STCE Newsletter

8 Sep 2025 - 14 Sep 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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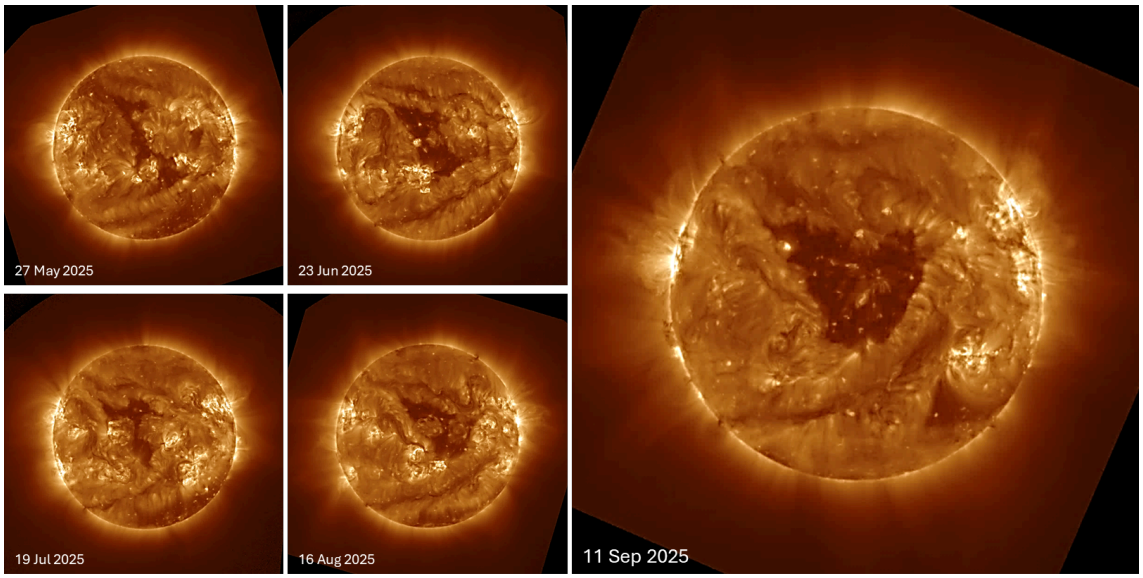
1. A supersized coronal hole

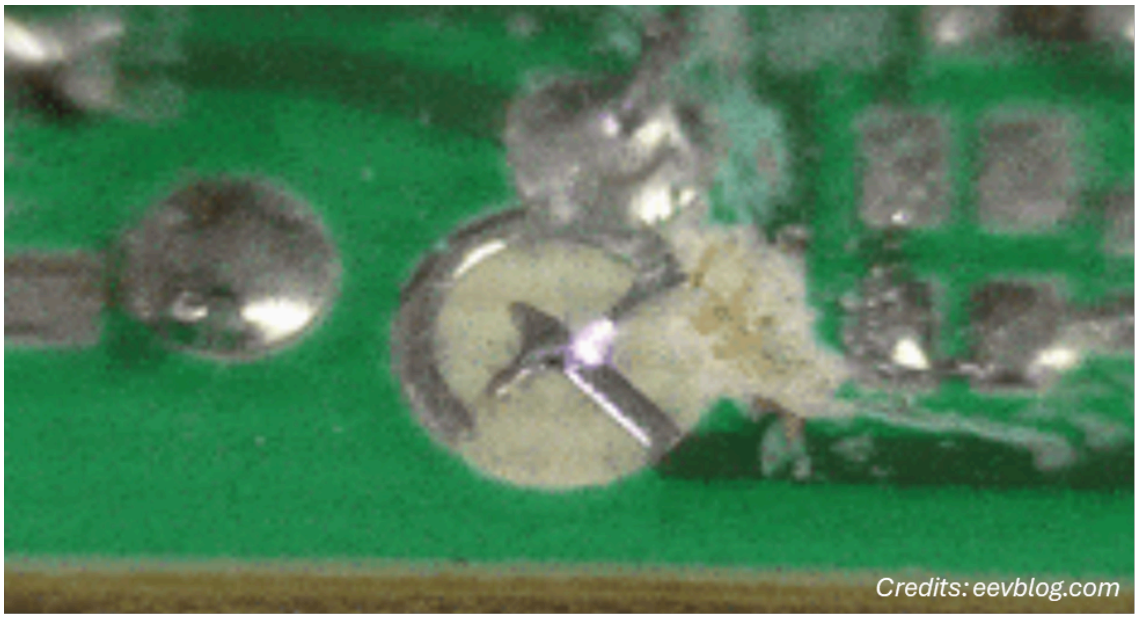
Coronal holes (CHs) are regions in the hot solar atmosphere ("corona") where the plasma density at that temperature is very low compared to its surroundings, and thus they look like dark shapes in the corona when viewed in extreme ultraviolet (EUV). Linked to unipolar (i.e. "open") magnetic fields stretching into space, they are the source of the high-speed solar wind which can create geomagnetic disturbances. Space weather forecasters at the SIDC (https://www.sidc.be/index.php) of the Royal Observatory of Belgium assign a number to each CH that appears on the Sun (link: https://www.sidc.be/index.php/services/event-chains/coronal-holes). Returning CHs get the same number. SIDC CH 116 was first numbered on 23 May 2025 and started its fifth transit over the solar disk on 6 September. This was indeed already the fifth appearance of this CH. It had a negative magnetic polarity, meaning that the open magnetic field lines were pointing towards the Sun. The EUV images underneath were taken by GOES/SUVI 193 and show how the CH evolved during its 5 passages over the Sun's central meridian (CM): from a narrow, elongated shape in May over a grouping of irregular, smaller CHs in July to the current single, supersized entity.



The area of the current CH is over 250 times the total surface area of the Earth. It was by far the largest of the 5 transits, but in the past there have been many other and larger CHs (see these STCE newsitems https://www.stce.be/news/208/welcome.html and https://www.stce.be/news/762/welcome.html for some references). The table underneath gives for each of the transits the date of the CM passage, the area of the CH in billion km^2 (from SIDC's SolarMap - https://www.sidc.be/spaceweatherservices/applications/solarmap/), the maximum speed (km/s) of the associated high-speed wind stream (HSS) and the time (in hours) that the speed remained above 500 km/s (DSCOVR). The last two columns give the Kp index (Potsdam) and the electron fluence, i.e. the number of highly energetic electrons (energies of 2 or more MeV) per cm^2 and per steradian, accumulated over 24 hours at geostationary orbit (GEO). More info on the Kp index and the electron fluence can be found on the STCE's Space Weather Classifications page (https://www.stce.be/educational/classification).

CM passage (2025)	CH area (10^9 km^2)	Vmax (km/s)	Time (hrs) V>500km/s	Kp	Electron Fluence (#/day cm^2 sr)
27 May	67	760	75*	6+	3.0 10^8
23 Jun	96	720	94	5o	2.3 10^8
19 Jul	59	720	90	5-	1.2 10^8
16 Aug	68	670	78	5-	5.6 10^7
11 Sep	129	800	*In progress*	7-	*In progress*

The effects of the HSS associated with the first passage of SIDC CH 116 were clipped short due to the passage of a fast and potent coronal mass ejection on 1 June (STCE newsitem at https://www.stce.be/news/771/welcome.html). But even then, this was still the strongest of the first four high-speed streams. The electron fluence reached moderate levels (more than 5 . 10^7 electrons / cm^2 sr day during each of the 4 first passages, but now with the ongoing wind stream there's a chance that the electron fluence will increase to high levels over the next few days. As the current solar cycle continues its (gradual) decline, the number and the size of coronal holes will increase. The associated wind streams may then drive the number of energetic electrons at GEO to even higher levels, to the point that these "killer electrons" pose a genuine threat to satellites. Note that fluence values greater than 5 . 10^7 electrons / cm^2 sr day are already indicative of adverse space weather conditions hazardous to GEO satellites. As these charged particles accumulate around the electronics of the satellite, an electrostatic discharge may occur (ESD ; see image underneath) that may affect the component and even cripple the satellite. A notable example of satellite damage due to ESD is the consecutive outage of Telesat Canada's Anik-E1 and Anik-E2 geostationary communication satellites on 20 January 1994 that interrupted telecommunication and data transmission services across Canada for a considerable time.



2. Review of Solar and Geomagnetic Activity

WEEK 1289 from 2025 Sep 08

Solar Active Regions (ARs) and flares

Solar flaring activity was low over the past week, with only C-class flares identified. The largest flare was a C7.6 flare (SIDC Flare 5471) peaking on September 11 at 15:21 UTC, which was produced by SIDC Sunspot Group 624 (NOAA Active Region 4207). During the flare, the source region (AR 4207) of the flare had beta configuration of its photospheric magnetic field. There were 11 NOAA numbered active regions and 5 short-lived unnumbered active regions on the visible solar disk throughout the week. At the end of the week, an active region (or regions) on SE limb produced C-class flares frequently.

Coronal mass ejections

A narrow coronal mass ejection (CME) was observed in SOHO/LASCO-C2 images on NW limb at 03:48 UTC on Sep 09 (about 40 deg). It was associated with a C1.5 flare (peak: 03:23 UTC, N28 W51) from the SIDC sunspot group 624 (NOAA AR 4207), and it did not arrive at Earth. A faint CME was observed in the SOHO/LASCO-C2 images around 10:30 UTC on Sep 11. It had a projected width of about 100 deg and a projected speed of about 350 km/s. This CME was associated to a filament eruption in the S hemisphere of the Sun. Narrow CMEs related to the same filament eruption were also observed prior to this CME. With the bulk of the mass strongly directed towards SW, only a glancing blow was expected at Earth around 06:00 UTC on Sep 16 and it possibly arrived early around 19:00 UTC on Sep 14. A CME, with a projected width of about 100 deg, was observed in SOHO/LASCO-C2 images around 15:12 on Sep 12. It was associated with a prominence eruption on SW limb, with the bulk of the mass strongly directed towards S and mostly backside, so it was not expected to impact Earth. Multiple CMEs have been observed to lift-off the NE limb on Sep 14, but none of them carried an Earth-directed component.

Coronal Holes

SIDC Coronal Hole 123 (recurrent, positive polarity, elongated coronal hole in the southern hemisphere), which started to cross the central meridian on Sep 02, passed the central meridian on Sep 08. The high speed streams related to this coronal hole enhanced the solar wind parameters near Earth until Sep 12. Another recurrent coronal hole (SIDC Coronal Hole 116, negative polarity), which spanned from 10 S to 30 N, crossed the central meridian during Sep 10-14. The high speed streams related to this coronal hole started to enhance the solar wind parameters near Earth from 19:00 UTC on Sep 14.

Proton flux levels

The greater than 10 MeV GOES proton flux was at nominal levels throughout the entire past week.

Electron fluxes at GEO

The greater than 2 MeV electron flux, as measured by GOES-18 and GOES-19 satellites, remained elevated and exceeded the 1000 pfu threshold level on multiple days, in response to the high solar wind speed associated with the SIDC Coronal Hole 123 (positive polarity) which crossed the central meridian during Sep 02-08. The 24h electron fluence was at normal level throughout the entire past week.

Solar wind

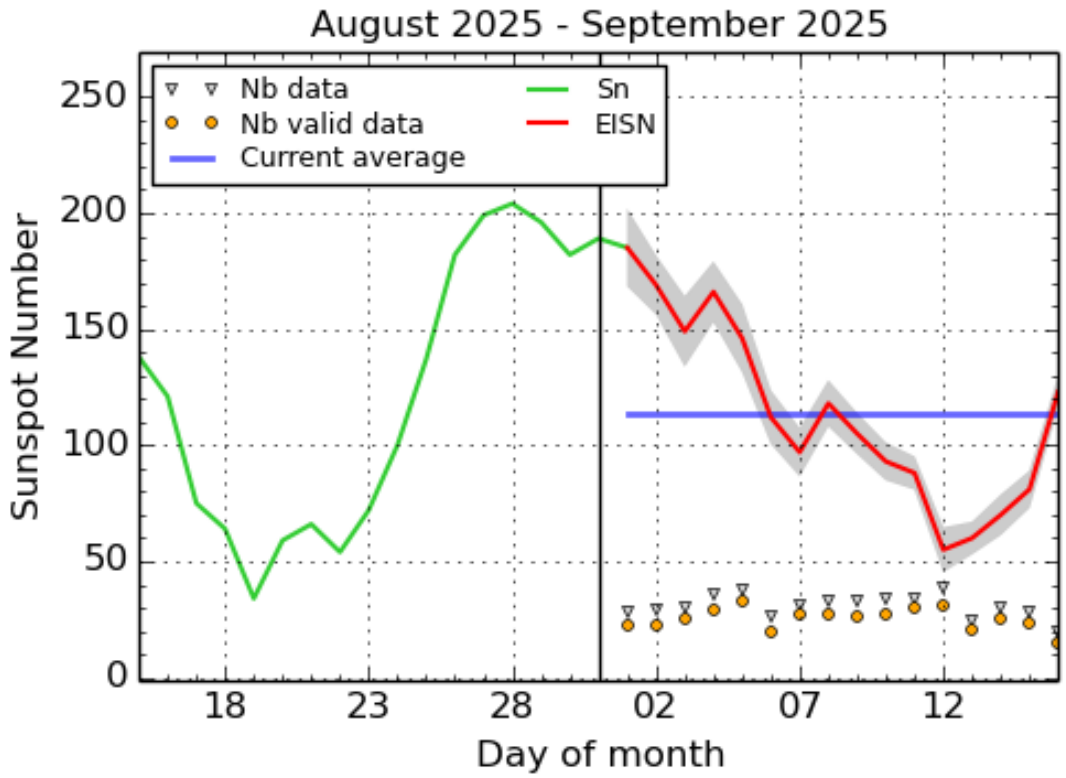
At the beginning of the past week, the solar wind parameters were under the influence of high speed streams (HSSs) from the SIDC Coronal Hole 123 (positive polarity, elongated coronal hole in the southern hemisphere) which crossed the central meridian during Sep 02-08. The solar wind speed was as high as 640 km/s and the interplanetary magnetic field (IMF) reaching 9 nT and North-South component (Bz) down to -6 nT. The solar wind parameters started to transition from fast to slow solar wind on Sep 11, and the Earth was inside the slow solar wind regime until the evening of Sep 14. The high speed streams related to another recurrent coronal hole (SIDC Coronal Hole 116, negative polarity), which crossed the central meridian during Sep 10-14, and possibly mixed with an interplanetary coronal mass ejection (ICME) arrival associated to a CME that departed the Sun on Sep 11, started to enhance

the solar wind parameters near Earth from 19:00 UTC on Sep 14. At the end of the week, the solar wind speed was as high as 655 km/s and the IMF reaching 20 nT and Bz component down to -17 nT.

Geomagnetism

Geomagnetic conditions were enhanced from the beginning of the week until Sep 11, due to the continuous arrival of high speed streams (HSSs) from the SIDC Coronal Hole 123 (positive polarity, elongated coronal hole in the southern hemisphere), which crossed the central meridian during Sep 02-08. Geomagnetic conditions were at quiet to active conditions (NOAA Kp 0 to 4, K_BEL 1 to 4), both globally and locally over Belgium until Sep 11. For an interval from 21:00 UTC on Sep 09 to 00:00 UTC on Sep 10, global geomagnetic conditions were at moderate or minor storm conditions (Kp=6- or Kp=5, which is not clear). From Sep 11 to late Sep 14, geomagnetic conditions were at quiet to unsettled conditions (NOAA Kp and K_BEL 0 to 3), both globally and locally over Belgium. At the end of the past week, geomagnetic conditions were at minor storm conditions (NOAA Kp=5) globally and at active conditions (K_BEL=4) locally over Belgium, due to the arrival of high speed streams from the SIDC Coronal Hole 116 (recurrent, negative polarity) that crossed the central meridian during Sep 10-14.

3. International Sunspot Number by SILSO



SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium, 2025 September 16

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. PROBA2 Observations

Solar Activity

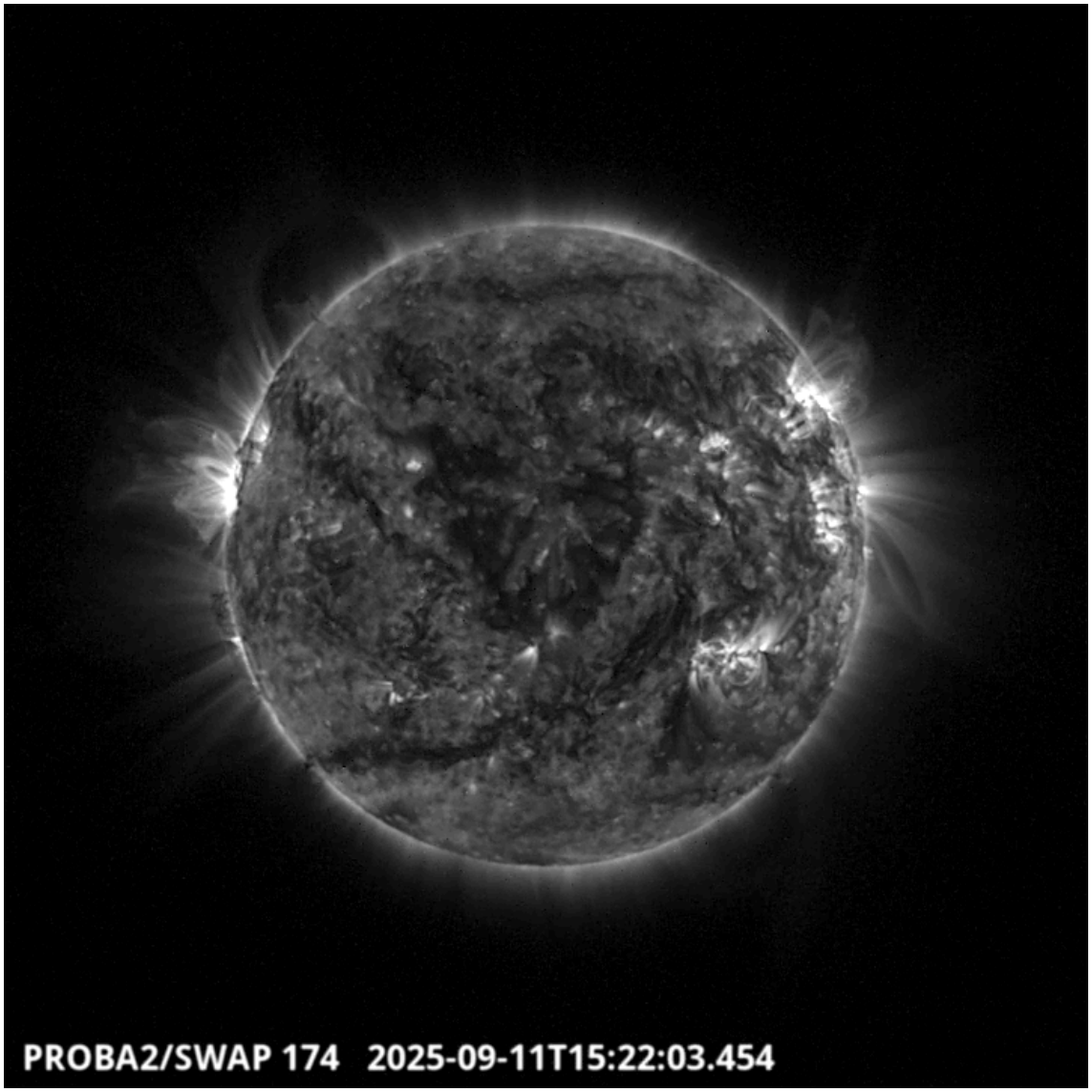
Solar flare activity was low during the week.
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: https://proba2.oma.be/ssa
This page also lists the recorded flaring events.

A weekly overview movie can be found here (SWAP week 807): https://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2025_09_08.mp4

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

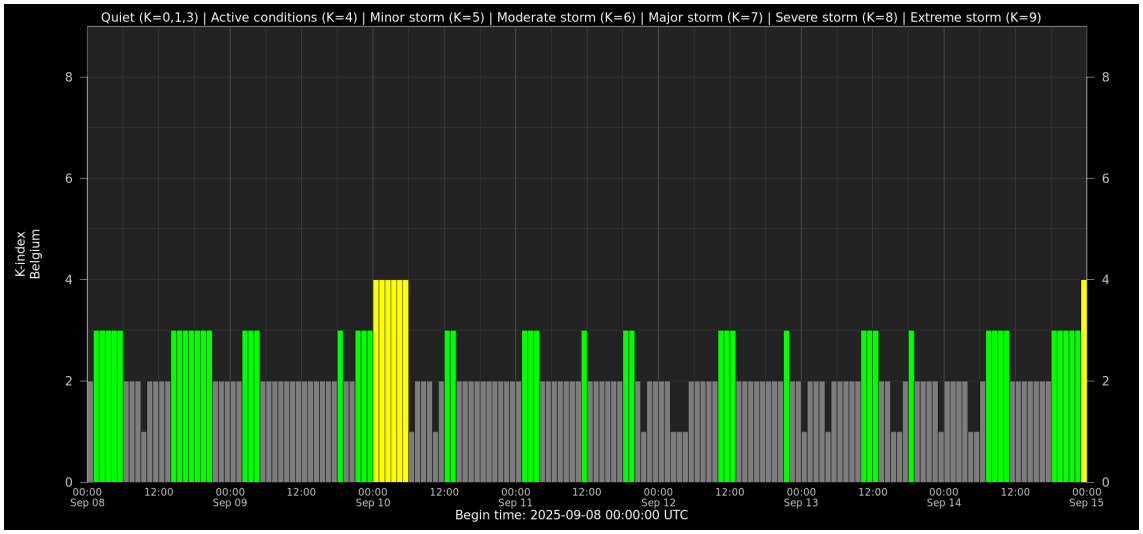
If any of the linked movies are unavailable they can be found in the P2SC movie repository here: https://proba2.oma.be/swap/data/mpg/movies/

Thursday Sept 11



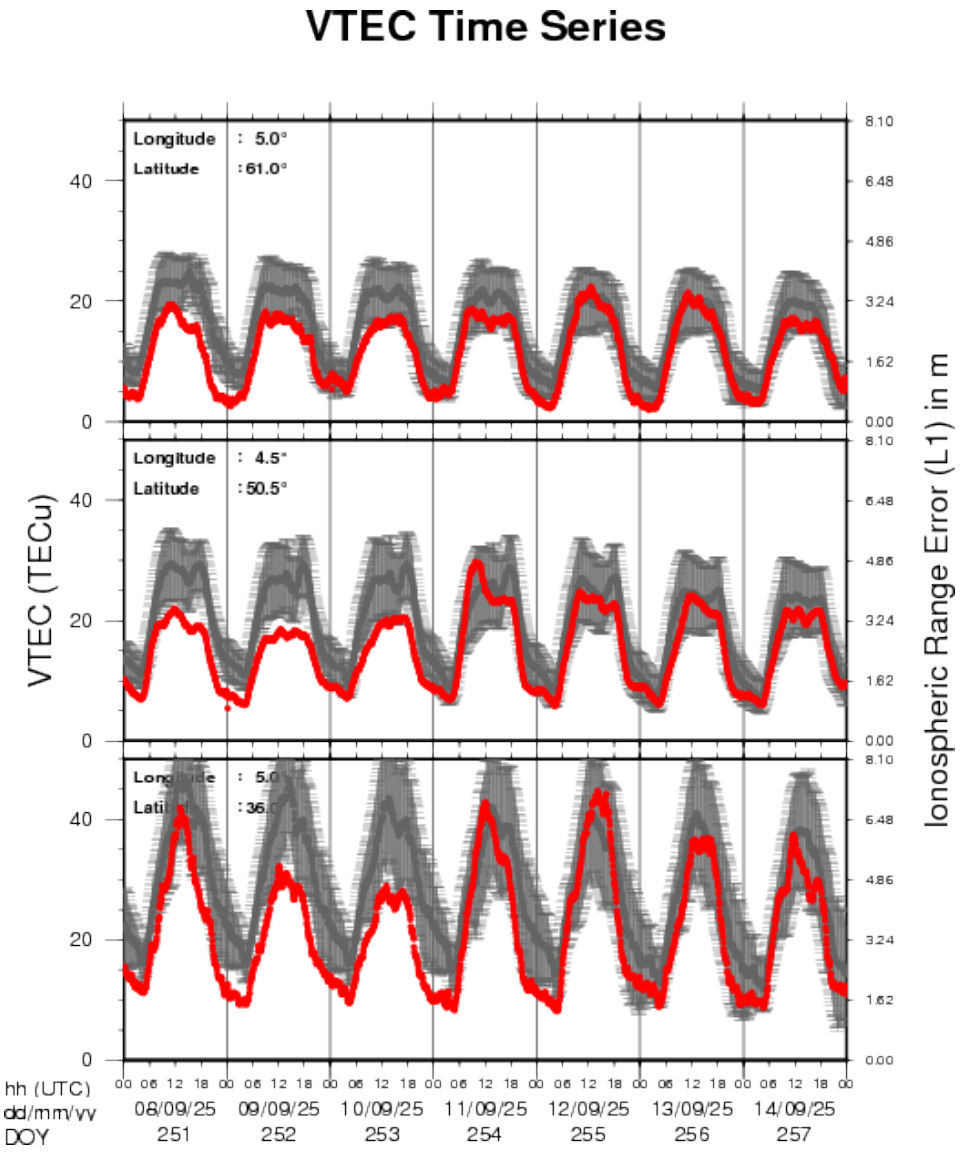
A coronal hole was visible on the solar disk for the whole week. On September 12, it was crossing the central meridian as we can see on the above SWAP image.
Find a SWAP movie of the event here: https://proba2.sidc.be/swap/movies/20250911_swap_movie.mp4

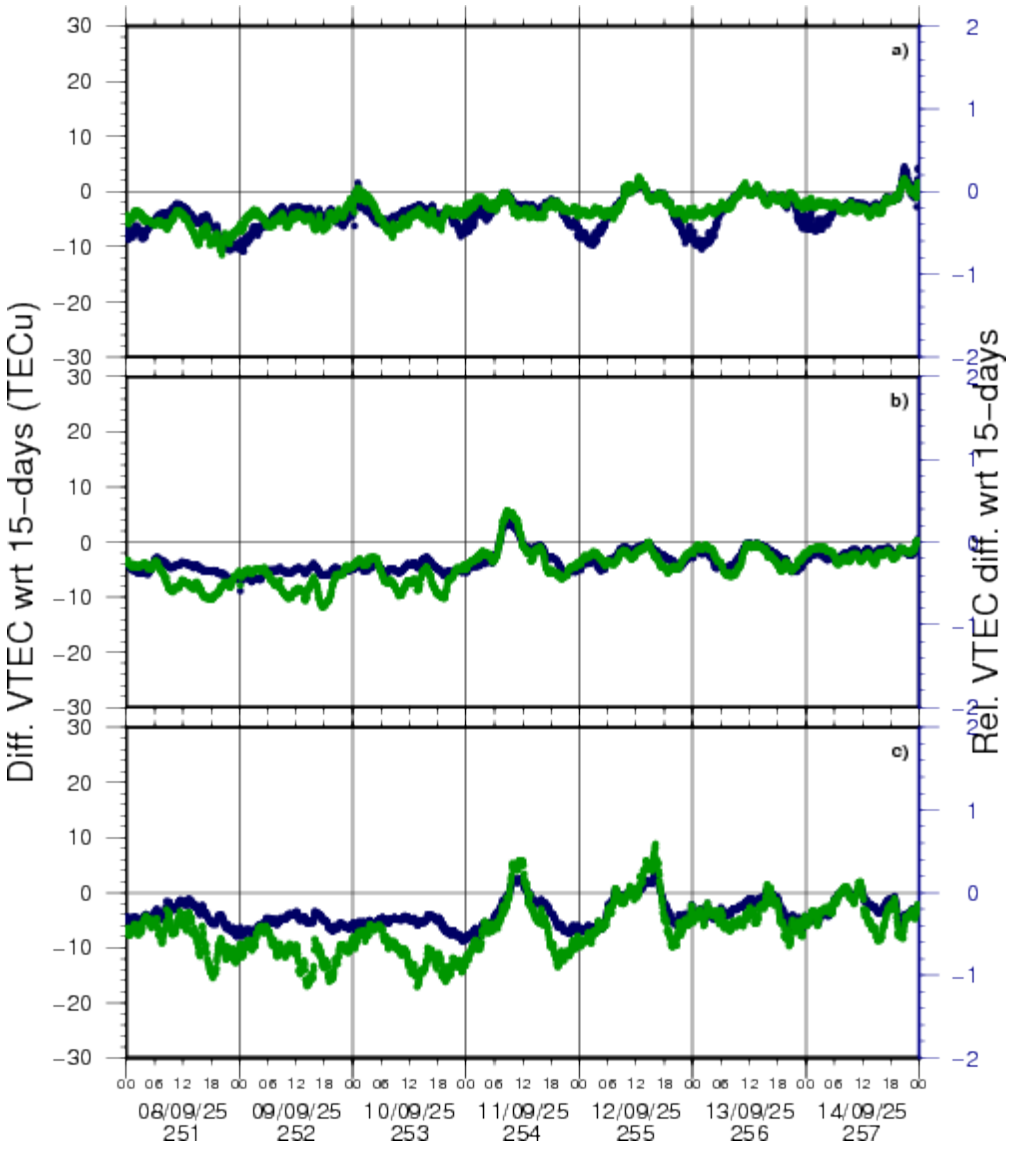
5. Geomagnetic Observations in Belgium



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. Review of Ionospheric Activity





VTEC time series at 3 locations in Europe from 8 Sep 2025 till 14 Sep 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).

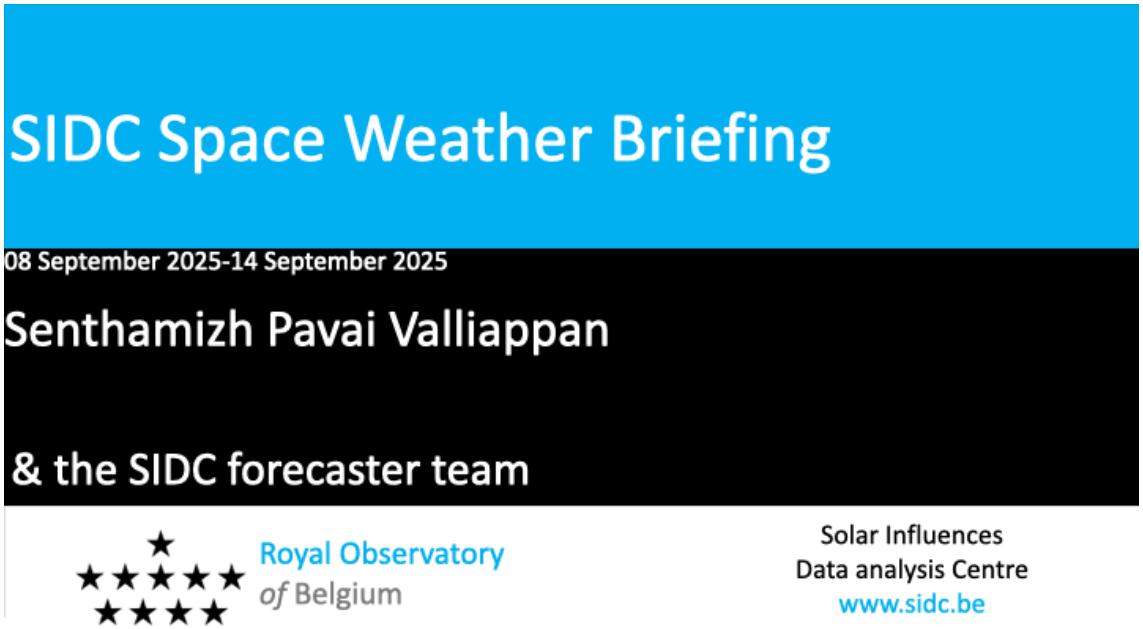
The Sun's radiation ionizes the Earth's upper atmosphere, the ionosphere, located from about 60km to 1000km above the Earth's surface.The ionization process in the ionosphere produces ions and free electrons. These electrons perturb the propagation of the GNSS (Global Navigation Satellite System) signals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

7. The SIDC Space Weather Briefing

The forecaster on duty presented the SIDC briefing that gives an overview of space weather from September 8 to 14.

The pdf of the presentation can be found here: https://www.stce.be/briefings/20250915_SWbriefing.pdf



8. Upcoming Activities

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 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