STCE Newsletter

6 Feb 2023 - 12 Feb 2023

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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.

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

1. Nerdland

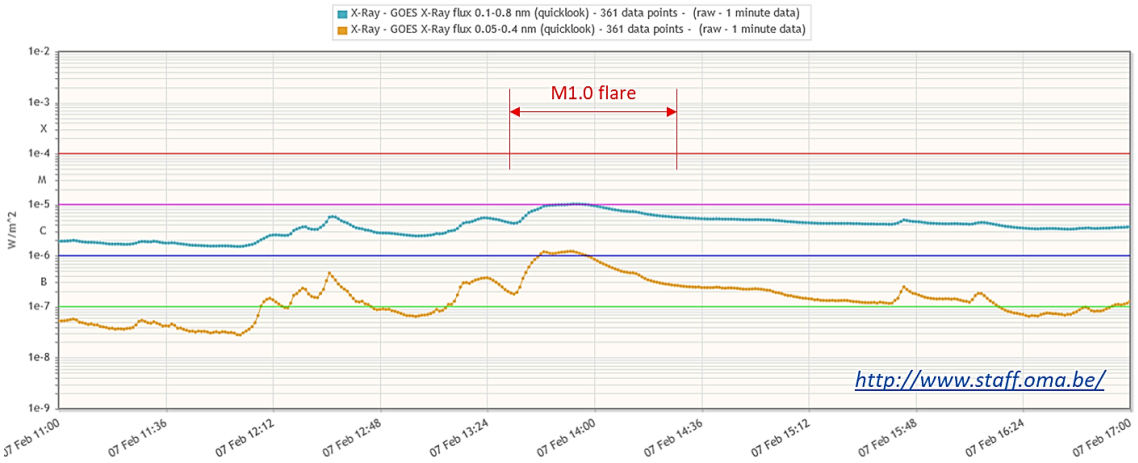
Nerdland has published a book: RUIMTEVAART.
To frame it: Nerdland is an organisation that brings geeks together around the theme science. They have a 3-days festival and now they published a book about space travel. Besides dinosaurs, also space sparks peoples imagination.

The book invites you to discover together with Blip facts and 'nice to know' things about astronauts, rockets and traveling to the moon and Mars.
Guess what, weather in space is also a chapter. A picture of the STCE space weather room is shown. The space weather person on duty watches the sun and sends out a space weather bulletin. Blip was able to understand parts of the space weather bulletin. Blip figured out that ‘No earth directed coronal mass ejection was seen in the available corona graphic images’ is saying ‘It’s OK, no bad things will happen’. Blip concludes that scientists says things in a complicated way.

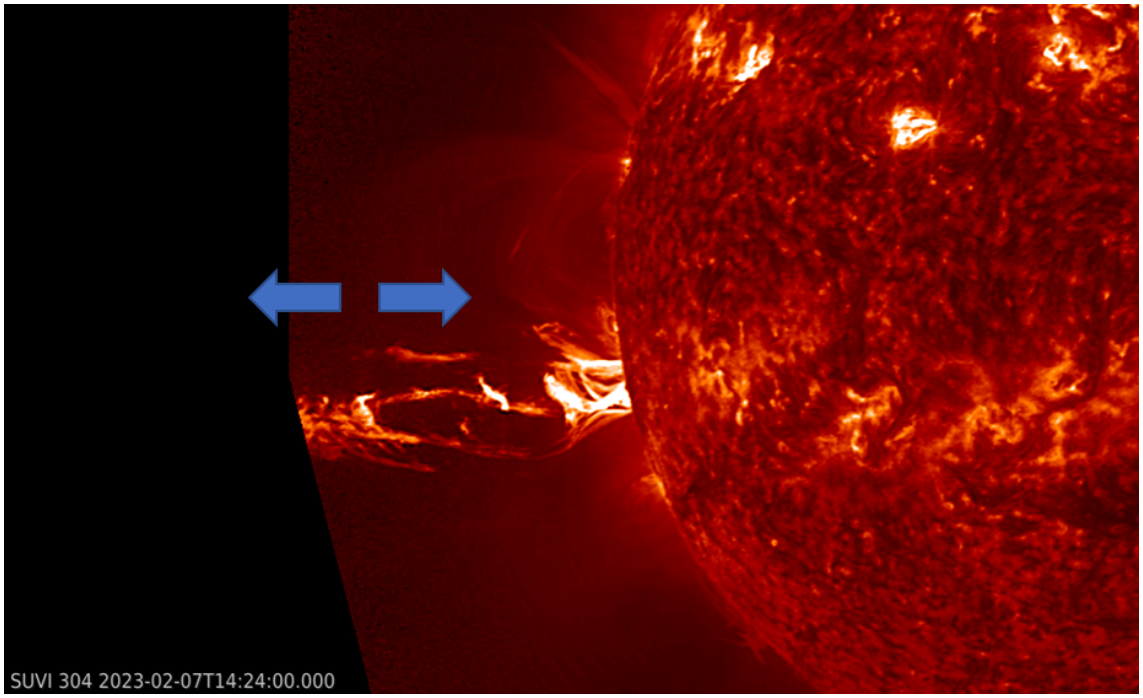
Nevertheless, it shows that more people are becoming aware of space weather. The chapter also states that, depending on your job, e.g. satellite launcher, you might want to check the weather in space.

2. Deflection

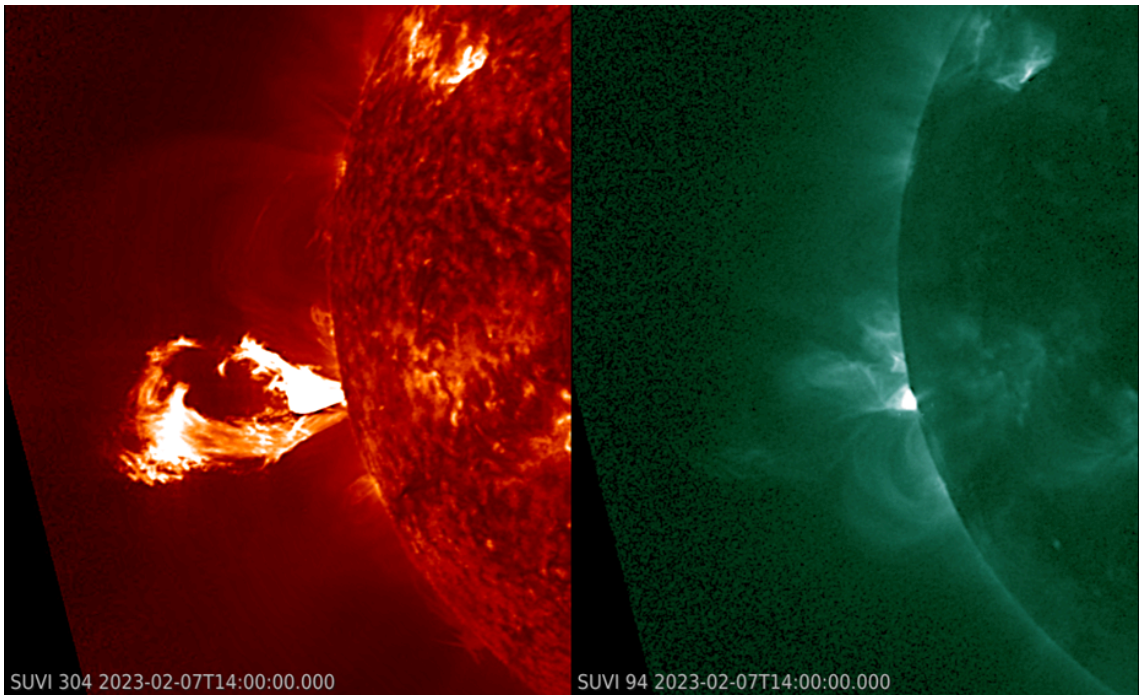
Images in extreme ultraviolet (EUV) taken shortly after noon on 7 February showed a spectacular eruption near the solar east limb. GOES soft x-ray flux (https://www.swpc.noaa.gov/products/goes-x-ray-flux) started to slowly increase from 13:33 UTC onwards reaching a peak of M1.0 at 13:53 UTC and ending near 14:25 UTC. Note that the C5.5 flare peaking at 13:23 UTC is unrelated and originated from a sunspot region near the Sun's central meridian.



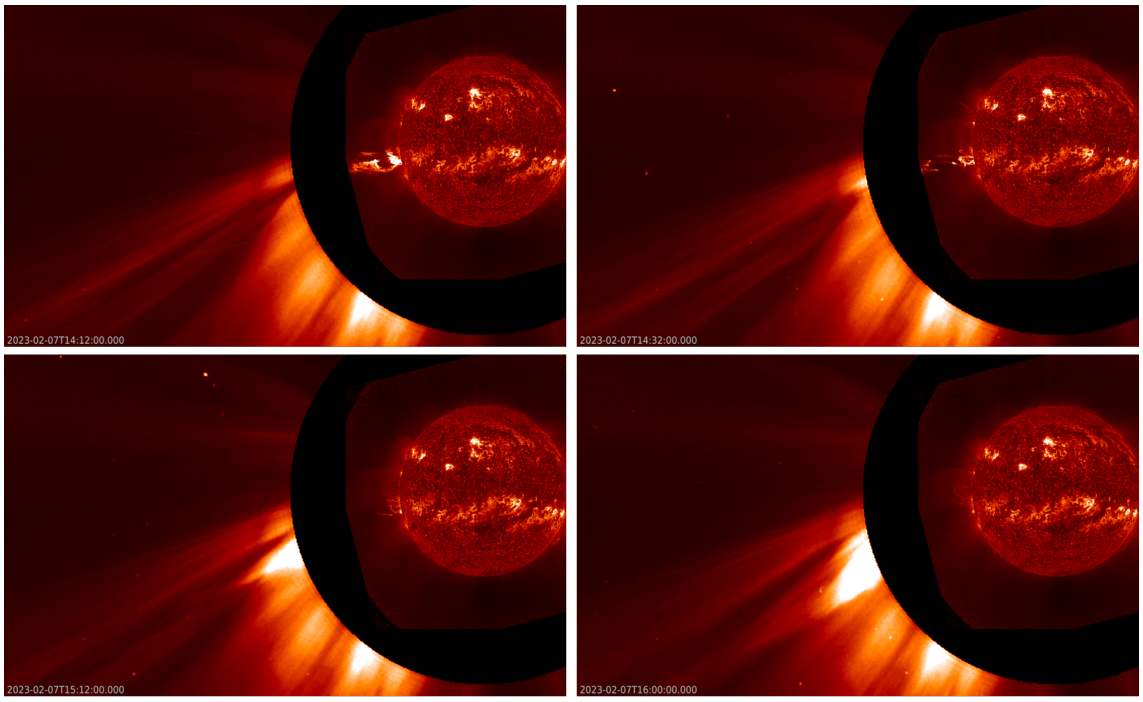
The annotated wide-field GOES/SUVI 304 image underneath (https://www.swpc.noaa.gov/products/goes-solar-ultraviolet-imager-suvi) shows a complex eruption stretching even beyond SUVI's field-of-view to the eastern direction. A part of the ejected material is permanently expelled into space towards the east (to the left), but a portion can also be seen returning to the solar surface. Clips of the event can be found in the online version of this newsitem at https://www.stce.be/news/628/welcome.html



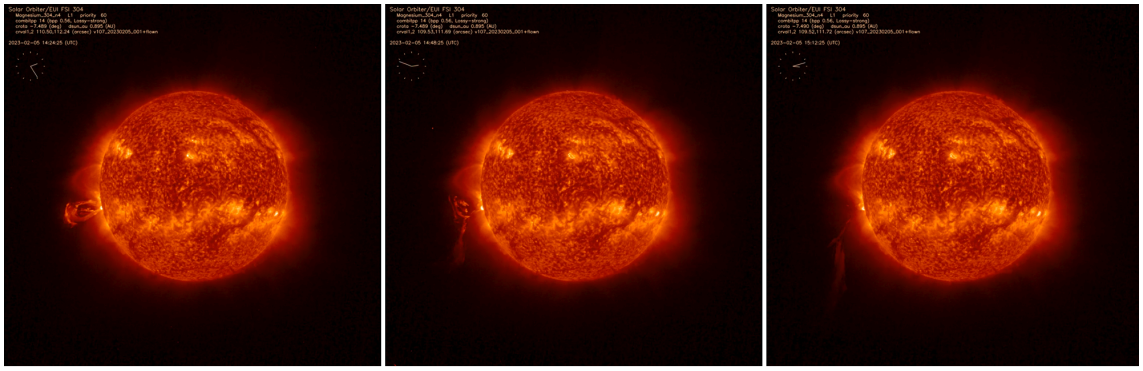
The imagery underneath show a side-by-side comparison of the event as observed by SUVI at 30.4 nm (about 80.000 degrees; left) and 9.4 nm (multi-million degrees; right), shortly after the peak in soft x-ray showing the eruption still ongoing. The source is clearly still behind the solar limb, implicating that the true intensity of the flaring event was most likely significantly higher than M1. It is thought that the source region of the event is NOAA 13217, which was also responsible for the X1.1 flare on 11 February (see this STCE newsflash at https://www.stce.be/news/627/welcome.html).



The most amazing observation pertaining to this event was that of the associated coronal mass ejection (CME), first visible in SOHO/LASCO C2 coronagraphic images at 14:32 UTC (https://soho.nascom.nasa.gov/home.html). Remarkably, the CME was not heading to the east as the ejected material, but rather to the southeast as can be seen in the compilation underneath. A more extreme deflection of a CME produced by what was most likely the same active region, was observed just 2 days earlier on 5 February by EUI (Extreme Ultraviolet Imager - https://www.sidc.be/EUI/intro) on board of Solar Orbiter (https://www.esa.int/Science_Exploration/Space_Science/Solar_Orbiter). The CME started out again in the eastern direction, but then -as if hitting a (magnetic) wall- turned due south. This kind of CME deflections are not so uncommon, with for example another eyebrow-raising event reported in this STCE newsitem (https://www.stce.be/news/484/welcome.html). CME deflections are the worst nightmare of space weather forecasters, as described e.g. in this paper (Möstl et al. 2015 https://www.nature.com/articles/ncomms8135). Their post-event analysis revealed that a fast "earth-directed" CME associated with an X1 flare near the solar disk centre on 7 January 2014 got deflected and eventually delivered only a glancing blow to the earth environment. Instead of the expected moderate to severe geomagnetic storm, only unsettled geomagnetic conditions were recorded.



GOES/SUVI 304 images overlaid on SOHO/LASCO C2 coronagraphic imagery – 7 February 2023



Solar Orbiter / EUI / FSI 304 images on 5 February 2023

3. Review of solar activity

Flares

Eighteen (18) active regions were observed on the sun as seen from the earth. NOAA AR 3213 and NOAA AR 3217 which were the sources of the majority of the flaring activity both had a beta-gamma-delta magnetic field configuration. Solar flaring activity was at moderate to high levels, with numerous C-class flares, 28 M-class flares and one X-class flare. The GOES X1.1-class flare (peaked at 15:48UT on February 11) originated from NOAA AR3217. The other active regions had simple magnetic configuration and they sourced mostly C-class flares and a few low M-class flares.

Coronal Mass Ejections

Although the majority of the reported flares had associated CMEs, none of them were Earth-directed.

Energic particles near Earth

The greater than 10 MeV proton flux was at background levels. The greater than 2 MeV electron flux stayed below the 1000 pfu threshold for most of the week. It crossed the threshold between 14:20 UT and 18:35UT on February 9 and from 00:00UT to 00:50UT
on February 10. The 24h electron fluence was at nominal levels.

4. Review of geomagnetic activity

Solar Wind at L1

From the late evening of February 5, the solar wind speed measured in the L1 point gradually increased. The high speed stream was linked with the negative polarity coronal hole in the northern solar hemisphere, which crossed the central meridian on February 3rd. The solar wind speed reached values of up to 600 km/s. Towards the end of the week, the solar wind speed gradually declined to 470 km/s. The magnitude of the interplanetary magnetic field (IMF) had maximum value of about 12 nT, and the Bz component of the IMF was as low as -10 nT.

Geomagnetic conditions

Active conditions were reported on multiple occasions during the week for short time intervals. Both, the K index measured by the local station at Dourbes and the NOAA Kp index, reached minor storm conditions on February 9th from 21:00UT to midnight in response to the high speed stream arrival.

5. Noticeable Solar Events (6 Feb 2023 - 12 Feb 2023)

DAY	BEGIN	MAX	END	LOC	XRAY	OP	10CM	TYPE	Cat	NOAA
07	1333	1353	1415		M1.0			III/1		
07	2001	2007	2014	N30E5	M1.5	1N	57			3213
07	2246	2258	2305		M3.8			III/1		
07	2305	2307	2309		M6.3			VI/2III/1		3213
08	0245	0253	0257		M2.0					3213
08	1528	1603	1626	N31W5	M1.6	2N		III/2		3213
08	1956	2012	2046	S9E72	M1.5	1N				3217
08	2103	2113	2121	N30W10	M1.7	1F		III/1VI/1		3213
09	0245	0310	0328	S2E70	M3.0	1F				3217
09	0711	0717	0721	S2E70	M1.1	SF		III/2		3217
09	0849	0907	0924		M2.8			IV/1II/1III/1		3217
09	1444	1456	1505	N30W18	M1.5	1N		III/2		3213
09	1514	1525	1534	S9E69	M1.4	SN				3217
09	1818	1842	1902		M1.8					3213
10	0245	0303	0320	N29W25	M3.7	2N	110	III/3II/2IV/1		3213
10	0802	0805	0809	N31W27	M1.4	SN				3213
10	1435	1455	1512	N34W29	M1.1	1F		III/2		3213
10	1529	1600	1613	N14W62	M1.6	SF				3213
10	2234	2241	2248	S18E63	M1.2	1N				3220
11	0759	0808	0815	N6W68	M2.2	1N				3208
11	1042	1058	1129	S18E57	M1.0	1N				3220
11	1129	1134	1141		M1.4					3222
11	1205	1209	1215	S11E42	M1.5	SF				3217
11	1218	1223	1228		M1.1					3217
11	1228	1240	1249	N6W71	M1.5	SF				3208

11	1540	1548	1554	S8E39	X1.1	2B		III/1	3217
11	1711	1723	1731	N30W76	M1.4	SF			3208
12	0835	0848	0852	S9E30	M3.1	1B	200		3217
12	0911	0927	0937		M1.4			VI/1III/1	3217
12	1323	1334	1344		M1.2				3222
12	1533	1538	1601	S9E26	M1.0	SN		III/2	3217

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

6. PROBA2 Observations (6 Feb 2023 - 12 Feb 2023)

Solar Activity

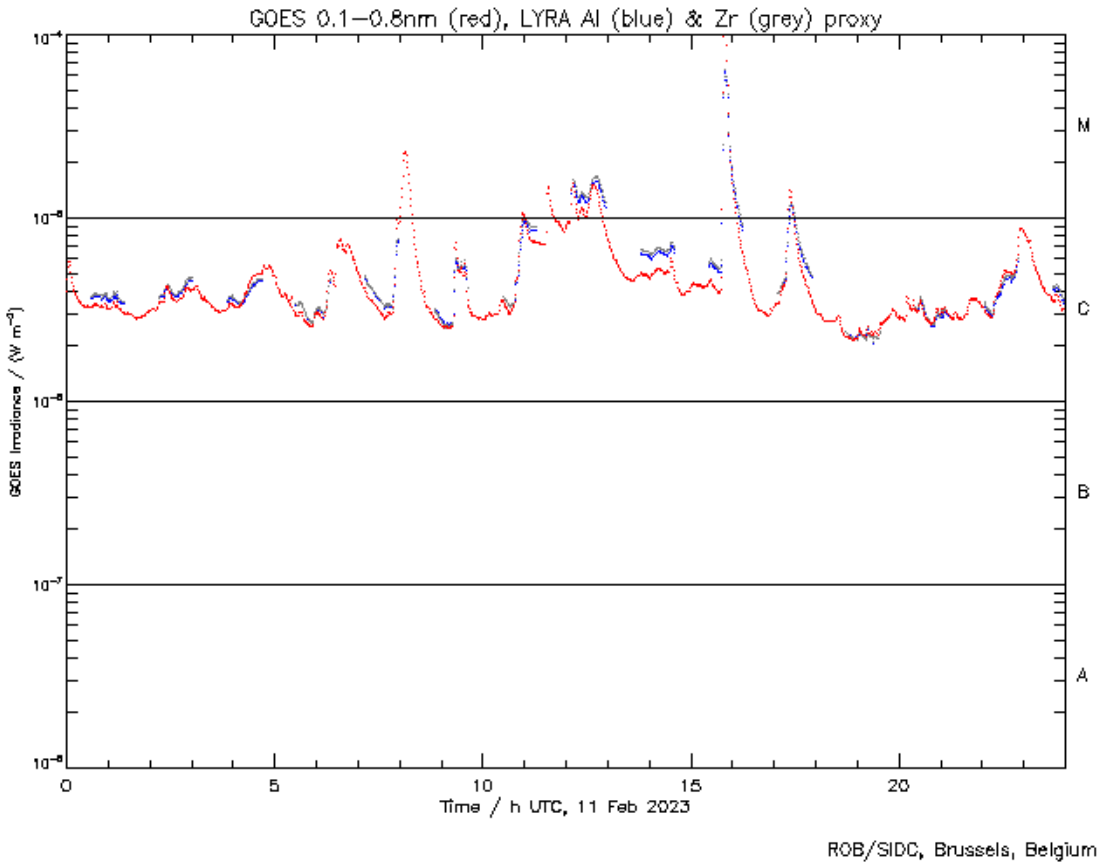
Solar flare activity fluctuated from low to high during the week.
In order to view the activity of this week in more detail, we suggest to go to the following website from which all the daily (normal and difference) movies can be accessed: https://proba2.oma.be/ssa
This page also lists the recorded flaring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

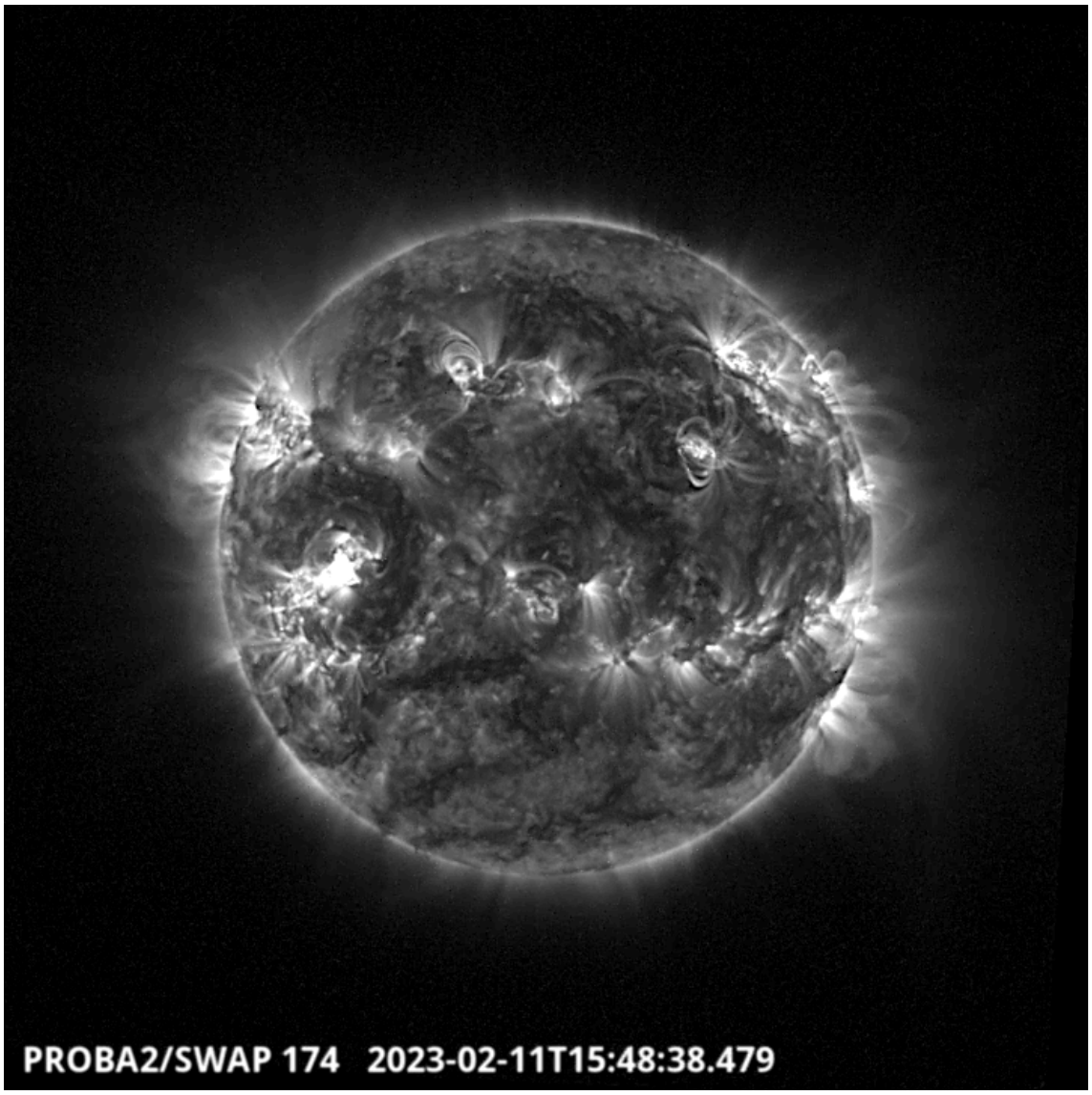
A weekly overview movie (SWAP week 672) can be found here: https://proba2.sidc.be/swap/data/mpg/movies/weekly_movies/weekly_movie_2023_02_06.mp4.

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/.

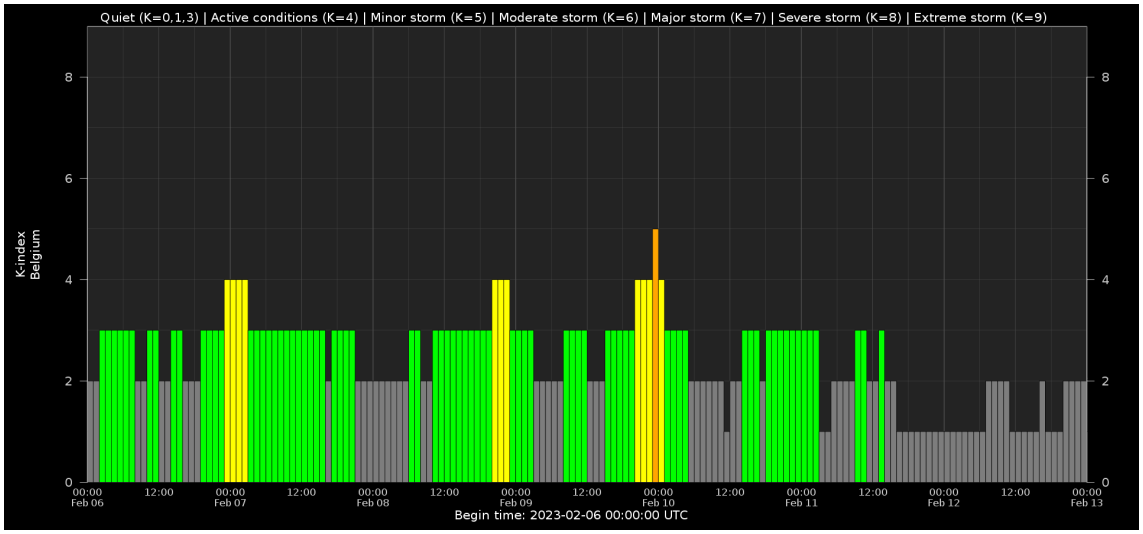
Saturday February 11





The largest flare of the week, an X1.1 flare, was observed by LYRA (top panel) and SWAP (bottom panel). The flare occurred on 2023-Feb-11 (peak at 15:48 UT) on the eastern hemisphere close to the equator, and it was associated with NOAA AR3217.
Find a SWAP movie of the event here: https://proba2.sidc.be/swap/movies/20230211_swap_movie.mp4.

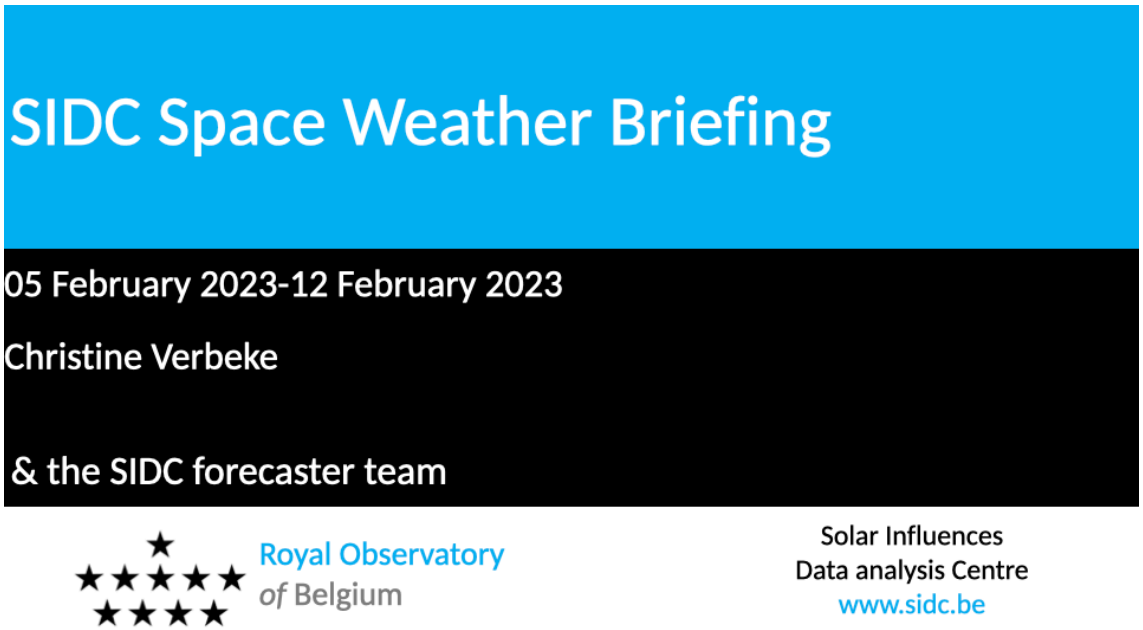
7. Geomagnetic Observations in Belgium (6 Feb 2023 - 12 Feb 2023)



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/

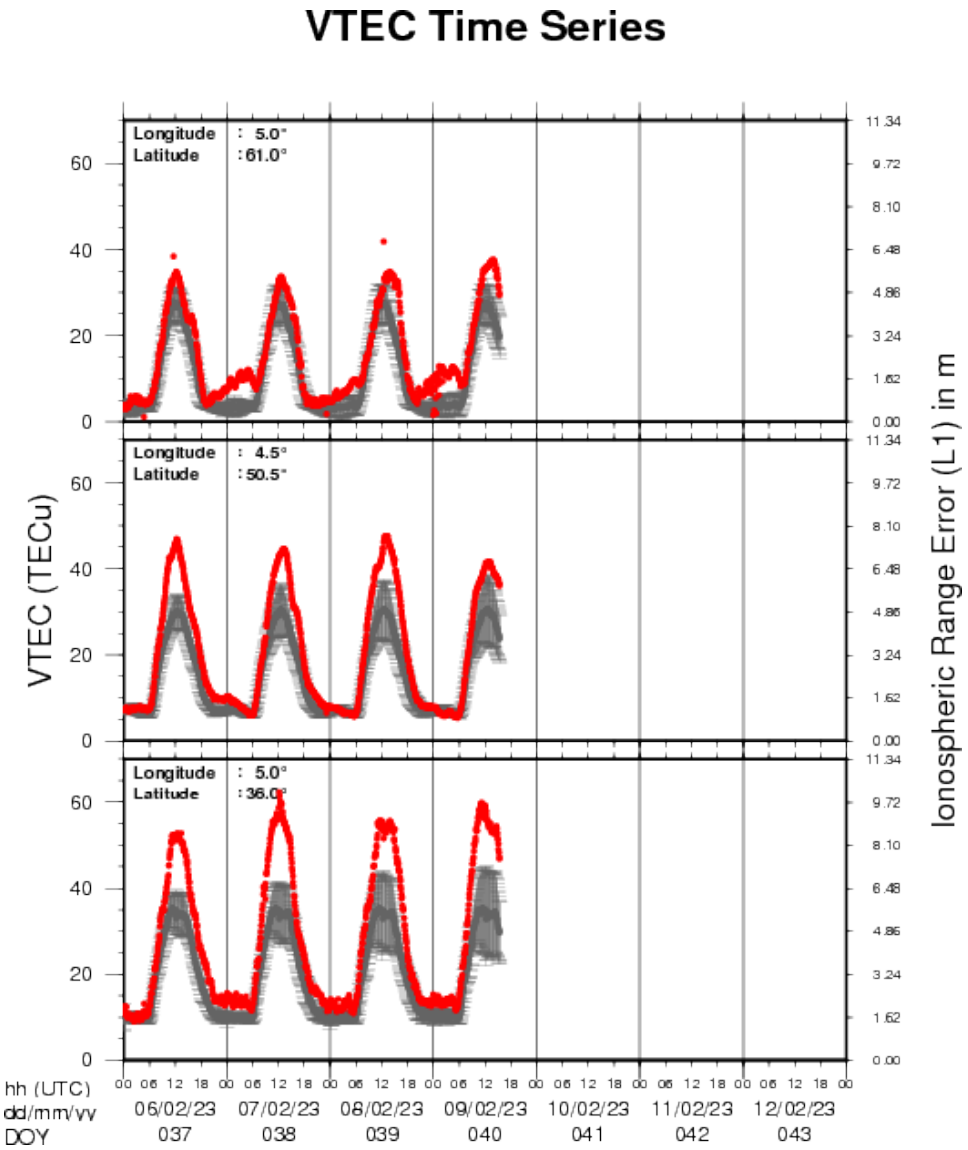
8. The SIDC Space Weather Briefing

The Space Weather Briefing presented by the forecaster on duty from Feb 06 to 12. It reflects in images and graphs what is written in the Solar and Geomagnetic Activity report: https://www.stce.be/briefings/20230213_SWbriefing.pdf



If you need to access the movies, contact us: stce_coordination at stce.be

9. Review of ionospheric activity (6 Feb 2023 - 12 Feb 2023)



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

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 detailed information, see http://gnss.be/ionosphere_tutorial.php

10. Check the calendar

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
* February 17, STCE seminar: Point spread function corrections in solar physics, Brussels, Belgium
* March 14, PITHIA-NRF High Profile Meeting, Brussels, Belgium
* March 15, PITHIA-NRF Innovation Day, Brussels, Belgium
* March 16, PITHIA-NRF Training for Partners, Brussels, Belgium
* March 17, PITHIA-NRF Workshop for Optimization of Observational Strategies, Brussels, Belgium
* March 27-29, Space Weather Introductory Course - onsite, by the STCE, Brussels, Belgium - FULL
* May 22-24, Space Weather Introductory Course - onsite, by the STCE, Brussels, Belgium - FULL
* May 29 - June 1, PITHIA-NRF Training School, Rome, Italy
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