STCE Newsletter

9 May 2022 - 15 May 2022

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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. The EUI telescope causes a revolution in solar physics

On March 26, 2022, the Solar Orbiter satellite came closer to the Sun than ever before. A particularly exciting moment. The images of this closest approach -the perihelion-, taken by the Extreme Ultraviolet Imager (EUI) on board are will revolutionize solar physics!

The invention of the microscope more than 400 years ago, gave scientists the opportunity to study nature in extraordinary detail. Cells, bacteria and small organisms were discovered. Microbiology was born. Similarly, EUI is revolutionizing our knowledge of the Sun. Like with a microscope, we can zoom in on the Sun with the EUI telescopes and study details in the solar atmosphere, the corona, that we have never been able to see despite decades of solar observations. The EUI telescopes are paving the way for a new branch of research: the study of the micro-corona. It feels like our eyes were finally opened.

There is so much new to see in the EUI-f images collected during this first close passage near the Sun that solar scientists at the Royal Observatory of Belgium are spending hours staring at the screen in fascination, just as microbiologists did 400 years ago. Let yourself be equally amazed by the ever-moving solar material in the videos below!

Many more passages close to the Sun will follow later in the mission. Solar Orbiter's orbit is becoming increasingly tilted, which will allow us to image the solar poles for the first time. Our researchers will not know where to look first!

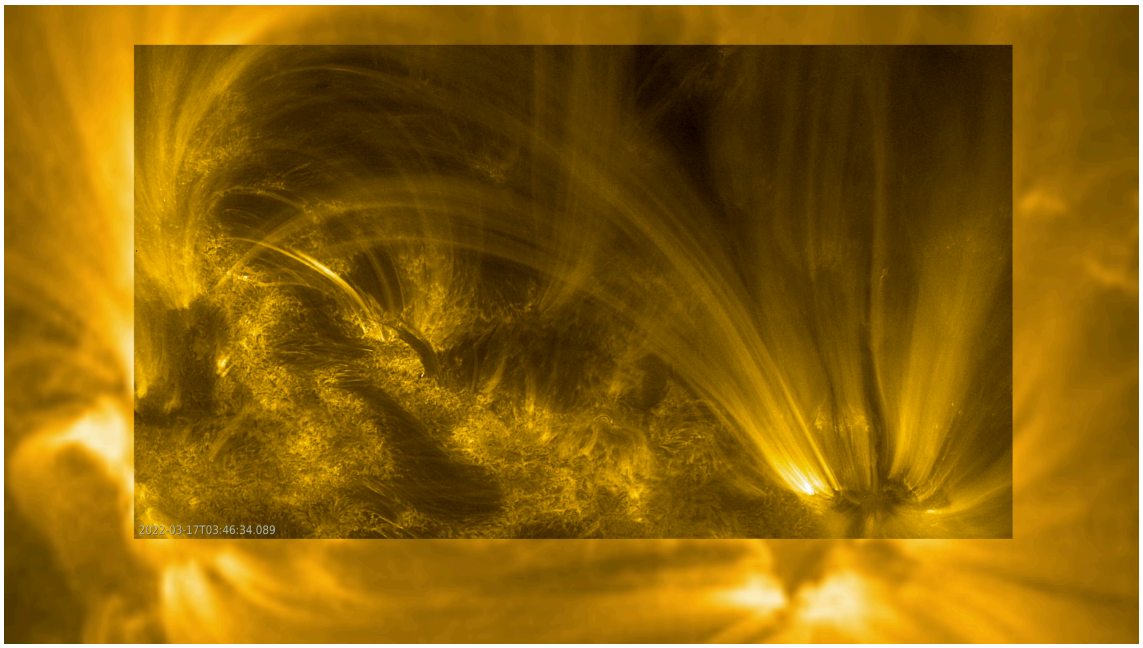


Image taken on March 17, 2022 by EUI's Full Sun Imager (FSI) telescope, using the High-Resolution Imager (HRI) to zoom in on the details of an active region.
Full movie here: https://www.stce.be/presentations/EUI_First_Perihelion/zoom%20zoom%20into%20active%20region.mp4

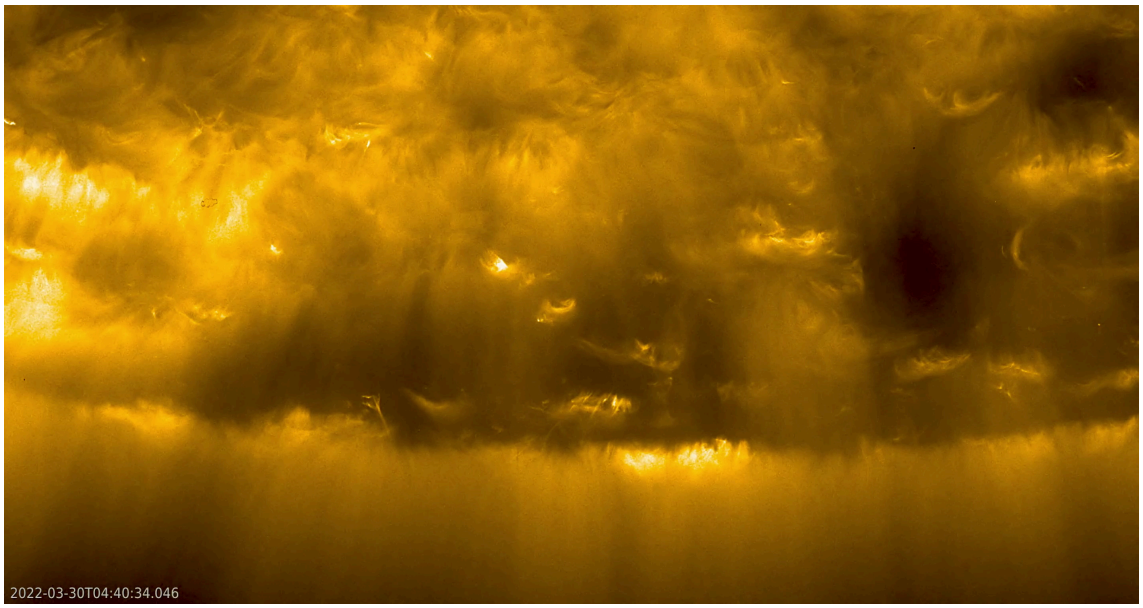
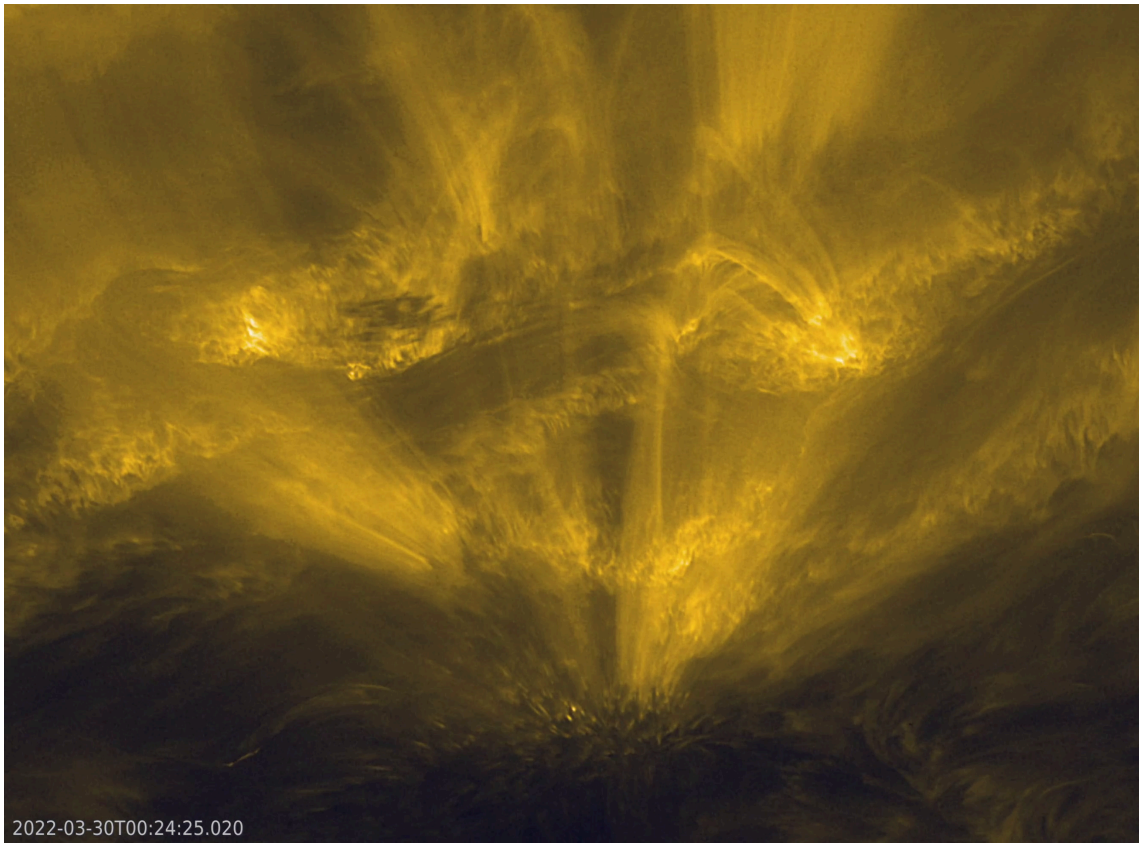


Image of the solar south pole taken on March 30, 2022, just 4 days after its closest approach to the Sun. Full movie here: https://www.stce.be/presentations/EUI_First_Perihelion/20220330-HRIEUV-SouthPole%20high%20NR_1.mp4

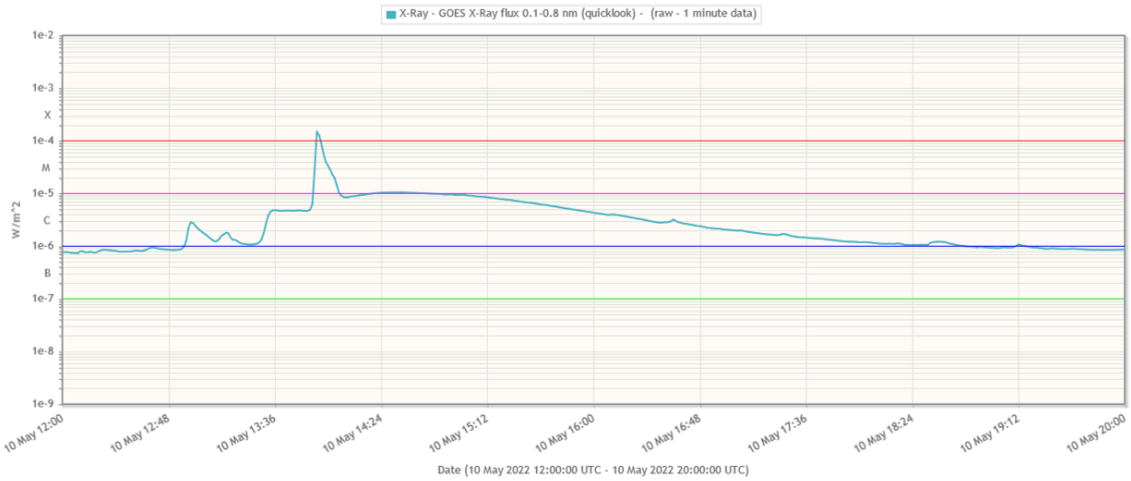


This close-up of the solar atmosphere shows a phenomenon that researchers have tentatively nicknamed "the hedgehog". What exactly the hedgehog is and how it was formed, further research has yet to reveal.
Full movie here: https://www.stce.be/presentations/EUI_First_Perihelion/hedgehog%20zoom%20proc.mov

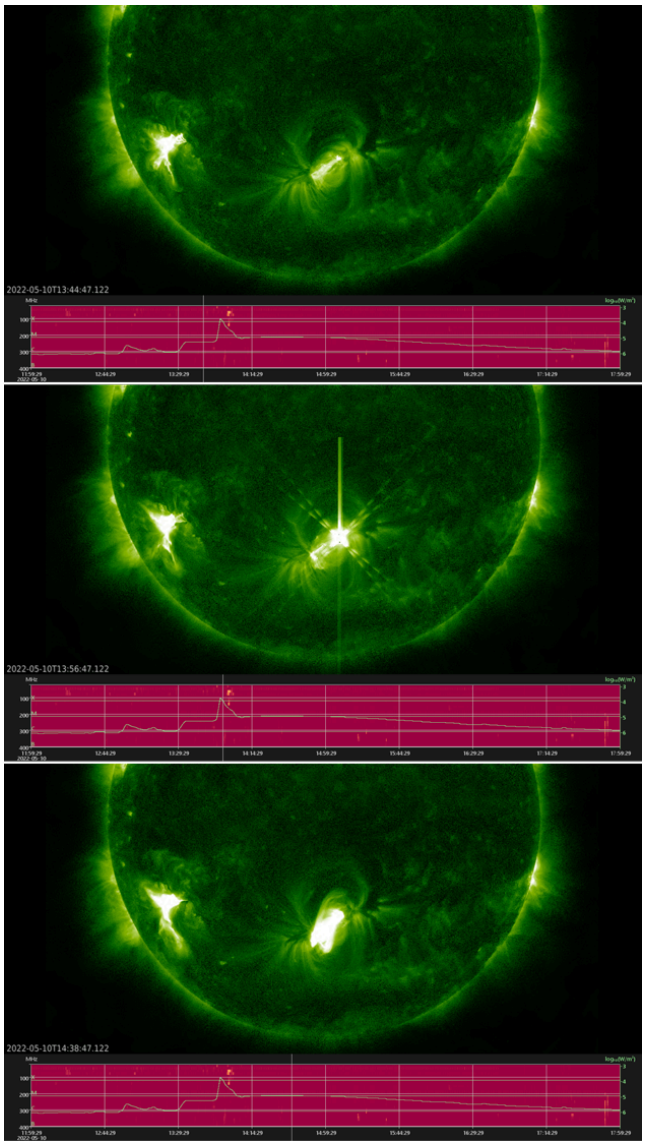
Want to know more?
The other instruments on board Solar Orbiter also made unique observations during this perihelion. More details can be found on ESA's website: https://www.esa.int/Science_Exploration/Space_Science/Solar_Orbiter/The_Sun_as_you_ve_never_seen_it_before

2. A complex eruption in a small sunspot region

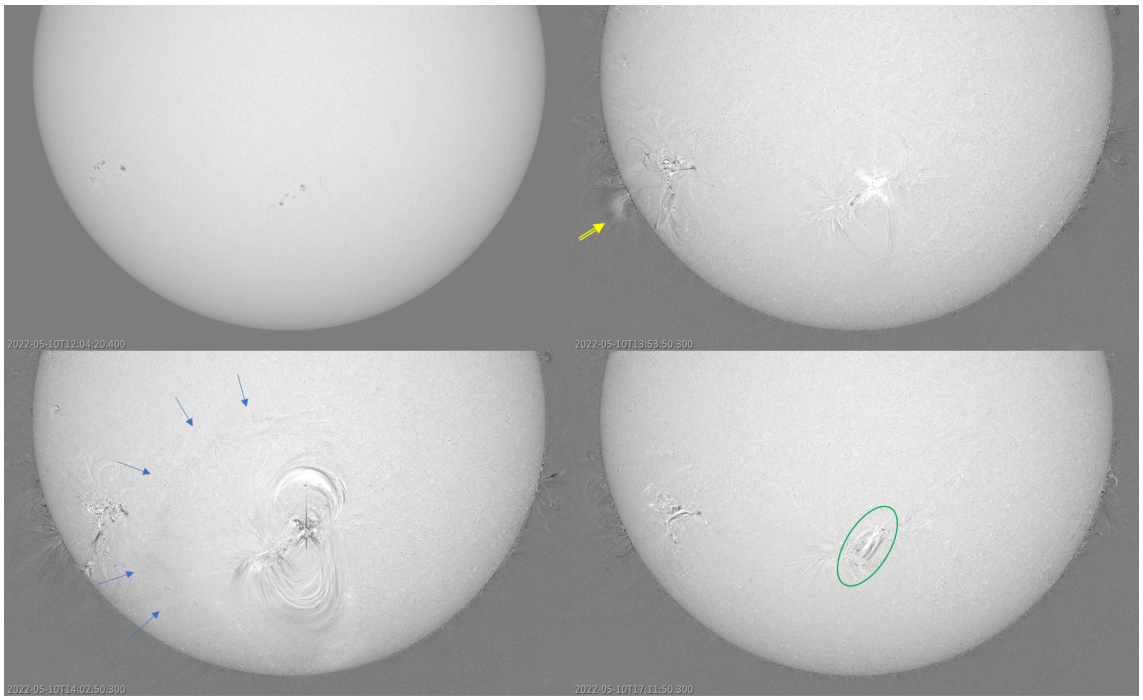
Last week's highlight certainly was the X1.5 flare on 10 May, peaking at 13:55UT. It was produced by active region NOAA 3006, which had also been the source of another X-class flare on 3 May. Both energetic events were previously discussed in these STCE newsitems at resp. https://www.stce.be/news/590/welcome.html and https://www.stce.be/news/588/welcome.html



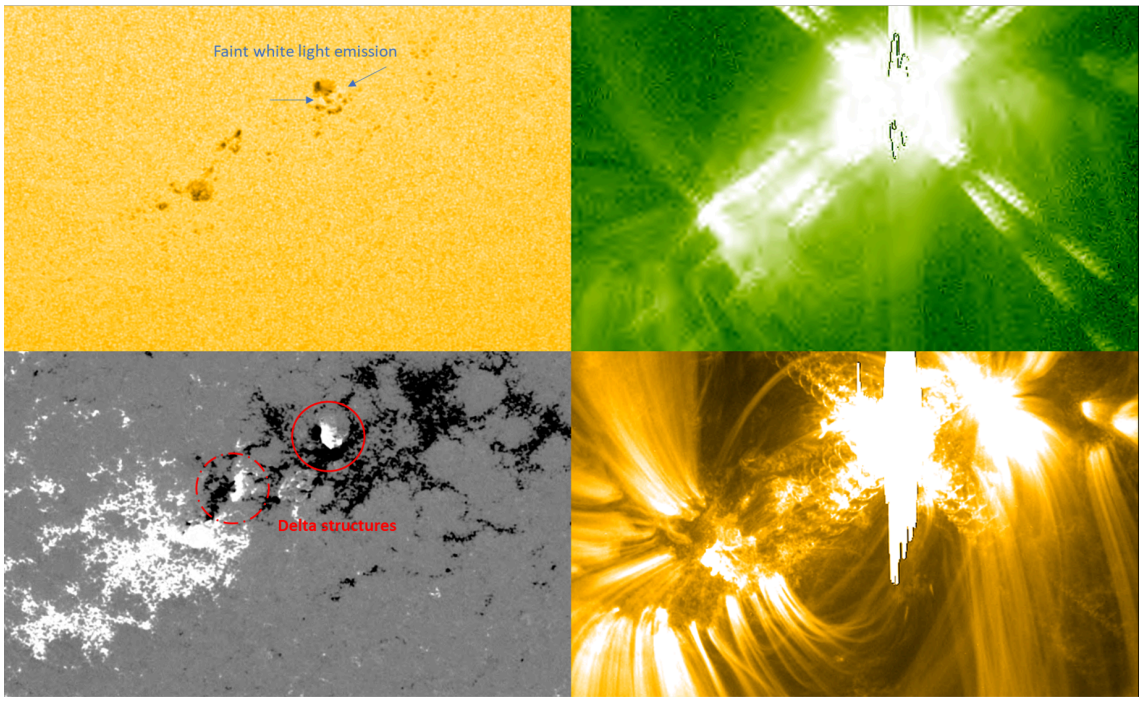
Upon closer examination, the soft x-ray (SXR) emission of the X1.5 event - as measured by the GOES-16 satellite (https://www.swpc.noaa.gov/products/goes-x-ray-flux) - showed a very atypical evolution. As is evident from the graph above (STAFF - http://www.staff.oma.be/default.jsp), there seemed to be a "step" in the increasing phase of the flare, which itself was an impulsive event lasting less than 10 minutes. Then came a shoulder-like structure with the X-ray flux hovering around the M1-level for nearly an hour, followed by a very slow decrease to pre-flare flux levels over the next 3-4 hours. The imagery underneath was created using the SWHV software (http://swhv.oma.be/user_manual/). The greenish image taken by SDO/AIA 094 (https://sdo.gsfc.nasa.gov/data/aiahmi/) shows the Sun in EUV at multi-million degrees. The graphs under this image show the evolution of the soft x-rays (remember that the SXR flux data are from the entire Sun, not a single region), and a radio spectrogram (reddish background) from the Callisto radio network. An animation can be found in the online version of this newsitem at https://www.stce.be/news/591/welcome.html



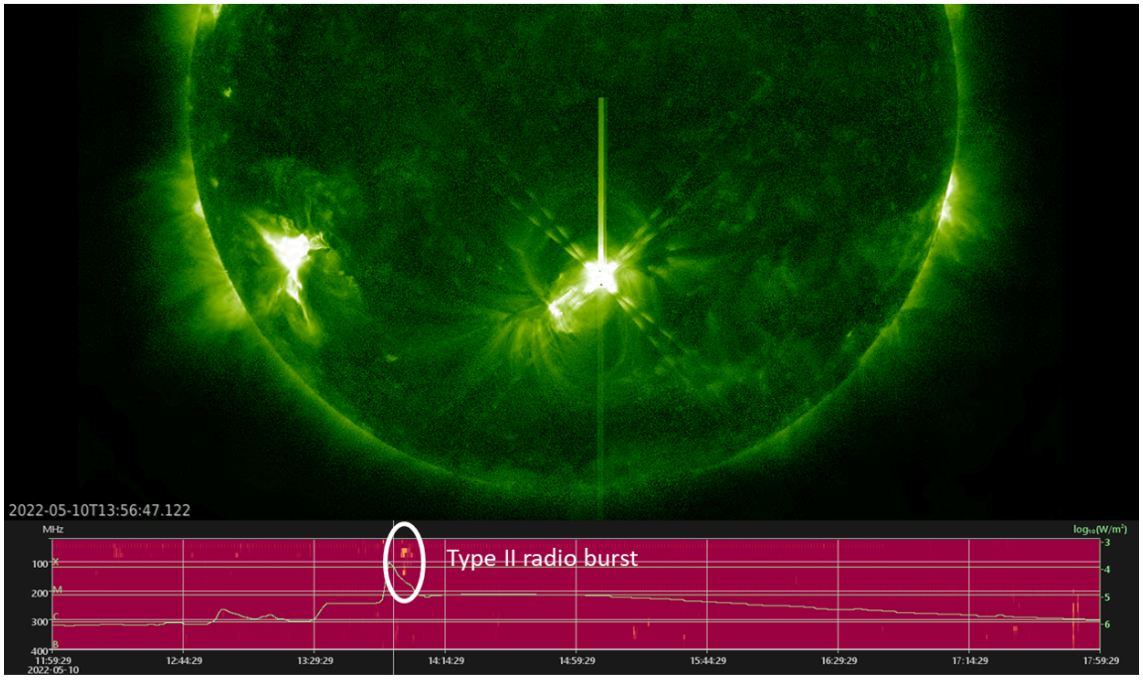
The step-like structure in the SXR curve was caused by an eruption in NOAA 3007 (top in the image above). It started around 13:28UT and reached a plateau near C4 about 6-7 minutes later and lasting for about a quarter of an hour, i.e. until the true start of the X-class flares in NOAA 3006 at 13:50UT. The SDO/AIA 094 images clearly show the enhanced emission in NOAA 3007 and nothing in NOAA 3006, thus "proving" that the step-like structure was not part of the X-class event. The eruption in NOAA 3007 was quite complex and longlasting, with EUV imagery showing the ejection of a small, slowly moving, plasma cloud coinciding with the rise of the X-class flare. This can be seen in the imagery underneath where a difference SDO/AIA 171 image (one image subtracted from the next) is overlaid on a white light image (SDO/HMI). The faint ejected cloud can be seen over the southeast limb in the annotated upper right image underneath.



The X-class flare started at 13:50UT, reached its peak at 13:55UT, and ended at 13:59UT. It was located right over the leading delta spot, as indicated in the magnetogram underneath (lower left). Some white light emission can be seen in SDO/HMI (upper left) but in satellite imagery this is nothing extraordinary. Of interest are some changes observed in the size and shape of the concerned sunspots (see the clip). The flare was clearly associated with a coronal wave, indicated in the SDO/AIA 171 difference imagery above (lower left image). It's curious to see this wave almost solely expanding in the north-east-south sector ("to the left"), and almost nothing to the west. There was no coronal hole in the neighborhood. The images show the blast area around the time of the maximum. The strong blooming and diffraction patterns that can be seen in the SDO AIA 094 and 171 images on the right are instrumental. For more on blooming and diffraction patterns, see Note 1 in this STCE newsitem at https://www.stce.be/news/499/welcome.html

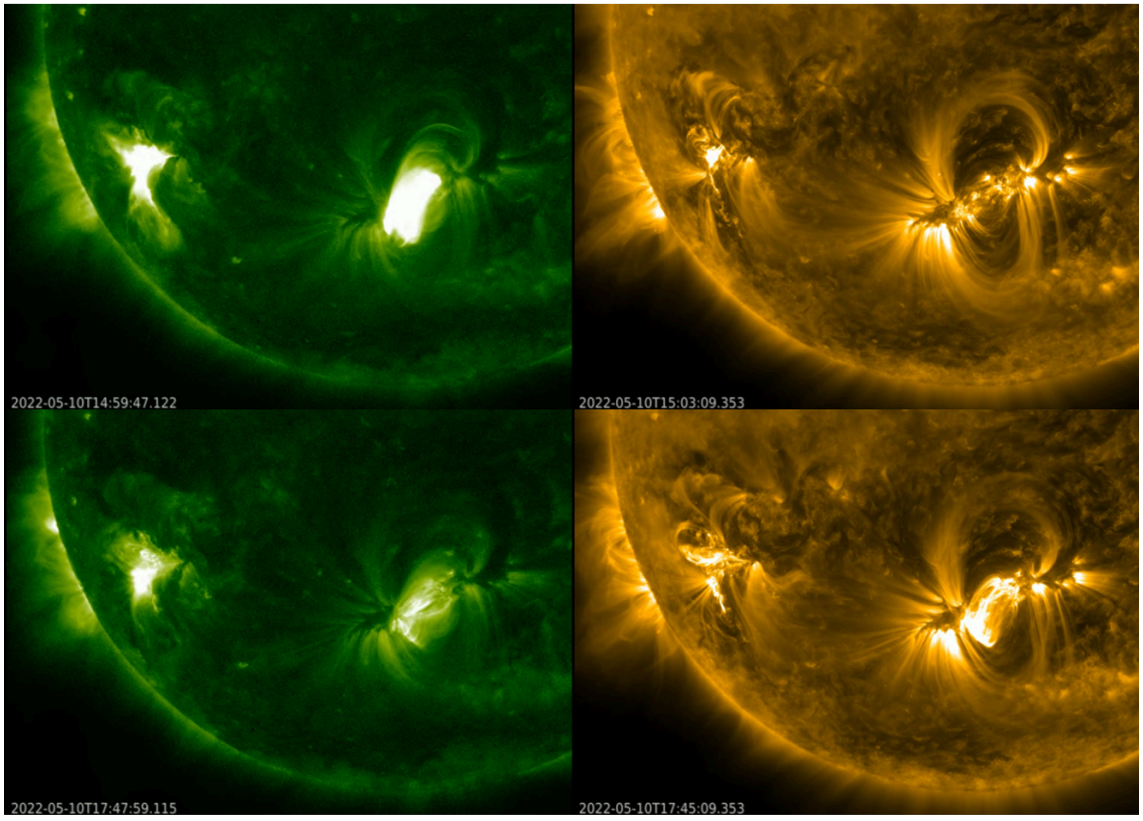


The less than 10 minutes lasting X-class flare puts it in the family of "impulsive" flares, which are known usually not to be associated with coronal mass ejections (CMEs). However, the presence of a fast coronal wave and post-eruption coronal loops seem to contradict this. Also a Type II radio burst can be seen in the radio spectrogram and -based on its timing- does not seem to be associated with preceding eruption by NOAA 3007. The observed CME was mostly directed to the east and south of the Sun-Earth line.



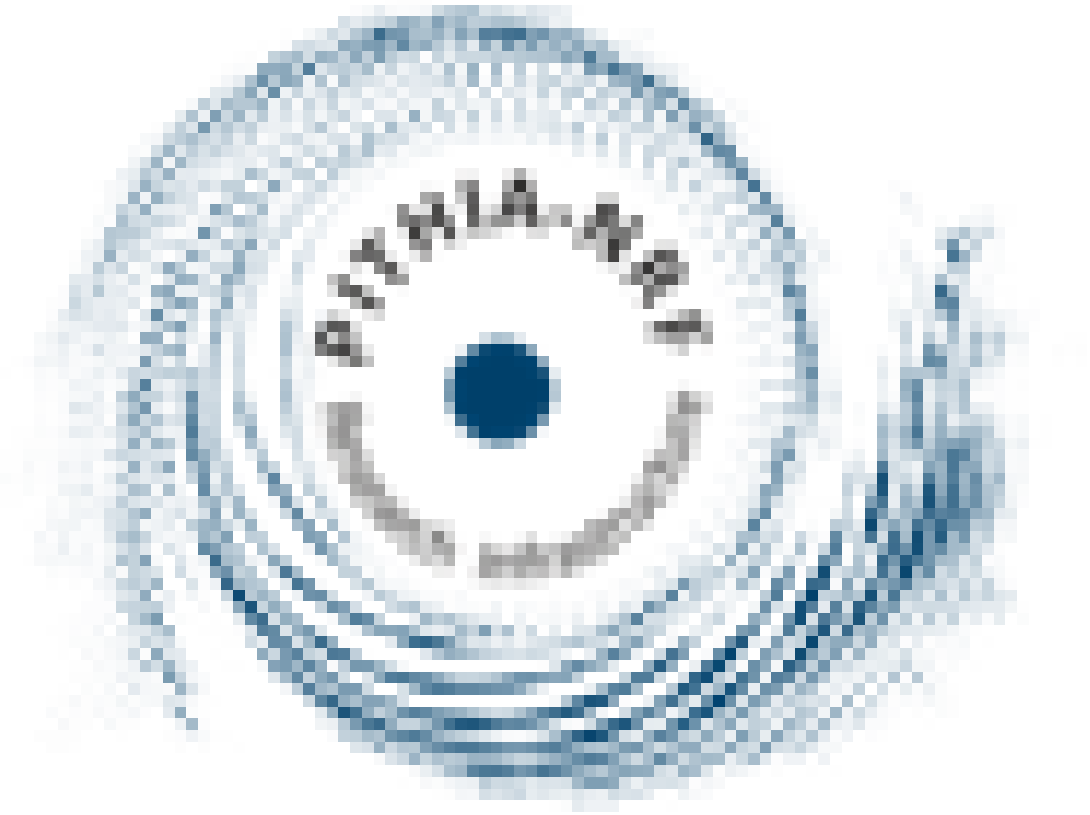
Another puzzling observation was the aftermath of the flare, with the SXR flux hovering around the M1 level for nearly an hour before gradually starting to decrease. This coincided with very bright patches

(no fine structure) in AIA 094 over NOAA 3006. The interesting part here is that in AIA 171, which shows the solar atmosphere at temperatures around 700.000 degrees -so at a much lower temperature than in AIA 094-, nothing was seen. The first post-eruption coronal loops in AIA 171 only started becoming visible from around 15:45UT onwards. Though there's usually a delay between the two, this time the delay of nearly 2 hours is amazing. The jury is still out on the precise cause of this difference. Maybe initially, the loops were too hot to be directly visible in AIA 171, and so we had to wait until they had cooled down sufficiently to become visible with the AIA 171 filter. It took until around 19:00UT before the SXR flux was back at pre-flare levels.



3. First innovation day PITHIA-NRF

WHAT IS PITHIA-NRF?



PITHIA-NRF (Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services: a Network of Research Facilities) is a Horizon 2020 project paving the way to new business practices and technological development in the near-Earth and upper atmosphere domains through science. PITHIA-NRF wishes to mitigate the adverse effects of upper atmosphere phenomena that pose scientific, operational, and societal challenges.

Project website: https://pithia-nrf.eu

WHAT SHOULD YOU EXPECT FROM INNOVATION DAY 1?
We want you to walk away from this event feeling aware of the kind of services you will be able to access through this innovative research infrastructure, like:
*Open access to PITHIA-NRF's nodes (TNA program) to install, calibrate, and validate new instrumentations.
*Open access to the best models of the Earth's Ionosphere, Thermosphere, and Plasmasphere through the e-science center.
*Open access to FAIR long-term observational data.
*Organised and systematic training for scientists and engineers.
*An innovation platform for promoting cooperation and collaboration between the consortium and its stakeholders.

Innovation Day website: https://progetti.ingv.it/en/PITHIA

4. Review of solar activity

Flares

Flaring activity reached high levels. Eleven numbered active regions and two unnumbered regions were present.

On May 10th, an X1.5 flare (start time 13:50 UTC, peak time 13:55 UTC, end time 13:59 UTC) was measured by the GOES-satellite. NOAA AR 3006, a dynamical and a magnetically complex region (beta-gamma-delta) in the south-west quadrant was the source.
On May 11th, a M1.5 flare (peak time 16:49 UTC) was measured by the GOES-satellite. NOAA AR 3007, near the central meridian and at that moment classified as a beta-gamma-delta was the source. At that moment, NOAA AR 3006 became less complex. Further on, low M-class activity from behind the west limb was measured, most probably from NOAA AR 3004, together with high C-class activity from the east limb.
The solar flaring activity remained at moderate levels on May 12th with a single M1.3-class flare, peak time 20:19 UTC, from behind the north-east limb.
The last noticeable event was an isolated M2.2-flare late on May 14 (peak time 00:09 UTC on May 15th) from behind the north-east limb.

Coronal Mass Ejections

The solar disc was streaked with filaments. The filaments which finally erupted, did not result in Earth-directed coronal mass ejections.
A partial halo CME was observed by LASCO C2 at 14:24 UTC on May 10th, following the earlier X1.5 and C4.7 flare. A flank from this CME was estimated to possibly affect Earth during the night of May 13th or early on May 14th.

Coronal Hole

A large patchy positive polarity coronal crossed the central meridian in the UTC afternoon on May 12th.

Particle flux near Earth

The 10 MeV proton flux was elevated on May 11th following the M-class flares by NOAA 3007 and NOAA 3004 and related coronal mass ejections. The 10 MeV proton flux values returned to background values on May 13th.
The greater than 2 MeV electron flux briefly crossed the 1000 pfu threshold in the UTC afternoon of May 08th. It returned to background values after a few hours. The electron fluence was at nominal levels throughout the entire week.

5. Review of geomagnetic activity

On May 14th, a coronating interaction region (CIR) and a high speed stream (HSS) were detected by ACE and DSCOVR. This structures were associated to the positive polarity coronal, which crossed the central meridian on May 12th. The magnitude of the interplanetary magnetic field increased to 20.7 nT. The Bz component reached -10.2 nT. On May 15th the solar wind speed approached 580 km/s.
The expected flank from the CME related to the X1.5- and C4.7-class flaring on May 10th did not arrive to Earth.

The geomagnetic conditions were quiet to unsettled with two isolated active periods in the early UTC morning on May 15th, while Earth was influenced by the CIR and the HSS.

6. Noticeable Solar Events (9 May 2022 - 15 May 2022)

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
10	1350	1355	1359	S30W4	X1.5	1B		II/3	1	3006
11	1635	1649	1658	S24E41	M1.6	1N			2	3007
11	1813	1858	1927		M2.6		82	II/2IV/2		
11	1927	1931	1935	S25E37	M2.2	SF				
12	2004	2019	2027		M1.3					
14	2358	0008	0017		M2.2					

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

7. PROBA2 Observations (9 May 2022 - 15 May 2022)

Solar Activity

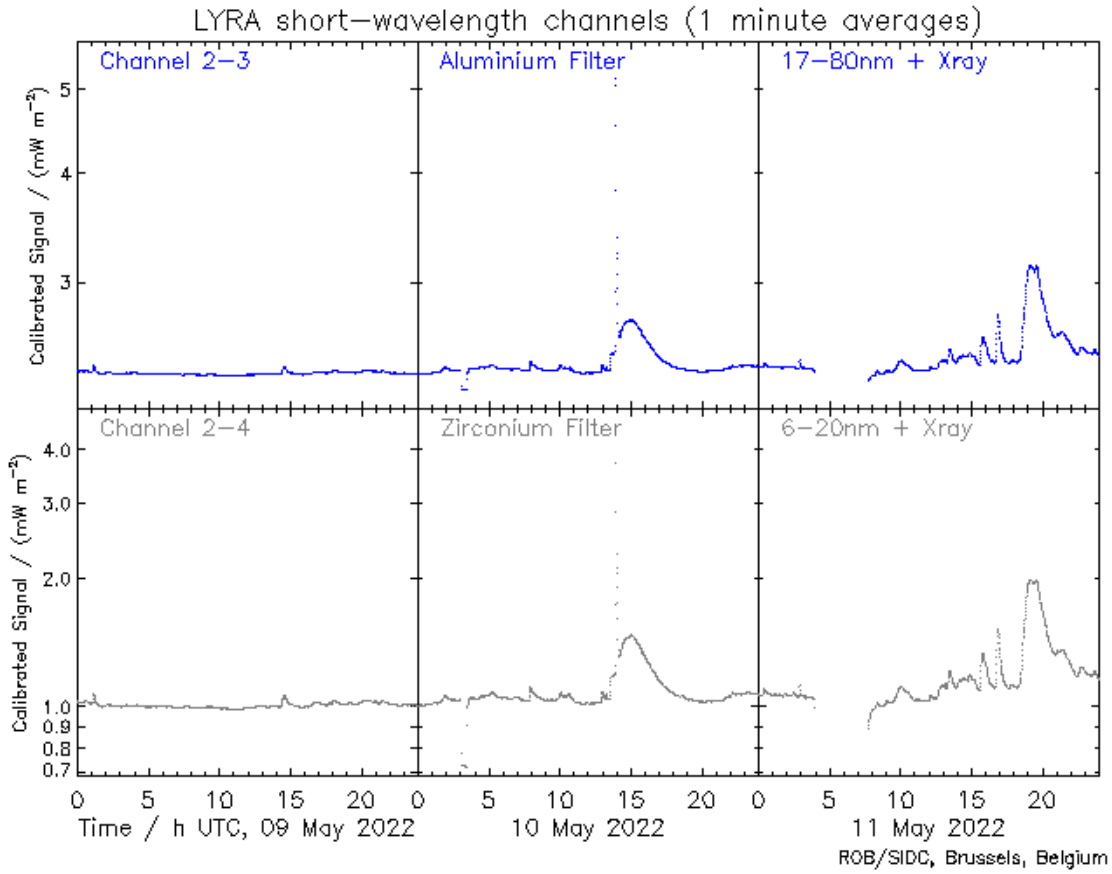
Solar flare activity fluctuated between low and high during the week.
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: https://proba2.oma.be/ssa
This page also lists the recorded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

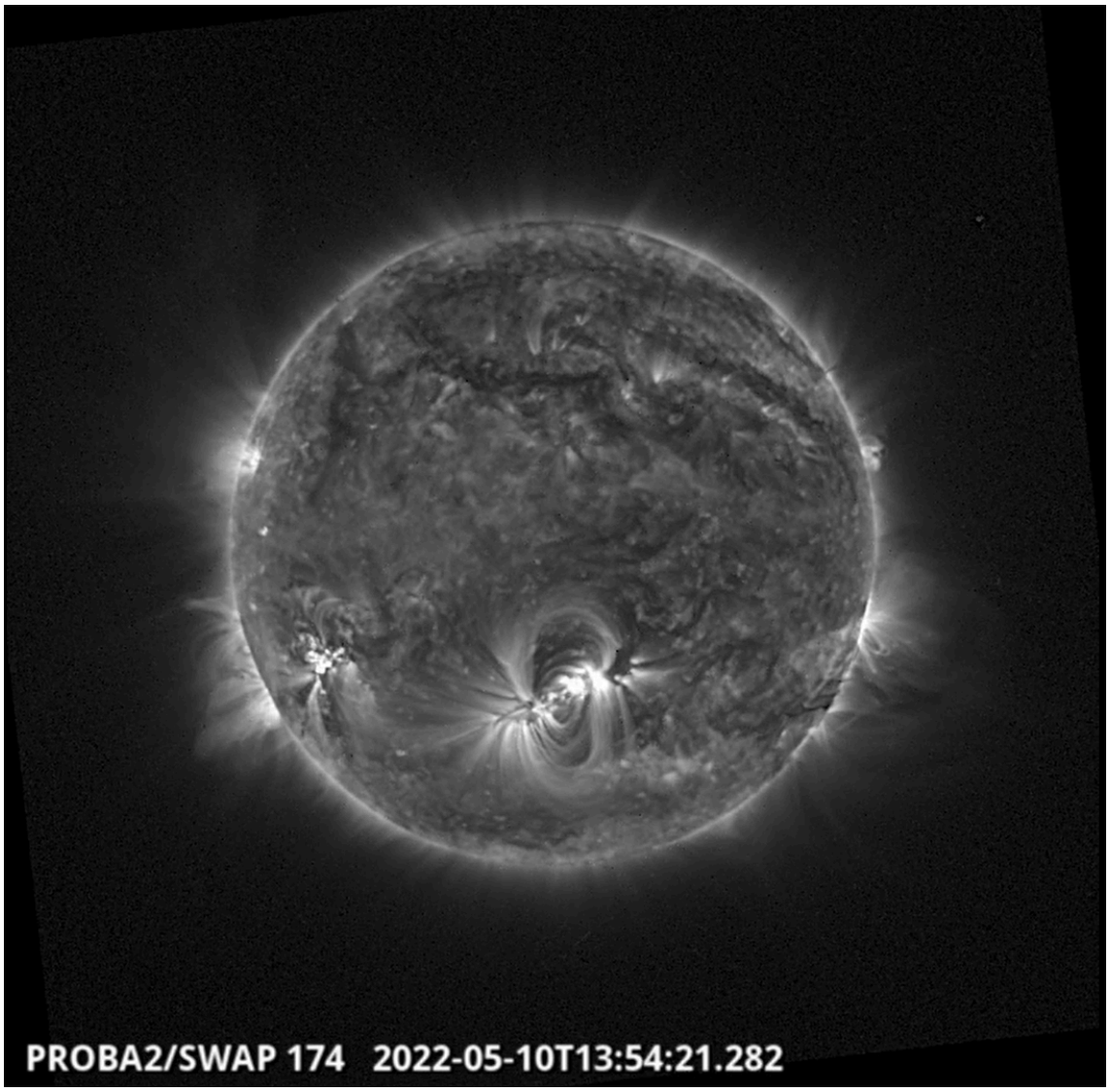
A weekly overview movie can be found here (SWAP week 633): https://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2022_05_09.mp4.

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/

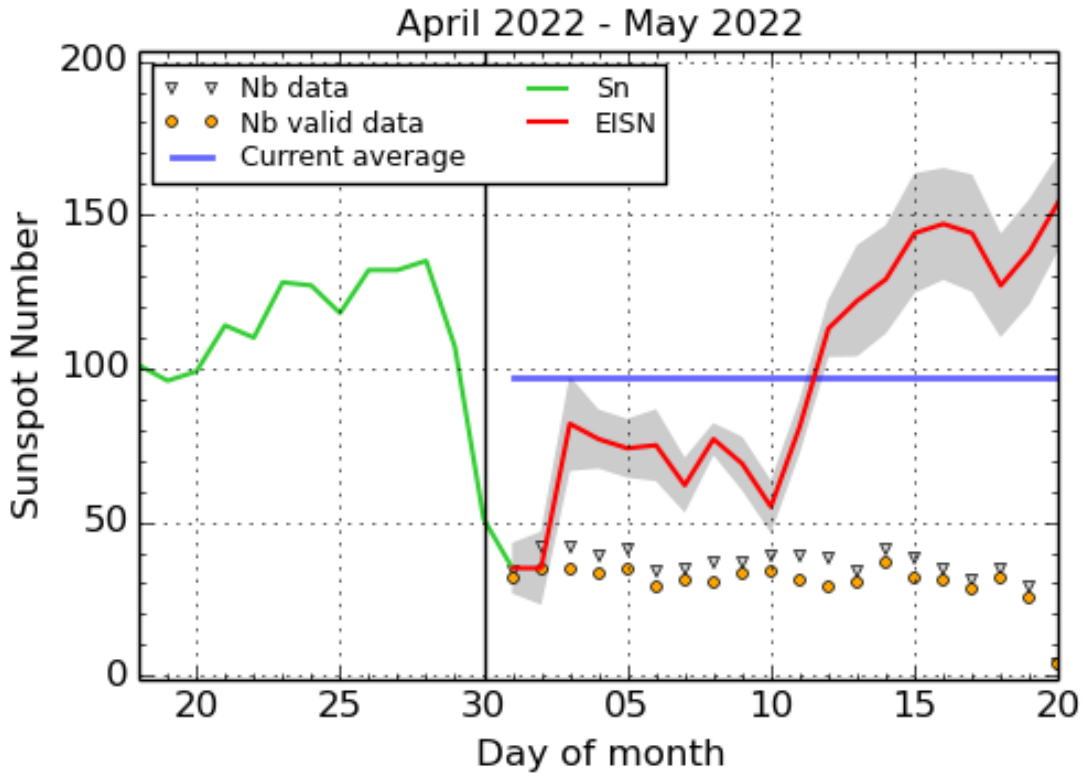
Tuesday May 09





The largest flare of the week, an X1.5 flare, was observed by SWAP and LYRA. The flare was associated with NOAA AR 3006 and is visible in the southern hemisphere near the central meridian on 2022-May-10, as shown in the SWAP image above taken at 13:54 UT.
Find a movie of the event here (SWAP movie): https://proba2.sidc.be/swap/movies/20220510_swap_movie.mp4

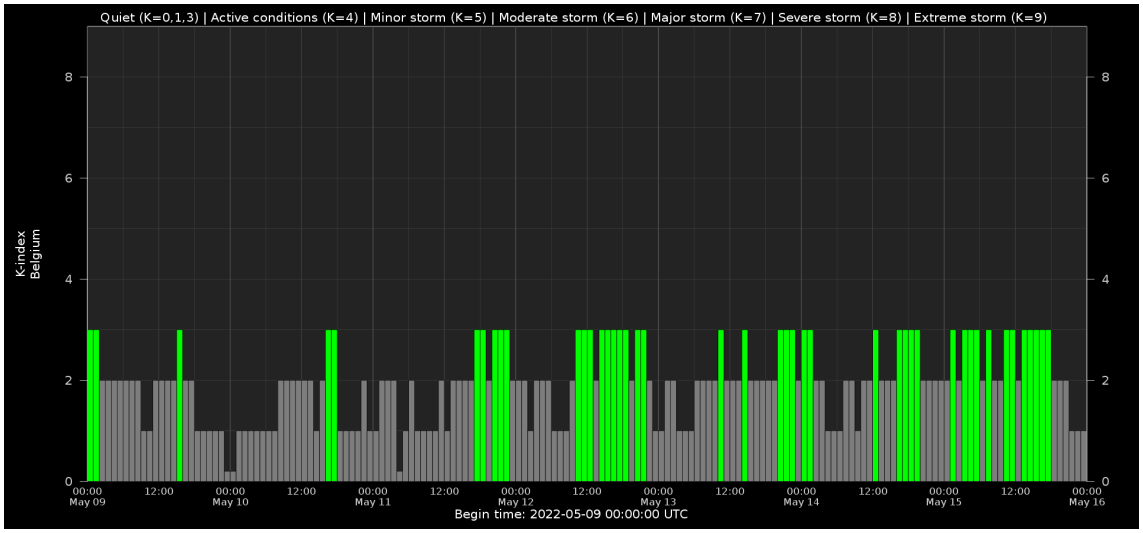
8. The International Sunspot Index by SILSO



SILSO graphics (http://sidc.be/silso) Royal Observatory of Belgium, 2022 May 20

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 gives 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.

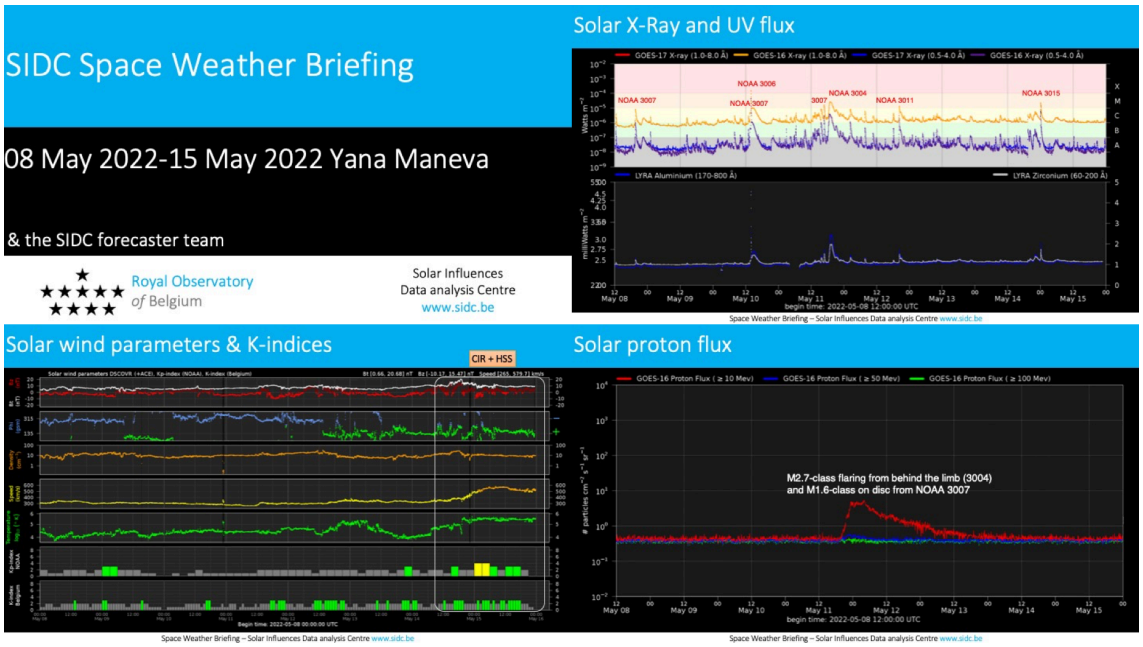
9. Geomagnetic Observations in Belgium (9 May 2022 - 15 May 2022)



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/

10. The SIDC space weather briefing

The forecaster on duty presented the space weather overview from May 8 to 15. The pdf and movies can be found in: https://www.stce.be/briefings/20220516/



11. Action!

Check out our activity calendar: activities and encounters 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.
If you want your event in our calendar, contact us: stce_coordination at stce.be
* June 9, Public Lecture, Noorderlicht - hemelse wetenschap, Molenhof, Leuven, Belgium
* June 13-15, Space Weather Introductory Course - onsite, by the STCE, Brussels, Belgium
* June 21, First Innovation day of PITHIA-NRF, Rome, Italy
* June 25, STCE at the Summer Space Festival
* July 3, Public Lecture on STCE's mission to the Sun, Cosmodrome, Genk, Belgium
* August 25, Public Lecture on Space Weather and Aviation, Astropolis, Oostende, Belgium
* October 24-28, 18th European Space Weather Week, Zagreb, Croatia
* November 21-23, Space Weather Introductory Course - onsite, by the STCE, Brussels, Belgium
* December 5, 6, 8, 9, Space Weather Introductory Course - online, by the STCE, zoom

Check: https://www.stce.be/calendar


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