ROYAL OBSERVATORY
OF BELGIUM

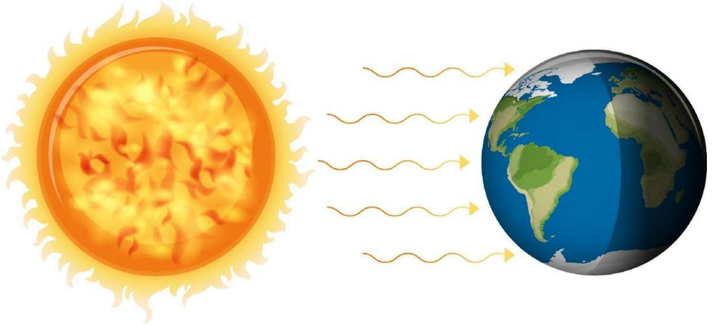
PART 2: Operational Space Weather Service

ROYAL OBSERVATORY OF BELGIUM

What is needed for operational service provision?

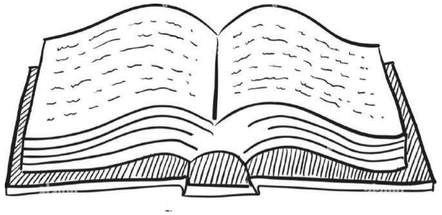
- Service definition

- Data, models, tools

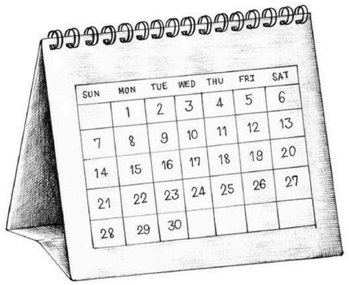


- Operators

- Procedures



- Shifts



- Supporting Personnel

- Robust IT infrastructure

ROYAL OBSERVATORY OF BELGIUM

What is needed for operational service provision?

- Service definition
- Data, models, tools
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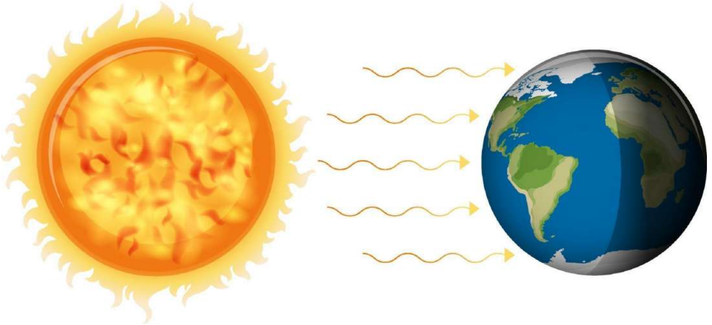
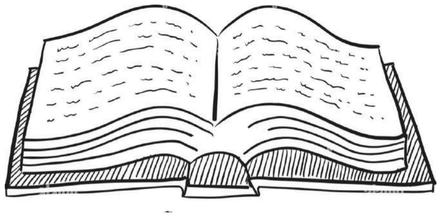
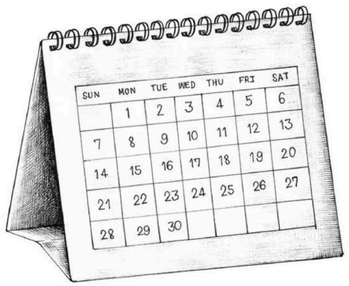






ROYAL OBSERVATORY OF BELGIUM

WHERE TO FIND SW DATA/TOOLS?

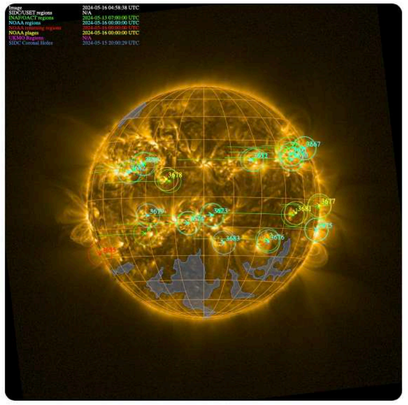
Space Weather Services

Detections

Solardemon
2024-05-16 07:54 B2 flare

CACTus
2024-05-15 16:24 436km/s

Solar Map



Latest Alerts

Presto 2024-05-15

An X3.0 flare was registered by GOES-16 as peaked today at 14:38 UTC. The source was an

Flaremail 2024-05-15

A class X2.9 solar X-ray flare occurred on 2024/05/15 with peak time 14:38UT

CACTus Halo 2024-05-16

A halo or partial-halo CME was detected with the following characteristics: t0 | dt0|

Forecasts

Flare:	M-class flares (≥50%)
Protons:	Event in progress (>10 MeV)
Geomagnetic:	Active conditions (A>=20 or K=4)
All quiet:	False
Provisional SSN:	212

Solar Activity

URSIgram 2024-05-15

Solar flaring activity was high during the last 24 hours with three X-class flares detected during the last 24 hours. The brightest flare was a long-lasting X8.7 emited from NOAA Active Region (AR) 3664 (magnetic configuration Beta-Gamma-Delta, Catania sunspot group 86) yesterday at 16:51 UTC. The same AR produced the rest of the X-class flare activity, namely an X3.4 that peaked today at

Solar Wind

URSIgram 2024-05-15

Geomagnetic conditions were both globally and locally unsettled to quiet (NOAA Kp 3- to 1 and K BEL 3 to 2) during the past 24 hours. In the next 24 hours they are expected to reach active levels as a result of the expected arrival of a Coronal Mass Ejection (CME). The Solar Wind (SW) conditions are gradually returning to the slow SW regime during the past 24 hours. The SW speed dropped from

SIDC

ROYAL OBSERVATORY OF BELGIUM

WHERE TO FIND SW DATA/TOOLS?

SIDC - Solar Influences Data Analysis Center

SIDC/RWC-Belgium visit us at https://www.sidc.be SIDC/RW

- Home
- Ground-based images (USET)
- Humain Solar Radioastronomy
- Sunspots (SILSO)
- Space Weather services
- Image Processing
- Hardware characterisation
- Space Instruments
- Visualisation
- Dissemination
- General info
- LEGAL NOTICES

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Mail header	SIDC code	Description	format	Frequency	Source
Boumeuss	bms	Sunspot data.	Encoded data (ISES)	daily	SEC (RWC-Boulder,US)
COMESEP SEP forecast	comesep_sep	Automated Solar Energetic Particle (SEP) radiation storm forecast for >10 MeV protons when a medium or stronger SEP storm risk is expected following detection of a >=M1 flare or a Ground Level Enhancement (GLE)	Plain text	ASAP, for expected medium or stronger SEP radiation risk	COMESEP Consortium (PI: BIRA-IASB)
Geoalert RWC-Belgium	xut	Forecast, solar events, daily solar and geomagnetic indices, solar regions: data and flare forecast.	Encoded data (ISES)	daily	SIDC (RWC-Belgium)
Geoalert RWC-Boulder	geo	Forecast, solar events, daily solar and geomagnetic indices, solar regions: data and flare forecast.	Encoded data (ISES)	daily	SEC (RWC-Boulder,US)
GOES X-ray flare detection alert	flaremail	This message is of the fast alert type. It is sent out when SIDC software detects in the GOES data a flare with an X-ray radiation flux stronger than M5.	Plain text	ASAP, when a flare >M5 has been detected	SIDC (RWC-Belgium)
Halo CME detection alert	cactus	This message is of the fast alert type. It is sent out when the CACTus software detects in image sequences from LASCO a halo CME with an angular width of more than 180°.	Plain text	ASAP, when CME has been reliably detected	SIDC (RWC-Belgium)
INDAA message	ind	Preliminary aa indices, based on k indices from Hartland (UK) and Canberra (Australia).	Encoded data (ISES)	weekly	SIDC (RWC-Belgium)
Indices K Canberra	kcan	K indices from Canberra.	Encoded data (ISES)	weekly	Canberra (Australia)
Indices K Hartland	khar	K indices from Hartland.	Encoded data (ISES)	weekly	Hartland (UK)

SIDC
sidc.be

```
:Issued: 2022 Mar 07 1248 UTC
:Product: documentation at http://www.sidc.be/products/meu
#-----------------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC        #
# (RWC Belgium)                                                         #
#-----------------------------------------------------------------------#
SIDC URSIGRAM 20307
SIDC SOLAR BULLETIN 07 Mar 2022, 1246UT
SIDC FORECAST (valid from 1230UT, 07 Mar 2022 until 09 Mar 2022)
SOLAR FLARES  : C-class flares expected, (probability >=50%)
GEOMAGNETISM  : Quiet (A<20 and K<4)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 07 Mar 2022  10CM FLUX: 113 / AP: 008
PREDICTIONS FOR 08 Mar 2022  10CM FLUX: 110 / AP: 007
PREDICTIONS FOR 09 Mar 2022  10CM FLUX: 112 / AP: 004
COMMENT: Solar activity over the past 24 hours was at very low to low
```

```
:Issued: 2022 Feb 16 0848 UTC
:Product: documentation at http://www.sidc.be/products/presto
#-----------------------------------------------------------------------#
# FAST WARNING 'PRESTO' MESSAGE  from the SIDC (RWC-Belgium)            #
#-----------------------------------------------------------------------#
SoHO LASCO C2 coronagraph data show a halo CME from Feb 15 22:12UT onwards. The
CME is directed primarily to the North-East from Earth perspective. Combined
with STEREO A cor2 coronagraph data (where the CME is seen as also primarily
directed to the North-East from that perspective) the CME is analysed to be
backward and will not influence Earth.
#-----------------------------------------------------------------------#
# Solar Influences Data analysis Center - RWC Belgium                   #
# Royal Observatory of Belgium                                          #
#                                                                       #
# Website         http://www.sidc.be.                                   #
# E-mail          sidc-support@oma.be                                   #
# To unsubscribe  http://www.sidc.be/registration/unsub.php             #
#                                                                       #
```

OBSERVATOIRE ROYAL DE BELGIQUE - PHYSIQUE SOLAIRE
KONINKLIJKE STERRENWACHT VAN BELGIE - ZONNEFYSICA

N°...../.....
Rotation N° .....
P : .....
B_0 : .....
L_0 : .....
Observateur: F. CLETTE
Date: 6 / 9 / 2012
Heure : 7 H. 20 m (u.t.)
Qualité: 3

CACTUS

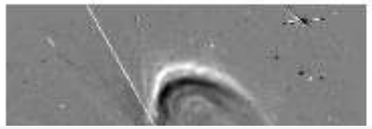
A software package for 'Computer Aided C

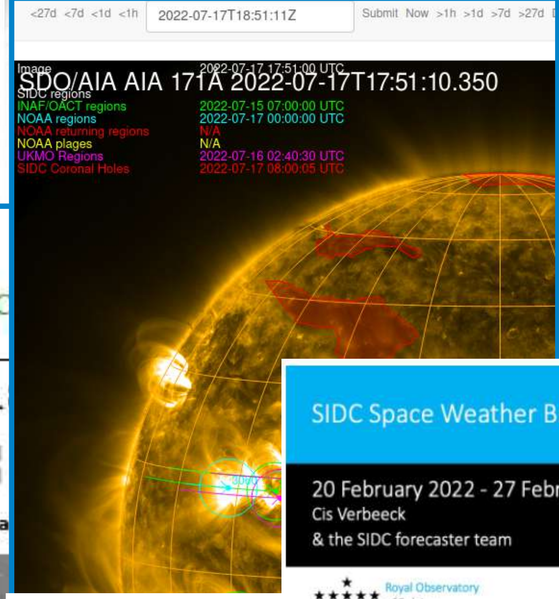
Details and graphs for CME001

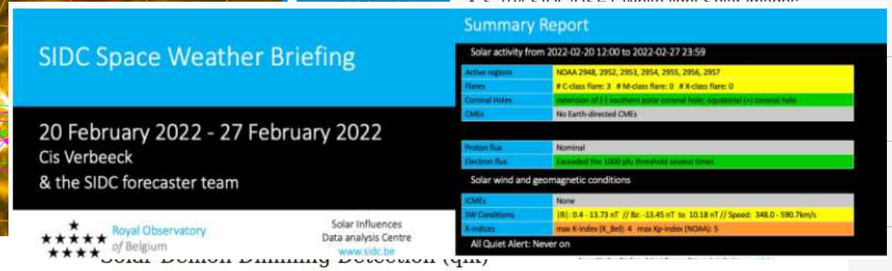
#	CME	t0	dt0	pa	da	v	dv
	0018	2022/07/15 15:36	02	335	108	0260	0020

CME Movie :: Download ::

Sample Ima







ROB/SIDC • S.101 Proba2/SWAP Images

ROB/SIDC • S.101c SIDC Solarmap

ROB/SIDC • S.102 Proba2/LYRA Data

ROB/SIDC • S.103 SIDC/USET Halpha Solar images

ROB/SIDC • S.104 SIDC/USET White-light Solar images

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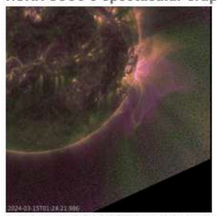
NOAA 3599's spectacular eruption

NEW



Active region NOAA 3599 had already rotated over the Sun's west limb when it produced a spectacular long duration C-class flare.

Slowly but surely

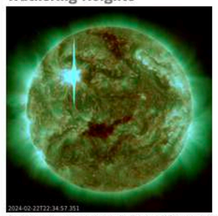
The polar field reversal on the Sun is ongoing, but it is not completed yet as testified by observations.

Colourful curtains

A moderate geomagnetic storm was observed on 3 March. Polar lights were photographed as far south as mid-England and Lower Saxony in Germany.

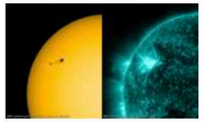
view

Wuthering Heights



So far this solar cycle, NOAA 13590 is the largest sunspot group and it has produced the strongest solar flare. Some perspective.

More X-class flares



NOAA 3590 produced 3 X-class flares in 24 hours: an X1.8 flare peaking late on 21 February, an X1.7 flare peaking early on 22 February, and an X6.3 event that peaked on 22 February at 22:34UTC. The latter is the strongest flare so far this solar cycle.

UPDATED.

Quick-look! running in real time on SDO/AIA 211 QLK data
3 minute cadence, typical delay 15 minutes
(detection version 1.00)
(view all Solar Demon detection tools)

Overview of dimming 3950

Detector 24h operating status:

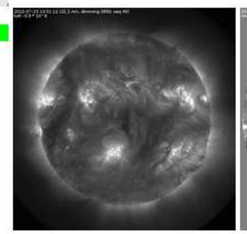
Last processed image:
0 hours and 54 minutes ago (2022-07-17 17:51 UTC)

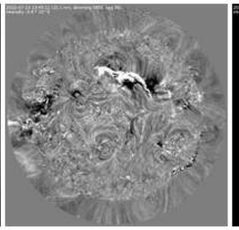
Last detected dimming:
0 hours and 54 minutes ago (2022-07-17 17:51 UTC)

Overview for dimming #:
3950 back to overview

Animations and graphs
derotated original images (non-derotated)
dimming intensity (overlaid on HMI)
dimming mask

base difference (percentage)
running difference (percentage)


more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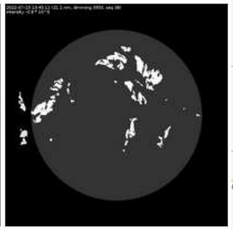
more

Details for dimming #: 3950

time	seq #
2022-07-15 11:54:11	1
2022-07-15 11:57:11	2
2022-07-15 12:00:11	3
2022-07-15 12:03:11	4
2022-07-15 12:06:11	5
2022-07-15 12:09:11	6
2022-07-15 12:12:11	7
2022-07-15 12:15:11	8

SWEC
Space Weather Education Center

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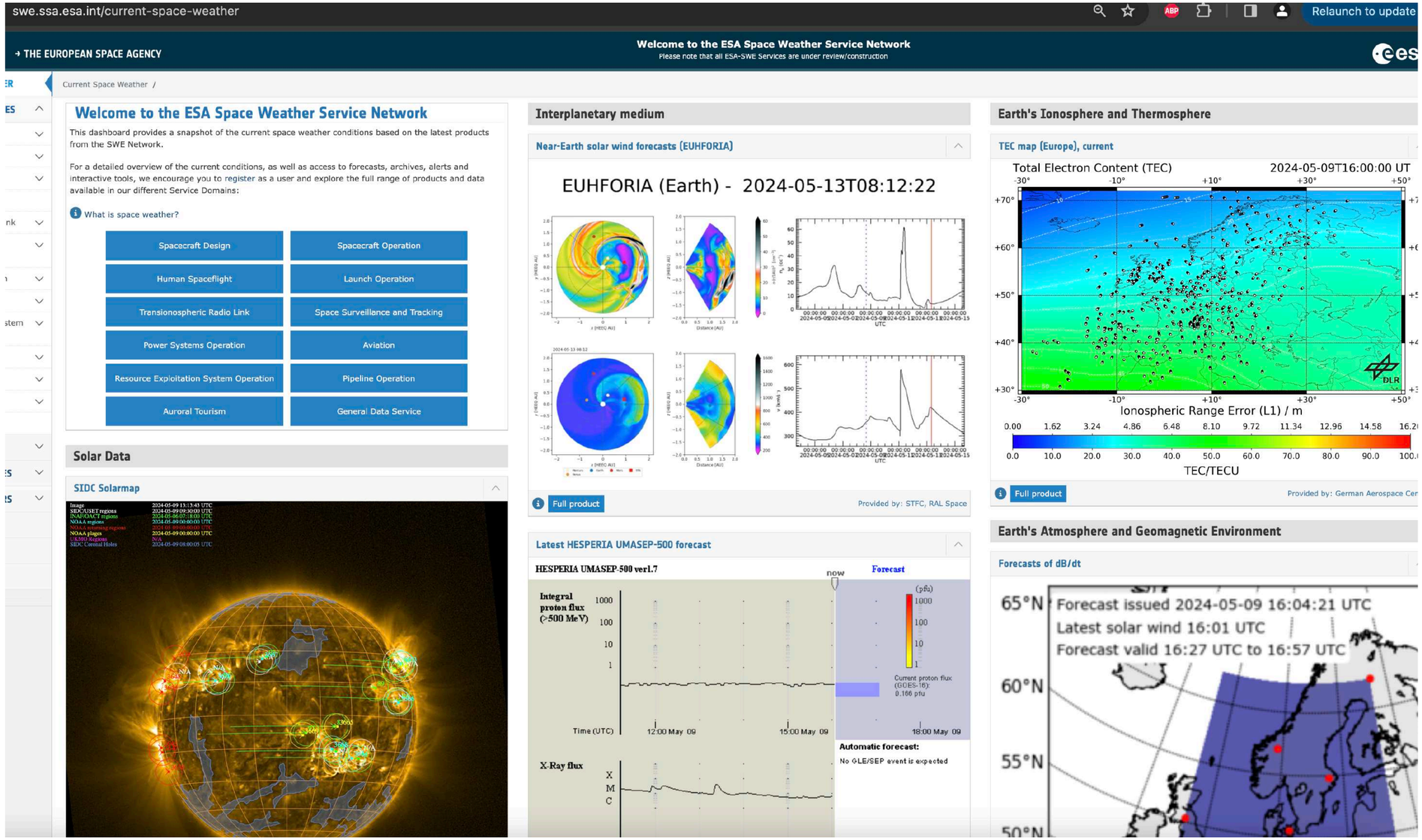
WHERE TO FIND SW DATA/TOOLS?



ESA SSA

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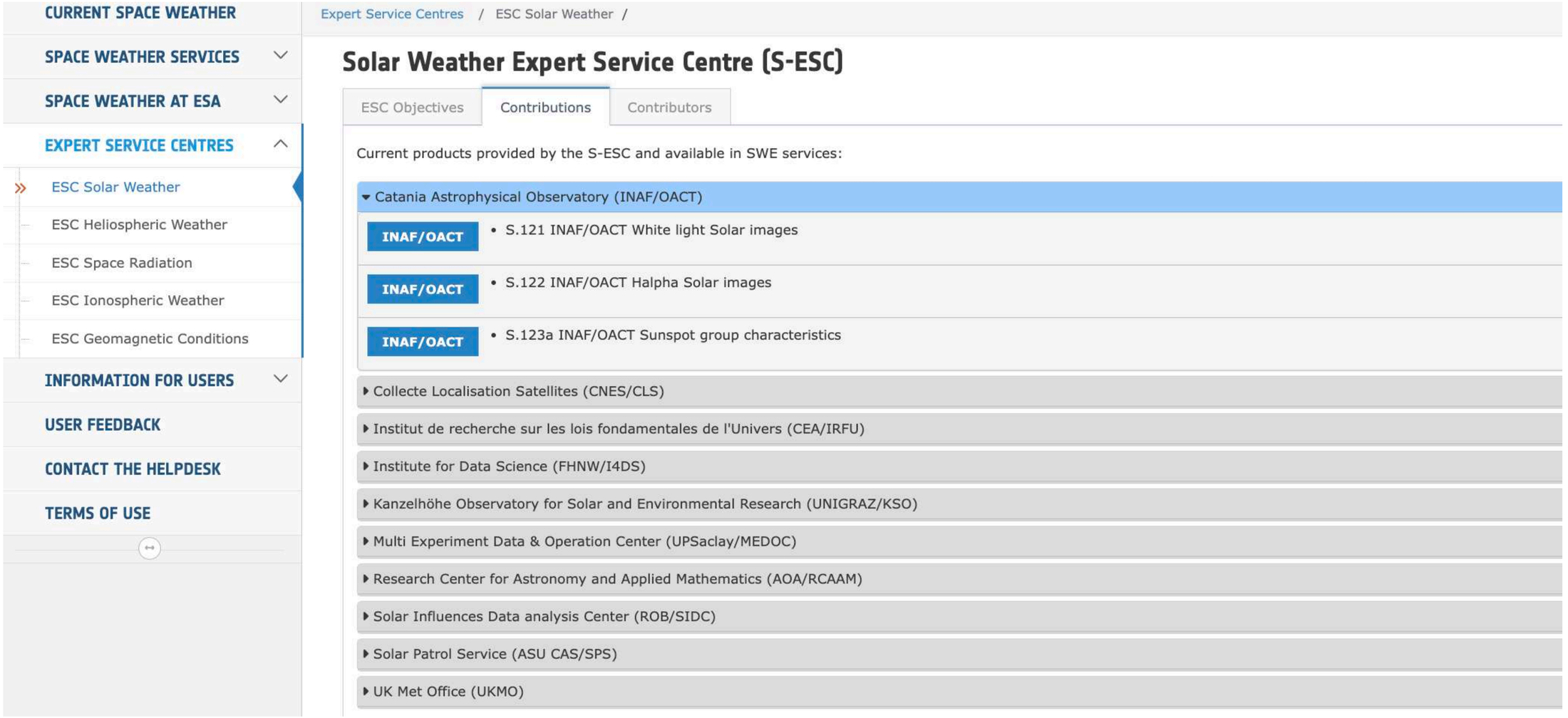
WHERE TO FIND SW DATA/TOOLS?



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SPACE WEATHER PREDICTION CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Thursday, May 09, 2024 16:08:11 UTC

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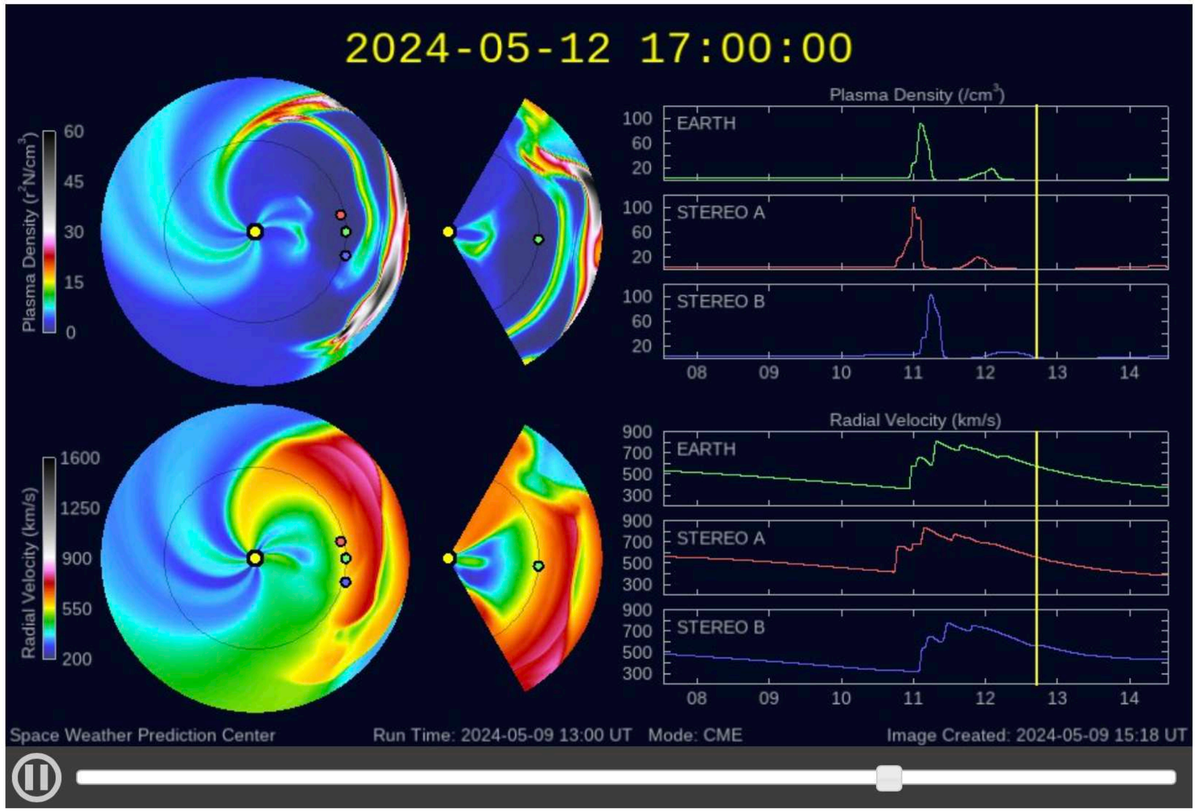
CURRENT SPACE WEATHER CONDITIONS on NOAA Scales

R none | S none | G none

WSA-ENLIL SOLAR WIND PREDICTION



NOAA

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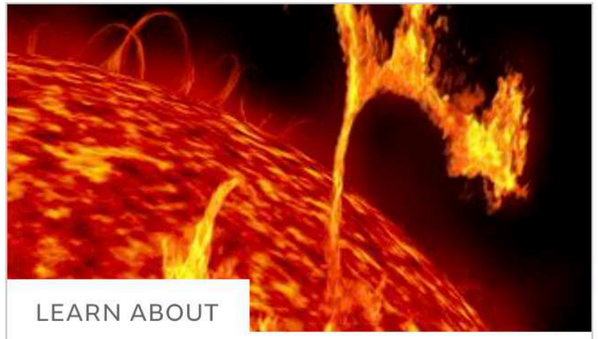

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The Met Office and space weather

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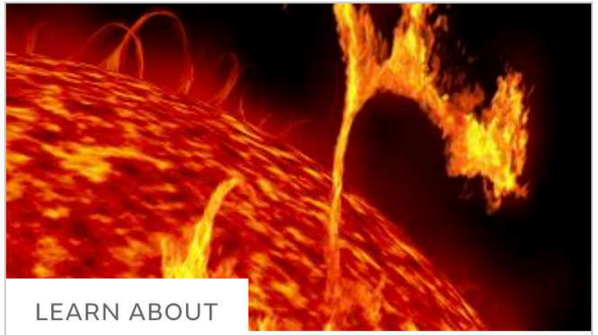

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Auroras

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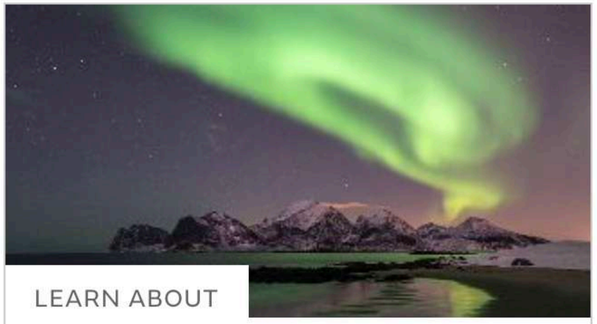

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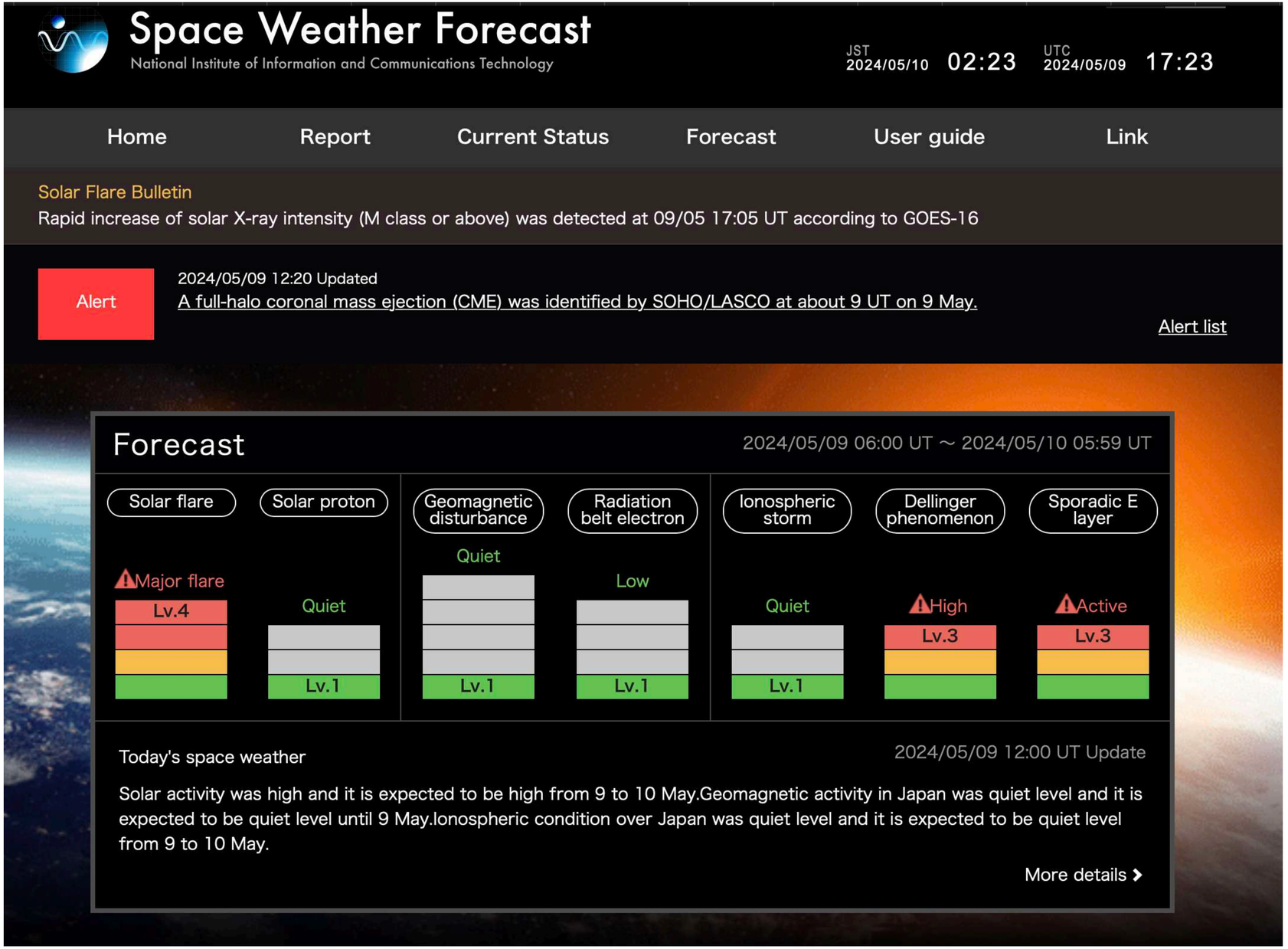

NICT

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WHERE TO FIND SW DATA/TOOLS?

※ Click the image to enlarge.

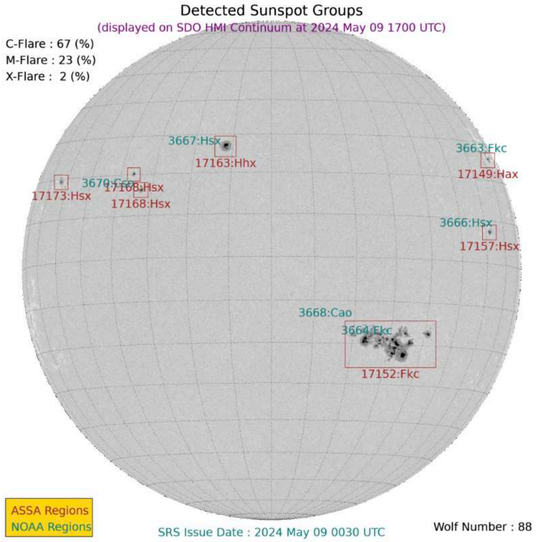


Fig1 Spot group detection and McIntosh classification result[TEXT INFO]

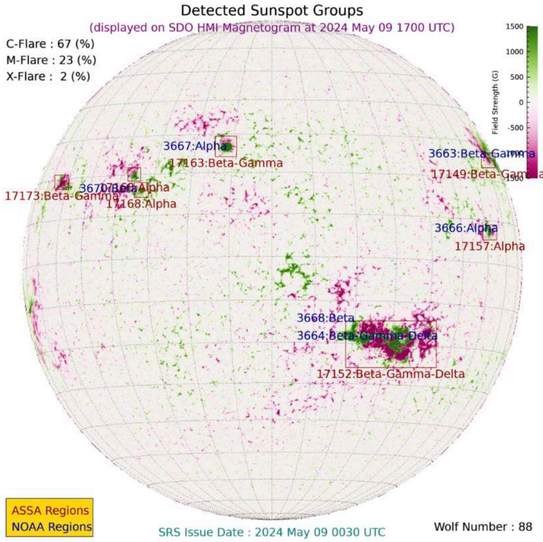
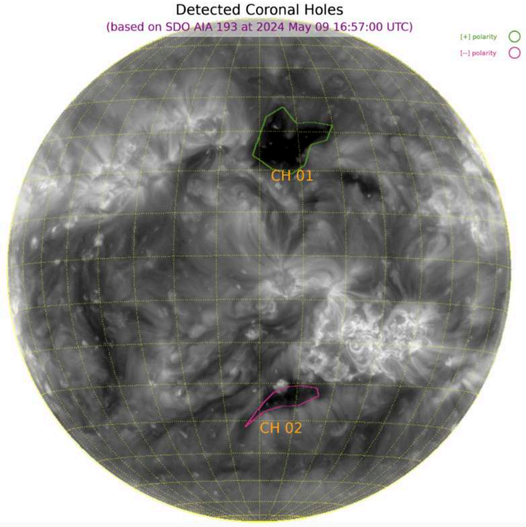
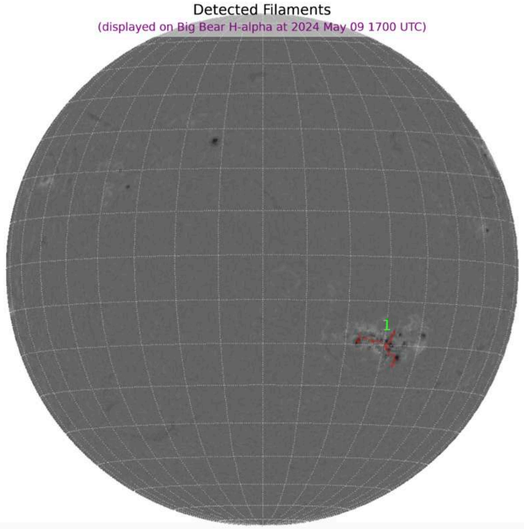


Fig1 Spot group detection and McIntosh classification result





KWSC

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WHERE TO FIND SW DATA/TOOLS?

SpaceWeatherLive

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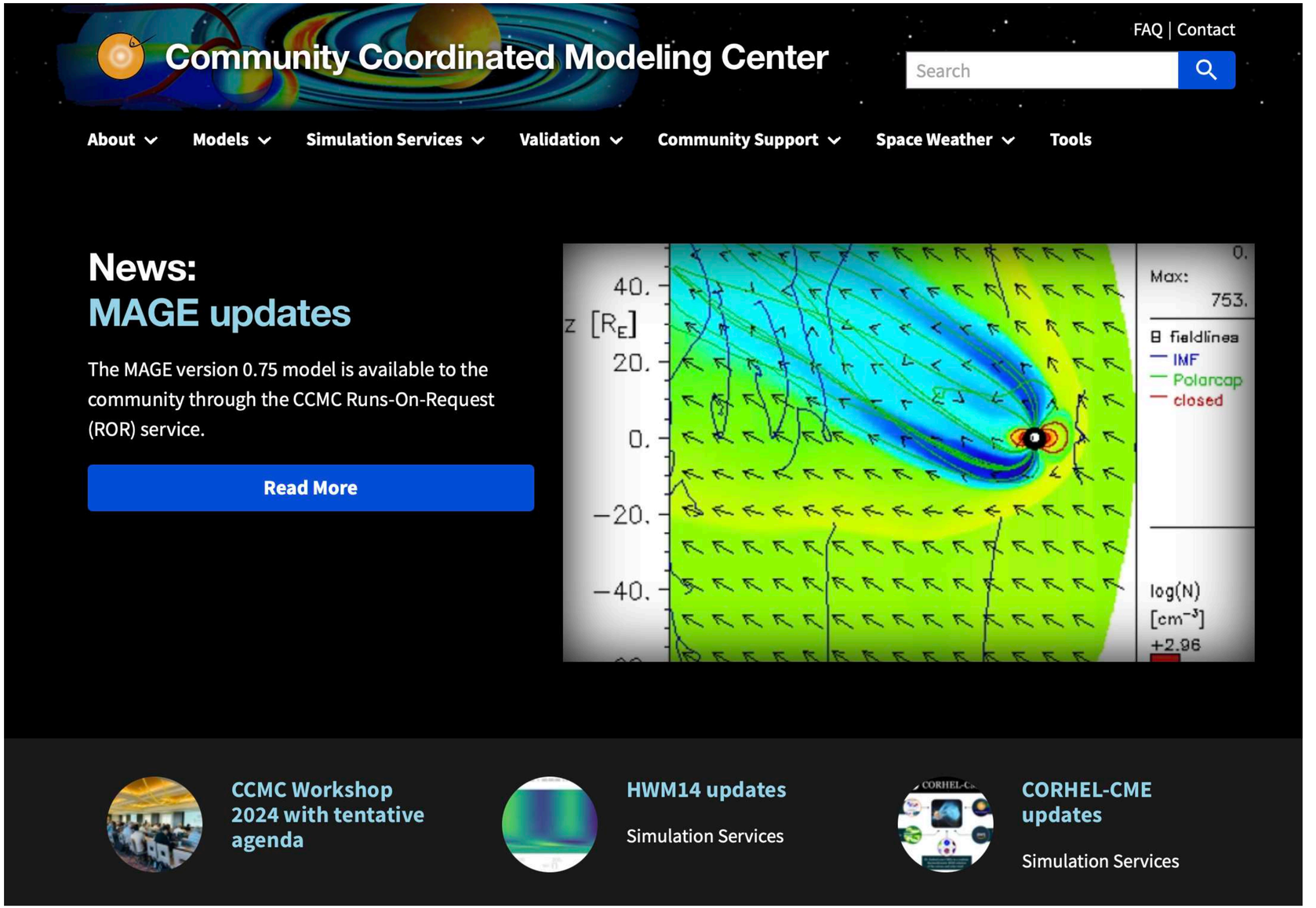
WHERE TO FIND SW DATA/TOOLS?



NASA CCMC

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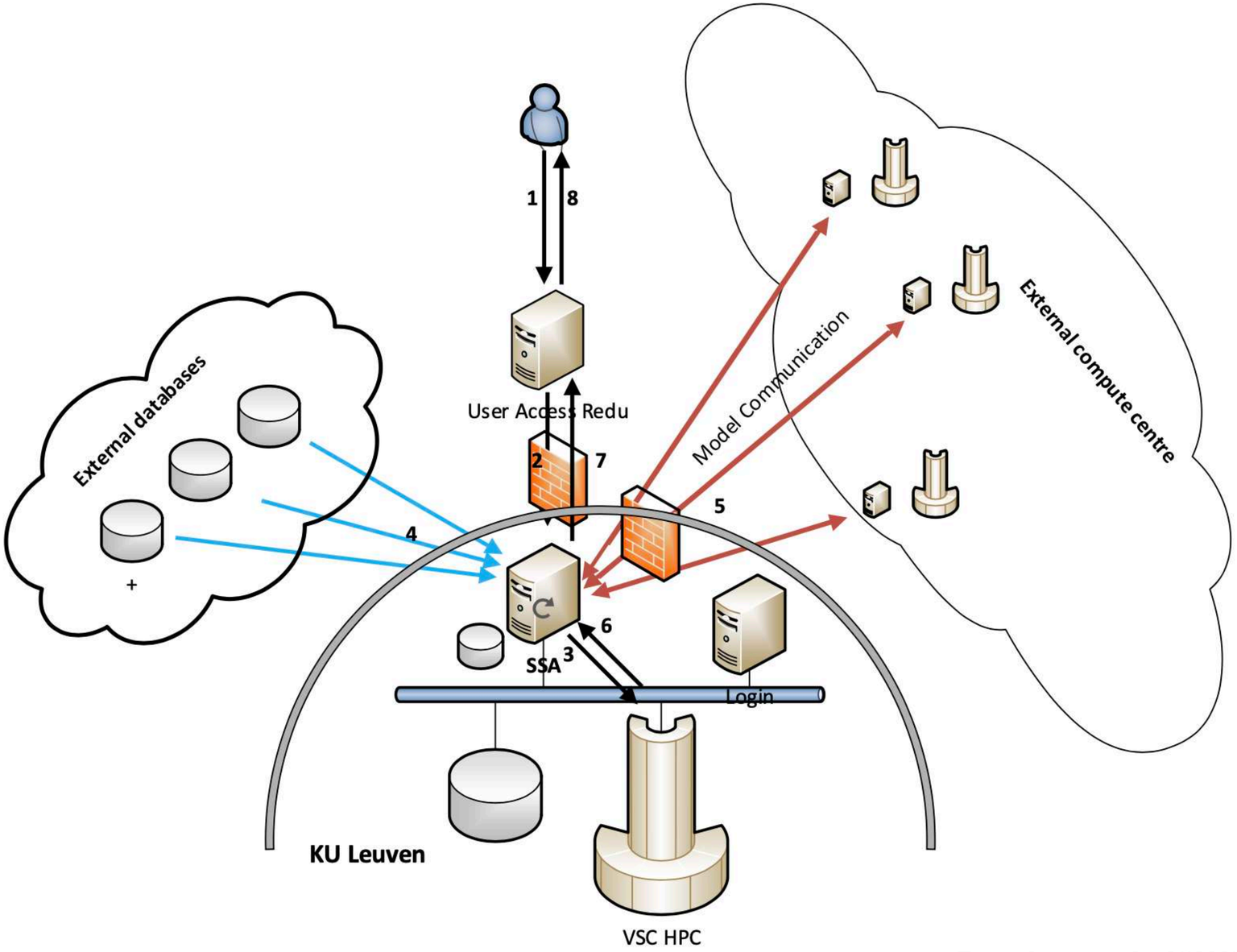
Virtual Space Weather Modeling Center (VSWMC)



Poedts et al, JSWSC 2020

ROYAL OBSERVATORY OF BELGIUM

Virtual Space Weather Modeling Center (VSWMC)

Heliospheric Weather Expert Service Centre (H-ESC)

ESC Objectives | Contributions | **Product demonstration** | Contributors

The H-ESC concept is to demonstrate state of the art products proposed for future integration in the SSA space weather services and assess their capabilities and functionally and user satisfaction. Therefore, H-ESC demonstrates products, which are currently in a prototype level. Each demonstration product is presented by the corresponding contributor on federated websites.

▼ Centre for mathematical Plasma-Astrophysics (KUL/CmPA)

VSWMC	• H.200a Virtual Space Weather Modelling Centre

ESA SSA netwrok

Other Event Chain Catalogues: DONKI (M2M_CATALOG, CCMC)

COMMUNITY COORDINATED MODELING CENTER

Space Weather Database Of Notifications, Knowledge, Information (DONKI)

Go to:

- About DONKI
- DONKI Home
- Search Space Weather Activity
- Search Notification Archive
- Login

Search Space Weather Activity Archive

Space Weather Activity Type : Solar Flare

Select Catalog : M2M_CATALOG

Optional start date in format (e.g. 2013-01-31) : 2023-09-03

Optional end date in format (e.g. 2013-06-30) : 2023-11-16

search

Event Type	Start Time (UT)	Associated Instrument	Peak Time	End Time	Class	Source Location	Active Region Number	Directly Linked Event(s)
Solar Flare	2023-09-03 00:14	GOES-P: EXIS 1.0-8.0	2023-09-03T00:23Z	2023-09-03T00:33Z	M1.1	N12W90	13413	2023-09-03T00:36:00-CME-001
Solar Flare	2023-09-03 04:00	GOES-P: EXIS 1.0-8.0	2023-09-03T04:10Z	2023-09-03T04:14Z	C1.8	N10W90	13413	2023-09-03T04:36:00-CME-001

CME scoreboard (CCMC)

COMMUNITY COORDINATED MODELING CENTER

CME Scoreboard

Active CMEs:

CME: 2024-05-14T10:09:00-CME-001

CME Note: Wide CME seen to the NE in all coronagraphs (STEREO A gets first visible frame). Source is an unnumbered region of the solar disk, centered around N23E35. Starting around 2024-05-14T09:07Z, field line movement is observed in SDO AIA 171/193/211 alongside a diagonal region of light dimming spanning approximately N40E60 -> N15E30 across that center point. A distinct post-eruptive arcade forms around 2024-05-14T10:47Z across SDO AIA 131/171/193/211.

Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2024-05-17T23:00Z (-7.0h, +7.0h)	----	----	2024-05-14T18:45Z	76.25	Max Kp Range: 2.0 - 3.0	WSA-ENLIL + Cone (NASA M2M)	Tony Iampietro (M2M)	Detail
2024-05-17T23:00Z	----	----	---	---	Max Kp Range: 2.0 - 3.0	Average of all Methods	Auto Generated (CCMC)	Detail

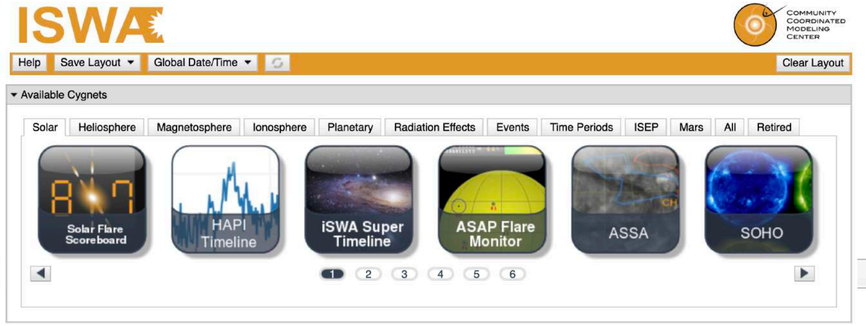
CME: 2024-05-11T01:36:00-CME-001

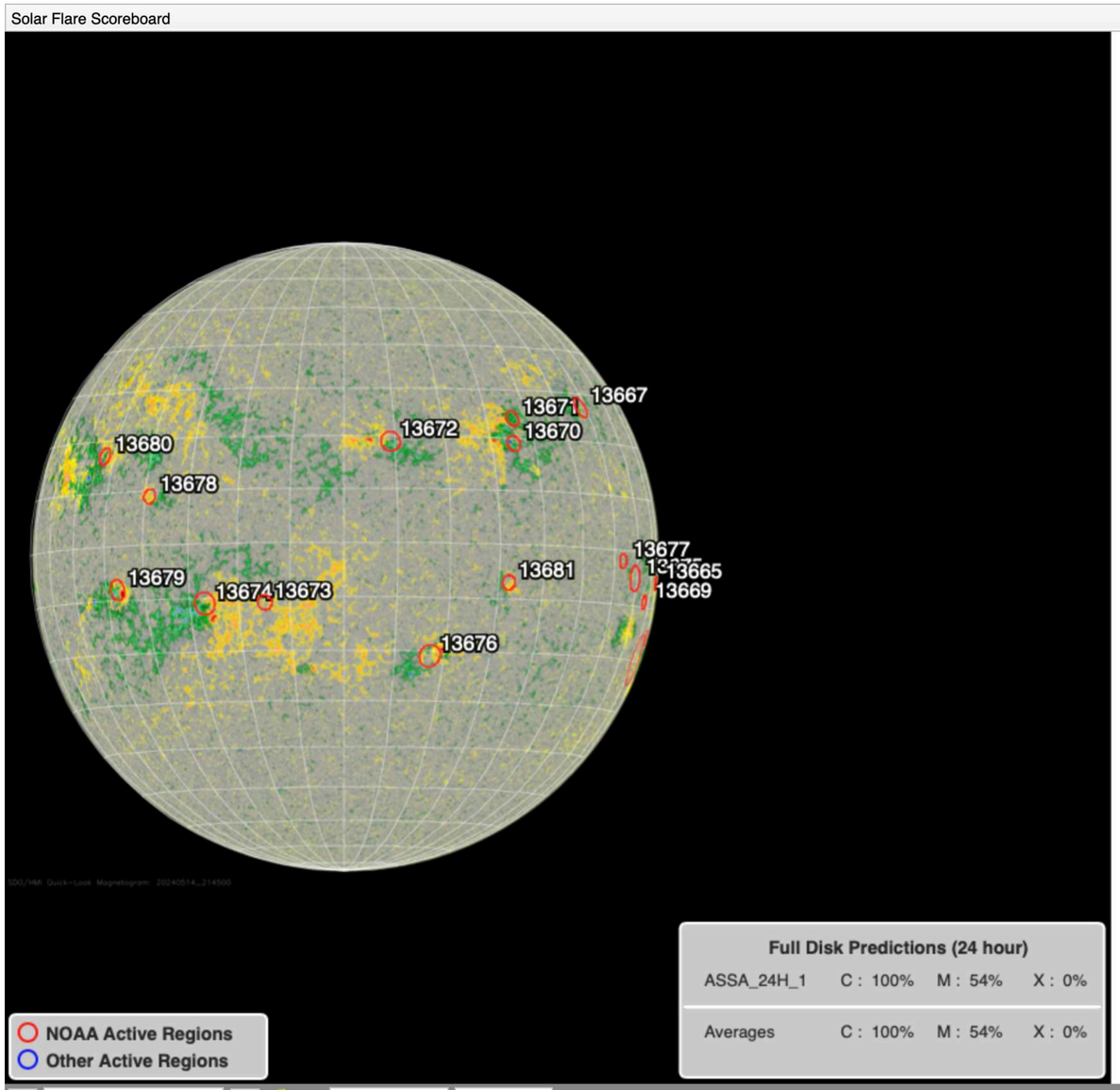
CME Note: Ear-shaped bright partial halo CME with a very complex shape brighter bulk and a fainter somewhat asymmetric full halo shock. The CME is associated with the X5.8 flare and a significant eruption (massive dimming) and EUV wave seen in SDO 193.

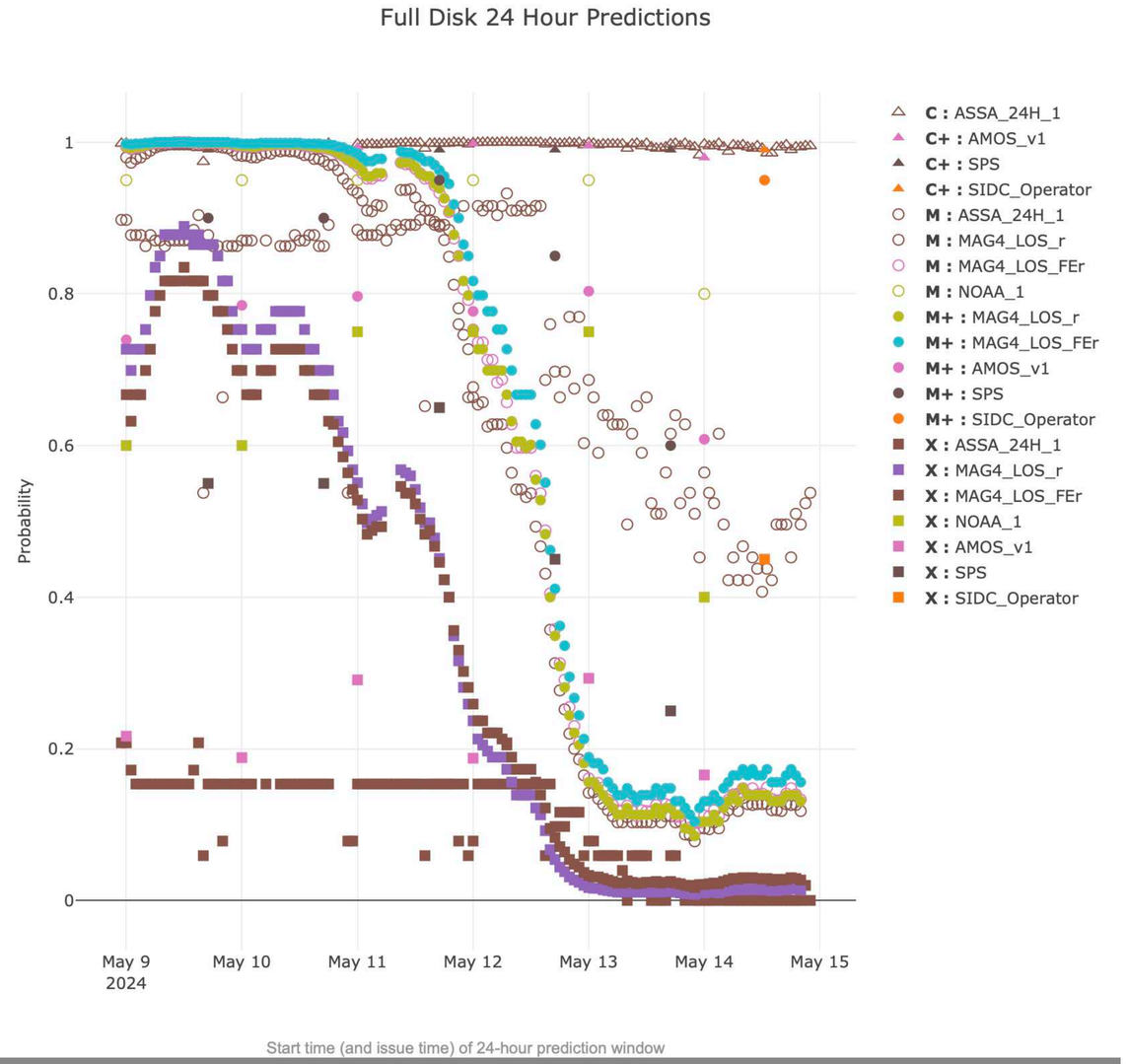
Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2024-05-12T11:13Z (-5.0h, +3.84h)	----	----	2024-05-11T05:24Z	29.82	----	CMEFM v.0.1	Garrett Imhoff (Other)	Detail
2024-05-13T13:00Z (-12.0h, +12.0h)	----	----	2024-05-11T06:38Z	54.37	Max Kp Range: 5.0 - 6.0	WSA-ENLIL + Cone (BoM)	Duty Forecaster (ASWFC)	Detail
2024-05-12T18:00Z (-6.0h, +12.0h)	----	70.0	2024-05-11T09:30Z	32.50	Max Kp Range: -- - 8.0	WSA-ENLIL + Cone (Met Office)	Met Office (Met Office)	Detail
2024-05-13T01:00Z	----	60.0	2024-05-11T10:20Z	38.67	Max Kp Range: 5.0 - 7.0	Cone + HAF (SEPC, NSSC, CAS)	Jingjing Wang (NSSC SEPC)	Detail
2024-05-13T04:59Z (-7.0h, +7.0h)	----	----	2024-05-11T14:23Z	38.60	Max Kp Range: 5.0 - 7.0	WSA-ENLIL + Cone (NASA M2M)	Carina Alden (M2M Office)	Detail

Flare scoreboard (CCMC/ISWA)

https://ccmc.gsfc.nasa.gov/tools/iSWA/







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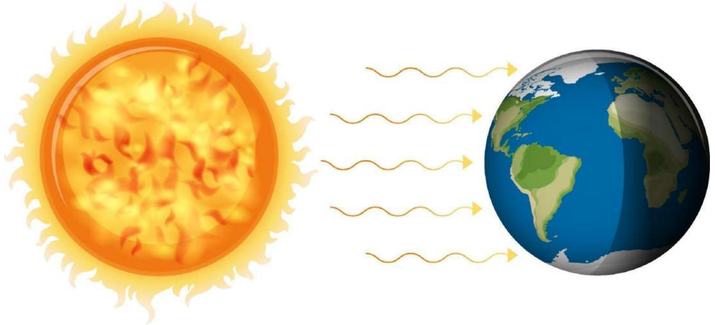
What is needed for operational service provision?

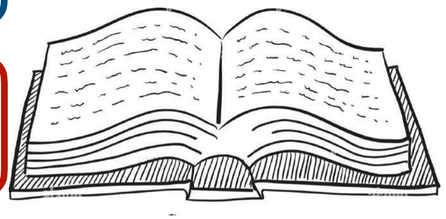
- Service definition

- Data, models, tools



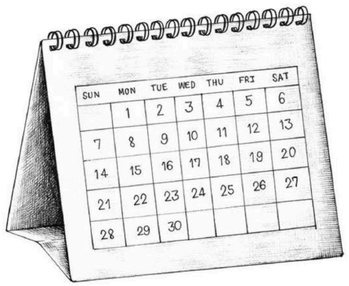
- Operators

- Procedures



- Shifts

- Supporting Personnel



- Robust IT infrastructure

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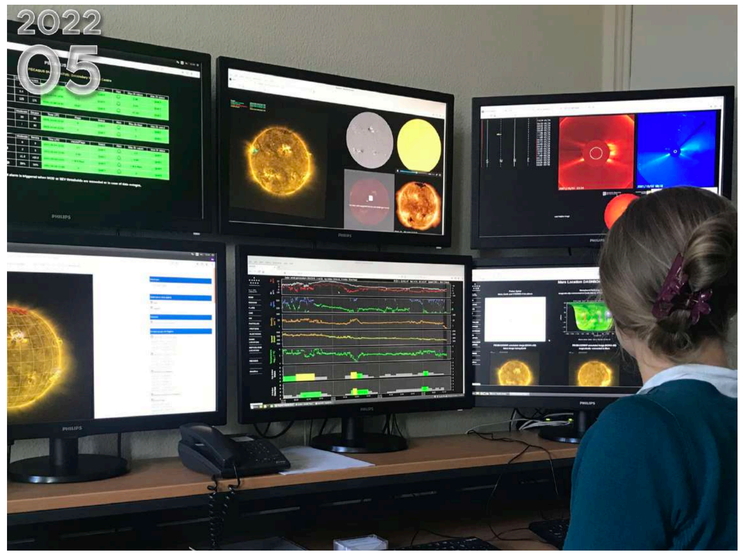
Space weather (SWX) monitoring and forecasting services at ROB/STCE

satellite and ground-based data

data processing & modelling software

General SWX service + 24/7 services to Aviation



Bulletins, Alerts and Forecast

Other input & data models

PECASUS

Solar Influences Data analysis Centre
www.sidc.be

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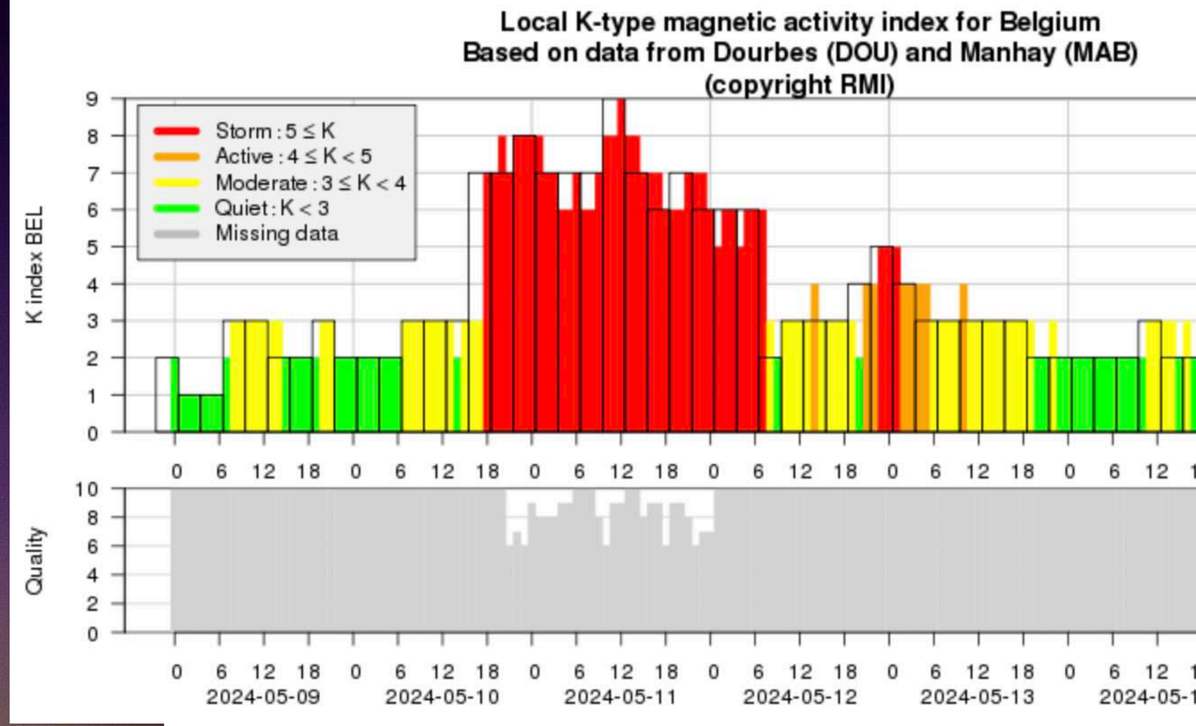
OF BELGIUM

EXERCISE 2: connect solar drivers to SWX impacts

Extreme geomagnetic storms (G5) on May 10th, May 11th



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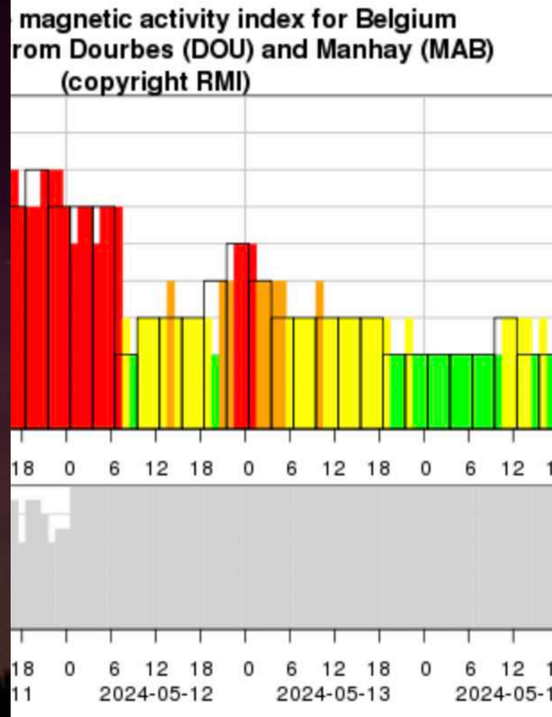
EXERCISE 2: connect solar drivers to SWX impacts

Extreme geo



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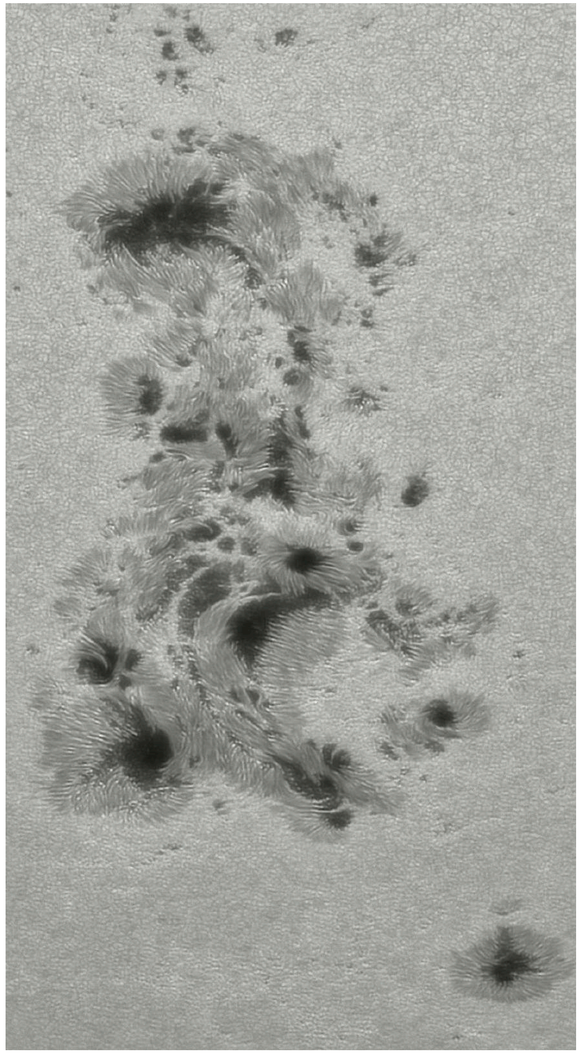
EXERCISE 2: connect solar drivers to SWX impacts

Go to https://tinyurl.com/SWXImpacts

Connect the solar drivers & model predictions with expected and observed SWX impacts

1. Check the data in Exercises/Data
2. Fill in Impact Table in Exercises/testImpacts
3. Bonus: try to understand the time flow

Hint: Possible answers: “Yes”, “No”, “No data”, “Possible”, …



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EXERCISE 2: Solution

Extreme geomagnetic storms (G5) on May 10th, May 11th

Domain	Possible Impact	Observed	Expected
Satellite Operators	Single Event Effects	No data	Possible intermittent SEUs, nothing serious
	Satellite charging	No data	No
	GNSS degradation	Yes	Yes
	Satellite drag	Probably Yes	YES!
GNSS users	Loss of lock (LOL) on GNSS signals	Yes	Yes
	GNSS degradation	Yes	Yes
Power systems operators	Geomagnetically induced currents (GIC) (based on electric field of on rate of change of the geomagnetic field [dB/dt])	Yes, but data not provided here	Yes
	Blackout	No data	Possible
	Transformer damages	No data	Possible
	Transformer saturation	No data	Possible
Airlines	Radiation level increase	No data	Slight increase over the poles
	VHF and HF radio communication degradation	No data	Yes
	GNSS degradation	No data	Yes
Service to pipeline operators	Geomagnetically induced currents (GIC) (based on electric field of on rate of change of the geomagnetic field [dB/dt])	Yes, but data not provided here	Yes
	Corrosion of the pipeline steel	No data	Possible
Auroral tourism sector	Aurora at lower latitudes	YES!!	Yes
Astronaut/Human Space Flight Safety	Radiation level increase	Yes	Yes
General Public Impacts	GPS, mobile networks, satellite TV/internet, power outage	No data	Yes
Geological Survey Interference	Errors in magnetic survey measurements	Probably, no data	Yes
Animal Migration	Disorientation of animals	Possible, No data	Yes

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STCE

END OF PART 2

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Data analysis Centre
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