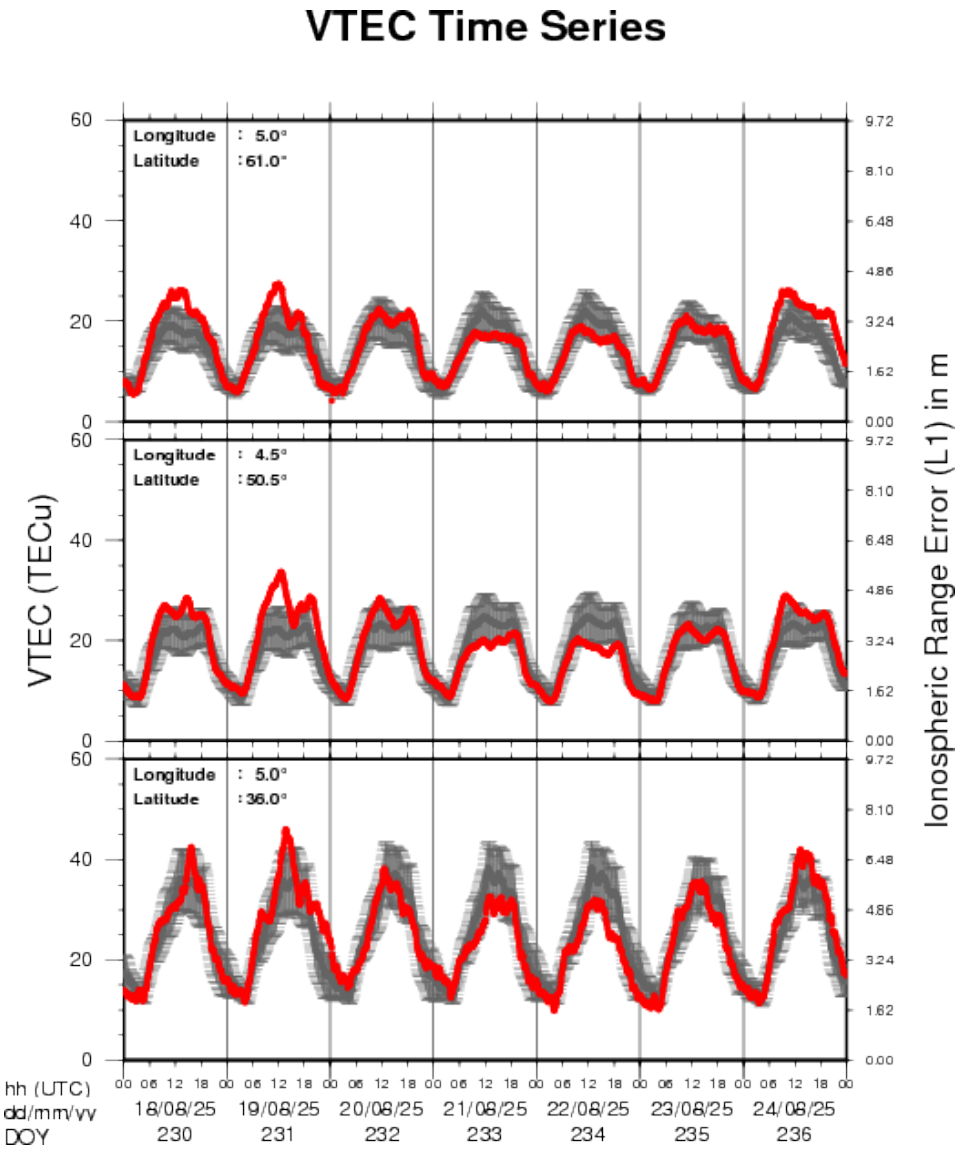
Elisabeth Dom

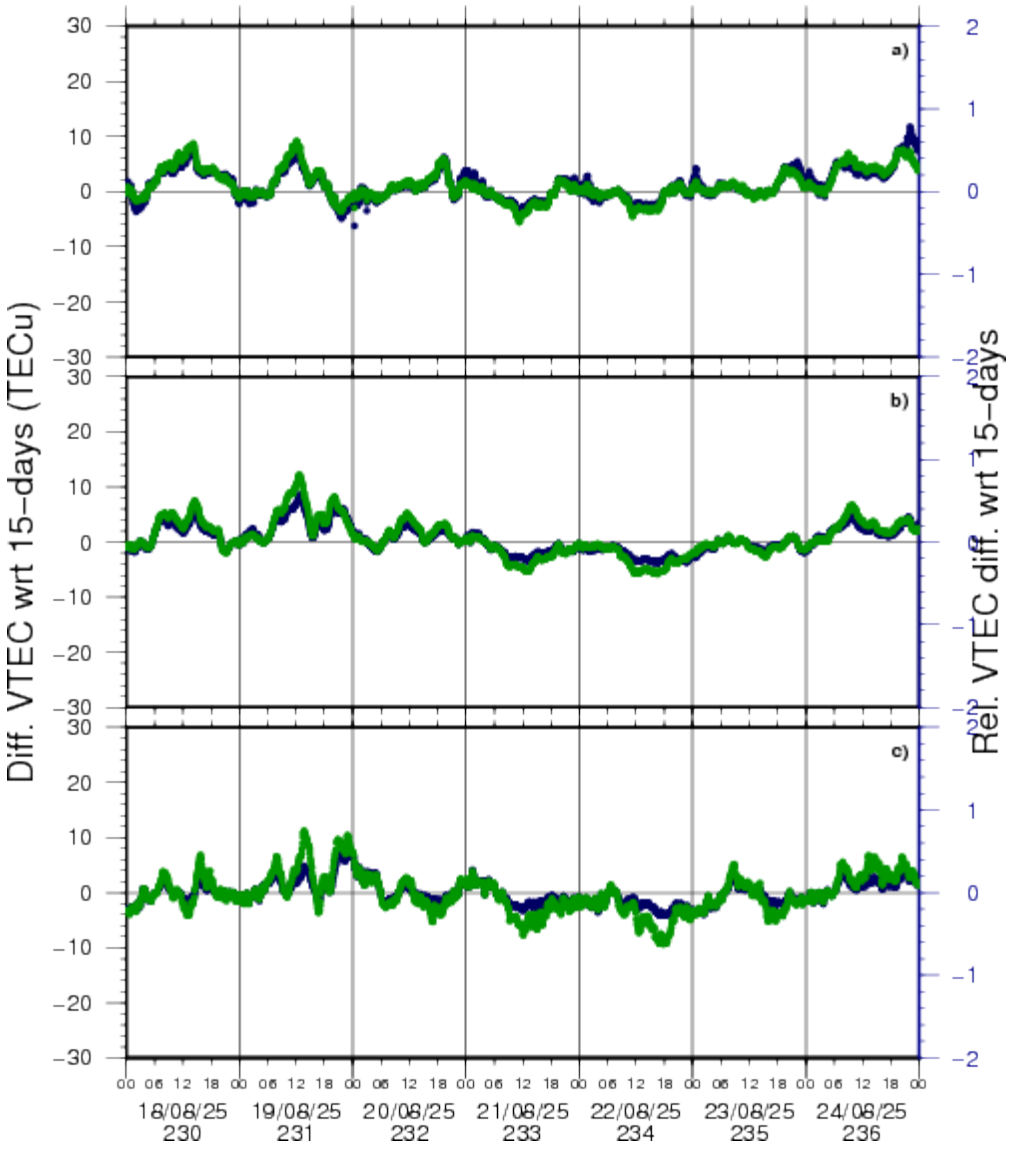
& the SIDC forecaster team

Royal Observatory *of* Belgium

Solar Influences
Data analysis Centre
www.sidc.be

7. Review of Ionospheric Activity





VTEC time series at 3 locations in Europe from 18 Aug 2025 till 24 Aug 2025

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

8. STCE Courses and presentations

Courses, seminars, presentations and events 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 1, STCE seminar: High resolution solar telescopes: the Dutch Open Telescope and beyond, Space Pole Uccle
* Sep 8-10, STCE course: Role of the ionosphere and space weather in military communications, Brussels, Belgium - register: https://events.spacepole.be/event/226/
* Sep 20, Public Lecture: België op weg naar de zon met Proba-3, UGhent Volkssterrenwacht Armand Pien, Gent, Belgium
* Oct 23-25, ESWW Space Weather Training by Umea University and STCE, Kiruna, Sweden - Full
* Oct 27-31, European Space Weather Week, Umea, Sweden - https://esww.eu/
* Nov 17-19, STCE Space Weather Introductory Course, Brussels, Belgium - register: https://events.spacepole.be/event/217/

To register for a course and check the seminar details, navigate to 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

Website: https://www.stce.be/SWEC