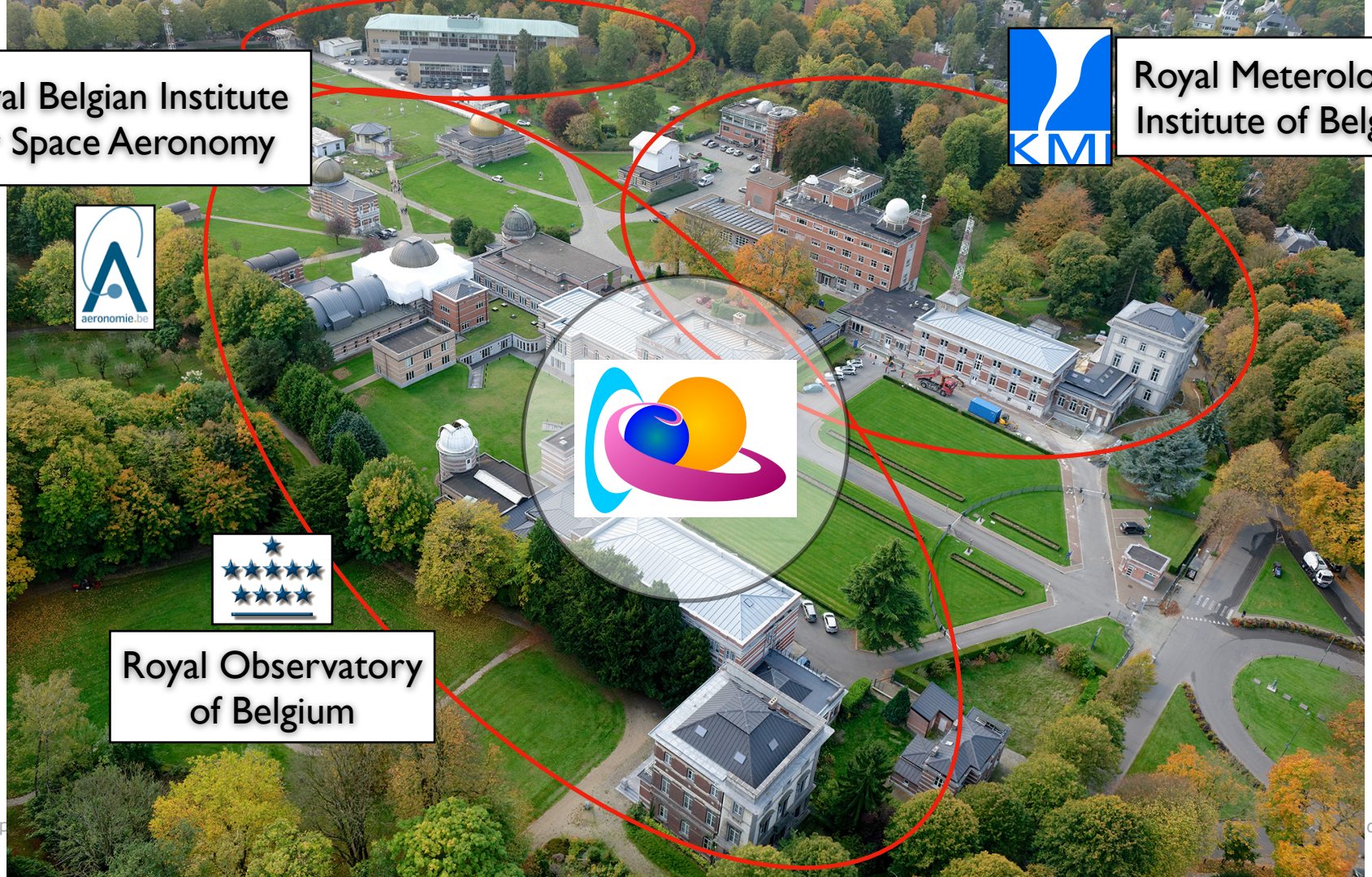
From Physics to Forecasting

PRESENTED BY
PETRA VANLOMMEL
Solar-Terrestrial Centre of Excellence

A collaboration between



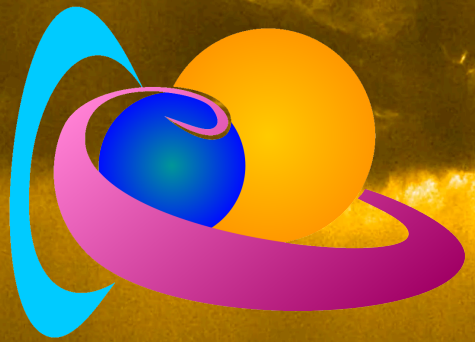



Royal Belgian Institute for Space Aeronomy
aeronomie.be
Royal Meterological Institute of Belgium
KMI
Royal Observatory of Belgium





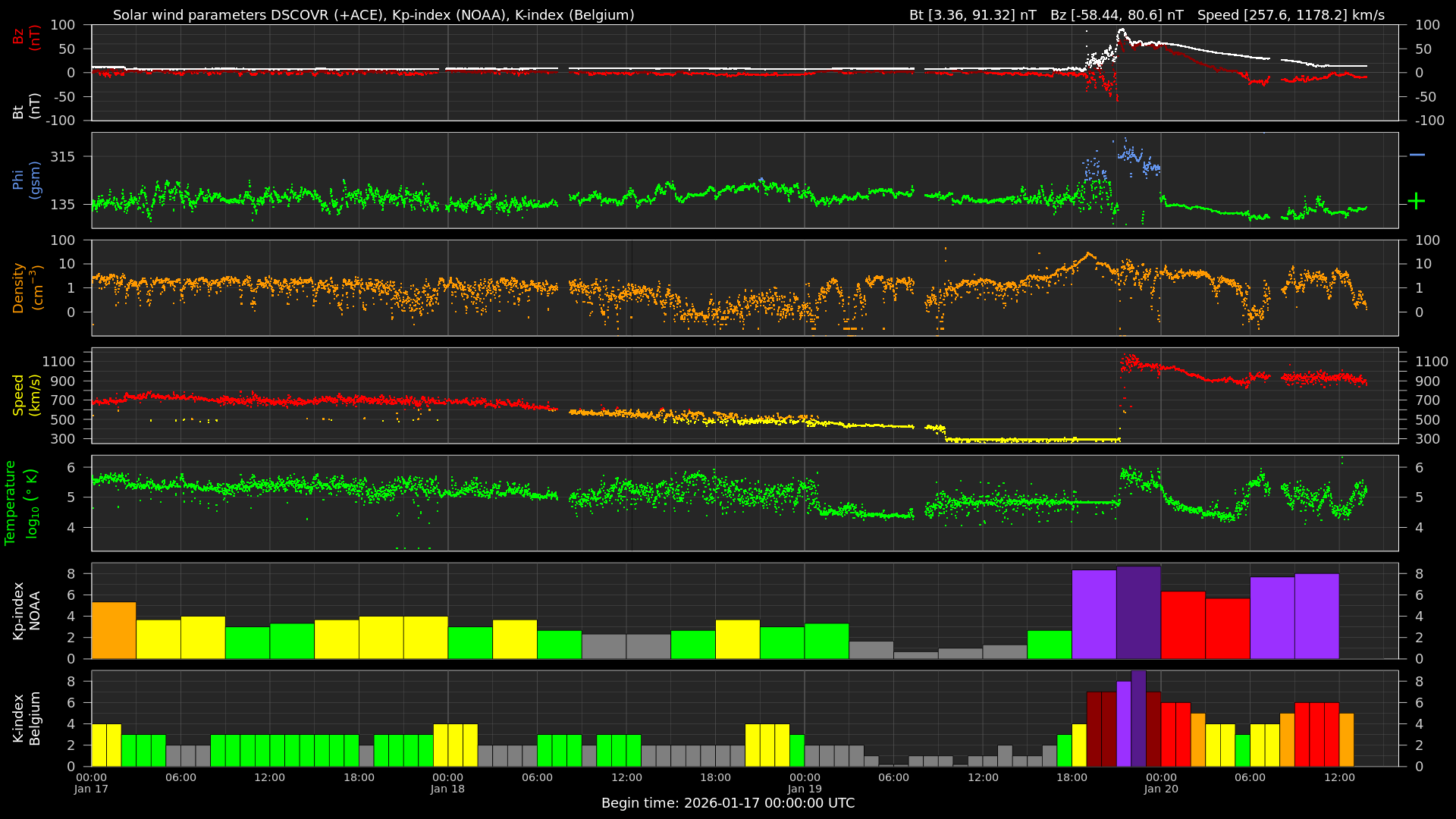
Space Storm










Solar wind parameters DSCOVR (+ACE), Kp-index (NOAA), K-index (Belgium)
Bt [3.36, 91.32] nT Bz [-58.44, 80.6] nT Speed [257.6, 1178.2] km/s
Bz (nT)
Bt (nT)
Phi (gsm)
Density (cm^{-3})
Speed (km/s)
Temperature log$_{10}$ (° K)
Kp-index NOAA
K-index Belgium
00:00 Jan 17
06:00
12:00
18:00
00:00 Jan 18
06:00
12:00
18:00
00:00 Jan 19
06:00
12:00
18:00
00:00 Jan 20
06:00
12:00
Begin time: 2026-01-17 00:00:00 UTC

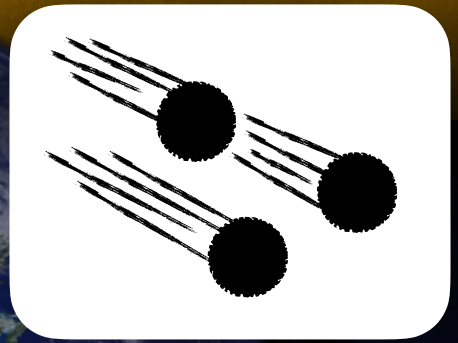
Space Weather



ABCMX



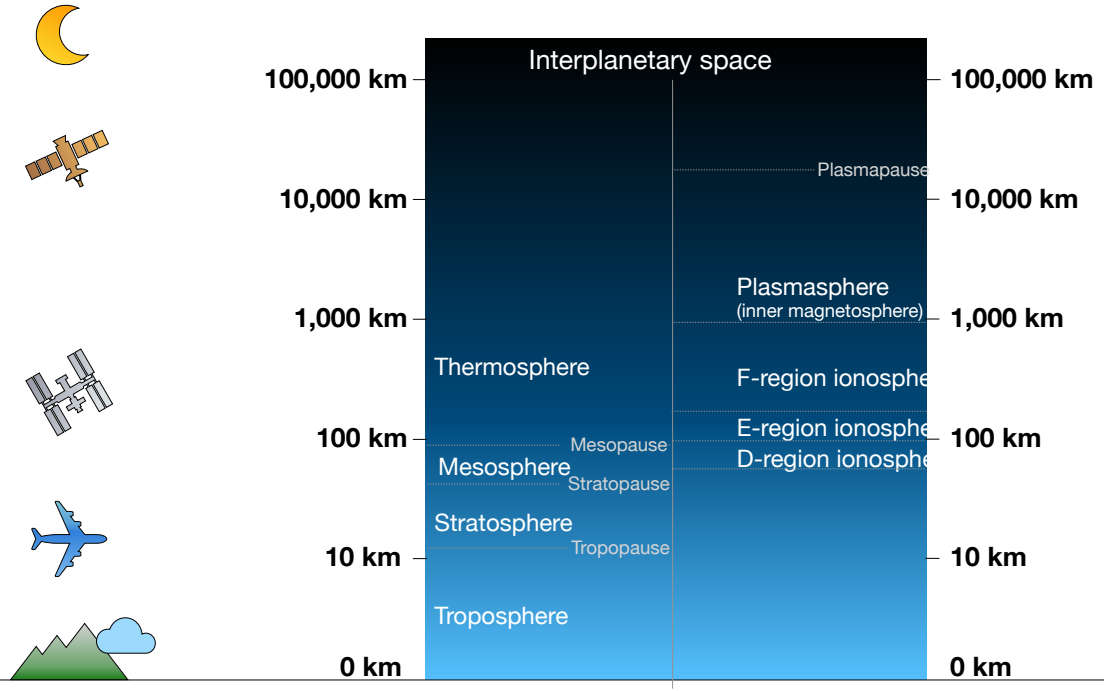
500 km/s



10

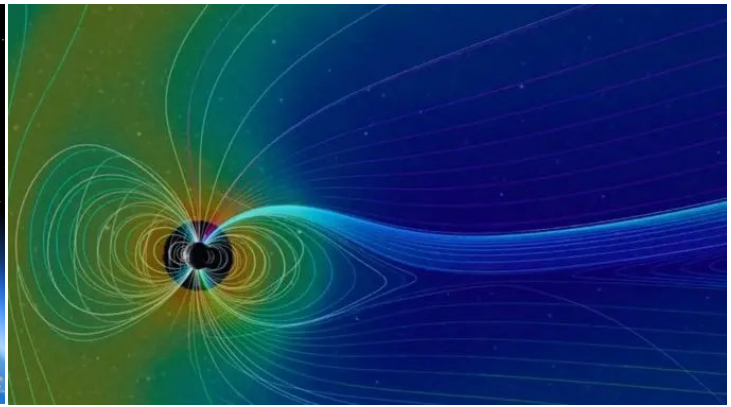
Earth’s spheres

Classification and nomenclature of the terrestrial atmosphere

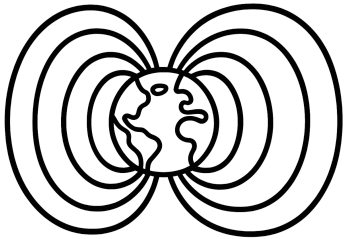


Based on G.W. Prölss, Physics of the Earth's Space Environment, Figure 2.13



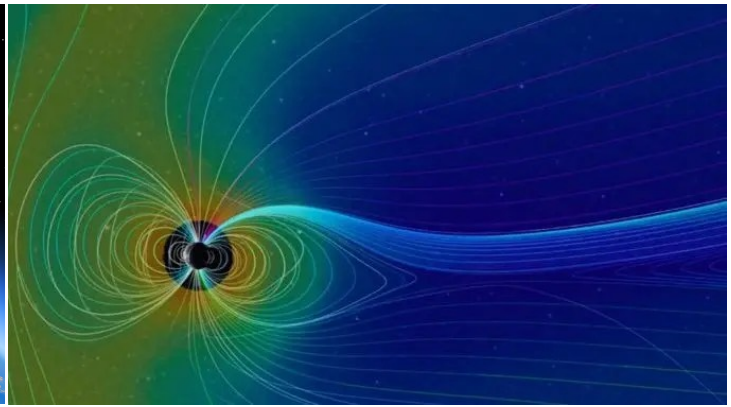




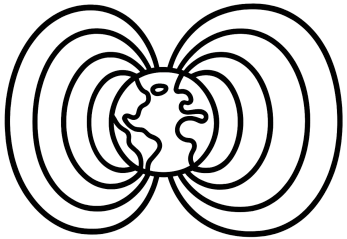


The Sun's energy impacting earth's atmosphere and magnetosphere

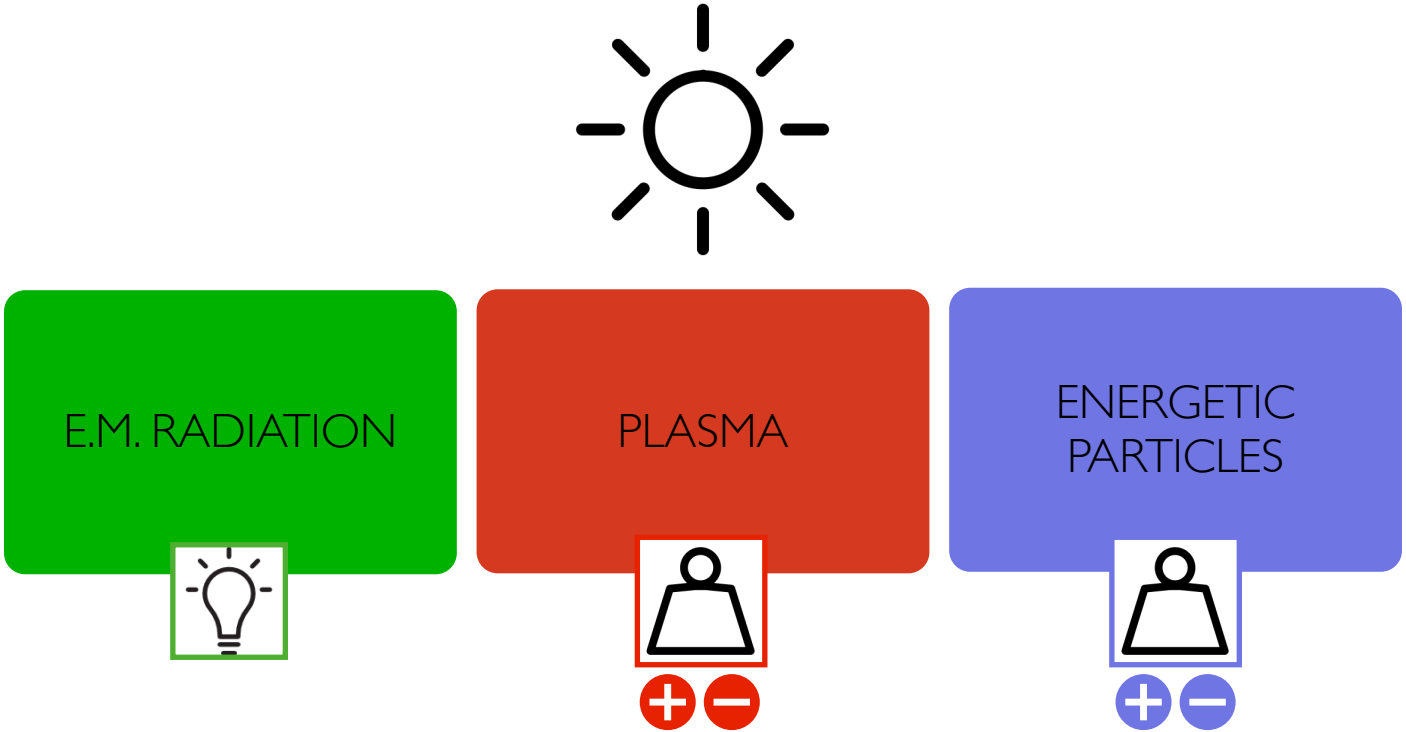








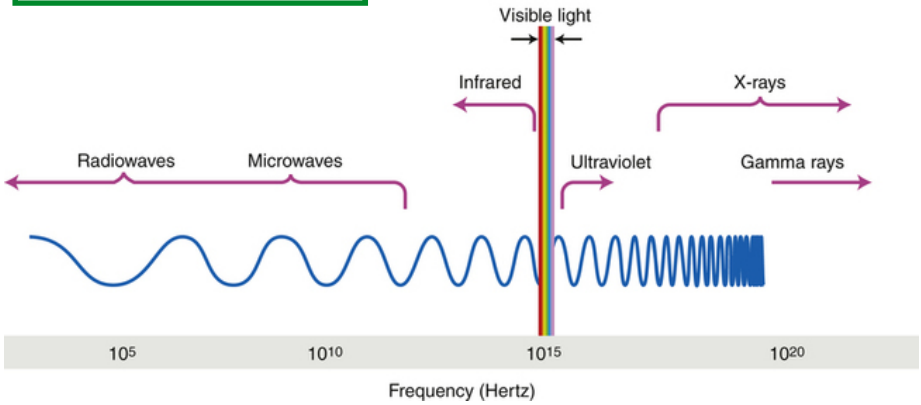
Space Weather


E.M. RADIATION
PLASMA
ENERGETIC PARTICLES

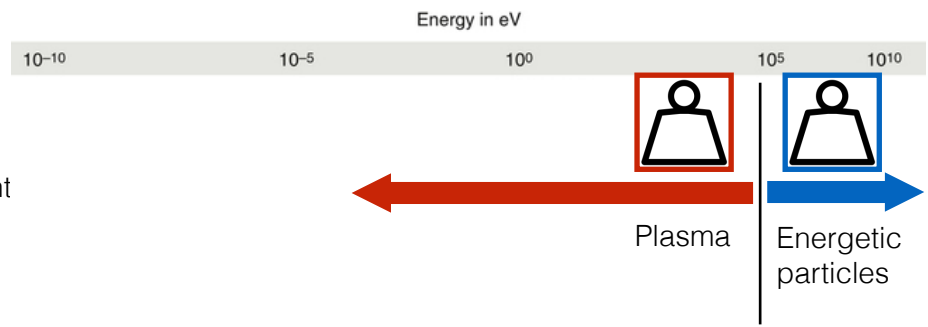
Electromagnetic radiation



- Photons / electromagnetic waves
- Speed of light



Particles

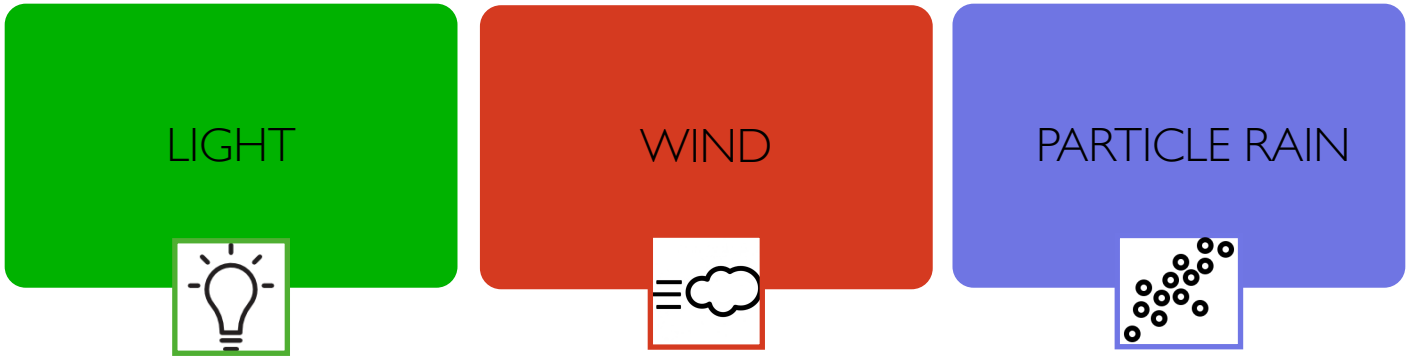


- Atomic & sub-atomic particles
- km/s to fractions of speed of light

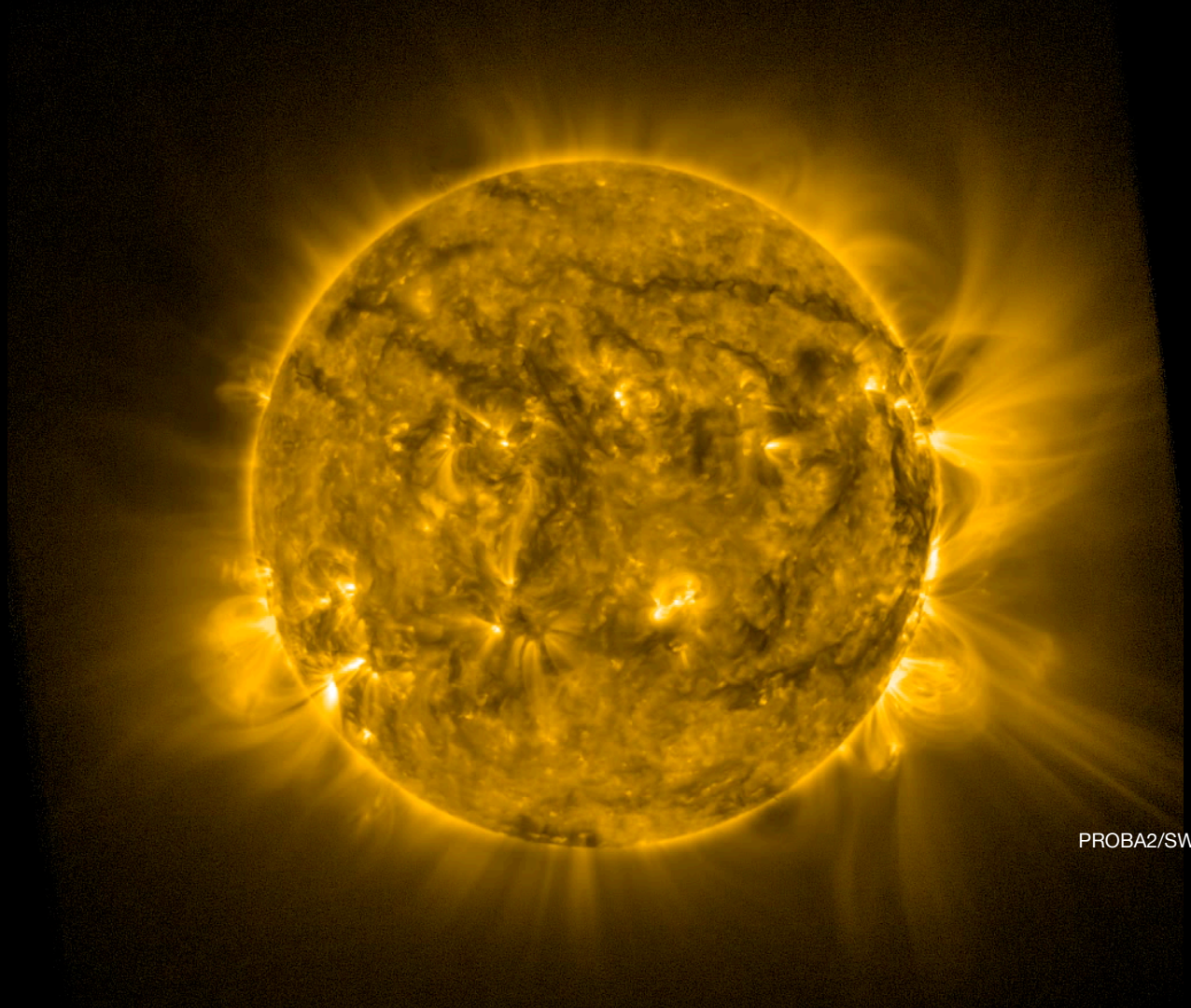
Three space weather phenomena

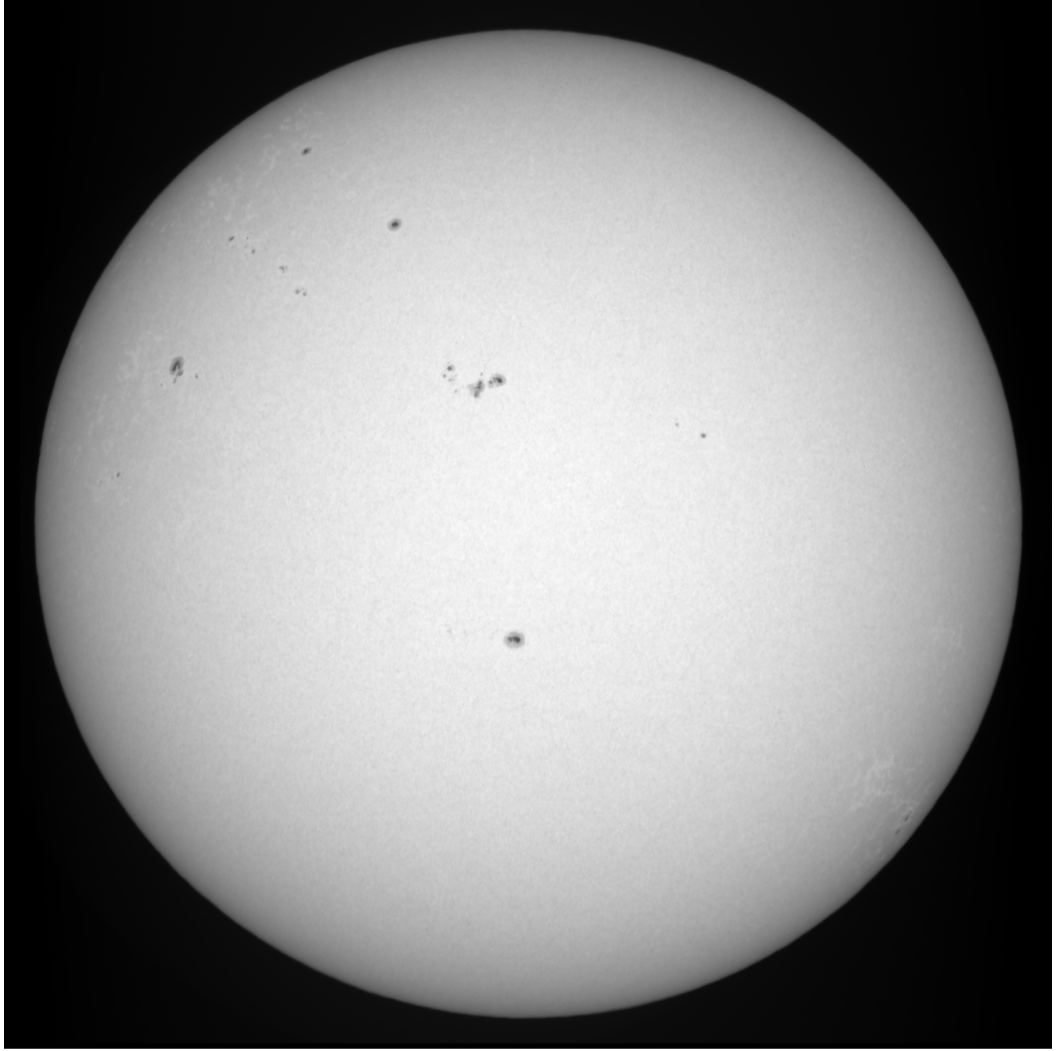
The sun's energy reaches the earth in 3 forms: light, moving gas and particle precipitation. This energy interacts with the magnetosphere and the atmosphere of the earth. This is space weather.

How and where the interaction occurs depends on the type of energy.



Magnetism drives the sun’s dynamics

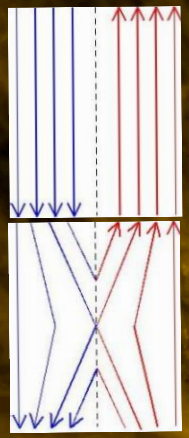

PROBA2/SWAP



Royal Observatory of Belgium – SIDC
Observation date : 12/03/2025
Instrument : USET_White_Light

Time of the day (UTC): 09:37:38
Exposure time: 0.001889

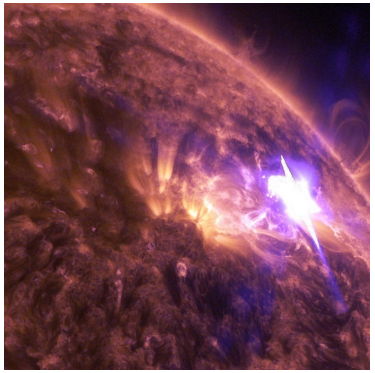
MAGNETIC RECONNECTION

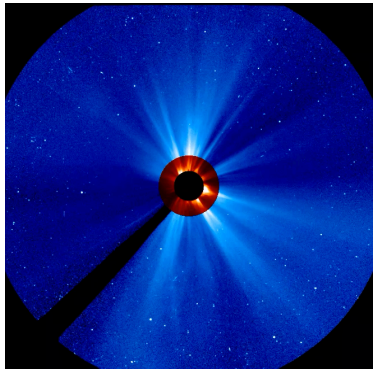


2024-03-23T22:30:02 WOW enhanced

Solar Weather & Storms

At a certain moment, energy can be released on a shorter time scale. A solar feature like a sunspot, an active region, filament etc. lies at the base of a solar storm in which energy is released in an eruptive manner.



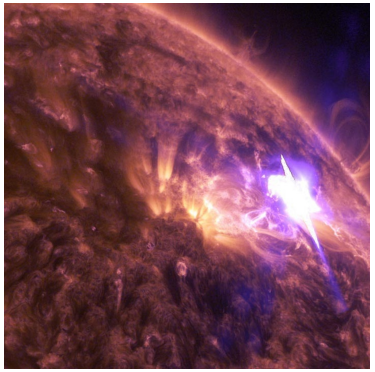


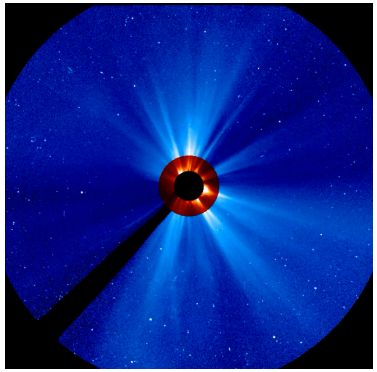
Flare

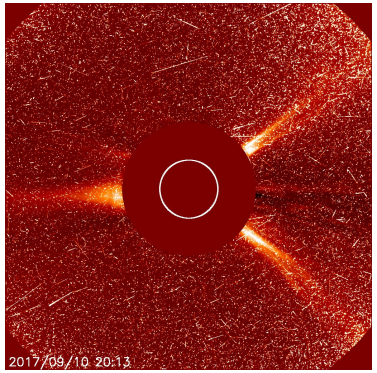
Coronal Mass Ejection

Solar Weather & Storms

At a certain moment, energy can be released on a shorter time scale. A solar feature like a sunspot, an active region, filament etc. lies at the base of a solar storm in which energy is released in an eruptive way. A particle storm is the consequence of a flare or CME.







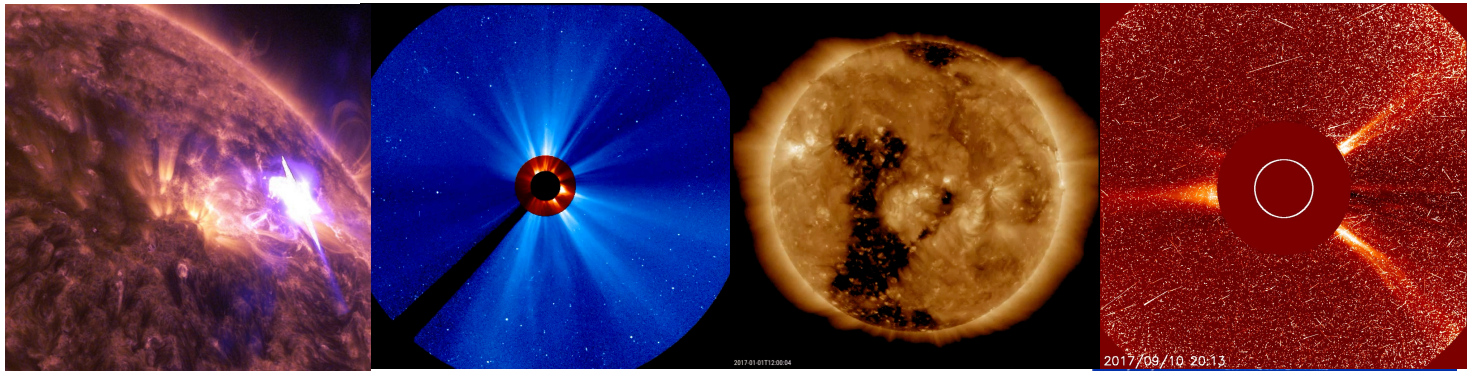
Flare

Coronal Mass Ejection

Particle Storm

Solar Weather & Storms

At a certain moment, energy can be released on a shorter time scale. A solar feature like a sunspot, an active region, coronal hole, filament etc. lies at the base of a solar storm in which energy is released. The release of energy might be in an abrupt, impulsive and brutal way or in a non-eruptive manner.



Flare

Coronal Mass Ejection
High Speed Stream

Particle Storm



AU TRANSIT TIME

The energy released during a solar storm moves through space, each with its own typical speed: speed of light, ….



AU TRANSIT TIME

The energy released during a solar storm moves through space, each with its own typical speed: speed of light, …



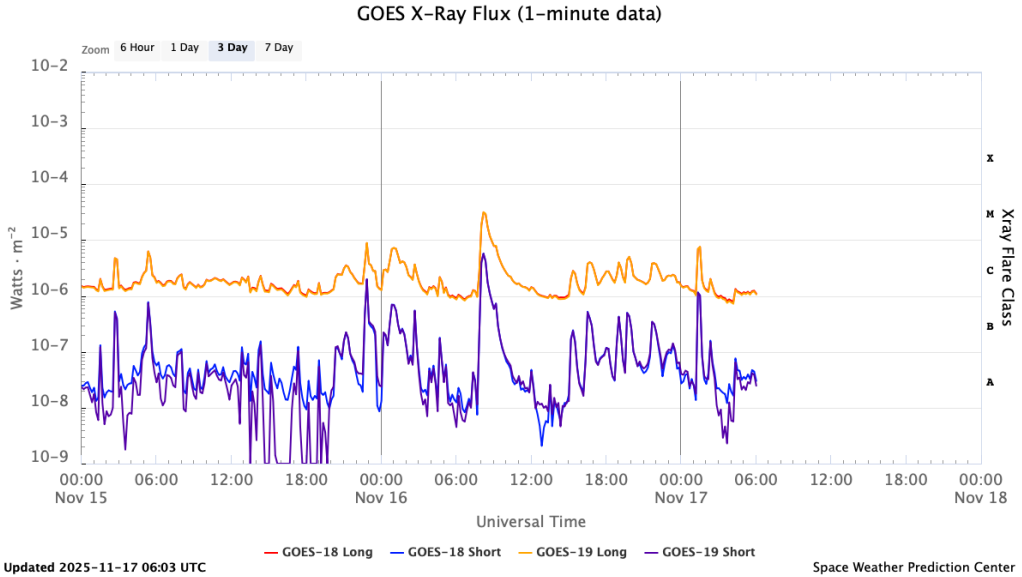


STORM SCALE



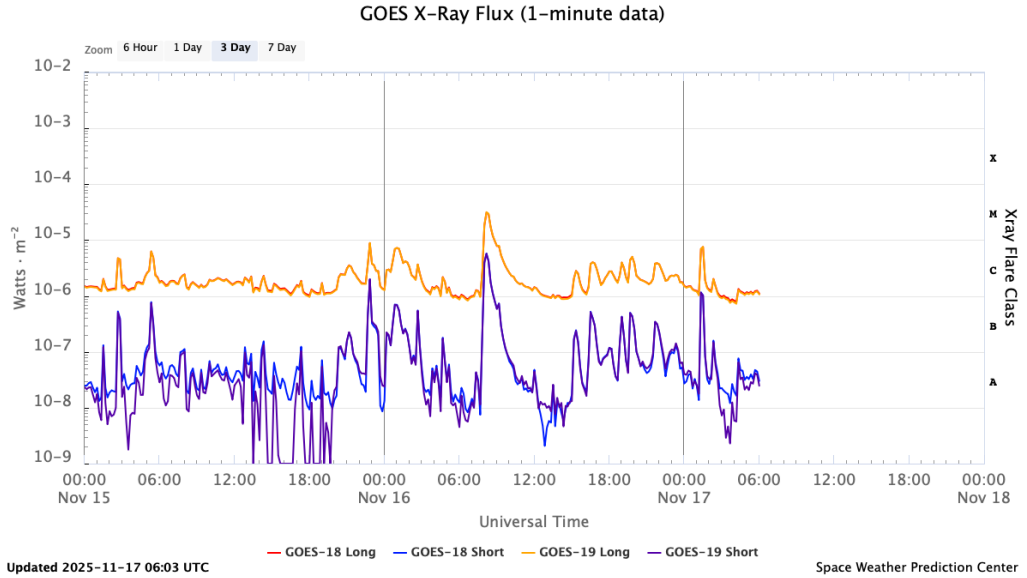
A,B,C,M,X





DURATION

MINs to HOUR

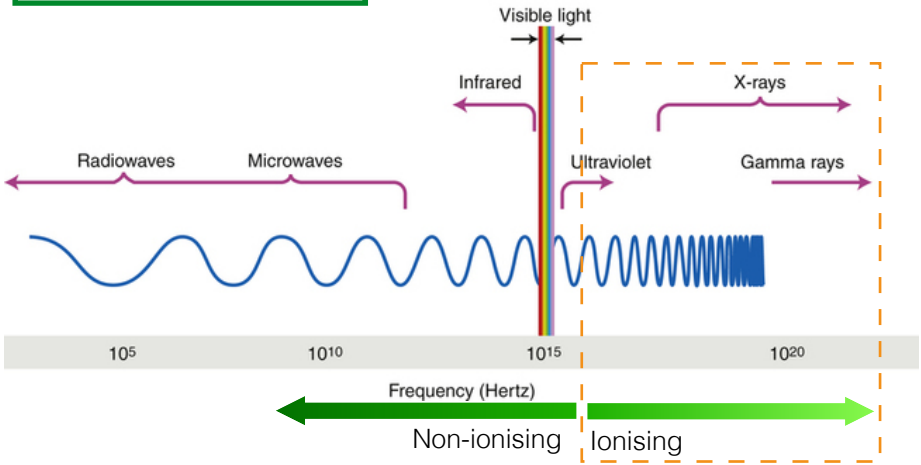


IMPACT



Electromagnetic radiation

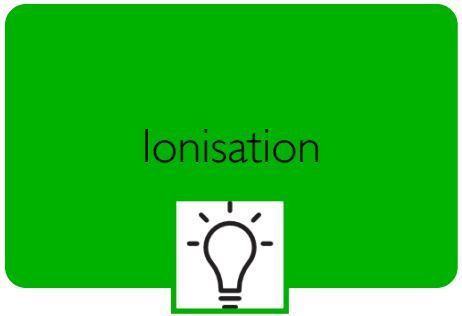
- Photons / electromagnetic waves
- Speed of light

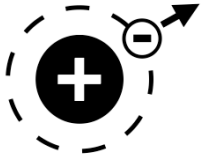


IMPACT

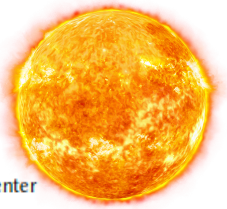




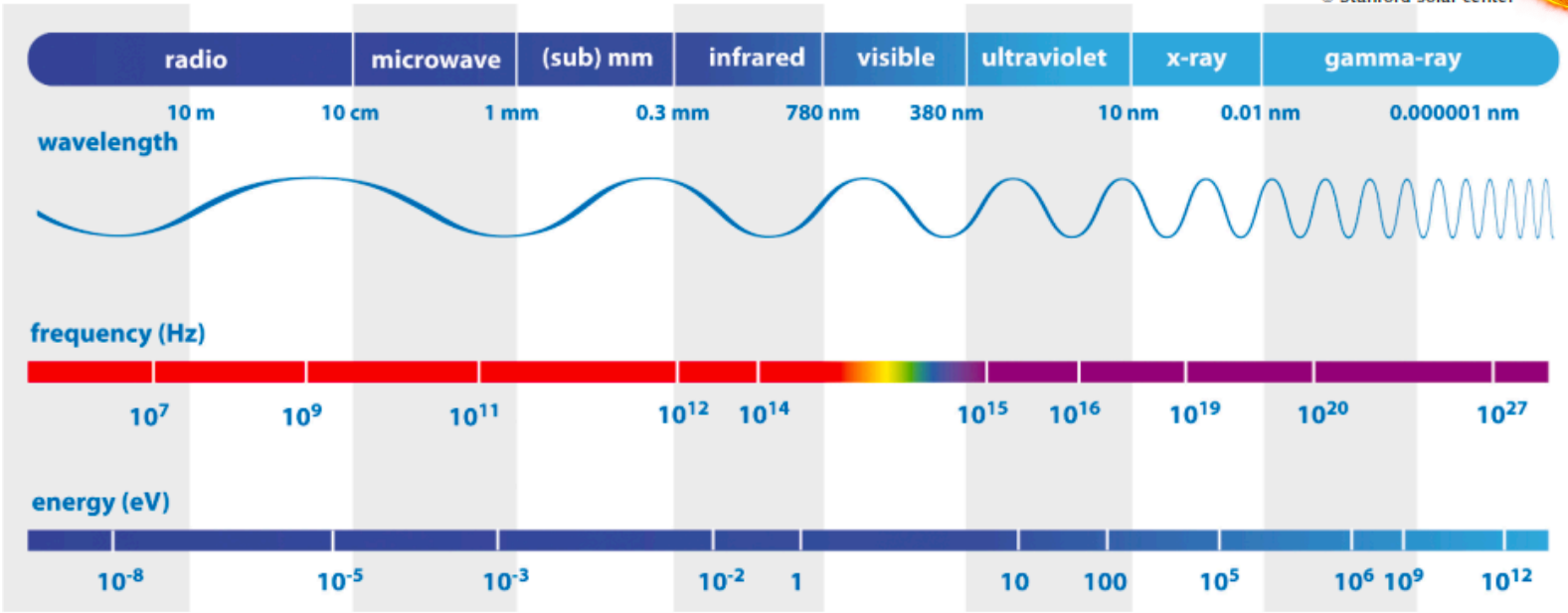




THE SOLAR ELECTROMAGNETIC SPECTRUM



© Stanford solar center



does not affect the thermosphere (much), but affected by the ionosphere

causes heating of the thermosphere

photo-dissociating radiation

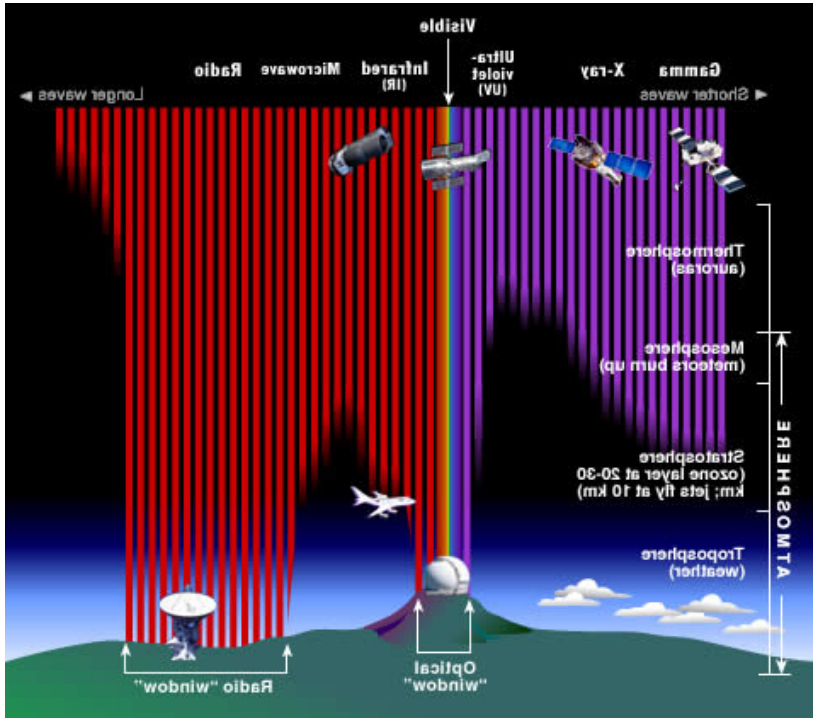
ionising radiation

ionising radiation (lower altitude)

also ionising radiation, but low flux

TRANSPARENCY OF EARTH ATMOSPHERE

Our atmosphere protects us against harmful solar light. This ionising solar light can penetrate only until a certain height.



AREA OF IMPACT

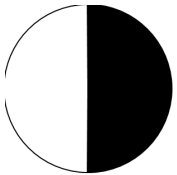


AREA OF IMPACT



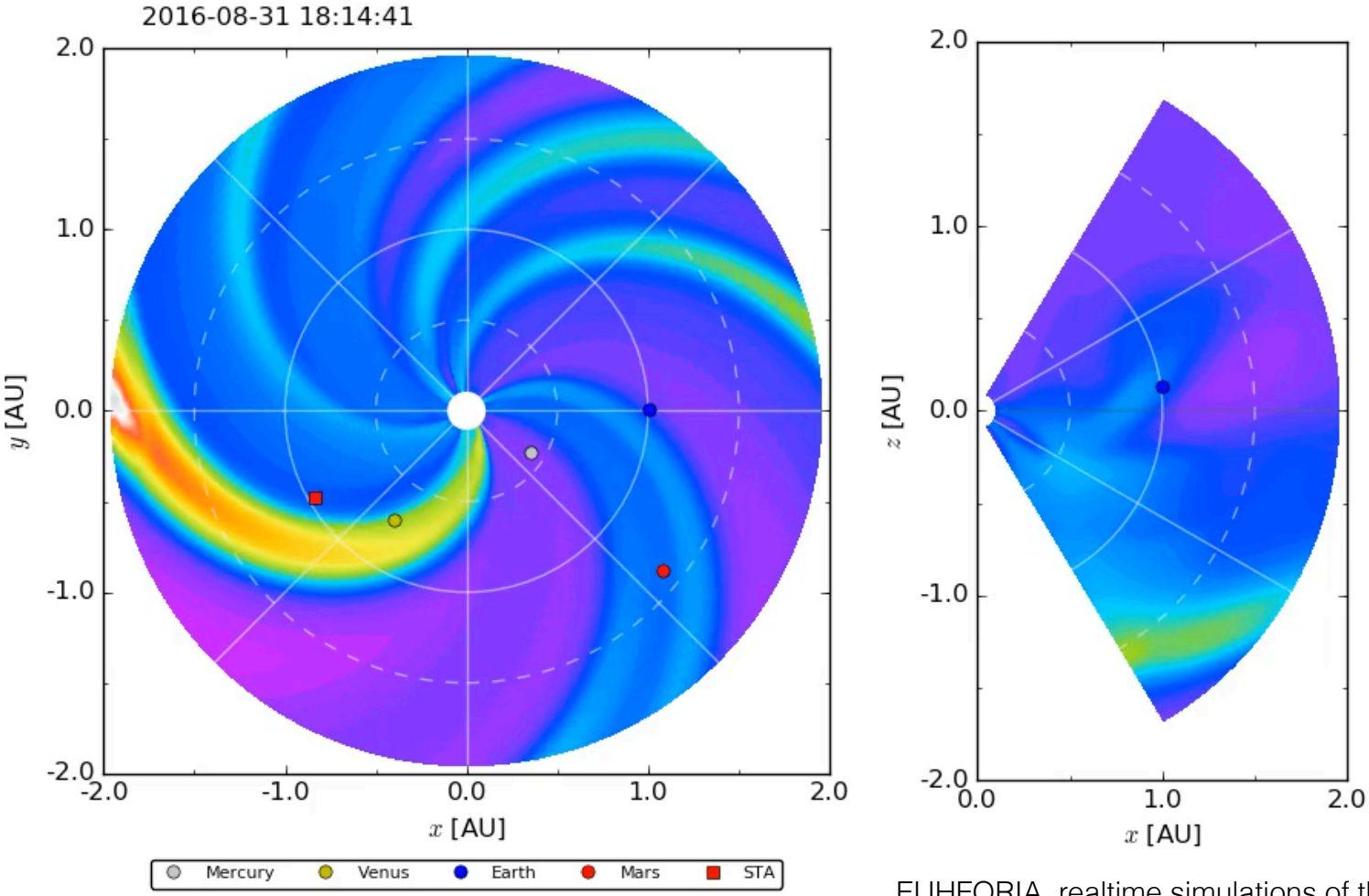
Illuminated area
Bottom of ionosphere



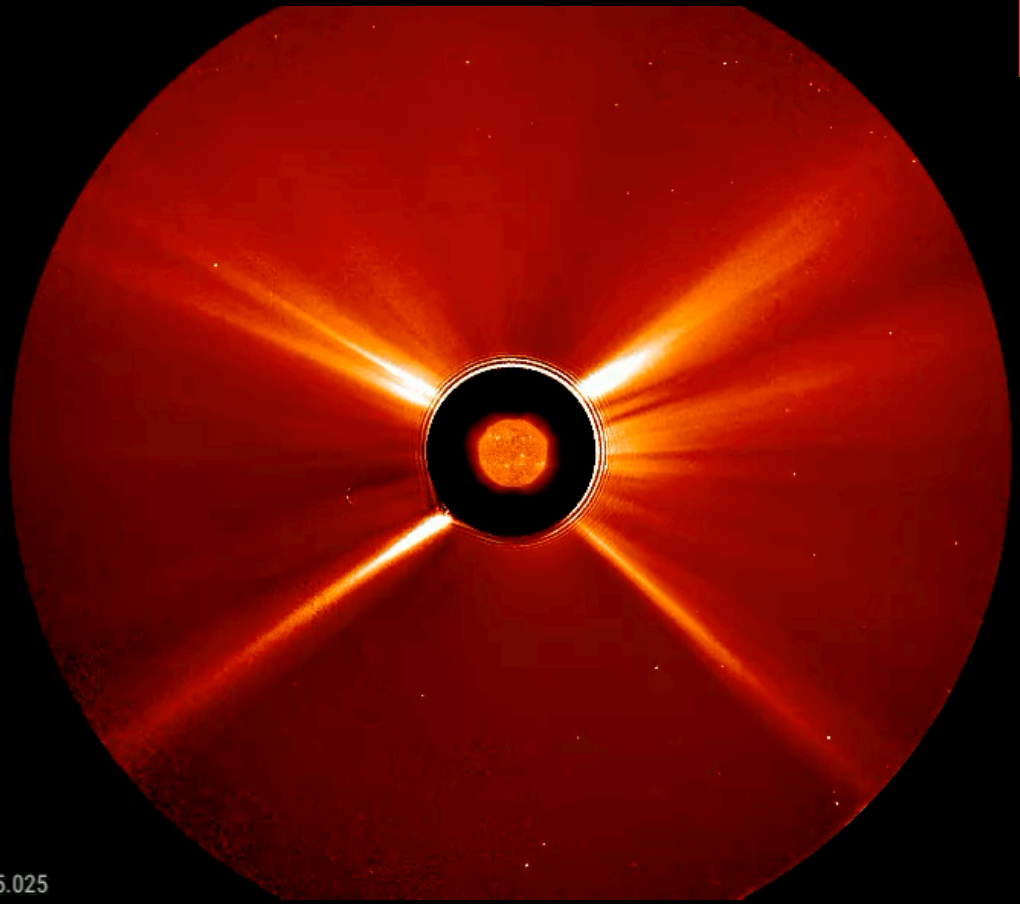


SOLAR WIND
CME - HSS





EUHFORIA, realtime simulations of the inner heliosphere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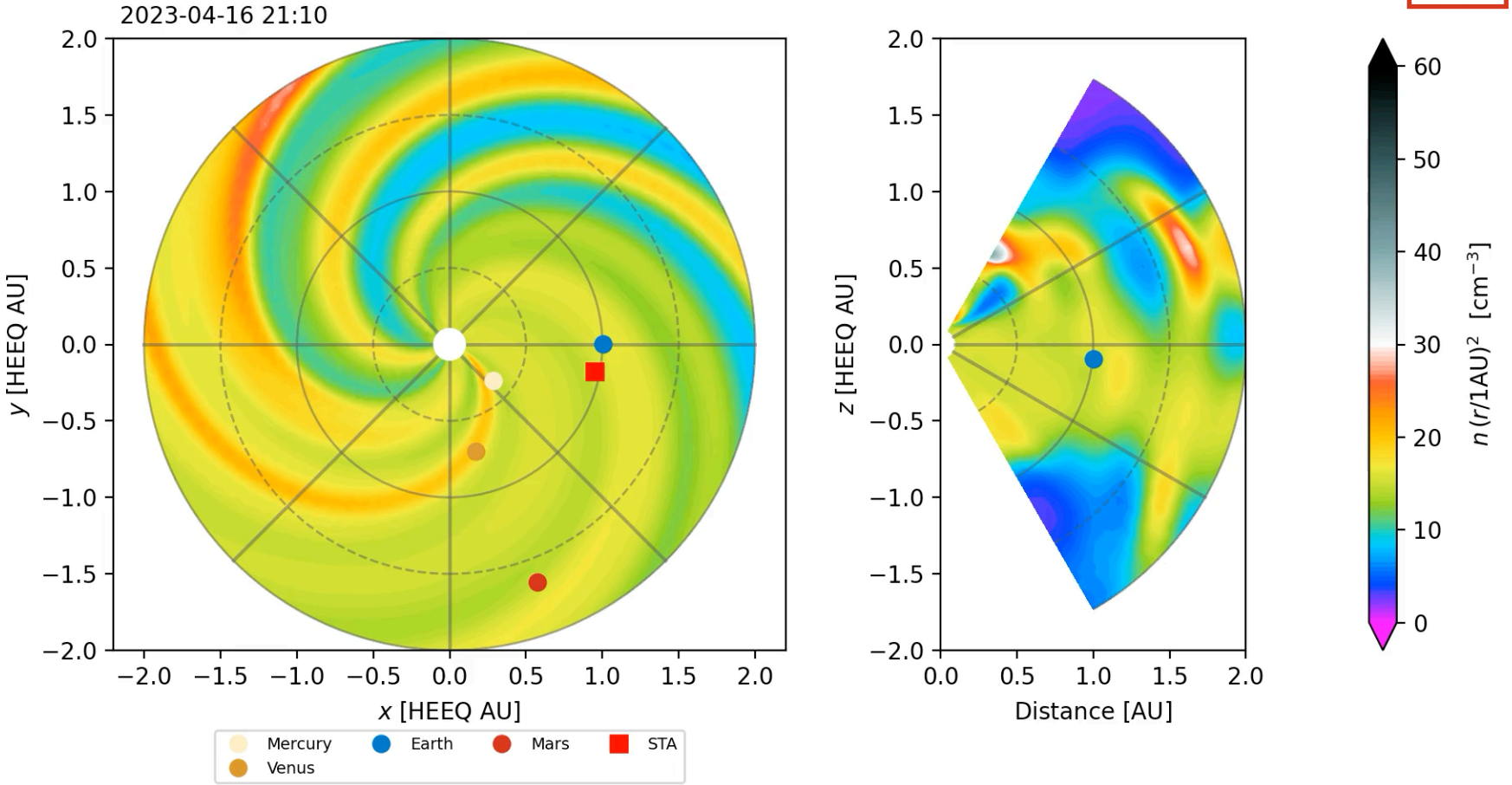
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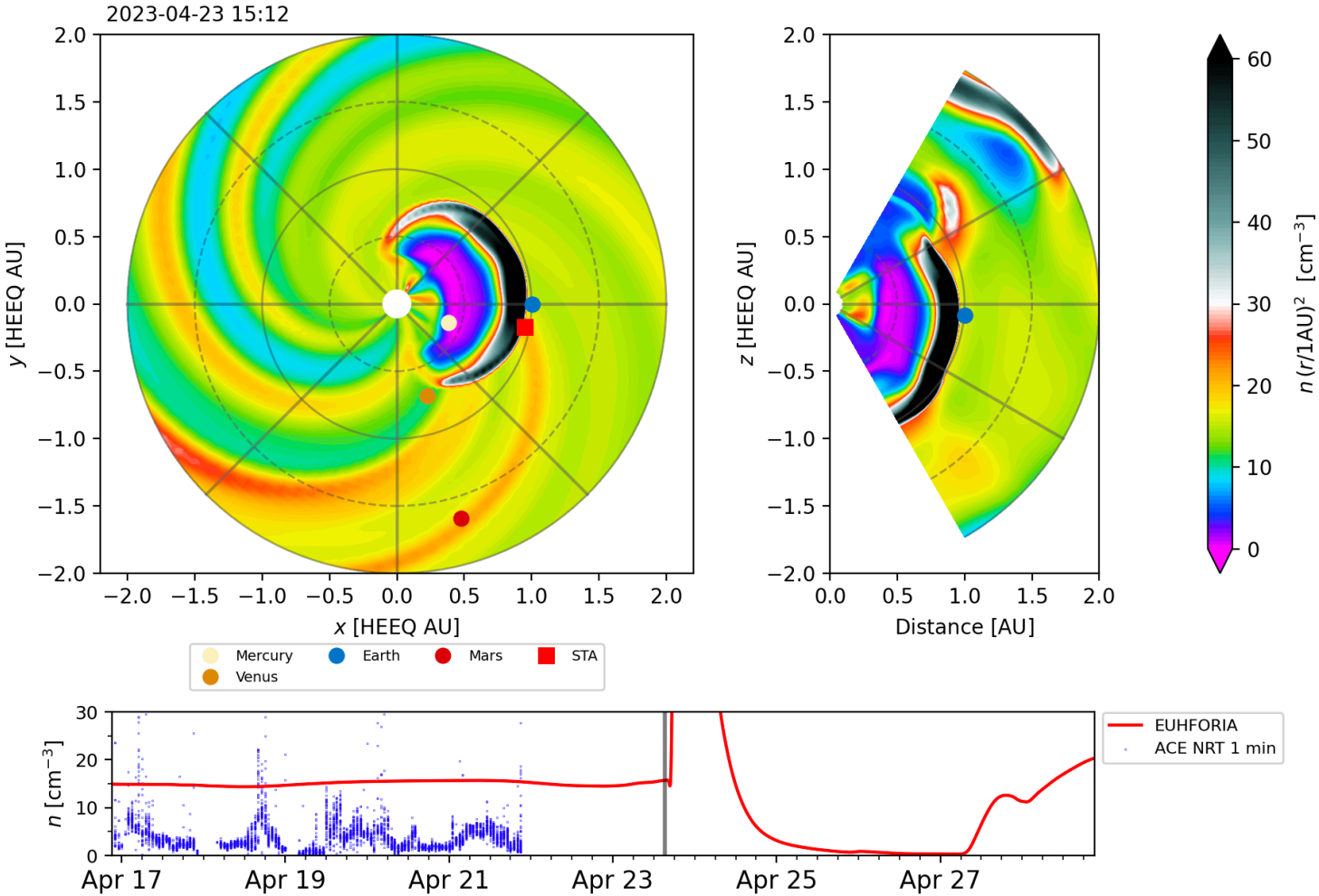
y [HEEQ AU]
x [HEEQ AU]
z [HEEQ AU]
Distance [AU]
n (r/1AU)² [cm⁻³]
Mercury
Venus
Earth
Mars
STA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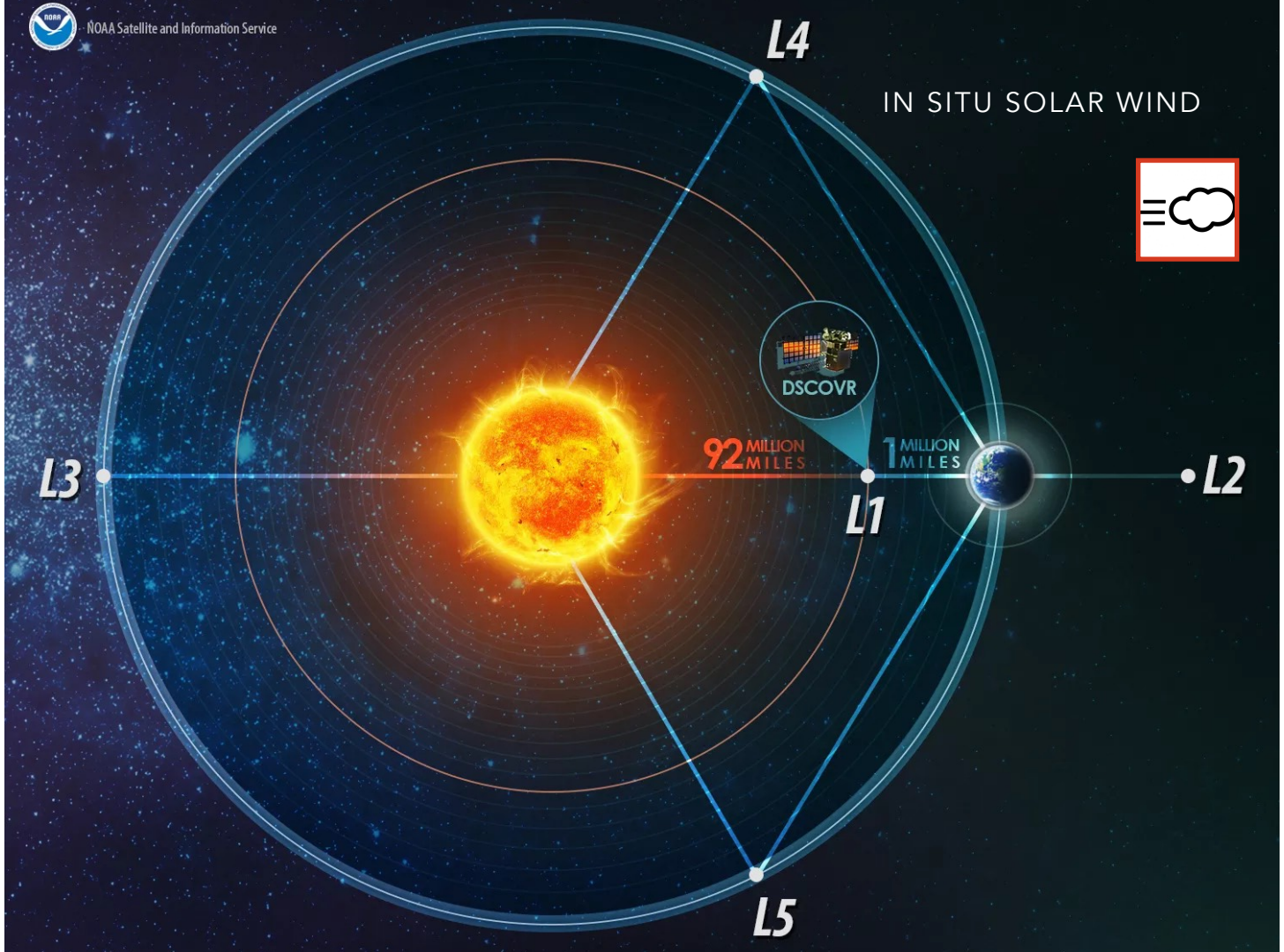
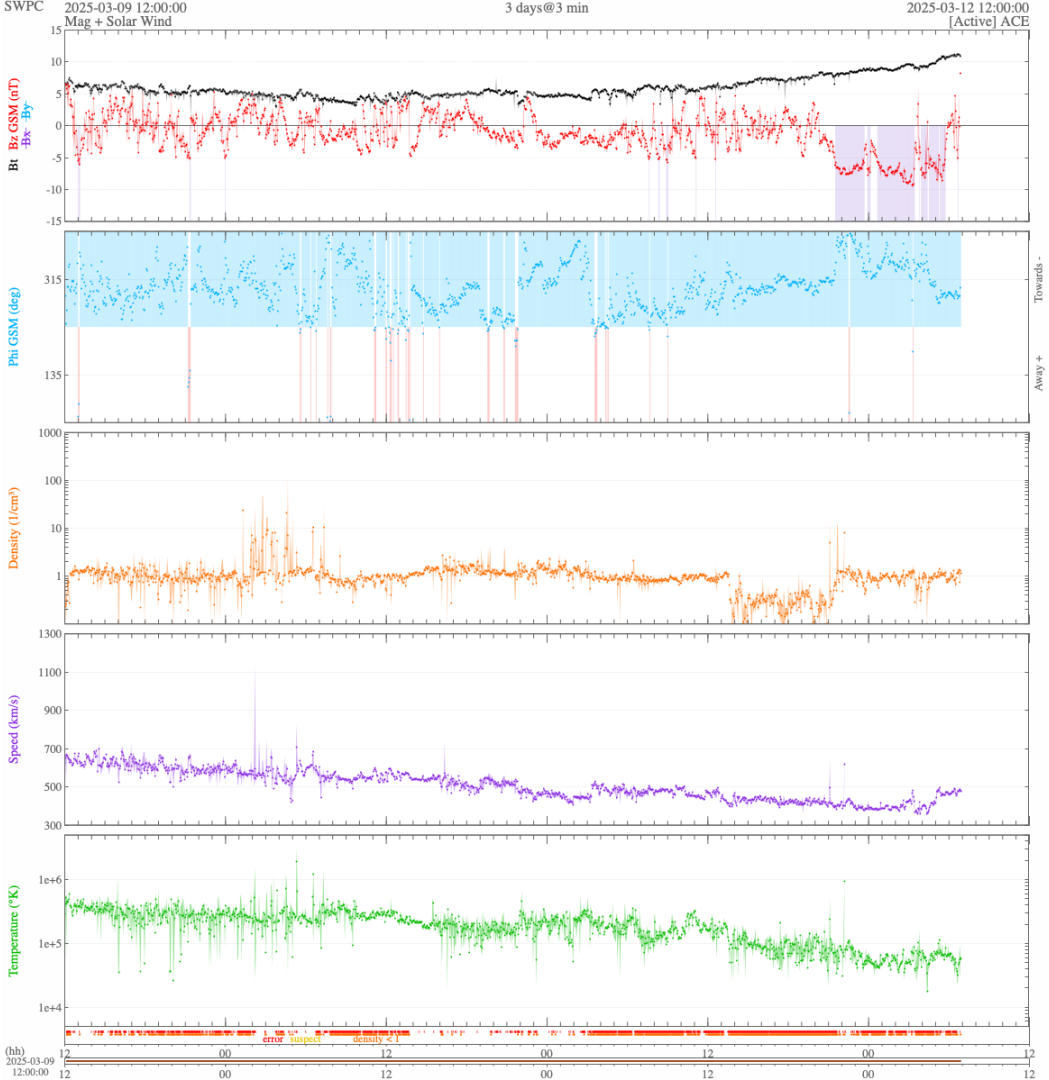
n (r/1AU)² [cm⁻³]
Mercury
Venus
Earth
Mars
STA
n [cm⁻³]
EUHFORIA
ACE NRT 1 min
Apr 17
Apr 19
Apr 21
Apr 23
Apr 25
Apr 27


NOAA Satellite and Information Service
L4
IN SITU SOLAR WIND
DSCOVR
92 MILLION MILES
1 MILLION MILES
L3
L1
L2
L5

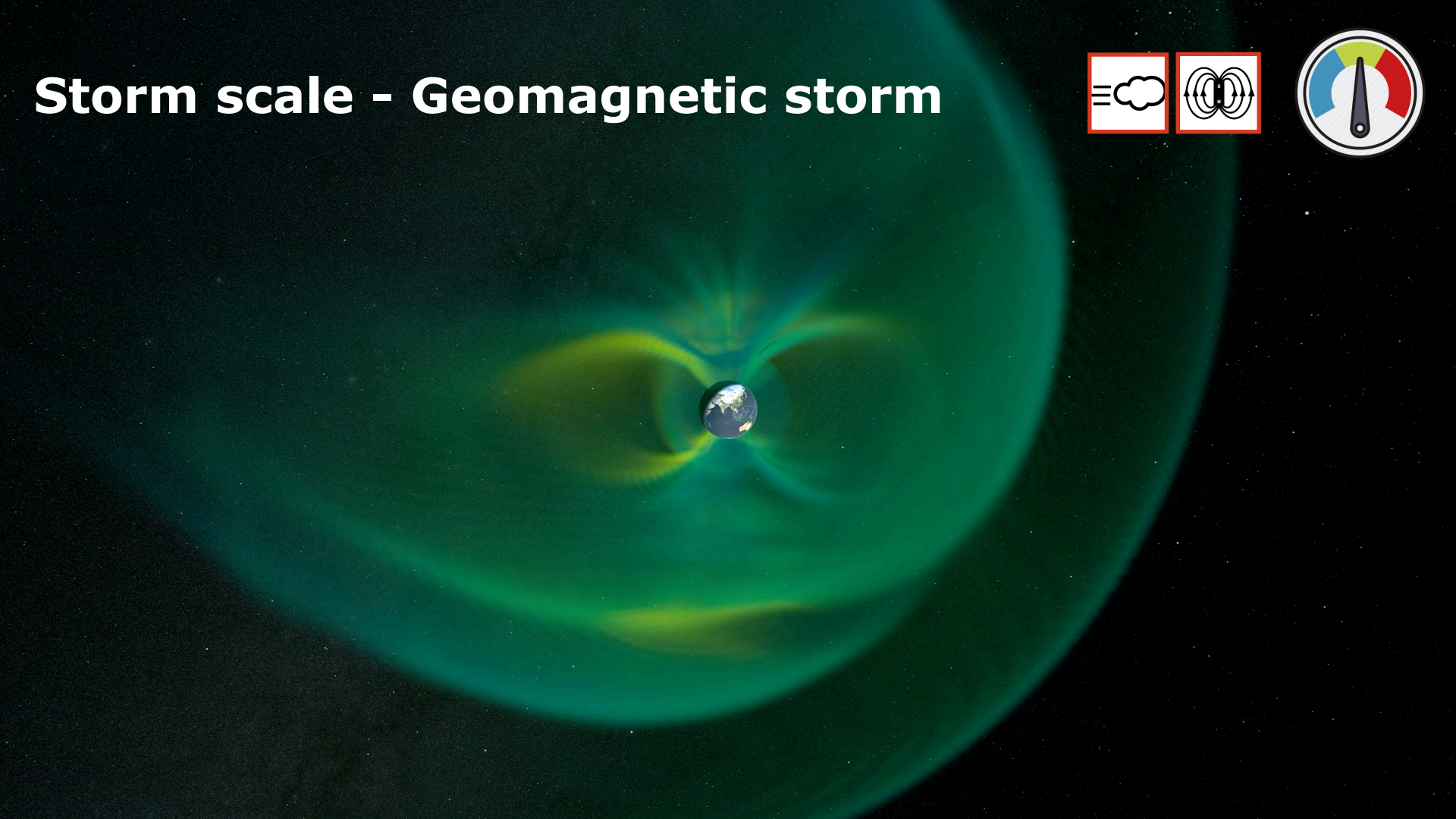

SWPC
2025-03-09 12:00:00
3 days@3 min
2025-03-12 12:00:00
Mag + Solar Wind
[Active] ACE
Bt
Bz GSM (nT)
Bx
By
Phi GSM (deg)
Towards -
Away +
Density (1/cm³)
Speed (km/s)
Temperature (°K)
error
suspect
density < 1
(hh)
2025-03-09
12:00:00

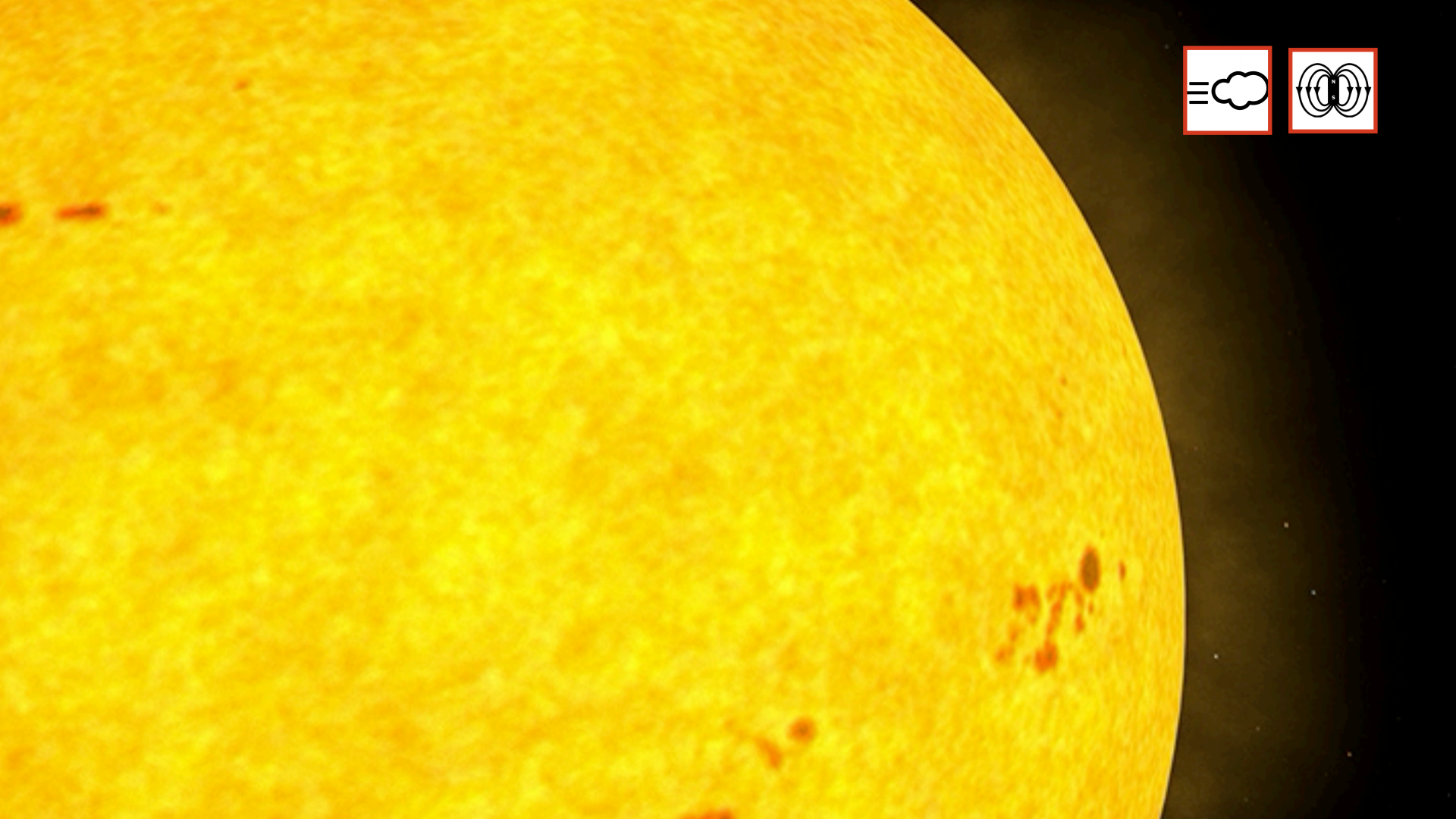
AU Transit time

The energy released during a solar storm moves through space, each with its own typical speed: speed of light, order of a few 100 km/s …

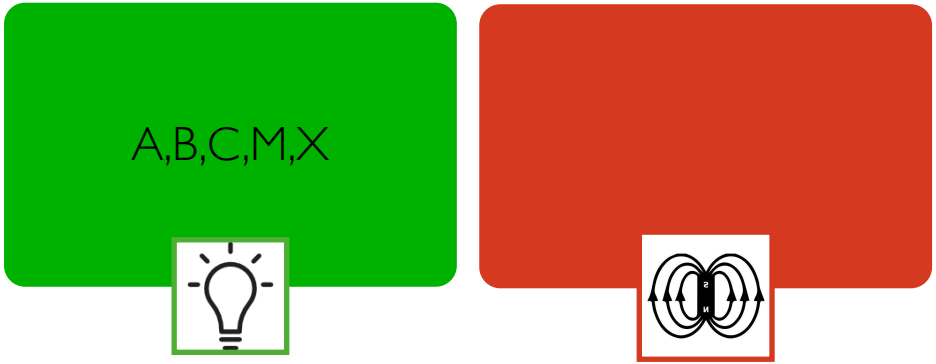


Storm scale - Geomagnetic storm

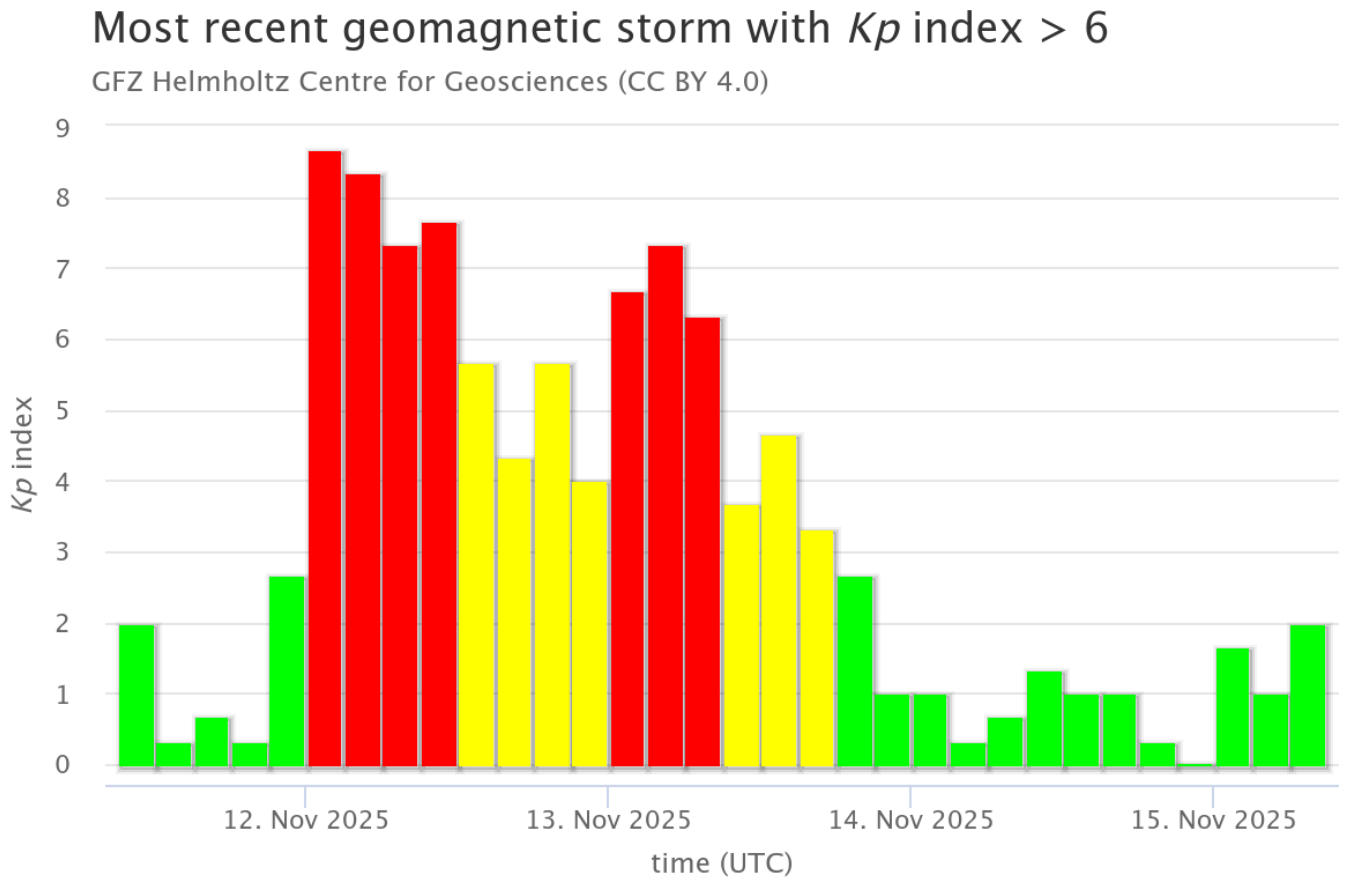




Storm scale



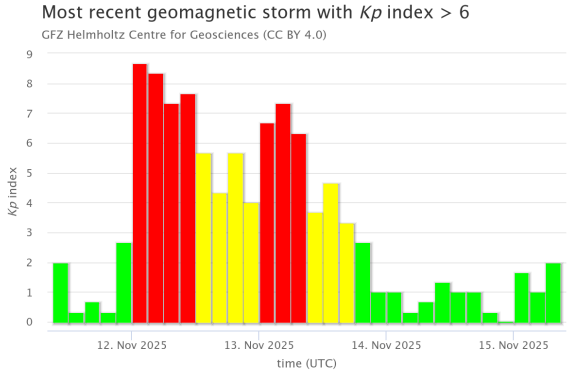
Storm scale


Most recent geomagnetic storm with Kp index > 6
GFZ Helmholtz Centre for Geosciences (CC BY 4.0)
Kp index
9
8
7
6
5
4
3
2
1
0
12. Nov 2025
13. Nov 2025
14. Nov 2025
15. Nov 2025
time (UTC)

Storm scale





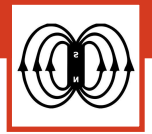




A,B,C,M,X

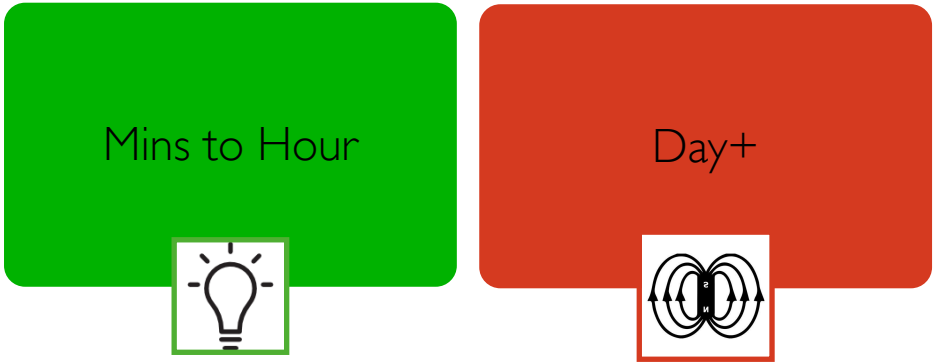


Kp
0 - 9

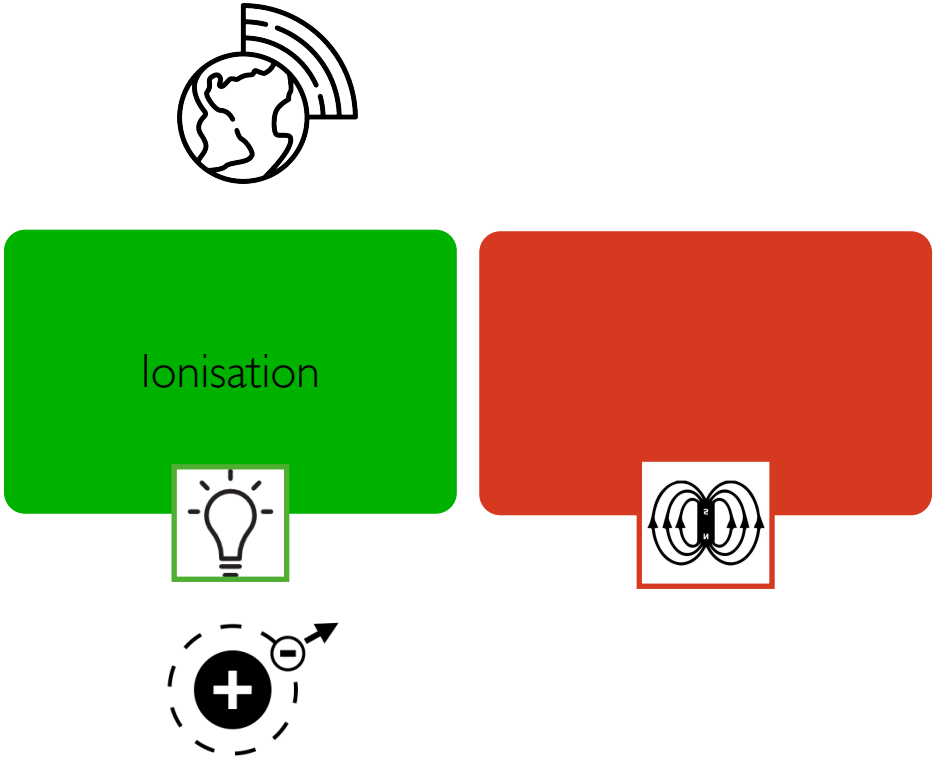


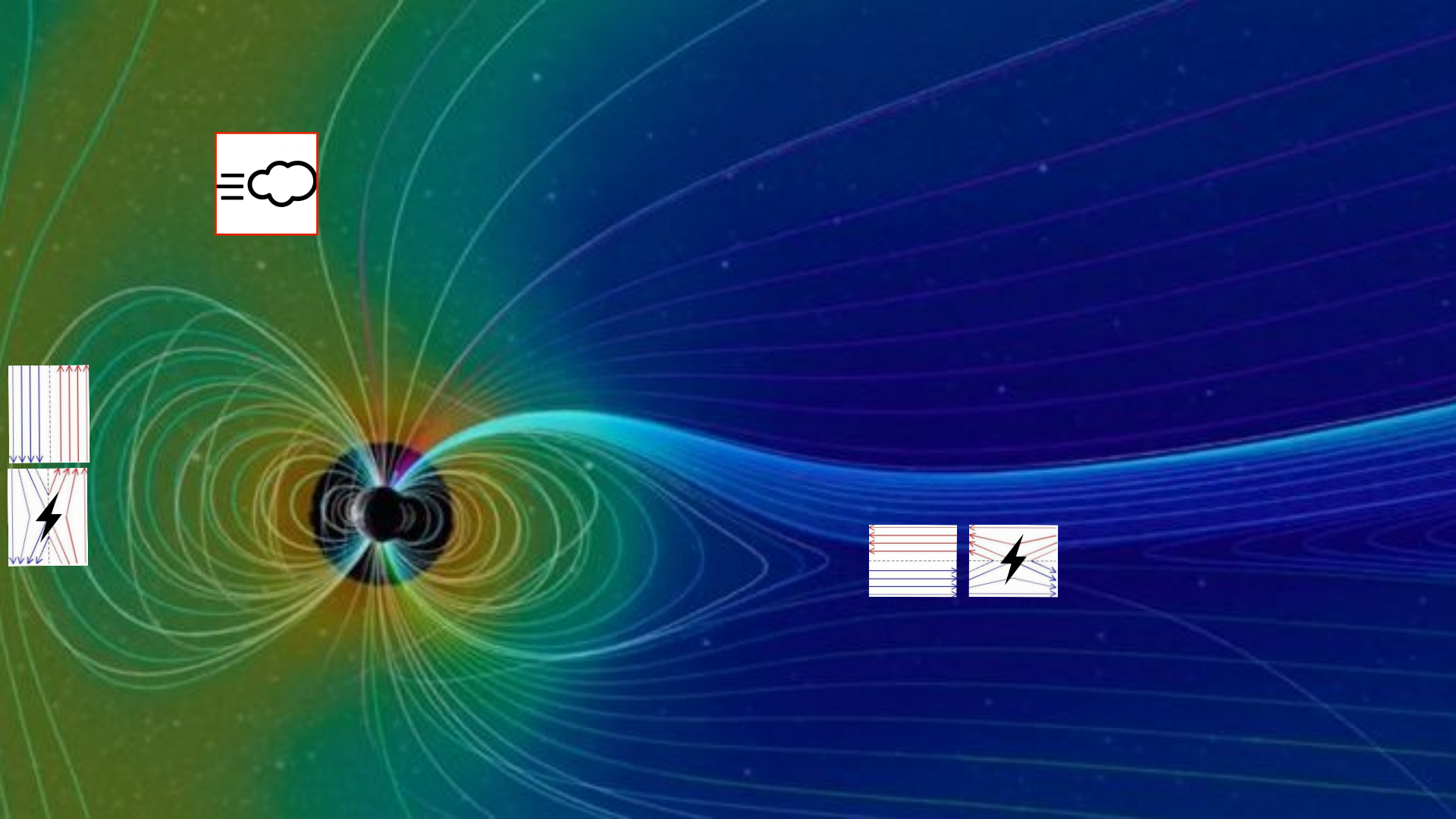
Duration





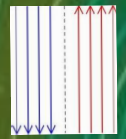
Impact

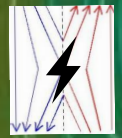




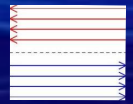
Magnetosphere - Ionosphere coupling

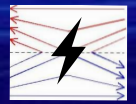








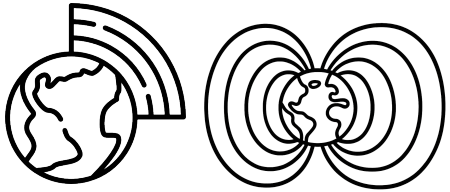




Impact





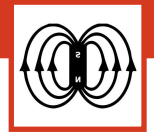


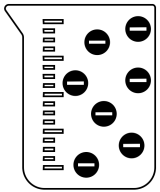
Ionisation





Particle content



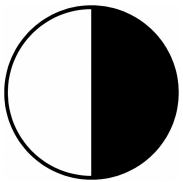


Area of Impact

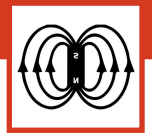


Illuminated area
Bottom of ionosphere

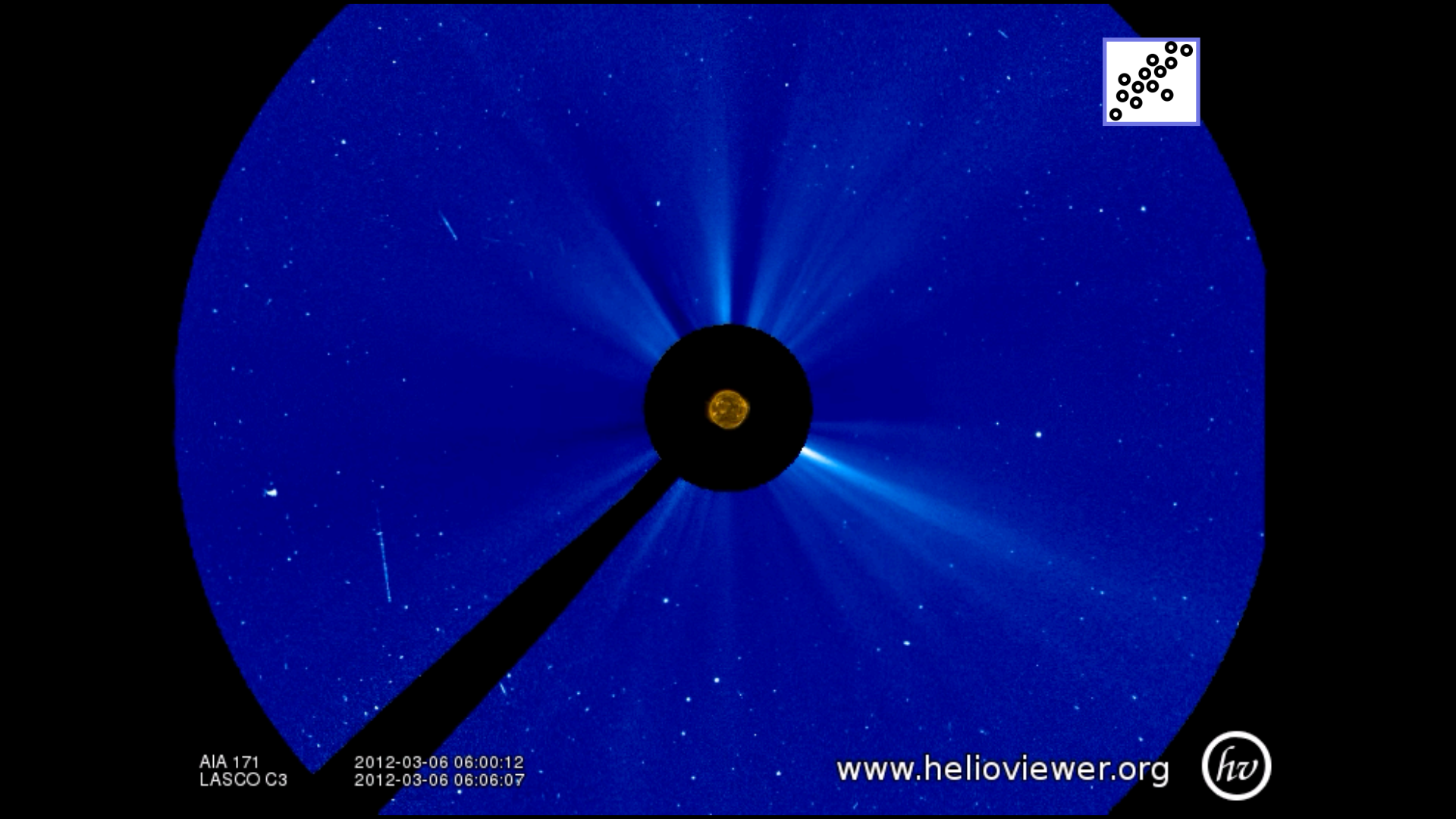




Auroral Oval & more
Latitude
Bottom of ionosphere



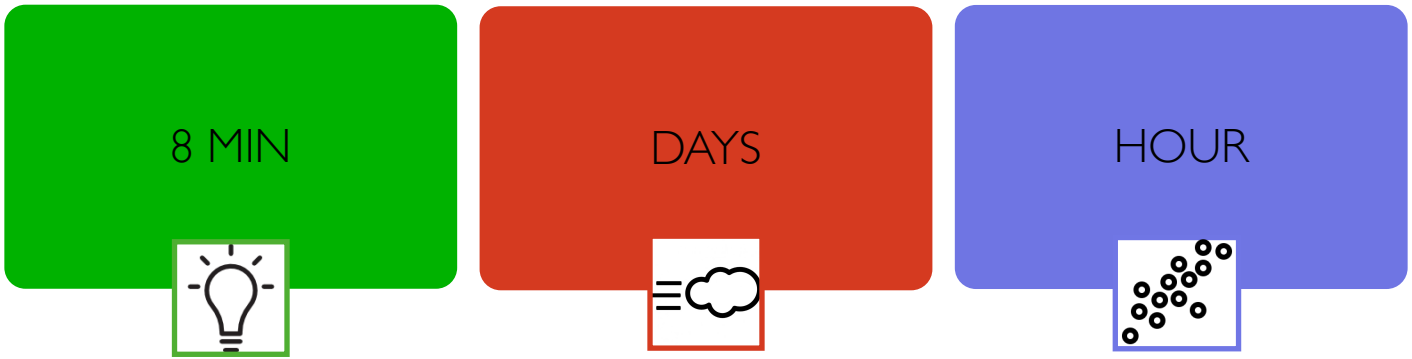



AIA 171
LASCO C3
2012-03-06 06:00:12
2012-03-06 06:06:07
www.helioviewer.org



AU Transit time

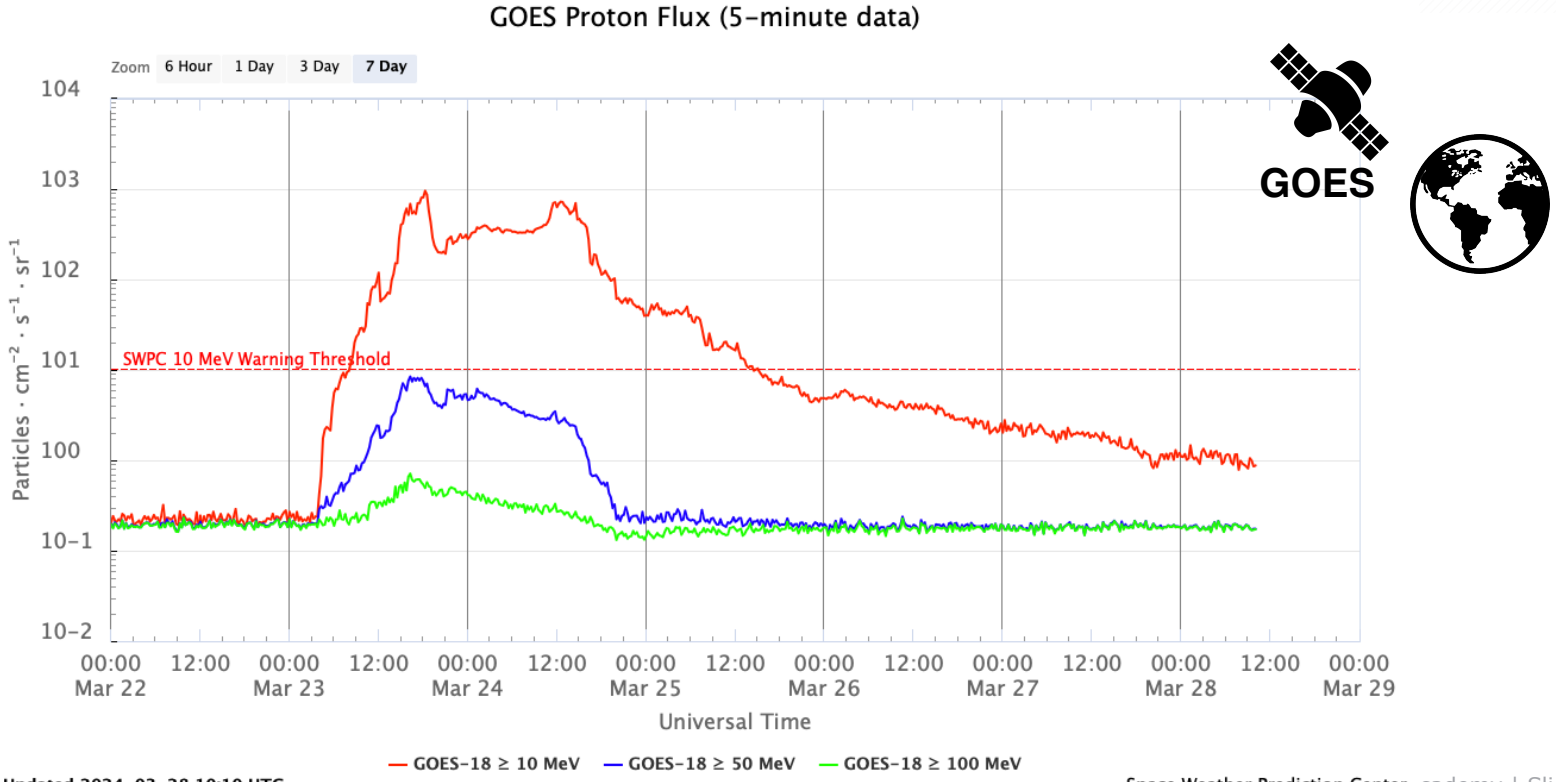
The energy released during a solar storm moves through space, each with its own typical speed: speed of light, order of a few 100 km/s, relativistic speeds …



Storm scale

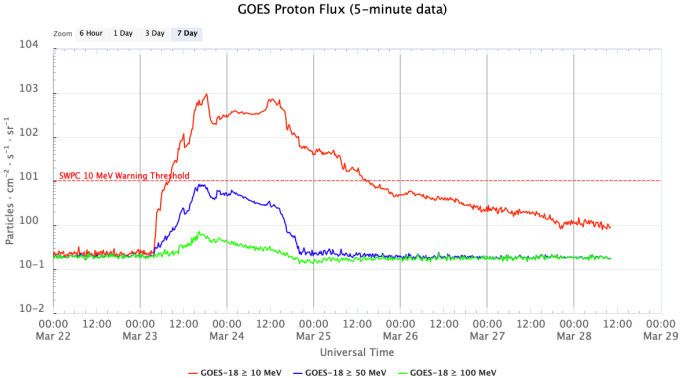





GOES Proton Flux (5-minute data)
Zoom 6 Hour 1 Day 3 Day 7 Day
104
103
102
101
100
10−1
10−2
Particles · cm−2 · s−1 · sr−1
SWPC 10 MeV Warning Threshold
00:00 Mar 22
12:00
00:00 Mar 23
12:00
00:00 Mar 24
12:00
00:00 Mar 25
12:00
00:00 Mar 26
12:00
00:00 Mar 27
12:00
00:00 Mar 28
12:00
00:00 Mar 29
Universal Time
GOES-18 ≥ 10 MeV
GOES-18 ≥ 50 MeV
GOES-18 ≥ 100 MeV
Updated 2024-03-28 10:10 UTC

GOES

Storm scale

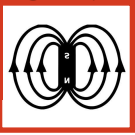




A,B,C,M,X



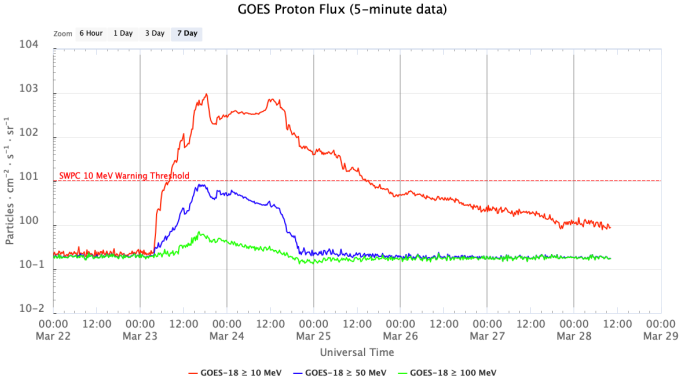
Kp
0 - 9



Storm - Major Storm



Duration

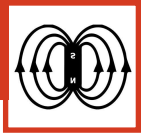




MINs to HOUR



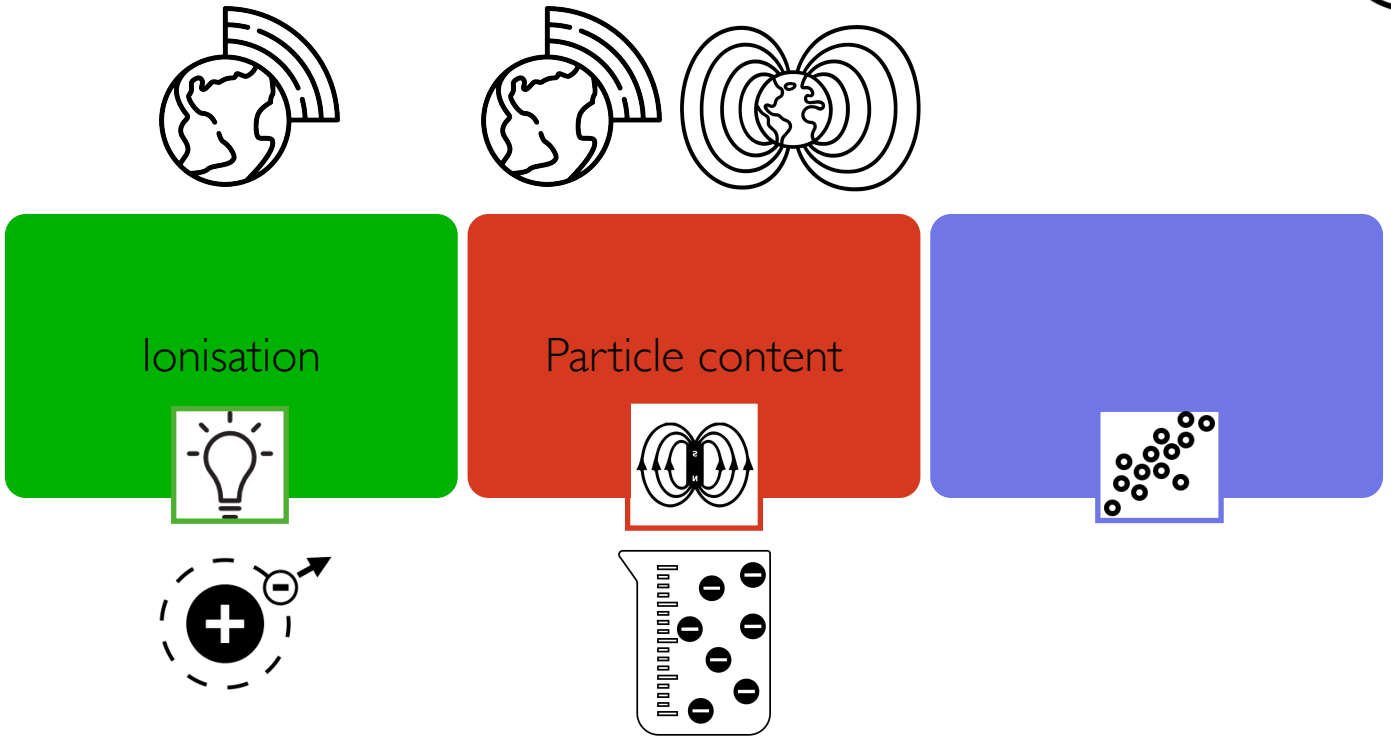
DAY+



HOURS to DAYS

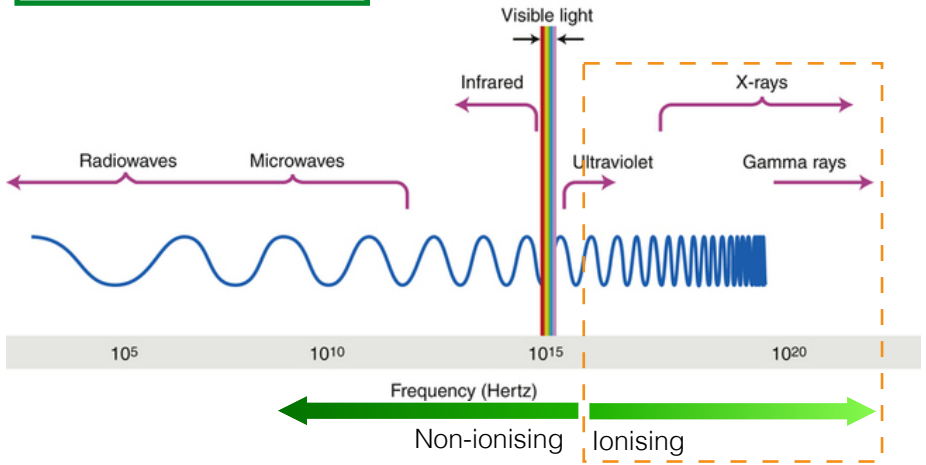


Impact



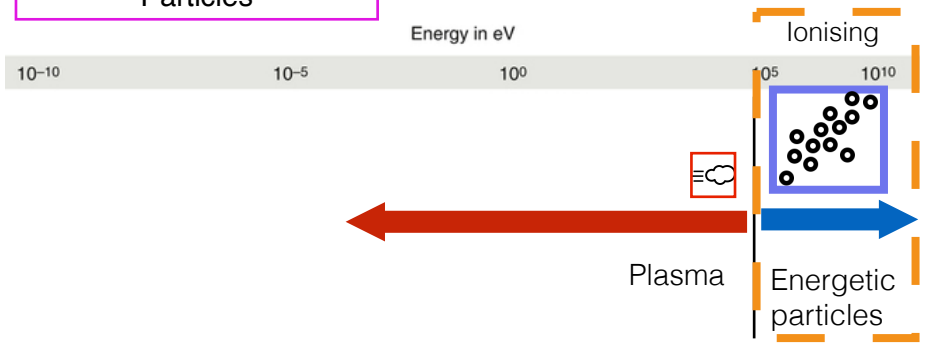
Electromagnetic radiation

- Photons / electromagnetic waves
- Speed of light

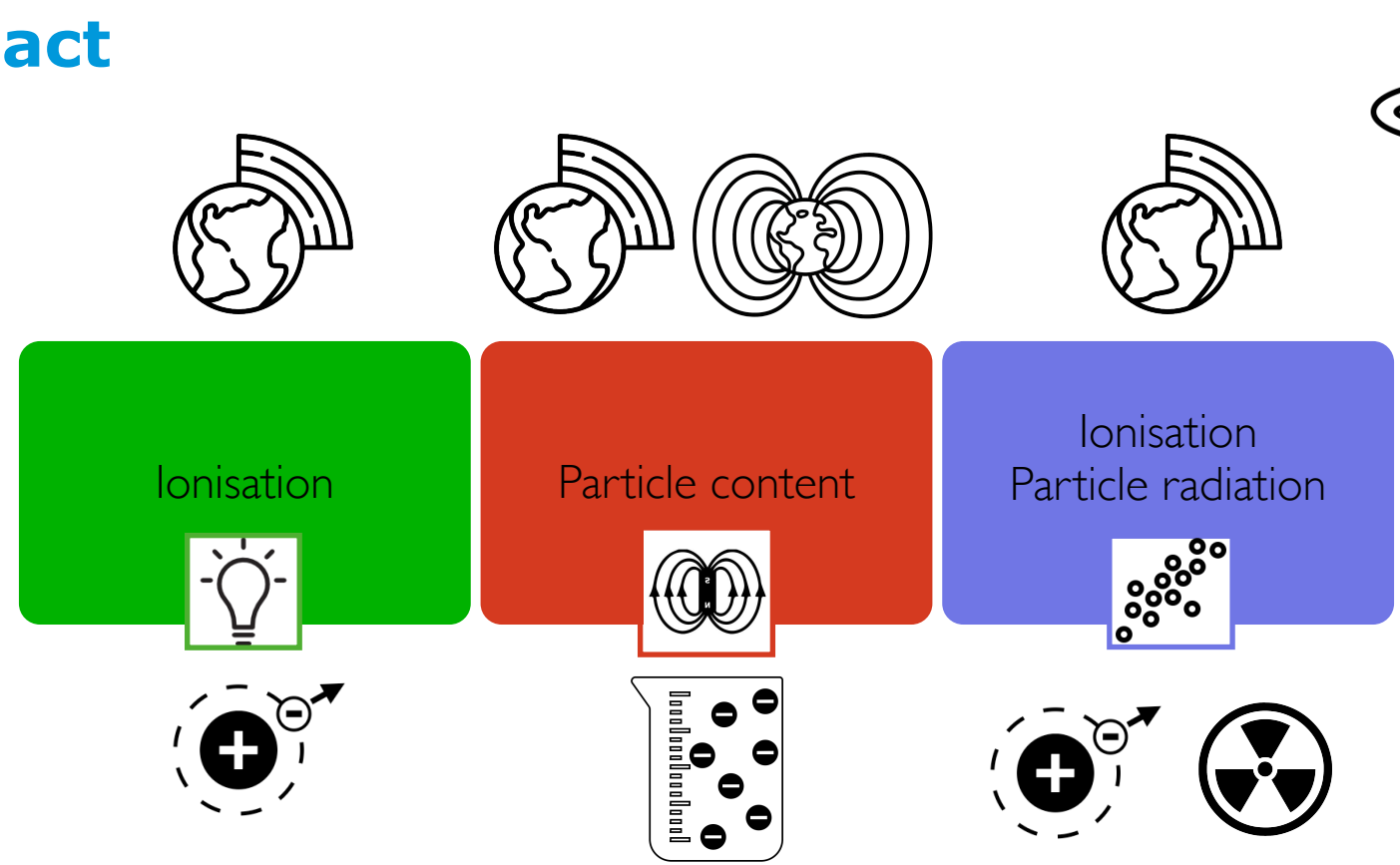


Particles

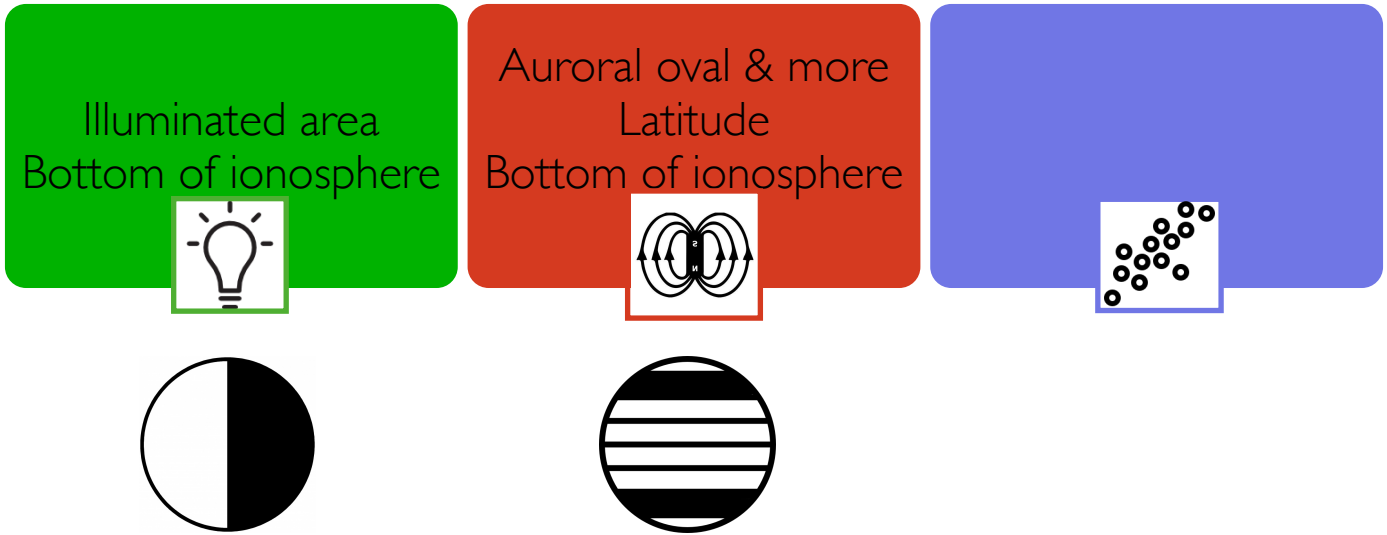
- Atomic & sub-atomic particles
- m/s to fractions of speed of light

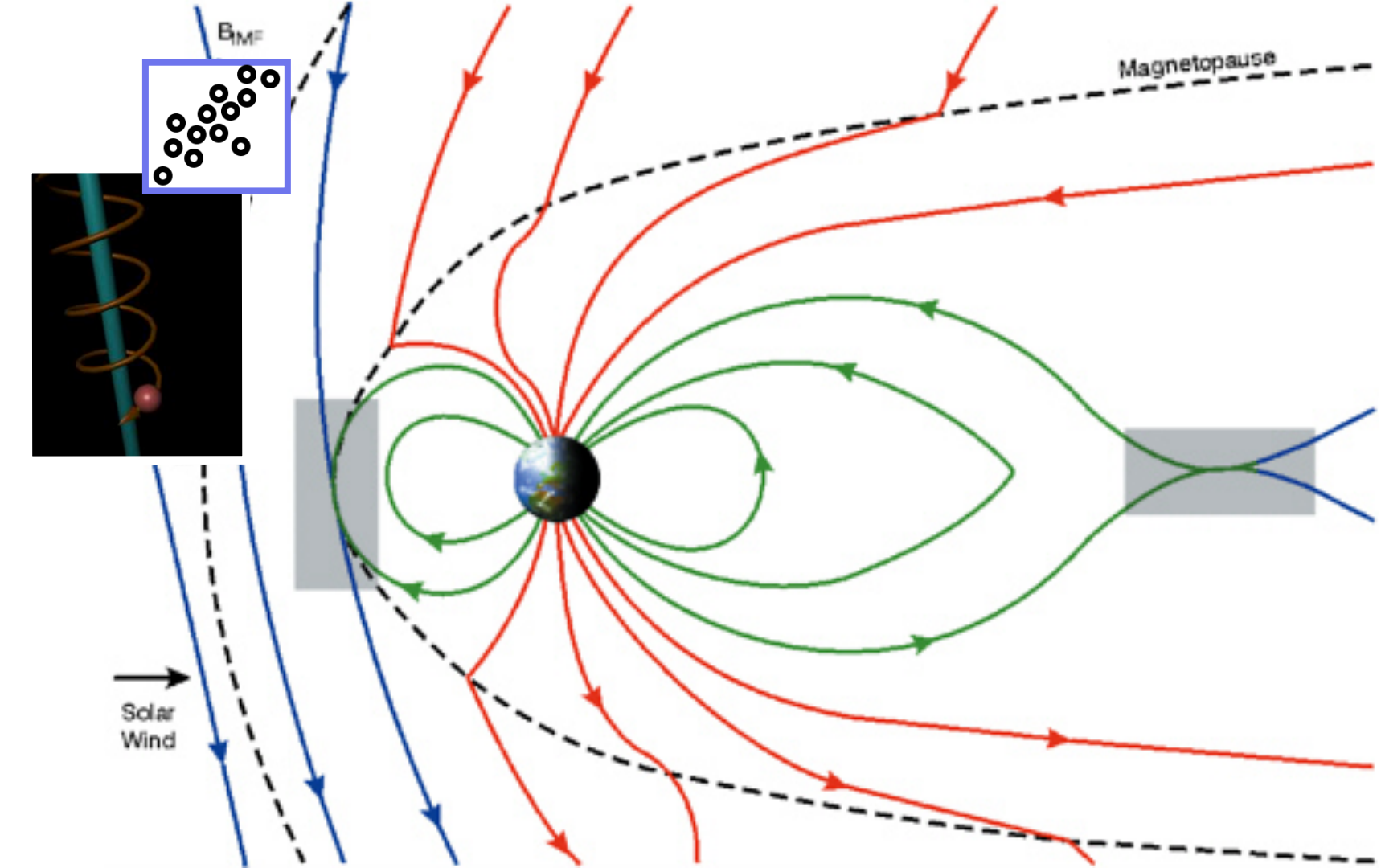


Impact


Ionisation
Particle content
Ionisation
Particle radiation

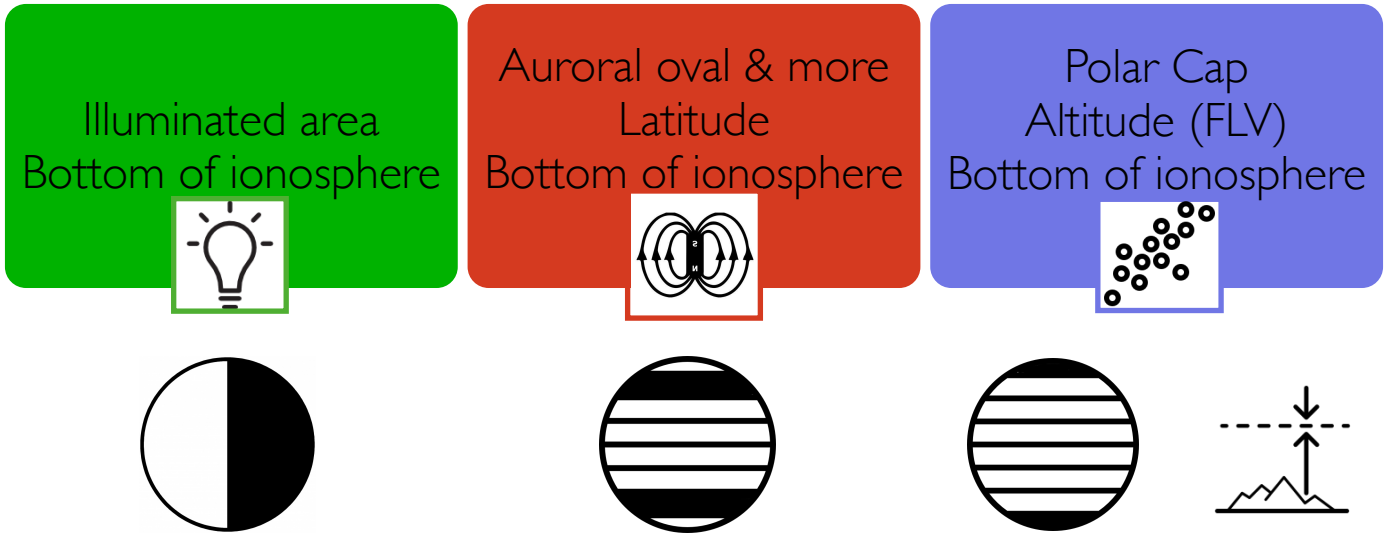
Area of Impact

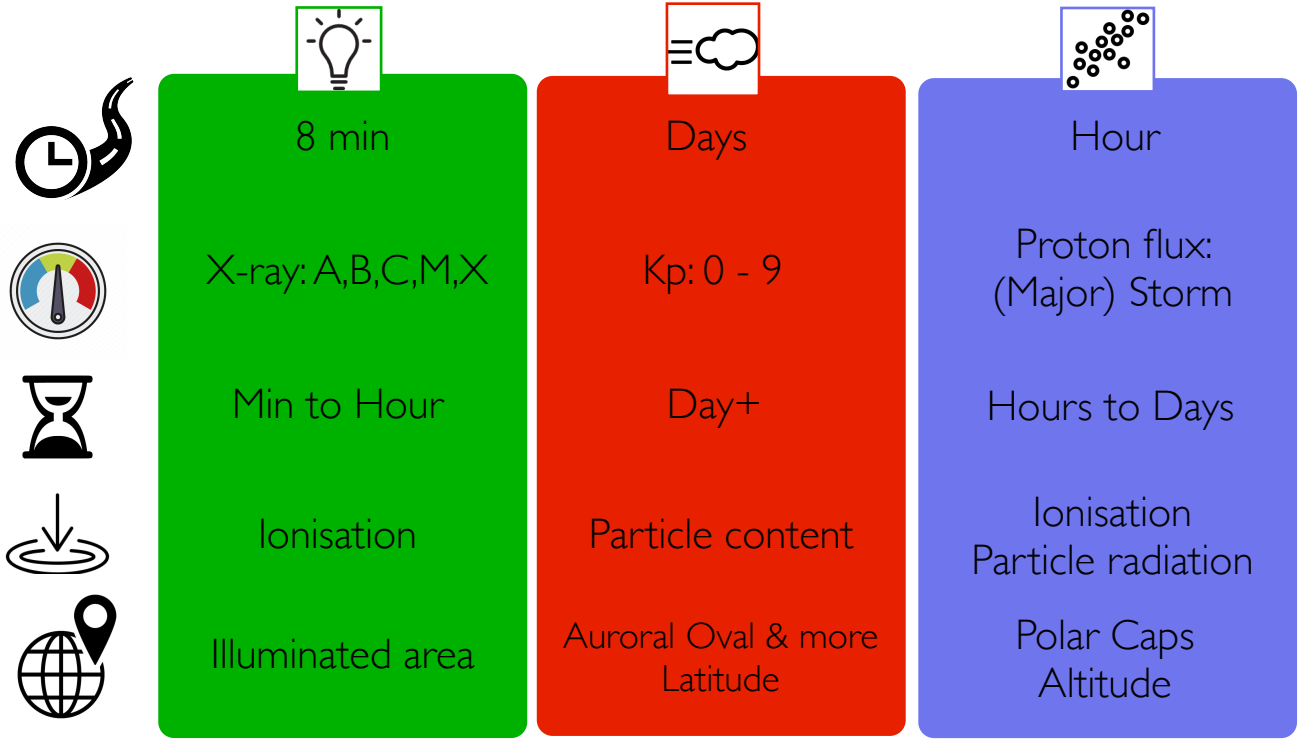



B_{IMF}
Magnetopause
Solar
Wind

Area of Impact






8 min
X-ray: A,B,C,M,X
Min to Hour
Ionisation
Illuminated area
Days
Kp: 0 - 9
Day+
Particle content
Auroral Oval & more Latitude
Hour
Proton flux: (Major) Storm
Hours to Days
Ionisation Particle radiation
Polar Caps Altitude

Space Weather Forecasts

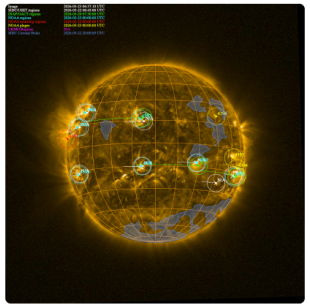
STCE Space Weather Services

Detections

Solardemon
2026-03-23 05:06 B2 flare

CACTus
2026-03-23 01:37 1844km/s

Solar Map



Latest Alerts

Presto 2026-03-22

Geomagnetic conditions reached major storm levels globally (NOAA Kp = 7-) between 09:00 and 12:00 UTC on March 22 and then

CACTus Halo 2026-03-23

A halo or partial-halo CME was detected with the following characteristics: t0 | dt0| pa | da | v | dv | minv| maxv|

Forecasts

Flare:	C-class flares (≥50%)
Protons:	Quiet
Geomagnetic:	Major (ISES: Severe) magstorm (A>=100 or K>=7)
All quiet:	False
Provisional SSN:	112

www.sidc.be

Solar Activity

URSIgram 2026-03-22

Solar flaring activity was low over the past 24 hours. The largest flare was a C1.1 flare (SIDC Flare 7238) peaking on March 21 at 16:07 UTC. There are currently 8 numbered regions on the disk. Three new regions rotated over the east solar limb and were numbered. SIDC Sunspot Group 828 (NOAA Active Region

Solar Wind

URSIgram 2026-03-22

The geomagnetic conditions were at unsettled to active levels at the start of the period but increased to minor storm conditions globally between 03:00 and 09:00 UTC on March 22 and then reached major storm conditions globally (NOAA KP 7-) from 09:00 UTC on March 22. This was in response to the extended period of

Mar 23, 2026
11:54:26 UTC

- MAIN
- REGIONS
- FLARE
- CME
- SW
- PARTICLES
- MARS LOCATION
- BEPICOLOMBO LOCATION
- SOLAR ORBITER
- INTERFACE
- PREVIWEB
- PRESTO
- ADVISORY
- LINKS
- PECASUS
- Workflow

RWC DASHBOARD

	10 minutes	1 hour	3 hours	6 hours	12 hours	24 hours	1 week
Max X-Ray Flux (GOES primary, secondary, 0.1-0.8nm)	C1.1 Low	C1.9 Low	C1.9 Low	C1.9 Low	C3.4 Low	C3.4 Low	M2.8 Moderate
Max Proton (GOES primary, secondary, Flux >=30 MeV)	N/A N/A	0.23 pfu Below	0.3 pfu Below	0.3 pfu Below	0.3 pfu Below	0.3 pfu Below	0.37 pfu Below
Smooth Solar Wind Speed (DSCOVR, 5min median filter)	524 km/s Fast	553 km/s Fast	553 km/s Fast	553 km/s Fast	553 km/s Fast	611 km/s Fast	615 km/s Fast
Smooth Solar Wind Bz (DSCOVR)	N/A N/A	-4 nT Negative, between 0 and -5 nT	-5 nT Negative, between 0 and -5 nT	-5 nT Negative, between 0 and -5 nT	-6 nT Negative, between -5 and -10 nT	-12 nT Negative, between -10 and -20 nT	-28 nT Negative, below 20 nT
Smooth Solar Wind Bt (DSCOVR)	N/A N/A	5 nT Nominal	5 nT Nominal	6 nT Nominal	6 nT Nominal	14 nT Enhanced	39 nT Enhanced
Kp (NOAA, realtime)	N/A N/A	3 Unsettled	3 Unsettled	4 Active	6 Moderate Storm	7 Major Storm	7 Major Storm
Kp (NOAA)	N/A N/A	N/A N/A	N/A N/A	1.67 Quiet	4.67 Minor Storm	6.67 Major Storm	7 Major Storm
Kbel	N/A N/A	3 Unsettled	3 Unsettled	3 Unsettled	5 Minor Storm	6 Moderate Storm	6 Moderate Storm
Cactus-Halo-CME Alert	False N/A	False N/A	False N/A	False N/A	True True	True True	True True
Cactus-Fast-CME Last Run	N/A N/A	N/A N/A	N/A N/A	654 km/s Fast	1844 km/s Very fast	1859 km/s Very fast	1859 km/s Very fast
Max Electron (GOES primary, secondary, Flux >=2 MeV)	N/A N/A	1024.76 pfu Above	1024.76 pfu Above	1138.95 pfu Above	1201.57 pfu Above	3152.35 pfu Above	4941.22 pfu Above
Electron Fluence	N/A N/A	6.46e+7 Moderate	6.46e+7 Moderate	6.46e+7 Moderate	6.46e+7 Moderate	6.46e+7 Moderate	1.52e+8 Moderate

Ursigram

:Issued: 2026 Mar 22 1239 UTC
:Product: documentation at http://www.sidc.be/products/meu
#---#
DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC
(RWC Belgium)
#---#
SIDC URSIGRAM 60322
SIDC SOLAR BULLETIN 22 Mar 2026, 1238UT
SIDC FORECAST
SOLAR FLARES : C-class flares expected, (probability >=50%)
GEOMAGNETISM : Major (ISES: Severe) magstorm expected (A>=100 or K>=7)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 22 Mar 2026 10CM FLUX: 113 / AP: 071
PREDICTIONS FOR 23 Mar 2026 10CM FLUX: 119 / AP: 043
PREDICTIONS FOR 24 Mar 2026 10CM FLUX: 124 / AP: 016

Solar Active Regions and flaring: Solar flaring activity was low over the past 24 hours. The largest flare was a C1.1 flare (SIDC Flare 7238) peaking on March 21 at 16:07 UTC. There are currently 8 numbered regions on the disk. Three new regions rotated over the east solar limb and were numbered. SIDC Sunspot Group 828 (NOAA Active Region 4398, magnetic type beta) and SIDC Sunspot Group 826 (NOAA Active Region 4400, magnetic type beta) both exhibited flux emergence. SIDC Sunspot Group 820 (NOAA Active Region 4392 magnetic type beta) is the largest region on disk but has been stable over the period. Solar flaring activity is expected to be low over the next 24 hours, with C-class flares probable and a chance for M-class flares.

Coronal mass ejections: No new Earth directed CMEs were detected in the available coronagraph imagery.

Coronal holes: An extended negative polarity equatorial coronal hole (SIDC Coronal Hole 147) continues to transit the central meridian.

Solar wind: The solar wind parameters reflected the ongoing ICME passage (SIDC CME 641) and a transition to the fast solar wind associated with (SIDC Coronal Hole 147). The interplanetary magnetic field reached a maximum of 39 nT at 15:24 UTC March 21. At the end of the period the interplanetary magnetic field strength was stable around 15 nT. The solar wind speed was around 500 km/s for the first half of the period and then began to gradually increase to values around 620 km/s by the end of the period. Bz was mostly positive until 06:00 UTC March 22 when a long period of negative Bz began with a minimum of -11nT. The solar wind speed is expected to remain enhanced over the next 24 hours due to the high speed stream associated with the large negative polarity equatorial coronal hole (SIDC Coronal Hole 147).

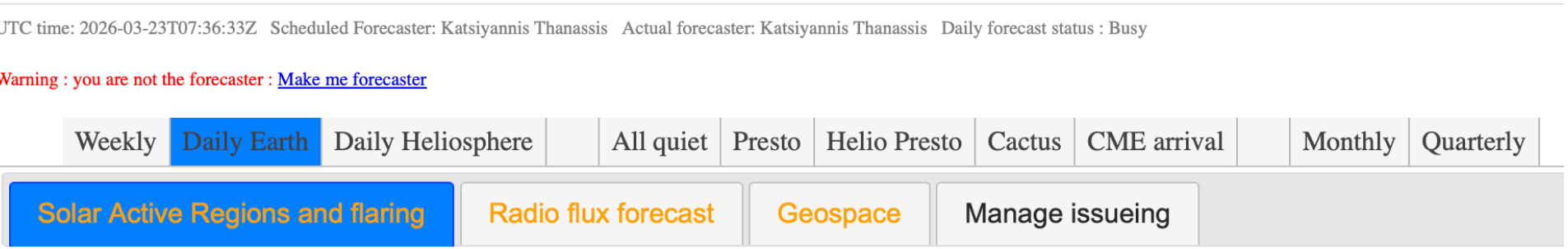
Geomagnetism: The geomagnetic conditions were at unsettled to active levels at the start of the period but increased to minor storm conditions globally between 03:00 and 09:00 UTC on March 22 and then reached major storm conditions globally (NOAA KP 7-) from 09:00 UTC on March 22. This was in response to the extended period of negative Bz. Locally, moderate storm levels were observed (K-Bel = 6). Moderate to major storm conditions are expected for the rest of March 22, due to the high speed a high speed stream influence. This is expected to gradually reduce to minor storm conditions from March 23.

Proton flux levels: The greater than 10 MeV proton flux was below the 10 pfu threshold over the past 24 hours. It is expected to remain below this threshold level over the next 24 hours.

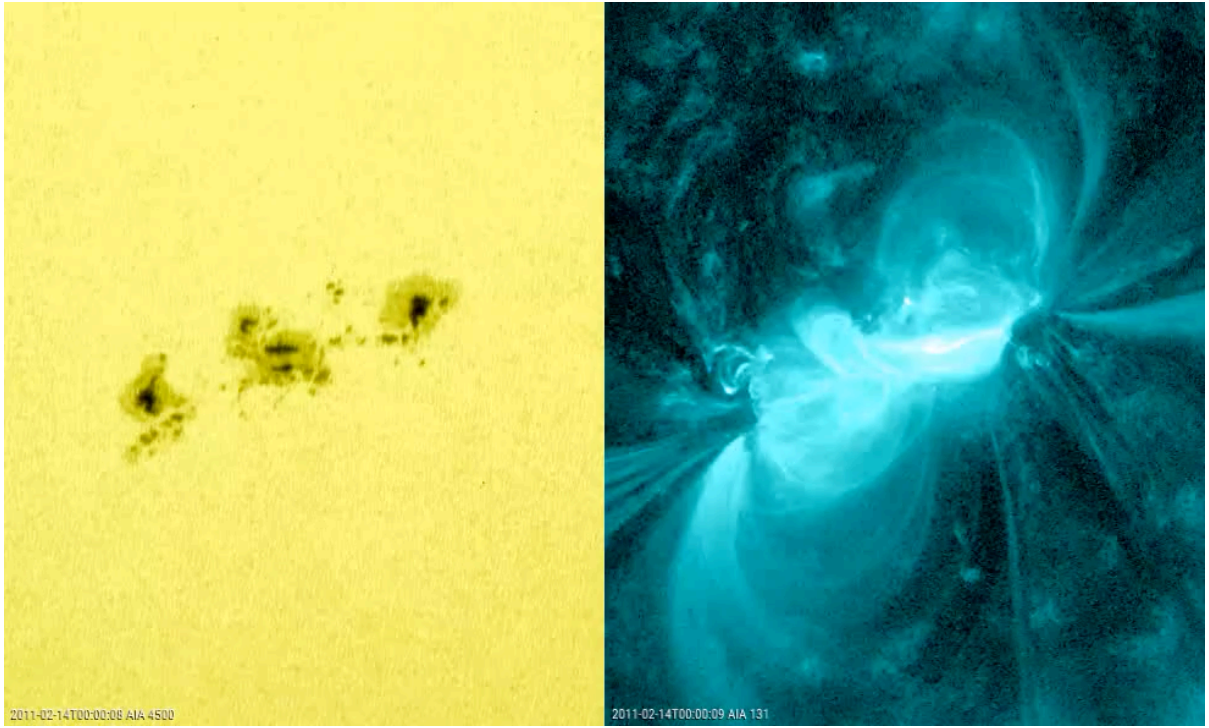
Electron fluxes at GEO: The greater than 2 MeV electron flux, as measured by GOES-18 and GOES-19 satellites, was below the 1000 pfu threshold. The greater than 2 MeV electron flux is expected to be at or just above the 1000 pfu threshold over the next 24 hours. The electron fluence was at normal levels and is expected to be at normal levels for the next 24 hours.

TODAY'S ESTIMATED ISN : 105, BASED ON 18 STATIONS.

Previweb - Forecaster's page



Solar Flares - Sunspots

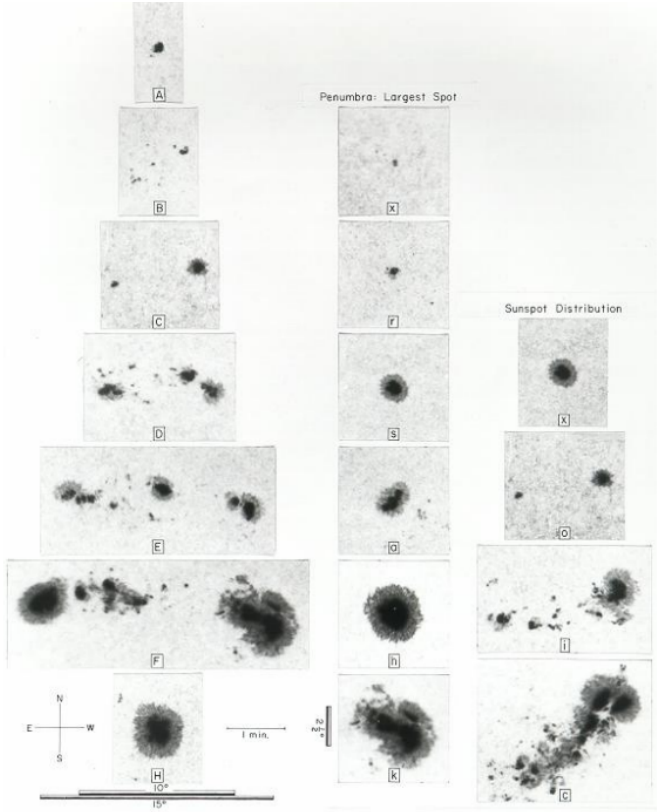


SDO/AIA

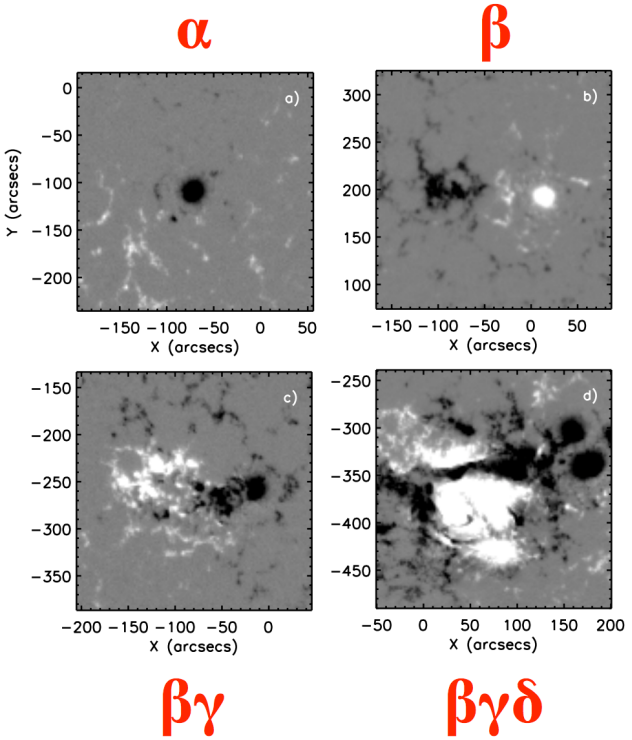
Magnetic restructuring
Magnetic reconnection
Conversion of stored energy

Solar Flares - Sunspot Classification

McIntosh



Mount Wilson/Hale



Solar Flares

Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Regional probabilistic flare forecast

Transfer from new database
Catania is up to date. Click Click here if you want to refresh the regions anyway.

Catania info (Last update: 2026-Mar-20)						NOAA info (Last update: 2026-Mar-23)					Probabilities for			
Number	area	nspots	Zurich	Longitude	Latitude	Number	Macintosh	Mag. type	Longitude	Latitude	C+ flare	M+ flare	X+ flare	Proton
53	23	10	C	30.0	-17.0	4392	Cso	Beta	65.0	-18.0	--	--	--	--
56	4	9	C	-51.0	17.0	4397	Cro	Beta	-14.0	16.0	--	--	--	--
						4398	Cro	Beta	-13.0	-15.0	--	--	--	--
						4399	Hax	Alpha	-68.0	-17.0	--	--	--	--
55	1	1	A	-13.0	-14.0	4400	Dai	Beta-Gamma-Delta	25.0	-12.0	--	--	--	--
						4401	Dao	Beta	-63.0	24.0	--	--	--	--
						4402	Hax	Alpha	-68.0	14.0	--	--	--	--

Full disc probabilistic flare forecast

Flare level	Total flares Catania (Last update: 2026-Mar-20)	Total flares NOAA (Last update: 2026-Mar-23)	Forecast 2026-03-23 [%]
C+	0	0	(95.0, 55.0)
M+	0	0	(40.0, 10.0)
X+	0	0	(1.0, 1.0)

Full disc categorical flare forecast

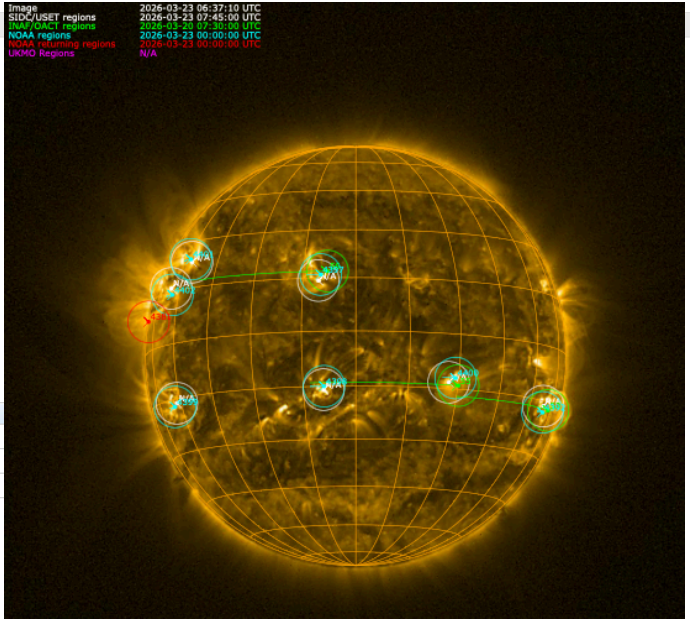
Forecast 2026-03-23 ---------- (C-class flares expected, (probability >=50%), C-class flares expected, (probability >=50%))
Forecast 2026-03-24 ---------- (C-class flares expected, (probability >=50%), /)
Forecast 2026-03-25 ---------- (/, /)

Full disc categorical proton forecast

Forecast 2026-03-23 ---------- (Quiet, Quiet)
Forecast 2026-03-24 ---------- (Quiet, /)
Forecast 2026-03-25 ---------- (/, /)

Solar Active Regions and flaring

Suggested sentences:



Links

Solar images and features

- Solar map
- USET regions
- Solar Monitor Regions
- Solar Monitor
- Latest NOAA synoptic map
- Raben Maps
- STEREO Stonyhurst heliographic maps
- PROBA2 LYRA data and SWAP images
- SDO movies
- SDO movies (ROB page)
- SOHO movietheater
- SOHO data
- STEREO movies
- Realtime GONG H-alpha movies (backup)
- SIDC Sunspots
- SIDC Coronal Holes

Flares

- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive
- Kanzelhoehe flare list
- Solar Demon
- SolarSoft Latest Events
- GOES X-ray, proton & electron flux, estimated Kp (assembled from NOAA by N3KL)
- GOES X-ray plots
- LYRA Quick Look viewer
- Solar monitor Flare Forecast
- Bradford university Flare monitor (ASAP)
- SIDC flare forecast archive
- SIDC Flares

Radio

- Latest 10.7cm measurement, Archive of 10.7cm measurement
- SWPC radio flux measurements
- 10.7cm forecasts by CLS
- ARCAS and HSRS Latest Observations
- Radio Bursts: CALLISTO Latest Observations
- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive
- Culgoora spectrographs
- Culgoora Latest Radio burst
- Learmonth spectrographs
- F10.7 Nowcast and Forecast

Solar Flares

Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Regional probabilistic flare forecast

Transfer from new database
Catania is up to date. Click Click here if you want to refresh the regions anyway.

Catania info (Last update: 2026-Mar-20)						NOAA info (Last update: 2026-Mar-23)					Probabilities for			
Number	area	nspots	Zurich	Longitude	Latitude	Number	Macintosh	Mag. type	Longitude	Latitude	C+ flare	M+ flare	X+ flare	Proton
53	23	10	C	30.0	-17.0	4392	Cso	Beta	30.0	-18.0	--	--	--	--
56	4	9	C	-51.0	17.0	4397	Cro	Beta	-14.0	16.0	--	--	--	--
						4398	Cro	Beta	-13.0	-15.0	--	--	--	--
						4399	Hax	Alpha	-68.0	-17.0	--	--	--	--
55	1	1	A	-13.0	-14.0	4400	Dso	Beta-Gamma-Delta	25.0	-12.0	--	--	--	--
						4401	Dao	Beta	-63.0	24.0	--	--	--	--
						4402	Hax	Alpha	-68.0	14.0	--	--	--	--

Per Region

Full disc probabilistic flare forecast

Flare level	Total flares Catania (Last update: 2026-Mar-20)	Total flares NOAA (Last update: 2026-Mar-23)	Forecast 2026-03-23 [%]
C+	0	0	(95.0, 55.0)
M+	0	0	(40.0, 10.0)
X+	0	0	(1.0, 1.0)

Full Disk

Full disc categorical flare forecast

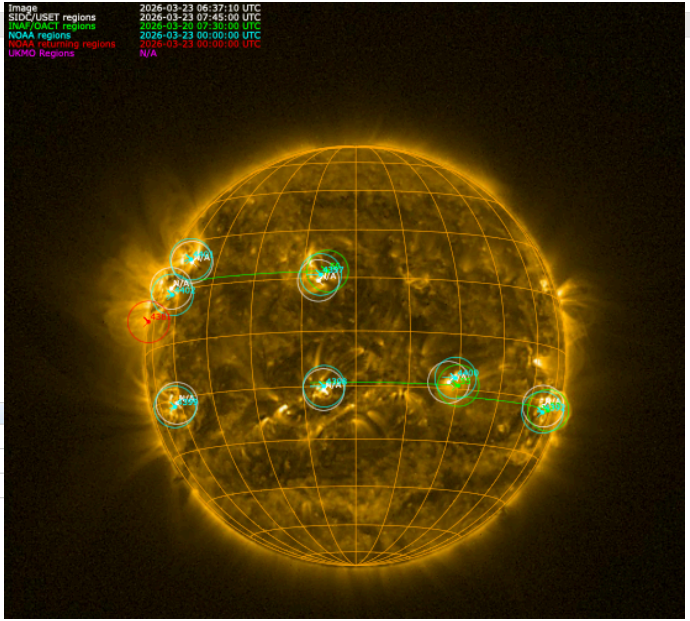
Forecast 2026-03-23 ---------- (C-class flares expected, (probability >=50%), C-class flares expected, (probability >=50%))
Forecast 2026-03-24 ---------- (C-class flares expected, (probability >=50%), /)
Forecast 2026-03-25 ---------- U, /)

Full disc categorical proton forecast

Forecast 2026-03-23 ---------- (Quiet, Quiet)
Forecast 2026-03-24 ---------- (Quiet, /)
Forecast 2026-03-25 ---------- U, /)

Solar Active Regions and flaring

Suggested sentences:



Links

Solar images and features

- Solar map
- USET regions
- Solar Monitor Regions
- Solar Monitor
- Latest NOAA synoptic map
- Raben Maps
- STEREO Stonyhurst heliographic maps
- PROBA2 LYRA data and SWAP images
- SDO movies
- SDO movies (ROB page)
- SOHO movietheater
- SOHO data
- STEREO movies
- Realtime GONG H-alpha movies (backup)
- SIDC Sunspots
- SIDC Coronal Holes

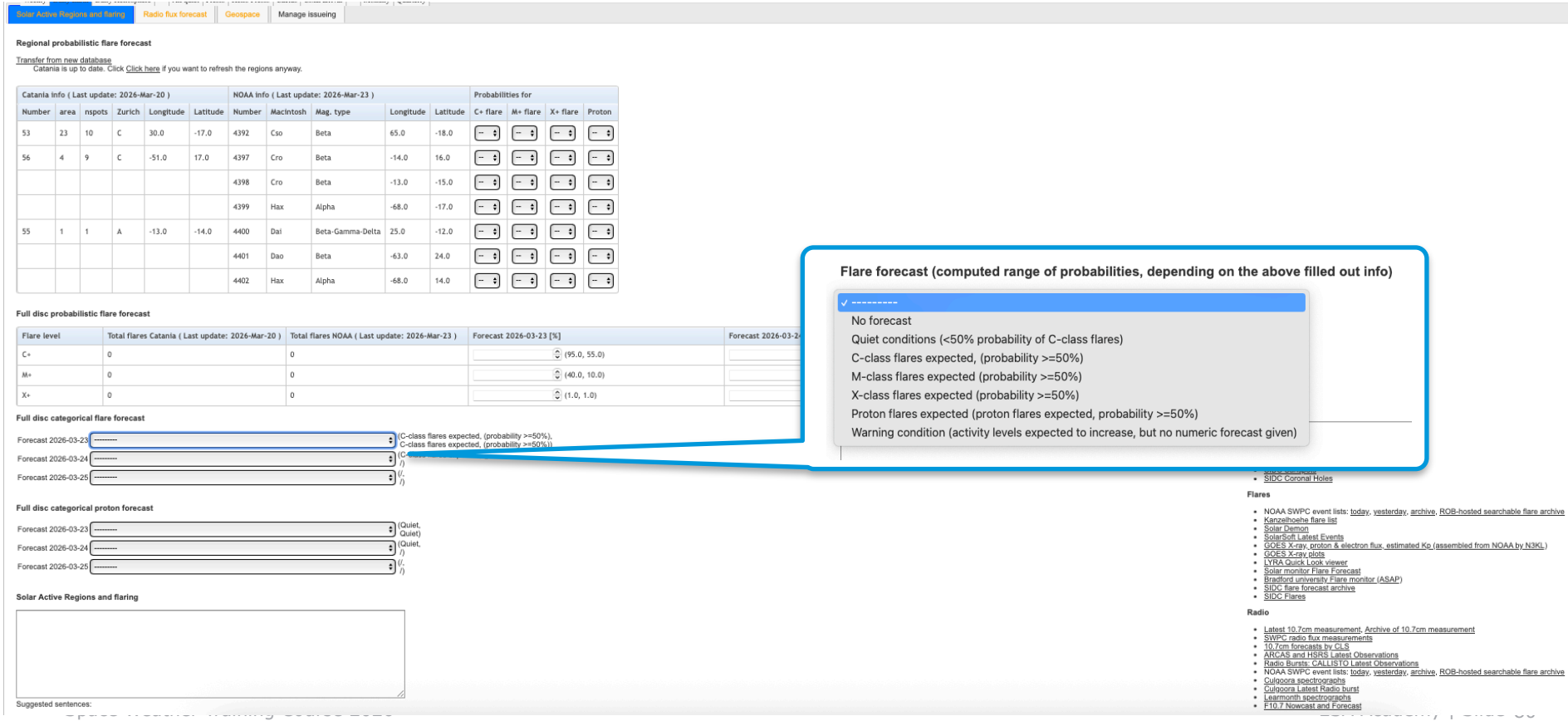
Flares

- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive
- Kanzelhoehe flare list
- Solar Demon
- SolarSoft Latest Events
- GOES X-ray, proton & electron flux, estimated Kp (assembled from NOAA by N3KL)
- GOES X-ray plots
- LYRA Quick Look viewer
- Solar monitor Flare Forecast
- Bradford university Flare monitor (ASAP)
- SIDC flare forecast archive
- SIDC Flares

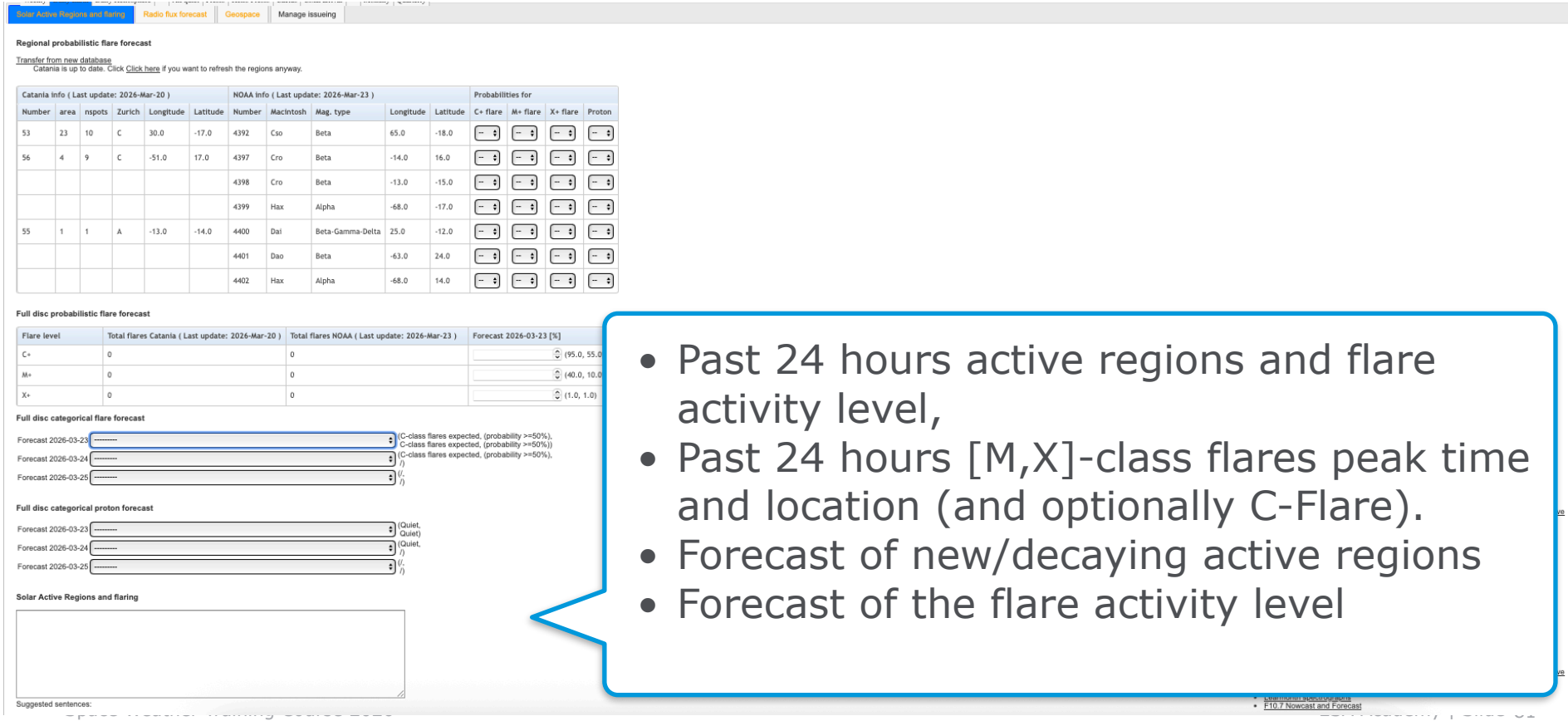
Radio

- Latest 10.7cm measurement, Archive of 10.7cm measurement
- SWPC radio flux measurements
- 10.7cm forecasts by CLS
- ARCAS and HSRS Latest Observations
- Radio Bursts: CALLISTO Latest Observations
- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive
- Culgoora spectrographs
- Culgoora Latest Radio burst
- Learmonth spectrographs
- F10.7 Nowcast and Forecast

Solar Flares



Solar Flares



- Past 24 hours active regions and flare activity level,
- Past 24 hours [M,X]-class flares peak time and location (and optionally C-Flare).
- Forecast of new/decaying active regions
- Forecast of the flare activity level

Protons



Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Regional probabilistic flare forecast

Transfer from new database
Catania is up to date. Click Click here if you want to refresh the regions anyway.

Catania info (Last update: 2026-Mar-20)						NOAA info (Last update: 2026-Mar-23)					Probabilities for			
Number	area	nspots	Zurich	Longitude	Latitude	Number	Macintosh	Mag. type	Longitude	Latitude	C+ flare	M+ flare	X+ flare	Proton
53	23	10	C	30.0	-17.0	4392	Cso	Beta	65.0	-18.0	--	--	--	--
56	4	9	C	-51.0	17.0	4397	Cro	Beta	-14.0	16.0	--	--	--	--
						4398	Cro	Beta	-13.0	-15.0	--	--	--	--
						4399	Hax	Alpha	-68.0	-17.0	--	--	--	--
55	1	1	A	-13.0	-14.0	4400	Dai	Beta-Gamma-Delta	25.0	-12.0	--	--	--	--
						4401	Dao	Beta	-63.0	24.0	--	--	--	--
						4402	Hax	Alpha	-68.0	14.0	--	--	--	--

Full disc probabilistic flare forecast

Flare level	Total flares Catania (Last update: 2026-Mar-20)	Total flares NOAA (Last update: 2026-Mar-23)	Forecast 2026-03-23 [%]
C+	0	0	(95.0, 55.0)
M+	0	0	(40.0, 10.0)
X+	0	0	(1.0, 1.0)

Full disc categorical flare forecast

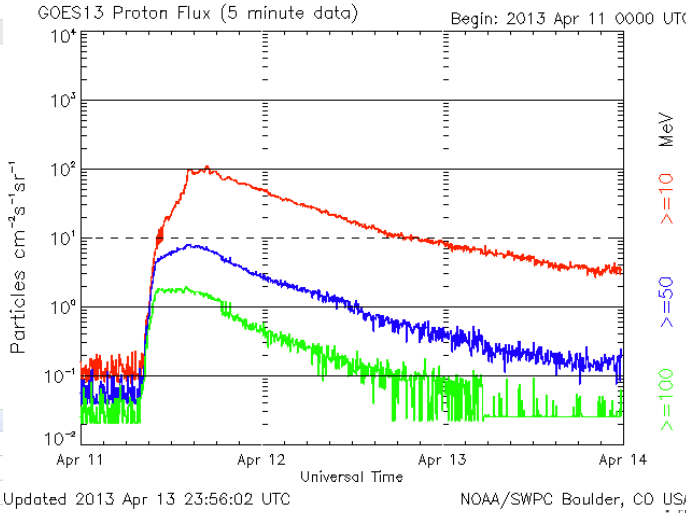
Forecast 2026-03-23 ---------- (C-class flares expected, (probability >=50%), C-class flares expected, (probability >=50%))
Forecast 2026-03-24 ---------- (C-class flares expected, (probability >=50%), /)
Forecast 2026-03-25 ---------- /, /)

Full disc categorical proton forecast

Forecast 2026-03-23 ---------- Quiet)
Forecast 2026-03-24 ---------- (Quiet, /)
Forecast 2026-03-25 ---------- /, /)

Solar Active Regions and flaring

Suggested sentences:



GOES

ages and features
ar map
ET regions
ar Monitor Regions
ar Monitor
est NOAA synoptic map
en Maps
STEREO Stonyhurst heliographic maps
GOES/SEM data
SDO movies
SDO movies (ROB page)
SOHO movietheater
SOHO data
STEREO movies
Realtime GONG H-alpha movies (backup)
SIDC Sunspots
SIDC Coronal Holes

Flares
- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive

from NOAA by N3KL)

ed searchable flare archive

Proton forecast

Total protons:

✓ ---------
No forecast
Quiet
Proton event expected (10 pfu at >10 MeV)
Major proton event expected (100 pfu at >100 MeV)
Proton event in progress (>10 MeV)
Warning condition (activity levels expected to increase, but no numeric forecast given)

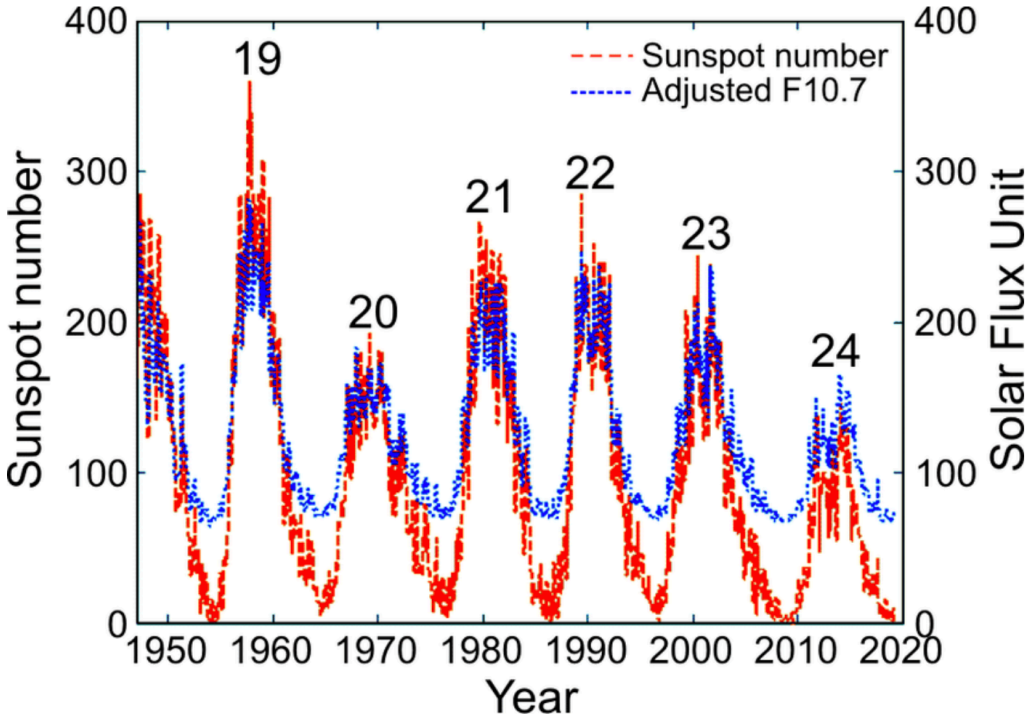
Previweb - Forecaster's Page

UTC time: 2026-03-23T08:48:15Z Scheduled Forecaster: Katsiyannis Thanassis Actual forecaster: Katsiyannis Thanassis Daily forecast status : Busy

Warning : you are not the forecaster : Make me forecaster



F10.7 - Observation



The sunspot numbers (red curve) and the 10.7 cm solar flux (F10.7, blue curve) from the middle of the 20th century [69-71]. The F10.7 values are in solar flux units (sfu), 1 sfu is equal to 10 -22 W m -2 ·Hz -1 . The observed F10.7 is presented on the right axis.

(Grytsai et al., 2020)

F10.7 - Forecast

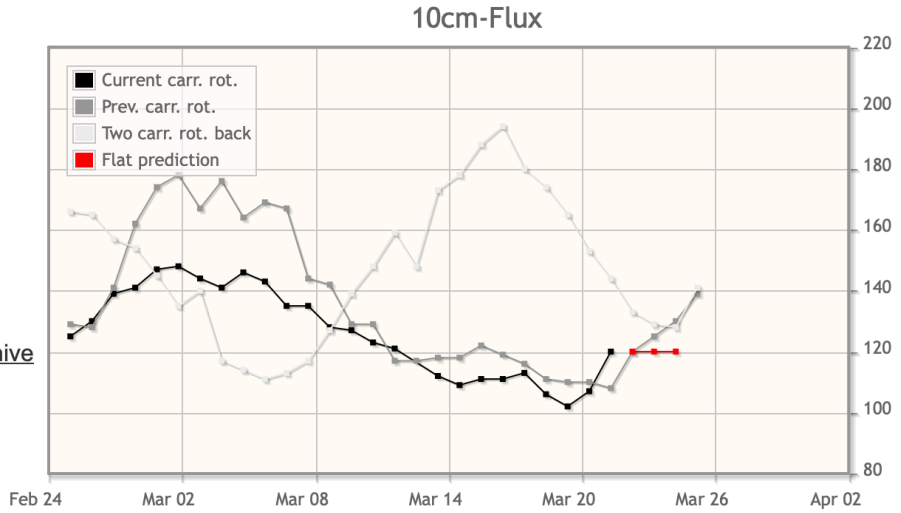
Weekly | Daily Earth | Daily Heliosphere | All quiet | Presto | Helio Presto | Cactus | CME arrival | Monthly | Quarterly

Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Forecast for 2026-03-23: (previous forecasts : (119,98))
Forecast for 2026-03-24: (previous forecasts : (124,/))
Forecast for 2026-03-25: (previous forecasts : (/,/))

Links

- Latest 10.7cm measurement, Archive of 10.7cm measurement
- SWPC radio flux measurements
- 10.7cm forecasts by CLS
- ARCAS and HSRS Latest Observations
- Radio Bursts: CALLISTO Latest Observations
- NOAA SWPC event lists: today, yesterday, archive, ROB-hosted searchable flare archive
- Culgoora spectrographs
- Culgoora Latest Radio burst
- Learmonth spectrographs
- F10.7 Nowcast and Forecast



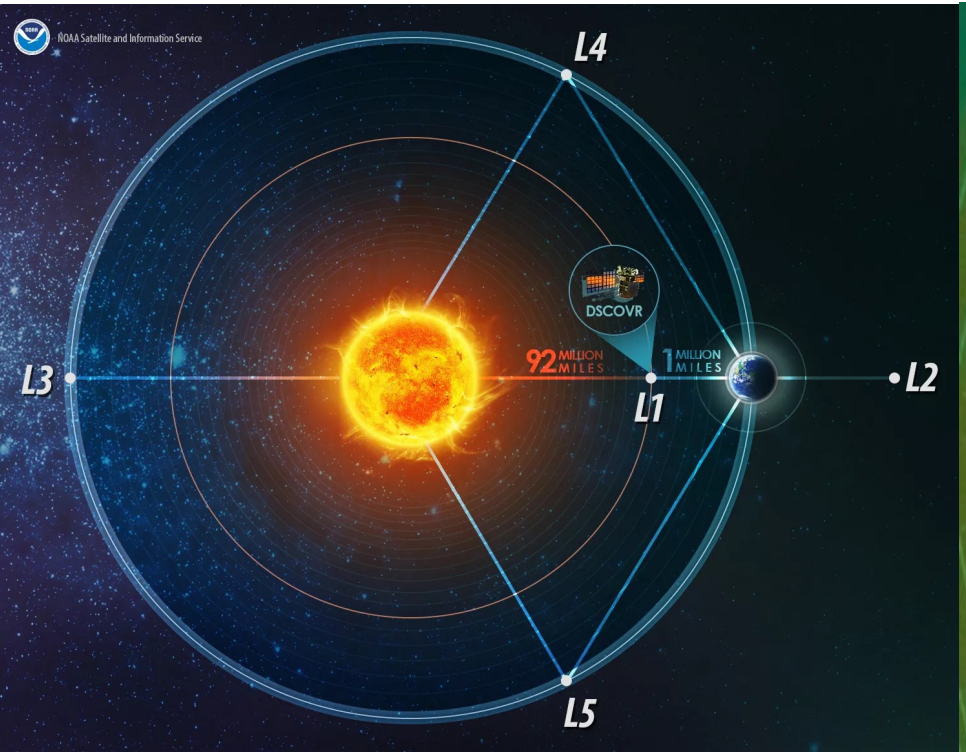
Previweb - Forecaster's Page

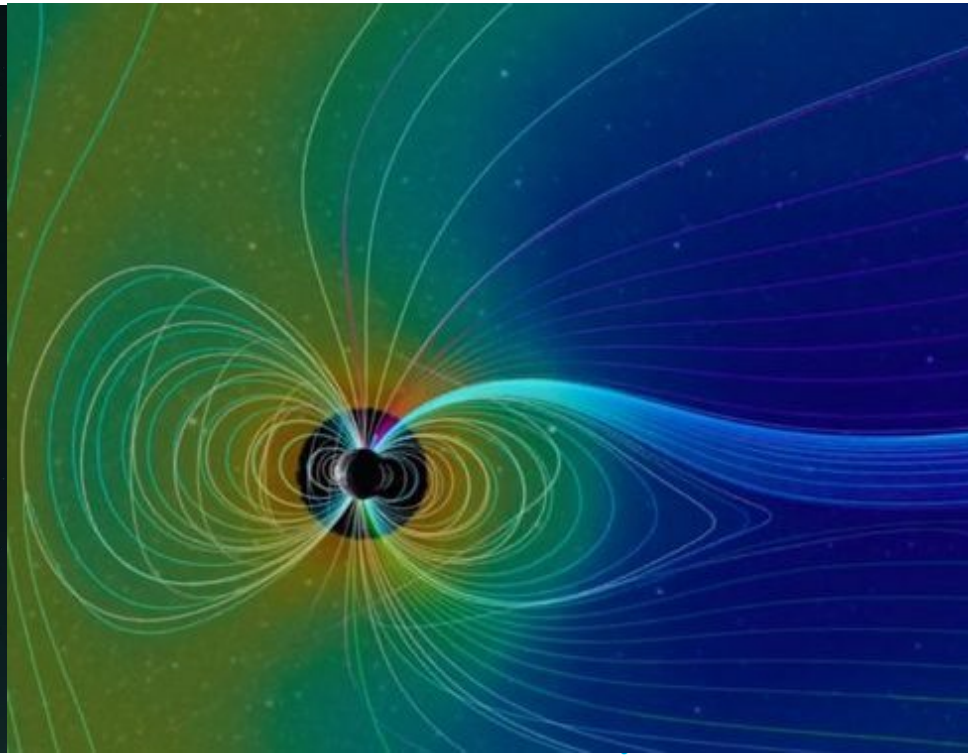
UTC time: 2026-03-23T08:53:55Z Scheduled Forecaster: Katsiyannis Thanassis Actual forecaster: Katsiyannis Thanassis Daily forecast status : Busy

Warning : you are not the forecaster : Make me forecaster

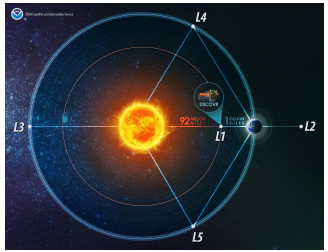


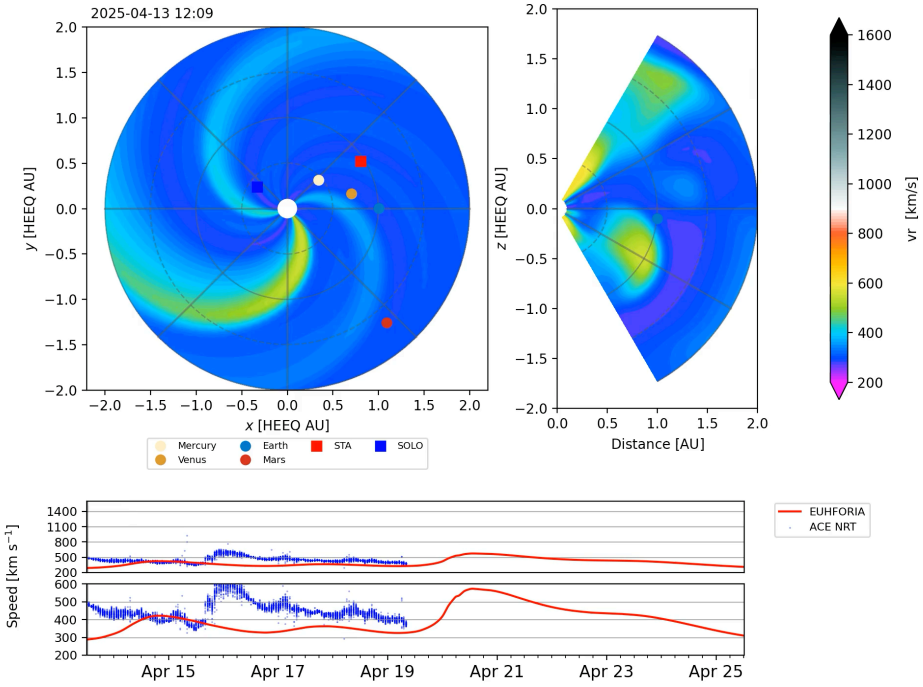
L1 and Magnetosphere



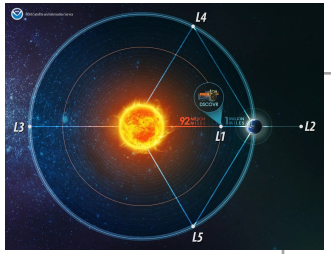


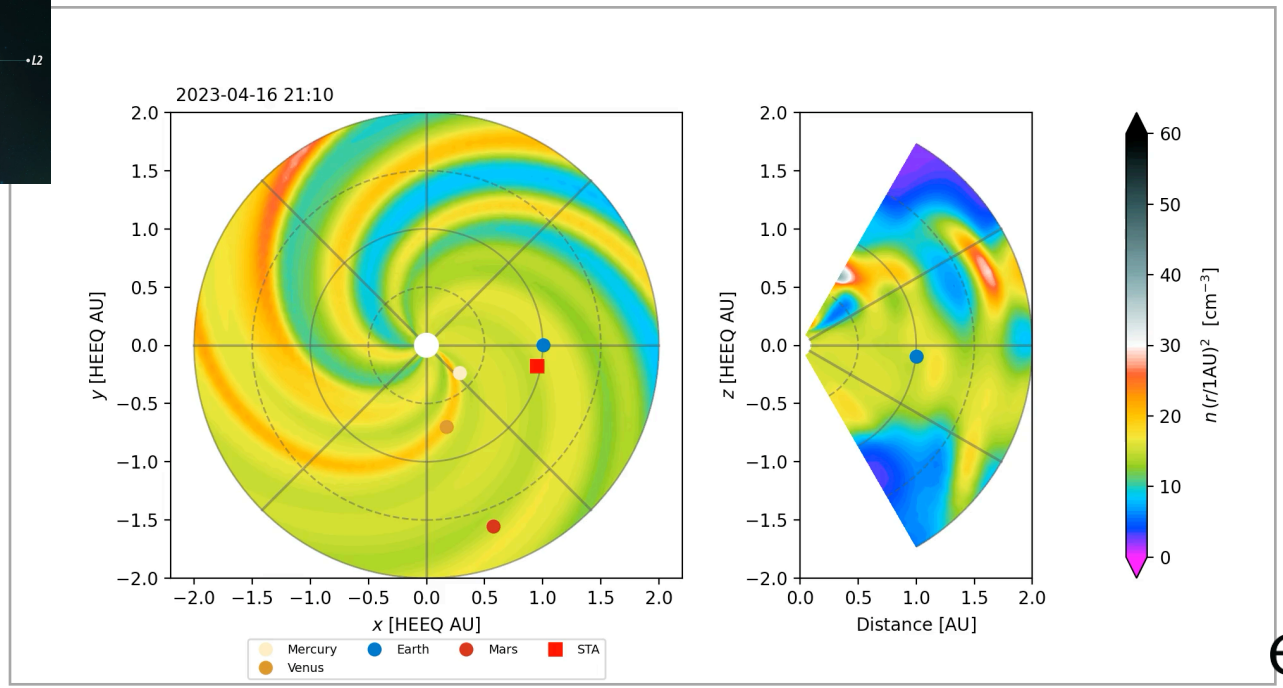
3 Solar Wind Transients: HSS



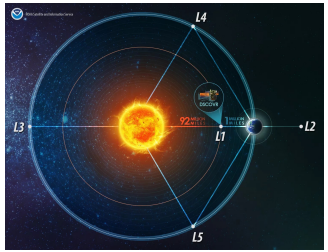


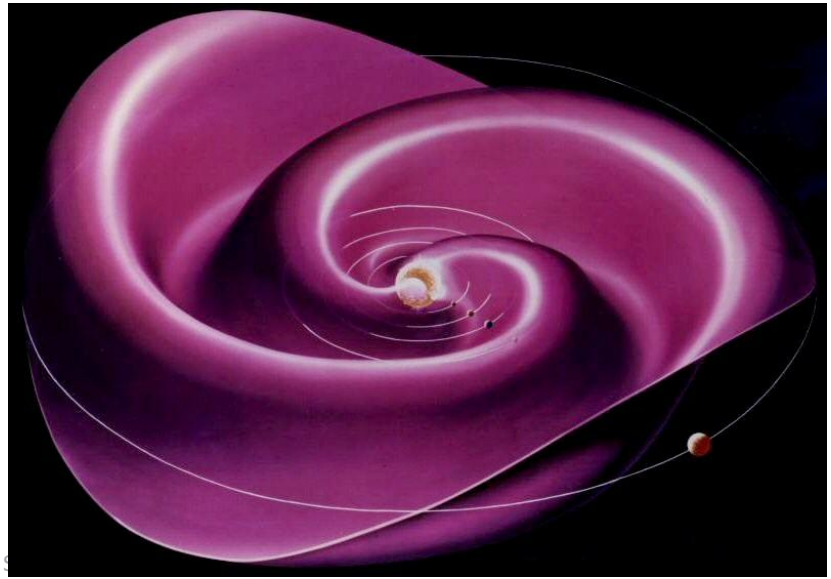
3 Solar Wind Transients: CME

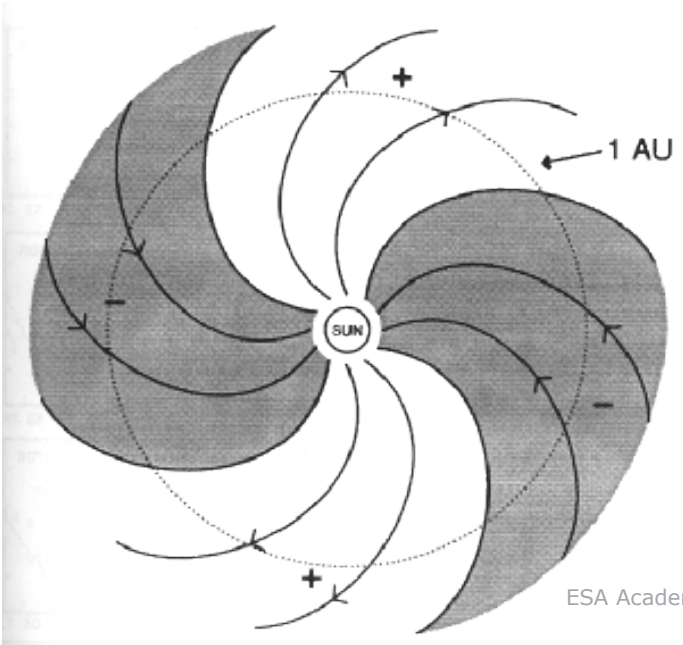


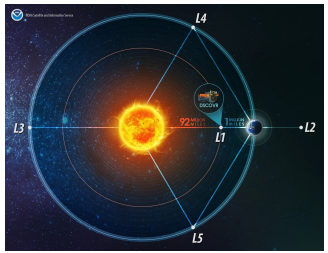


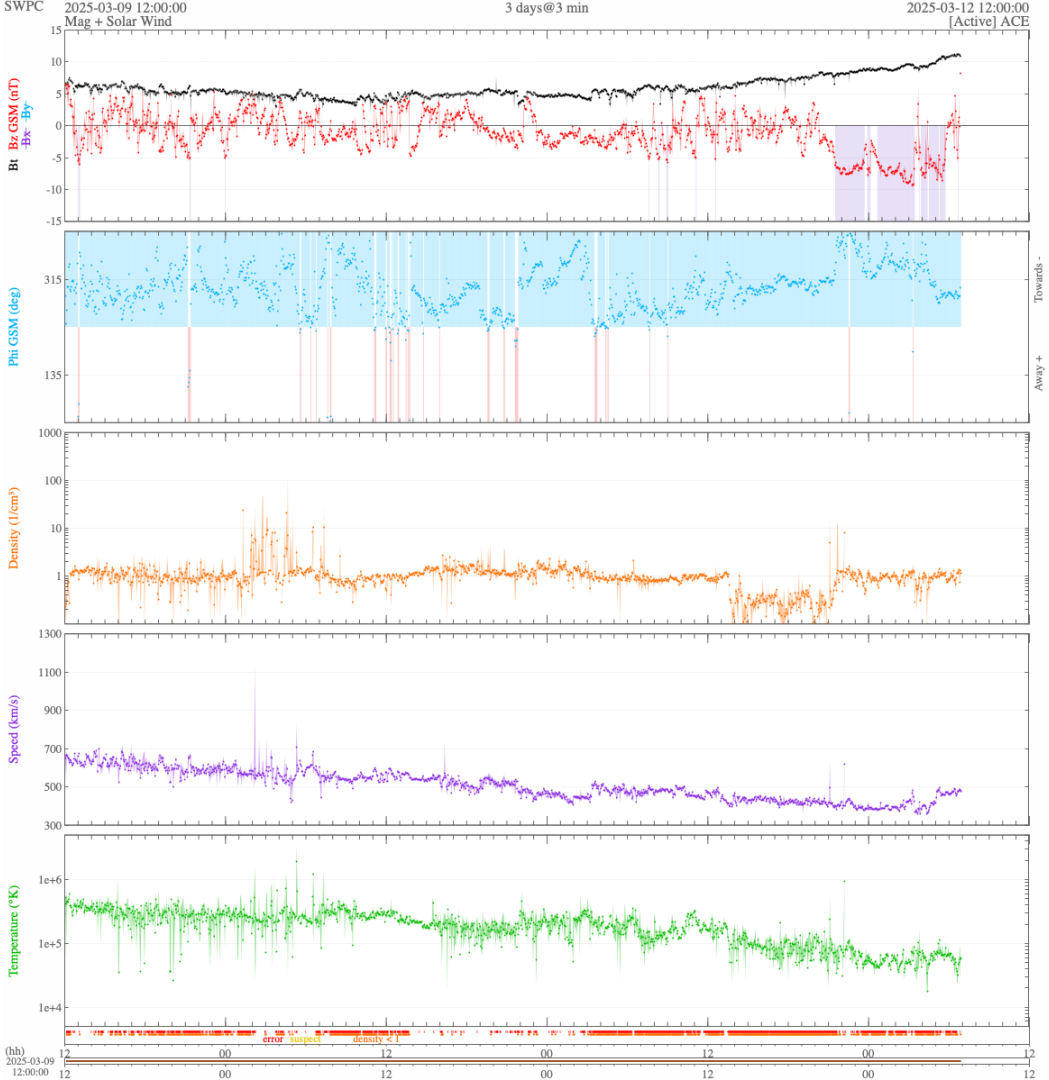
3 Solar Wind Transients: SBC

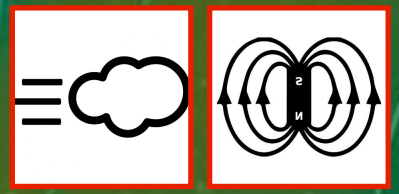




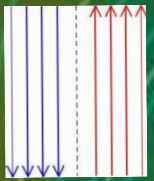


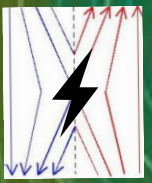

L4
L3
L1
L2
L5

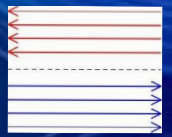

SWPC
2025-03-09 12:00:00
3 days@3 min
2025-03-12 12:00:00
Mag + Solar Wind
[Active] ACE
Bt
Bz GSM (nT)
Bx
By
Phi GSM (deg)
Towards -
Away +
Density (1/cm³)
Speed (km/s)
Temperature (°K)
error
suspect
density < 1
(hh)
2025-03-09
12:00:00

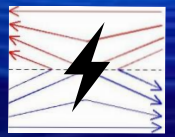


Magnetosphere
Geomagnetic Disturbance

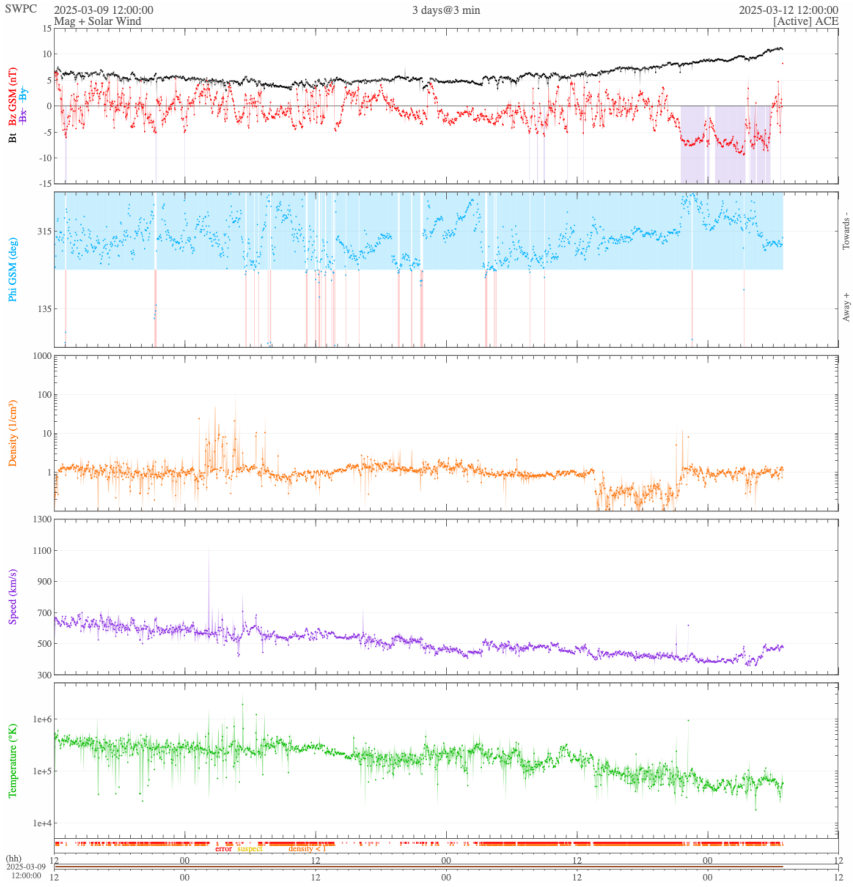




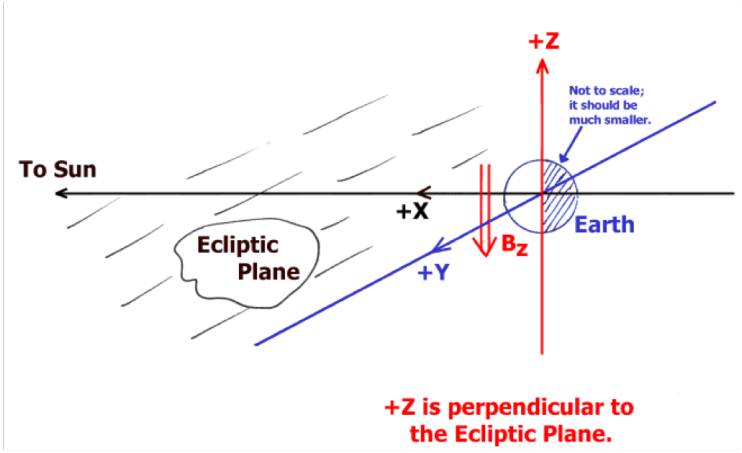


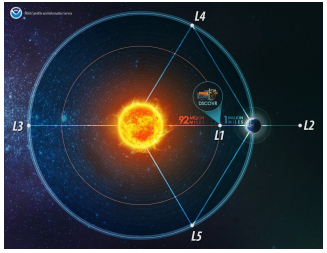


Solar Wind at L1



DSCOVR/ACE





Geomagnetic Disturbance



Weekly | Daily Earth | Daily Heliosphere | All quiet | Presto | Helio Presto | Cactus | CME arrival | Monthly | Quarterly

Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Solar wind

At L1

Categorical electron fluence forecast at GEO

Forecast for 2026-03-23 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (Moderate (>=5e7 and <5e8 part./sr/cm2/day),Moderate (>=5e7 and <5e8 part./sr/cm2/day))

Forecast for 2026-03-24 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (Moderate (>=5e7 and <5e8 part./sr/cm2/day),/)

Forecast for 2026-03-25 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (/,/)

Electron fluxes at GEO

At L1

Categorical Geomagnetism forecast

Day	Category
Forecast for 2026-03-23 (valid for 24h from 12:00 UTC)	--------
Forecast for 2026-03-24 (valid for 24h from 12:00 UTC)	--------
Forecast for 2026-03-25 (valid for 24h from 12:00 UTC)	--------

Geomagnetism K forecast

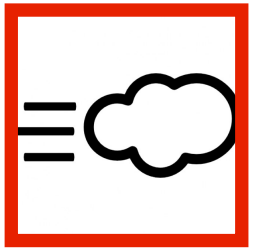
Day/Hours	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24
Forecast local K-index for day 2026-03-23:	* (5,4)	* (5,3)	* (4,3)	* (3,3)	(4,4)	(5,3)	(4,4)	(4,3)
Forecast local K-index for day 2026-03-24:	(3,2)	(3,3)	(2,2)	(3,3)	(4,/)	(3,/)	(3,/)	(2,/)
Forecast local K-index for day 2026-03-25:	(2,/)	(3,/)	(3,/)	(2,/)	(/,/)	(/,/)	(/,/)	(/,/)
Forecast local K-index for day 2026-03-26:	(/,/)	(/,/)		(/,/)				

Between brackets: (forecast from [illegible] ago, forecast from 2 days ago); / means it is not available
*Values indicated with an * will be replaced by the observed values at the moment the ursigram is created.*
Hint: double click on a field to [illegible] in all empty fields!

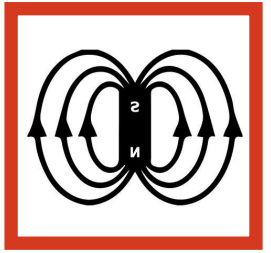
Magnetosphere

Geomagnetism

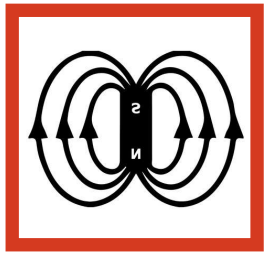
Solar Wind



K index - Forecast



K index - Forecast



Weekly | Daily Earth | Daily Heliosphere | All quiet | Presto | Helio Presto | Cactus | CME arrival | Monthly | Quarterly

Solar Active Regions and flaring | Radio flux forecast | Geospace | Manage issueing

Solar wind

Categorical electron fluence forecast at GEO

Forecast for 2026-03-23 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (Moderate (>=5e7 and <5e8 part./sr/cm2/day),Moderate (>=5e7 and <5e8 part./sr/cm2/day))

Forecast for 2026-03-24 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (Moderate (>=5e7 and <5e8 part./sr/cm2/day),/)

Forecast for 2026-03-25 (valid for 24h from 12:00 UTC): -------- (previous forecasts : (/,/)

Electron fluxes at GEO

Categorical Geomagnetism forecast

Day	Category
Forecast for 2026-03-23 (valid for 24h from 12:00 UTC)	--------
Forecast for 2026-03-24 (valid for 24h from 12:00 UTC)	--------
Forecast for 2026-03-25 (valid for 24h from 12:00 UTC)	--------

Geomagnetism K forecast

Day/Hours	0-3	3-6	6-9	9-12	12-15	15-18	18-21
Forecast local K-index for day 2026-03-23:	* (5,4)	* (5,3)	* (4,3)	* (5,4)	(4,4)	(5,3)	(4,
Forecast local K-index for day 2026-03-24:	(3,2)	(3,3)	(2,2)	(3,3)	(4,/)	(3,/)	(3,
Forecast local K-index for day 2026-03-25:	(2,/)	(3,/)	(3,/)	(2,/)	(/,/)	(/,/)	(/,
Forecast local K-index for day 2026-03-26:	(/,/)	(/,/)	(/,/)	(/,/)			
	*Between brackets: (forecast from 1 day ago, forecast from 2 days ago); / means it is not available Values indicated with an * will be replaced by the observed values at the moment the ursigram is created. Hint: double click on a field to copy it in all empty fields!*						

Geomagnetism

Between brackets : (forecast from 1 day ago, forecast from 2 days ago); / means it is not availabl

ist

- ✓ ---------
- No forecast
- Quiet (A<20 and K<4)
- Active conditions expected (A>=20 or K=4)
- Minor storm expected (A>=30 or K=5)
- Moderate (ISES: Major) magstorm expected (A>=50 or K=6)
- Major (ISES: Severe) magstorm expected (A>=100 or K>=7)
- Warning condition (activity levels expected to increase, but no numeric forecast given)

on.

Ursigram

```
:Issued: 2026 Mar 22 1239 UTC
:Product: documentation at http://www.sidc.be/products/meu
#-----------------------------------------------------------------------#
# DAILY BULLETIN ON SOLAR AND GEOMAGNETIC ACTIVITY from the SIDC        #
# (RWC Belgium)                                                         #
#-----------------------------------------------------------------------#
SIDC URSIGRAM 60322
SIDC SOLAR BULLETIN 22 Mar 2026, 1238UT
SIDC FORECAST
SOLAR FLARES  : C-class flares expected, (probability >=50%)
GEOMAGNETISM  : Major (ISES: Severe) magstorm expected (A>=100 or K>=7)
SOLAR PROTONS : Quiet
PREDICTIONS FOR 22 Mar 2026  10CM FLUX: 113 / AP: 071
PREDICTIONS FOR 23 Mar 2026  10CM FLUX: 119 / AP: 043
PREDICTIONS FOR 24 Mar 2026  10CM FLUX: 124 / AP: 016

Solar Active Regions and flaring: Solar flaring activity was low over the
past 24 hours. The largest flare was a C1.1 flare (SIDC Flare 7238) peaking
on March 21 at 16:07 UTC. There are currently 8 numbered regions on the
disk. Three new regions rotated over the east solar limb and were numbered.
SIDC Sunspot Group 828 (NOAA Active Region 4398, magnetic type beta) and
SIDC Sunspot Group 826 (NOAA Active Region 4400, magnetic type beta) both
exhibited flux emergence. SIDC Sunspot Group 820 (NOAA Active Region 4392
magnetic type beta) is the largest region on disk but has been stable over
the period. Solar flaring activity is expected to be low over the next 24
hours, with C-class flares probable and a chance for M-class flares.

Coronal mass ejections: No new Earth directed CMEs were detected in the
available coronagraph imagery.

Coronal holes: An extended negative polarity equatorial coronal hole (SIDC
Coronal Hole 147) continues to transit the central meridian.

Solar wind: The solar wind parameters reflected the ongoing ICME passage
(SIDC CME 641) and a transition to the fast solar wind associated with
(SIDC Coronal Hole 147). The interplanetary magnetic field reached a
maximum of 39 nT at 15:24 UTC March 21. At the end of the period the
interplanetary magnetic field strength was stable around 15 nT. The solar
wind speed was around 500 km/s for the first half of the period and then
began to gradually increase to values around 620 km/s by the end of the
period. Bz was mostly positive until 06:00 UTC March 22 when a long period
of negative Bz began with a minimum of -11nT. The solar wind speed is
expected to remain enhanced over the next 24 hours due to the high speed
stream associated with the large negative polarity equatorial coronal hole
(SIDC Coronal Hole 147).

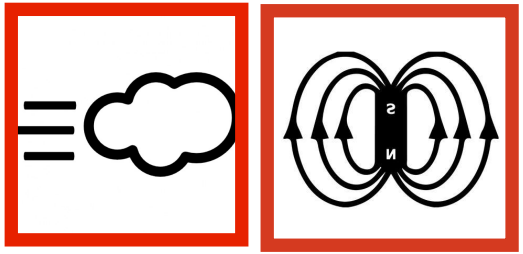
Geomagnetism: The geomagnetic conditions were at unsettled to active levels
at the start of the period but increased to minor storm conditions globally
between 03:00 and 09:00 UTC on March 22 and then reached major storm
conditions globally (NOAA KP  7-) from 09:00 UTC on March 22. This was in
response to the extended period of negative Bz. Locally, moderate storm
levels were observed (K-Bel = 6).  Moderate to major storm conditions are
expected for the rest of March 22, due to the high speed a high speed
stream influence. This is expected to gradually reduce to minor storm
conditions from March 23.

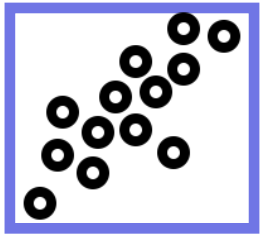
Proton flux levels: The greater than 10 MeV proton flux was below the 10
pfu threshold over the past 24 hours. It is expected to remain below this
threshold level over the next 24 hours.

Electron fluxes at GEO: The greater than 2 MeV electron flux, as measured
by GOES-18 and GOES-19 satellites, was below the 1000 pfu threshold. The
greater than 2 MeV electron flux is expected to be at or just above the
1000 pfu threshold over the next 24 hours. The electron fluence was at
normal levels and is expected to be at normal levels for the next 24 hours.

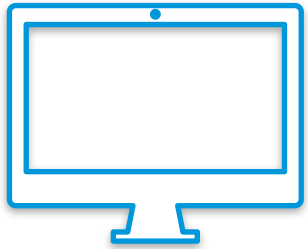

TODAY'S ESTIMATED ISN  : 105, BASED ON 18 STATIONS.
```



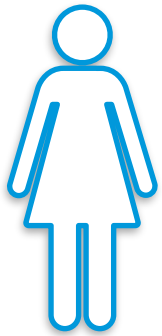


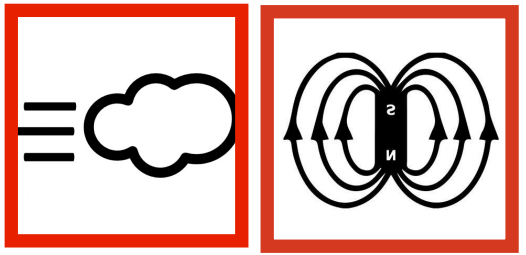


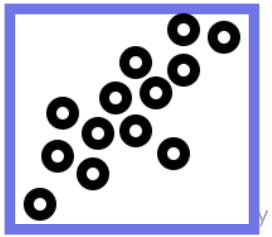
Alerts







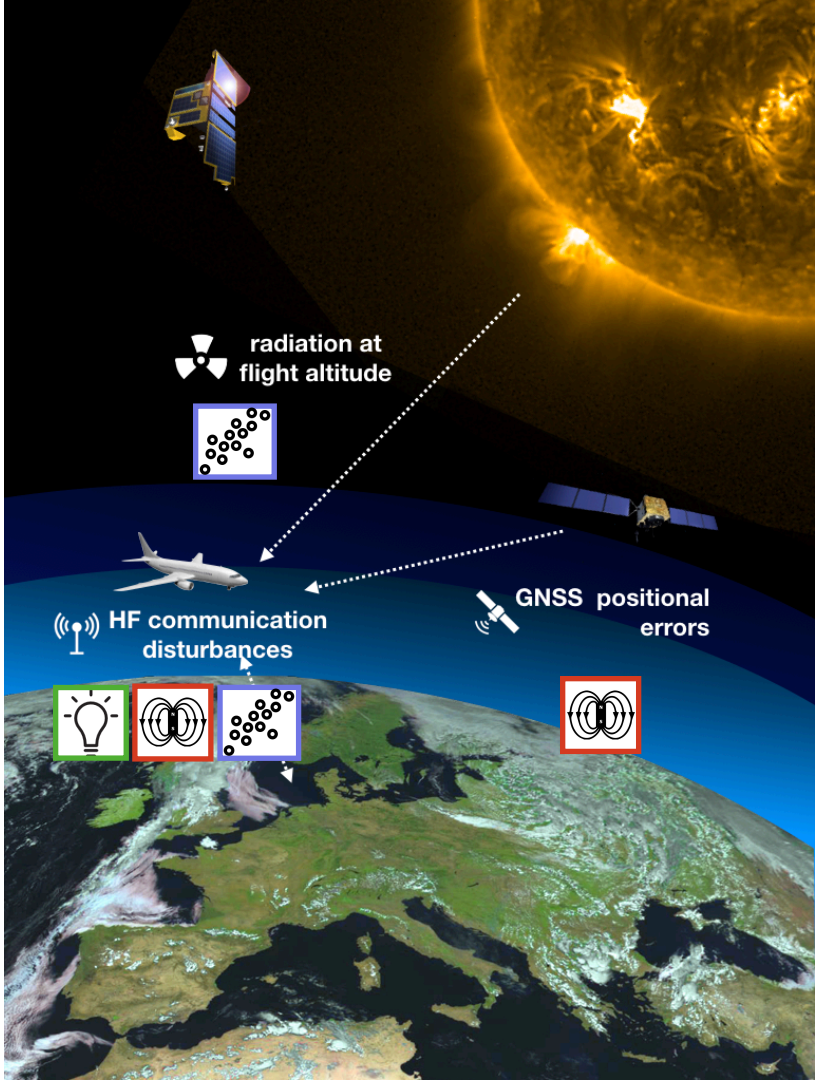




IMPACTS

SWx IMPACT on aviation

Space weather impact our navigation and radio communication systems and can cause an increase of radiation levels at flight altitude.



GNSS	Moderate	Severe	Time UTC	Value	Status	Alert	3h-Value	3h-Status
GNSS amplitude HNH	0.5	0.8	2026-02-10 10:05	0.00	QUIET		0.00	QUIET
GNSS phase HNH	0.4	0.7	2026-02-10 10:05	0.00	QUIET		0.00	QUIET
GNSS amplitude HSH	0.5	0.8	2026-02-10 09:45	0.00	QUIET		0.00	QUIET
GNSS phase HSH	0.4	0.7	2026-02-10 09:45	0.00	QUIET		0.00	QUIET
GNSS amplitude EQMH	0.5	0.8	2026-02-10 10:10	0.00	QUIET		0.00	QUIET
GNSS phase EQMH	0.4	0.7	2026-02-10 10:10	0.00	QUIET		0.00	QUIET
Vertical TEC	125	175	2026-02-10 10:10	71	QUIET		79	QUIET

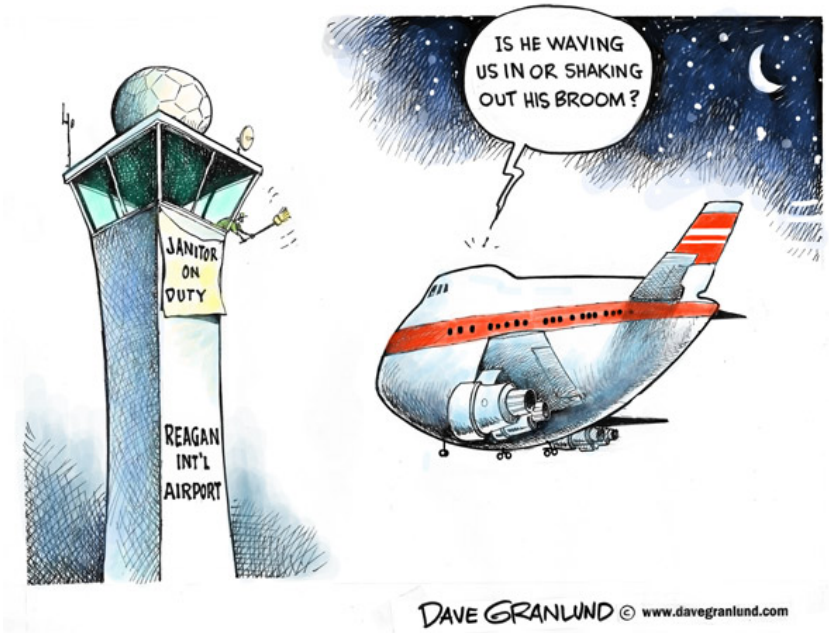
RADIATION	Moderate	Severe	Time UTC	Value	Status	Alert	3h-Value	3h-Status
Effective Dose FL ≤ 460	30	80	2026-02-10 10:10	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2026-02-10 10:10	0	QUIET		0	QUIET

HF	Moderate	Severe	Time UTC	Value	Status	Alert	3h-Value	3h-Status
Auroral Absorption (AA)	7.66	8.66	2026-02-10 10:00	2	QUIET		2	QUIET
Polar Cap Absorption (PCA)	2	5	2026-02-10 10:05	0.15	QUIET		0.31	QUIET
Shortwave Fadeout (SWF)	X1.0	X10.0	2026-02-10 10:10	C1.5	QUIET		C3.2	QUIET
Post-Storm Depression (PSD)	0.3	0.5	2026-02-10 10:00	0	QUIET		0	QUIET

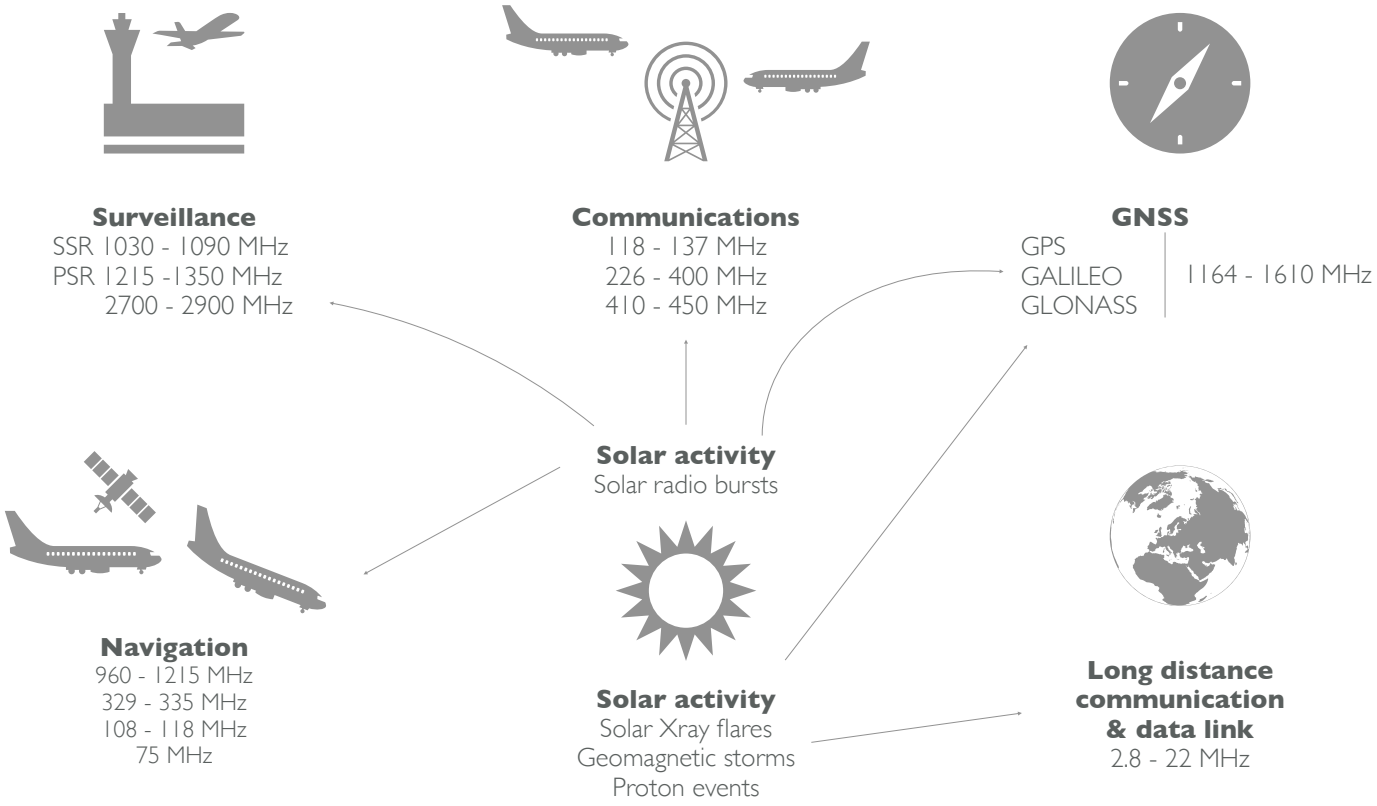
HF Advisory:

0000057501
FNXX02 EFKL 020814
SWX ADVISORY
DTG: 20260202/0814Z
SWXC: PECASUS
SWX EFFECT: HF COM
ADVISORY NR: 2026/63
OBS SWX: 02/0808Z MOD DAYSIDE
FCST SWX +6 HR: 02/1500Z NOT AVBL
FCST SWX +12 HR: 02/2100Z NOT AVBL
FCST SWX +18 HR: 03/0300Z NOT AVBL
FCST SWX +24 HR: 03/0900Z NOT AVBL
RMK: SPACE WEATHER EVENT (SOLAR FLARE) IN PROGRESS. IMPACT ON LOWER HF COM FREQUENCY BANDS EXPECTED
ON THE DAYLIGHT SIDE. HIGHER FREQUENCY BANDS MAY BE LESS
IMPACTED.
NXT ADVISORY: WILL BE ISSUED BY 20260202/1408Z=

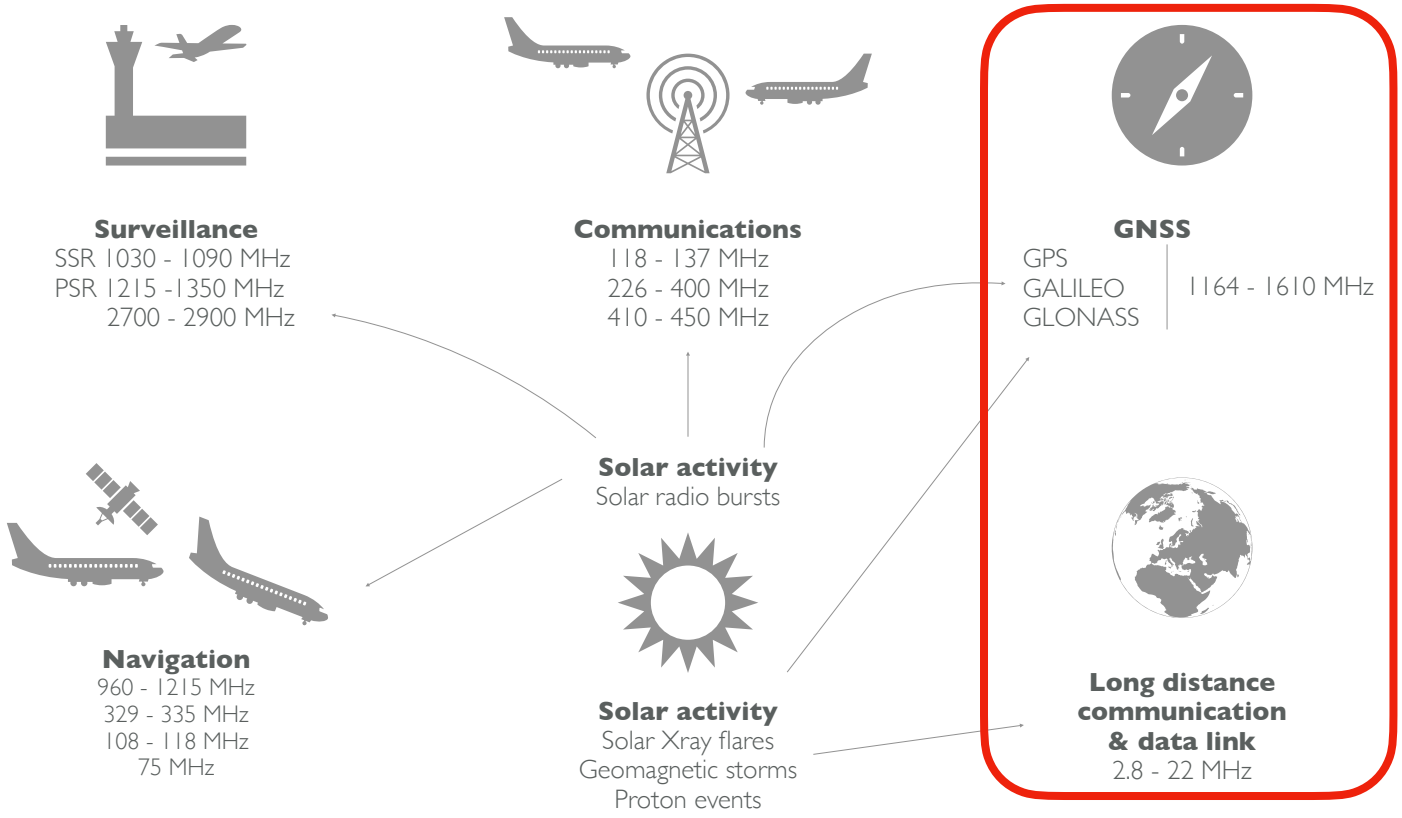
Radio Frequencies used in aviation



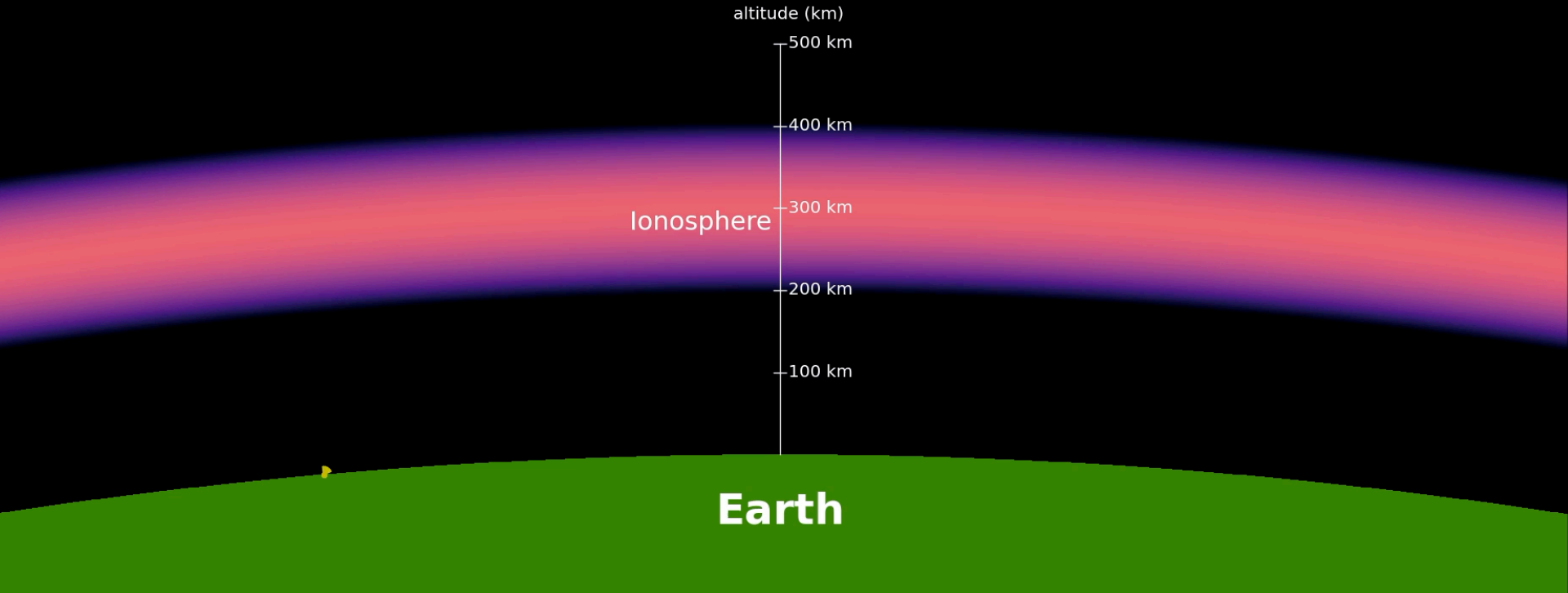
Radio Frequencies used in aviation



Radio Frequencies used in aviation



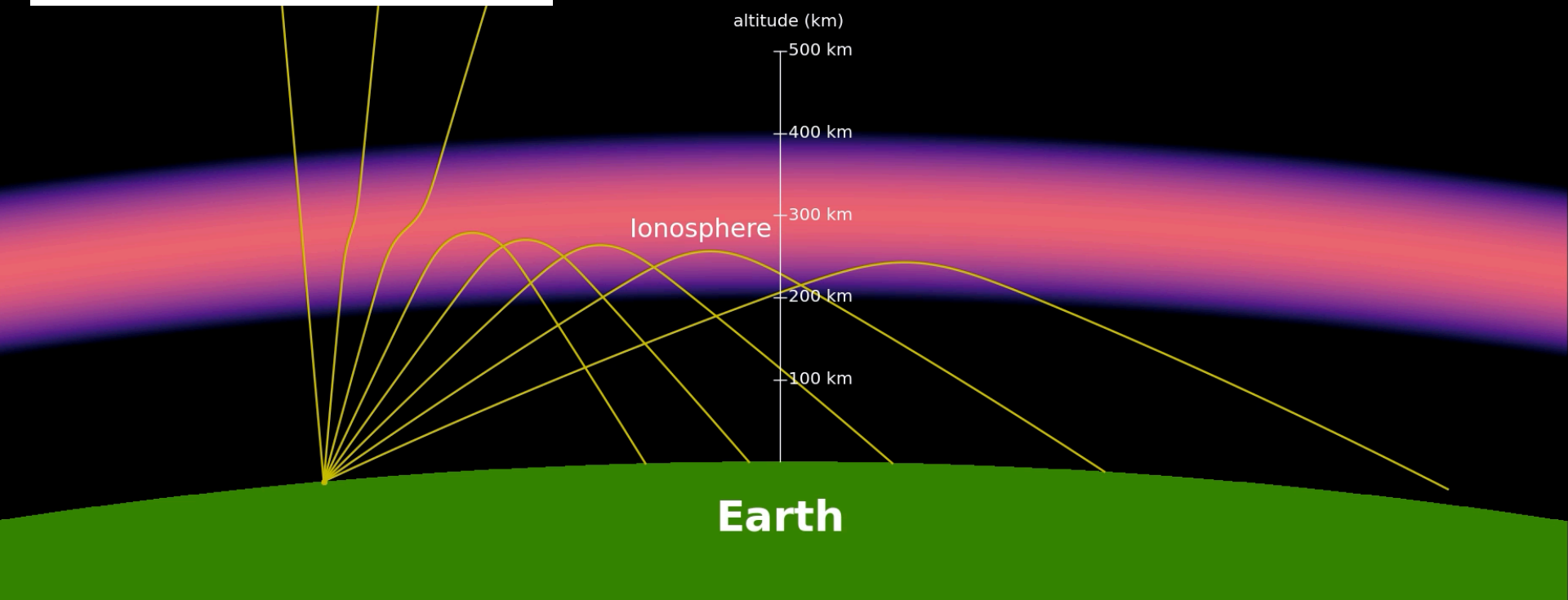
Radio waves and the ionosphere



The plasma frequency affects the refractive index of the medium

$$f_p \propto \sqrt{n_o} \qquad n = \sqrt{1 - \frac{f_p^2}{f^2}}$$

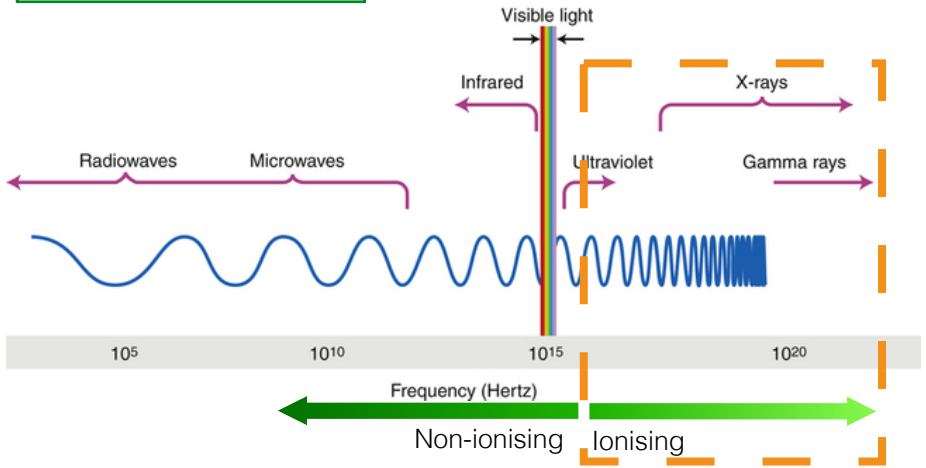
Each layer will reflect or absorb or let pass radio waves depending on their frequencies and on the characteristic frequency.



What can ionise and define the electron density?

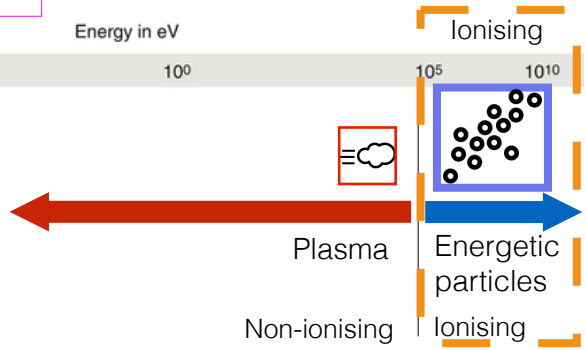
Electromagnetic radiation

- Photons / electromagnetic waves
- Speed of light

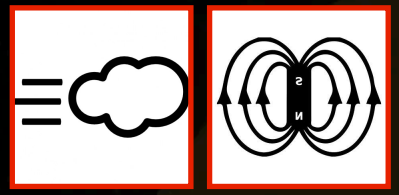


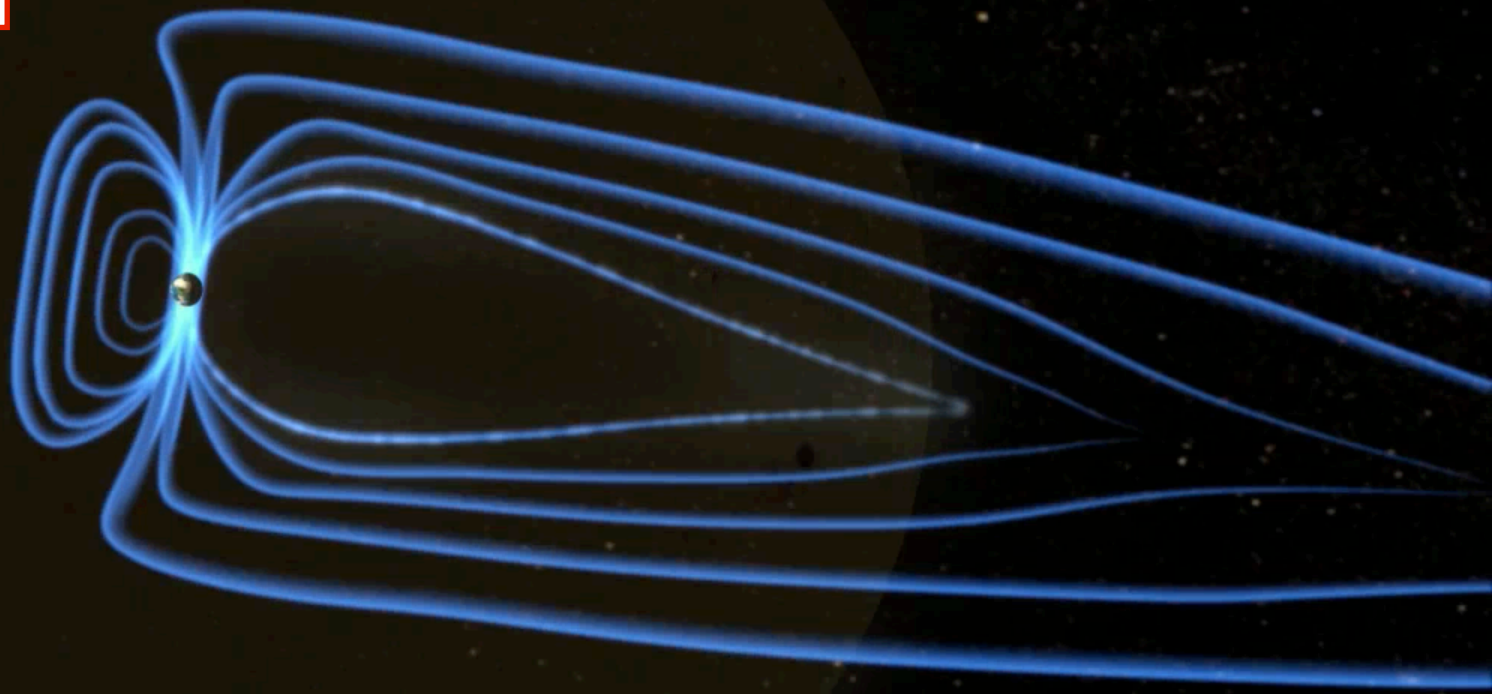
Particles

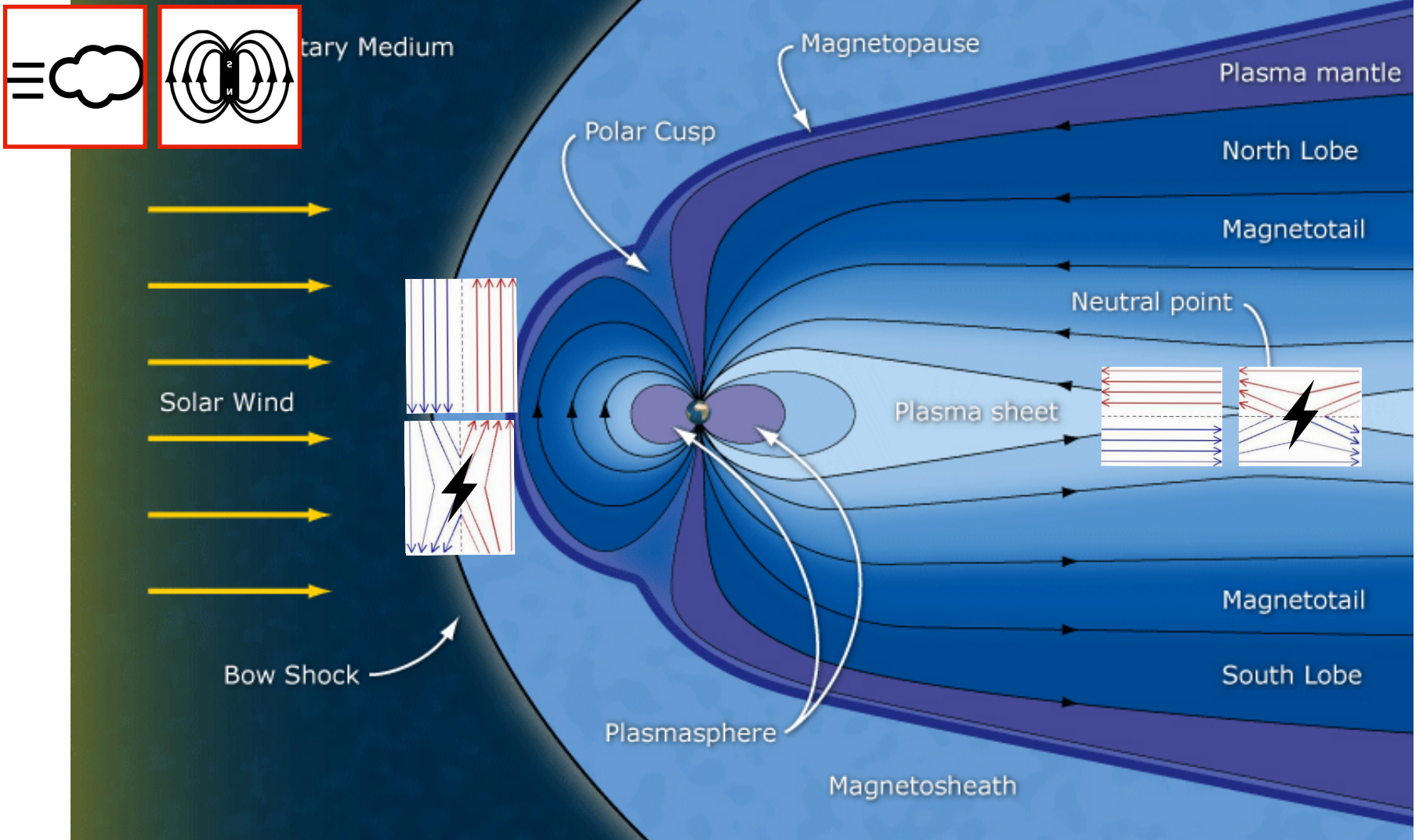
- Atomic & sub-atomic particles
- m/s to fractions of speed of light

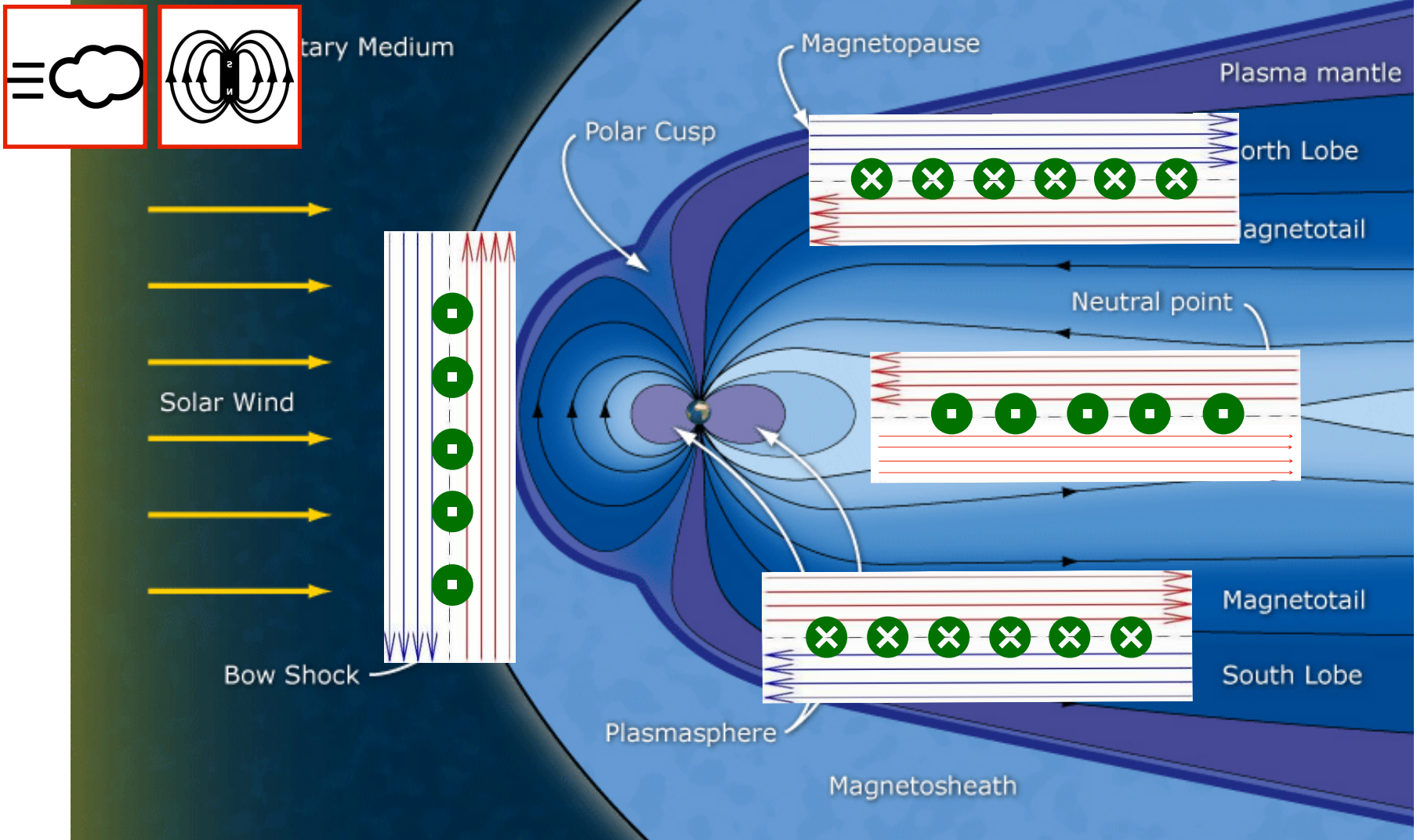


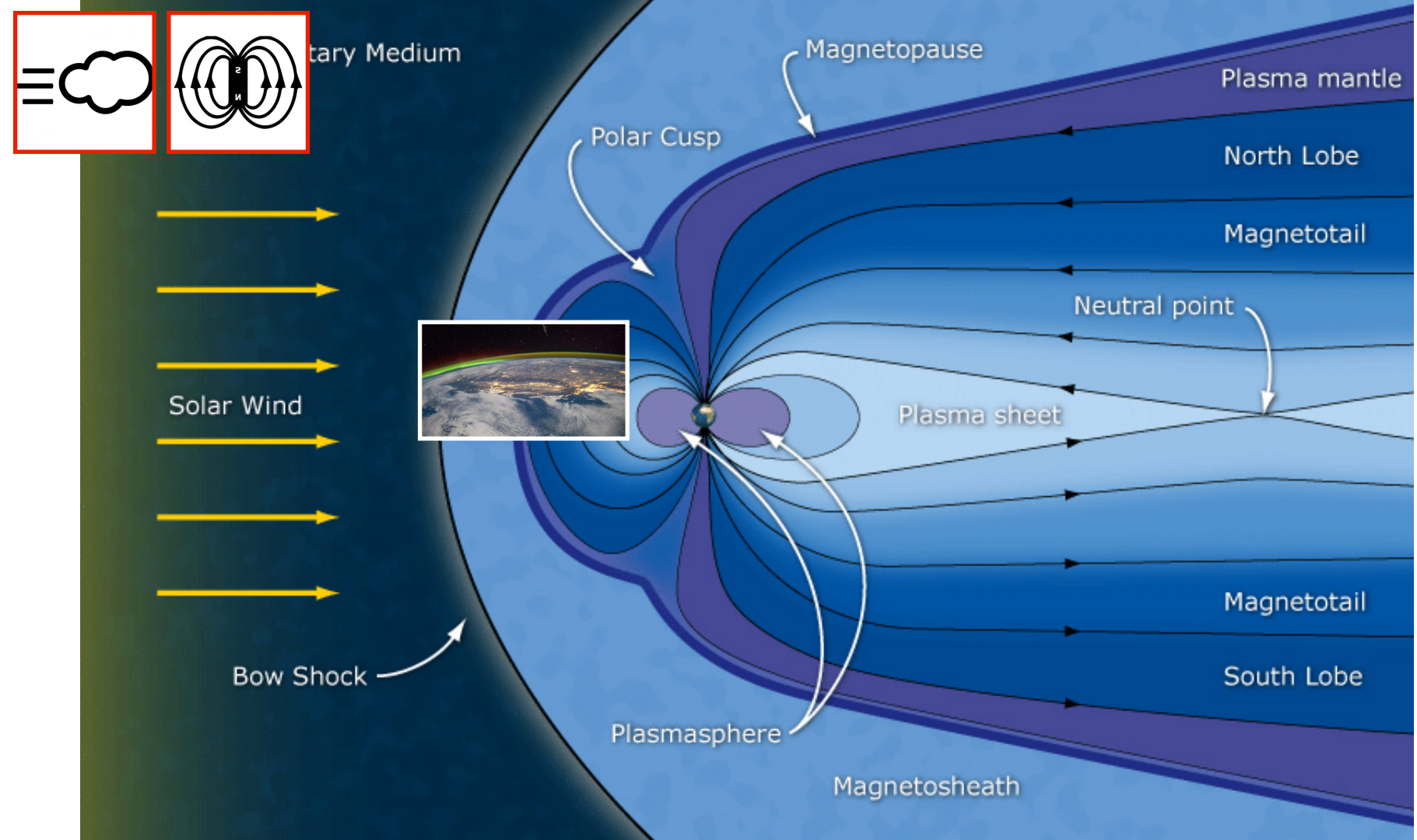
Can the solar wind impact the ionosphere and change the electron density?


S
N



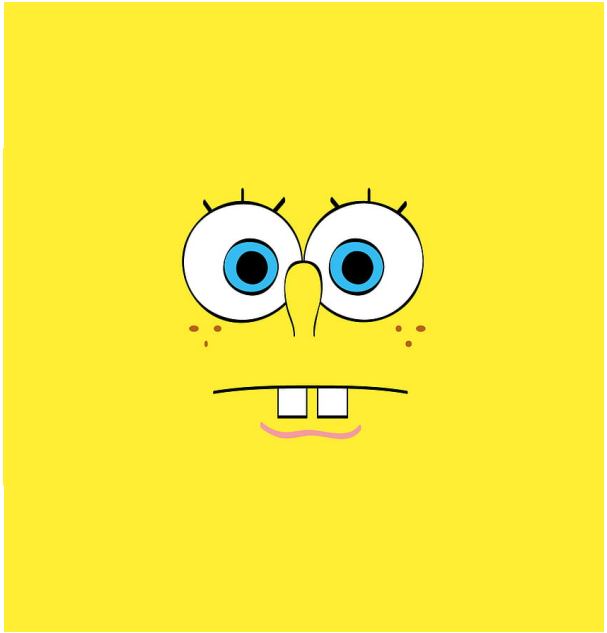

tary Medium
Magnetopause
Plasma mantle
Polar Cusp
North Lobe
Magnetotail
Neutral point
Solar Wind
Plasma sheet
Magnetotail
Bow Shock
South Lobe
Plasmasphere
Magnetosheath


tary Medium
Magnetopause
Plasma mantle
Polar Cusp
orth Lobe
agnetotail
Neutral point
Solar Wind
Magnetotail
South Lobe
Bow Shock
Plasmasphere
Magnetosheath


tary Medium
Magnetopause
Plasma mantle
Polar Cusp
North Lobe
Magnetotail
Neutral point
Solar Wind
Plasma sheet
Magnetotail
Bow Shock
South Lobe
Plasmasphere
Magnetosheath

Impact of space storms on Radio Waves

Absorption



Decrease of MUF



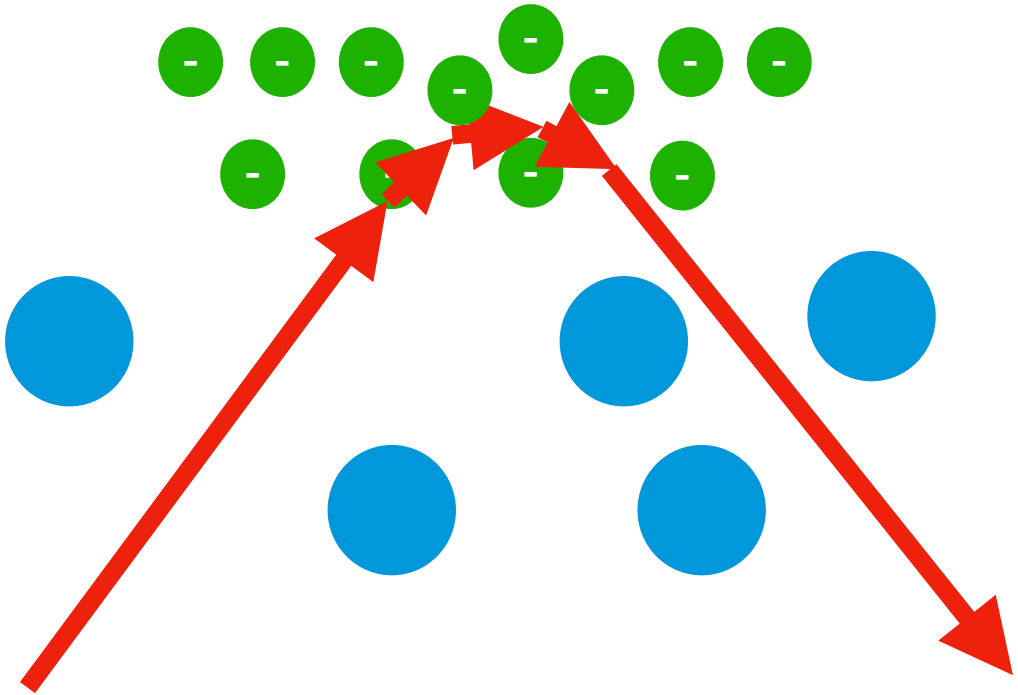
Scintillation



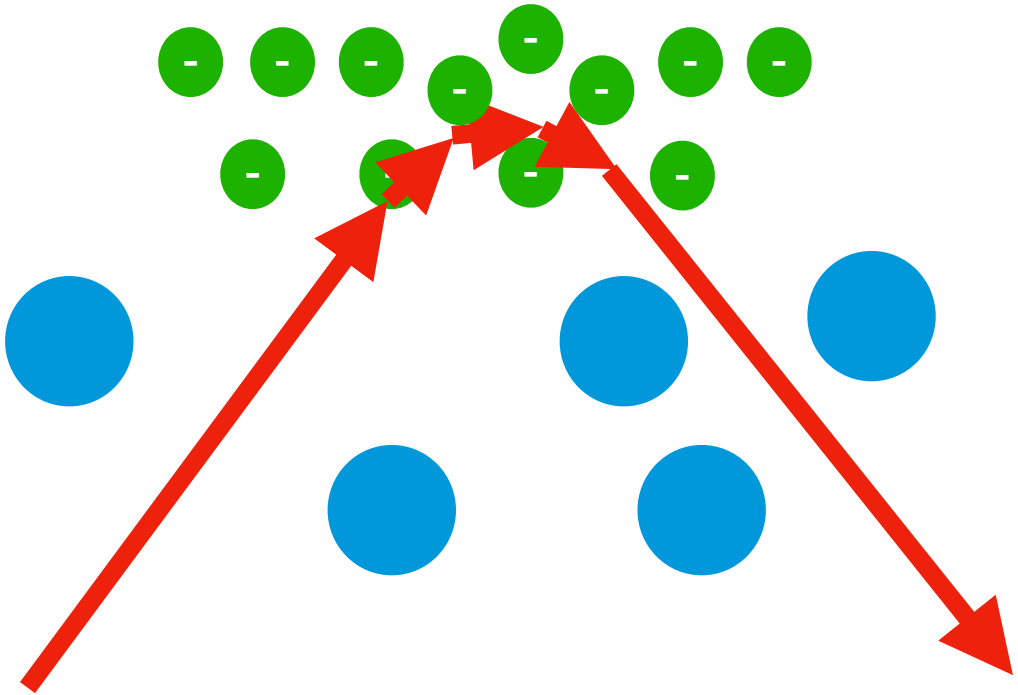
Impact: Absorption of waves



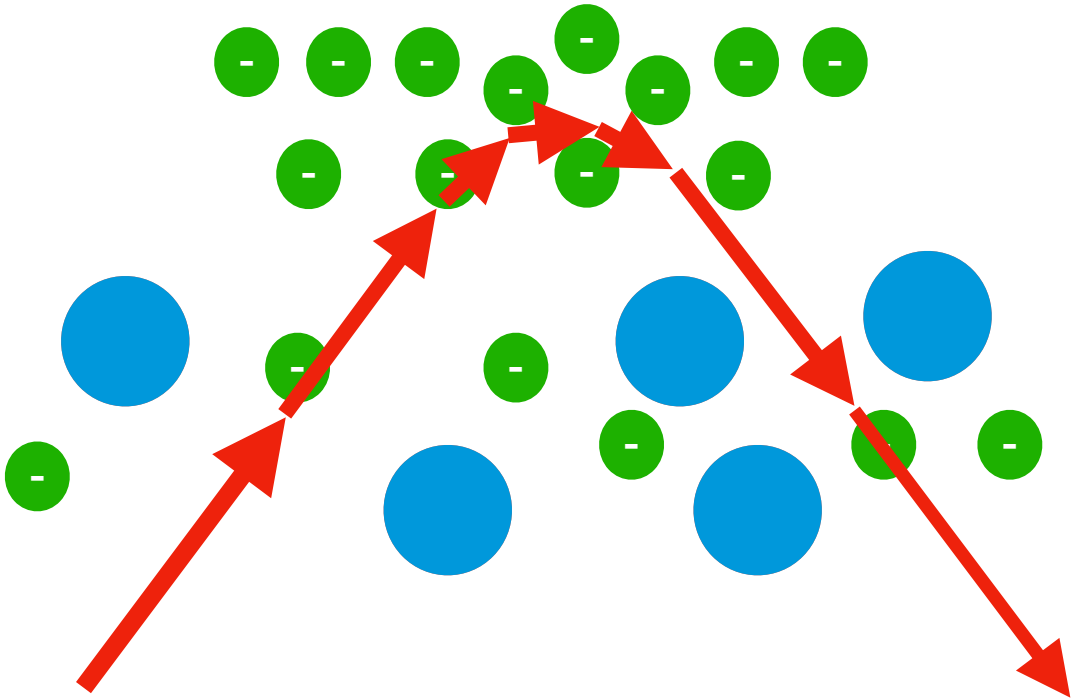
Reflection of waves



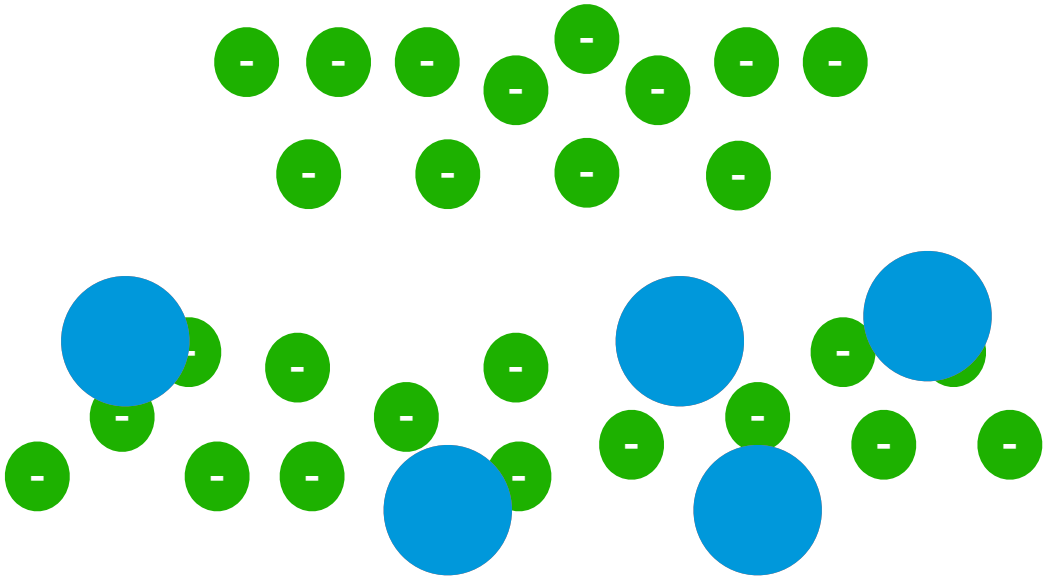
D-layer during the night



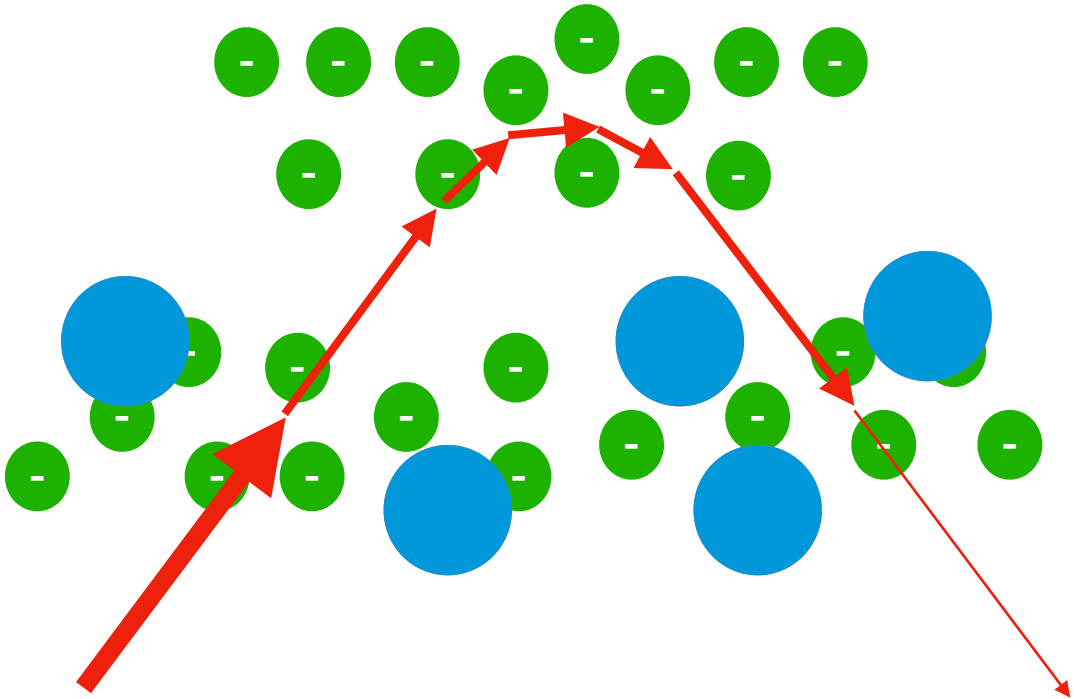
D-layer during the day



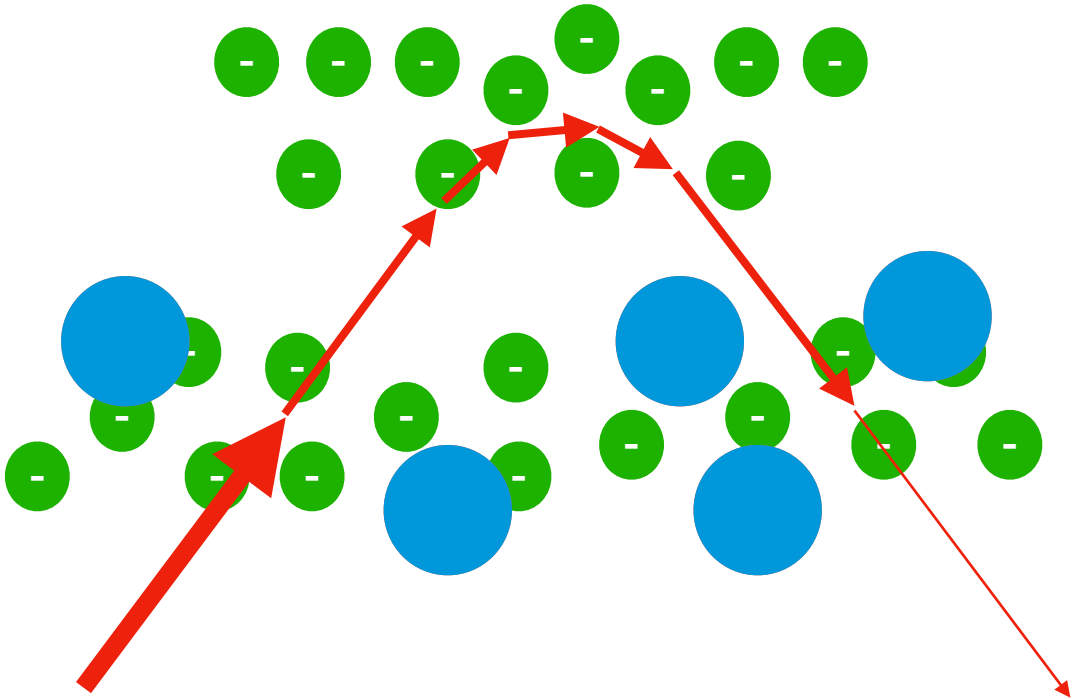
D-layer with extra ionisation

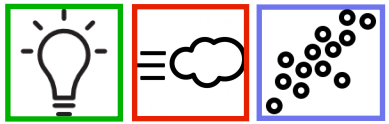


D-layer absorbs radio waves



D-layer with extra ionisation due to a solar event



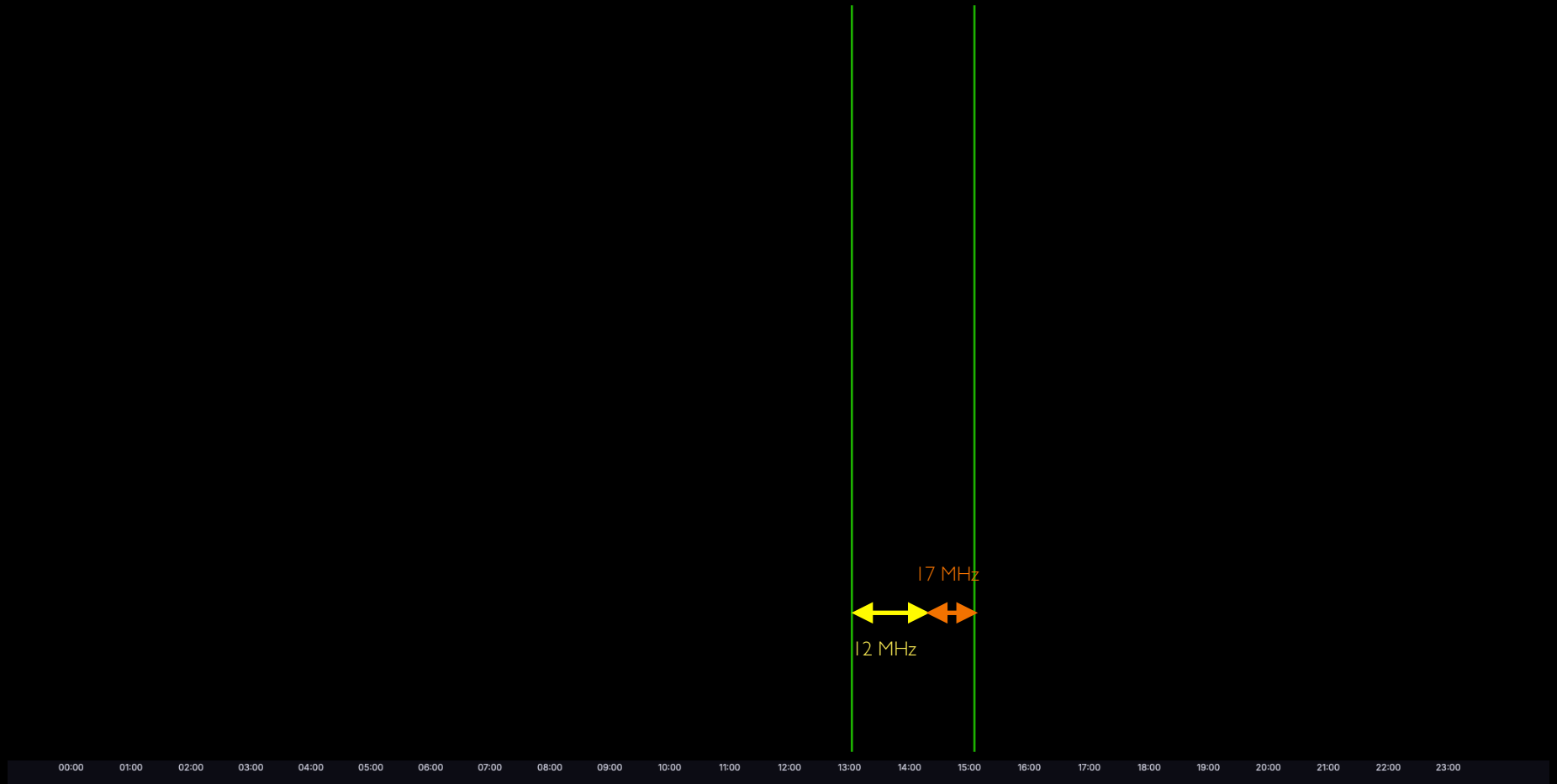


After Mother's day storm - May 15, 2024

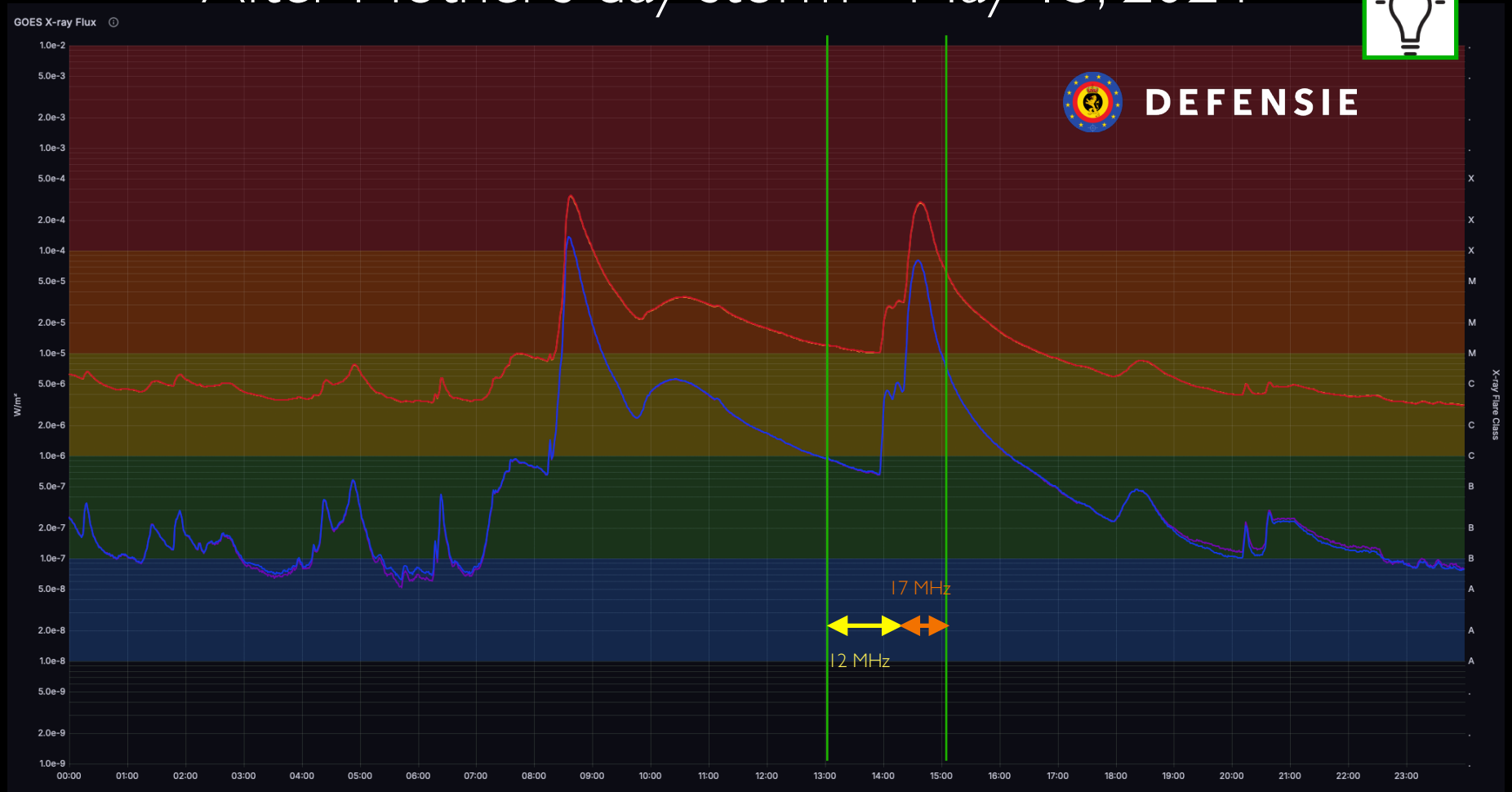


DEFENSIE

After Mother's day storm - May 15, 2024

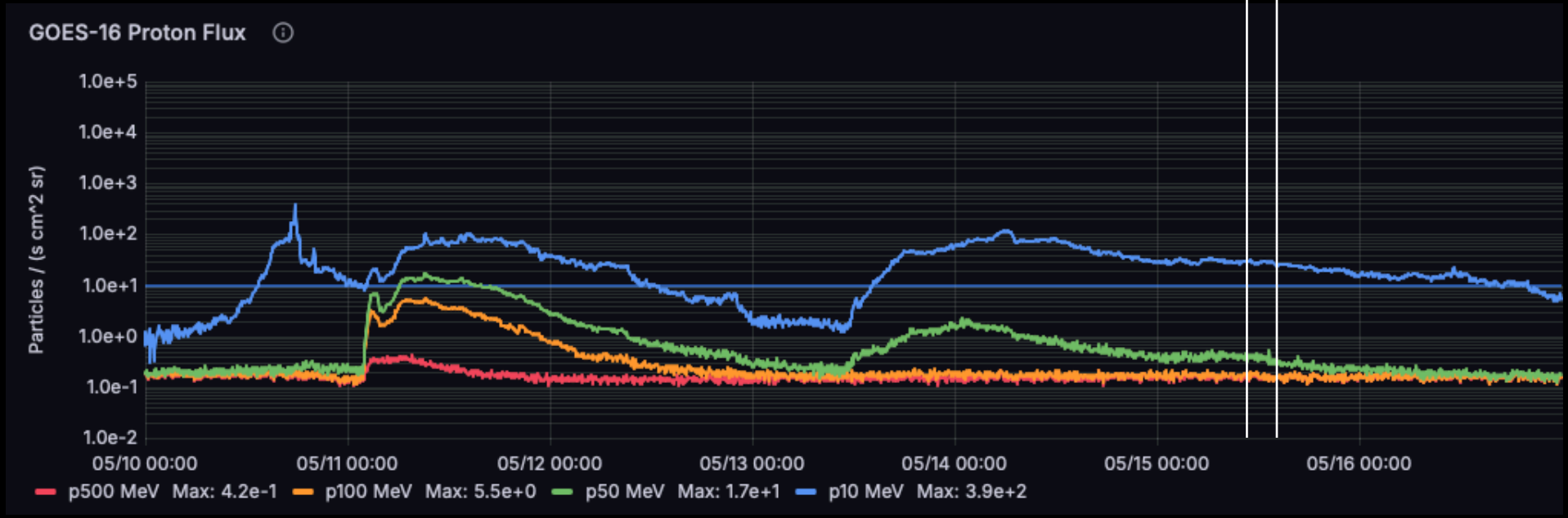


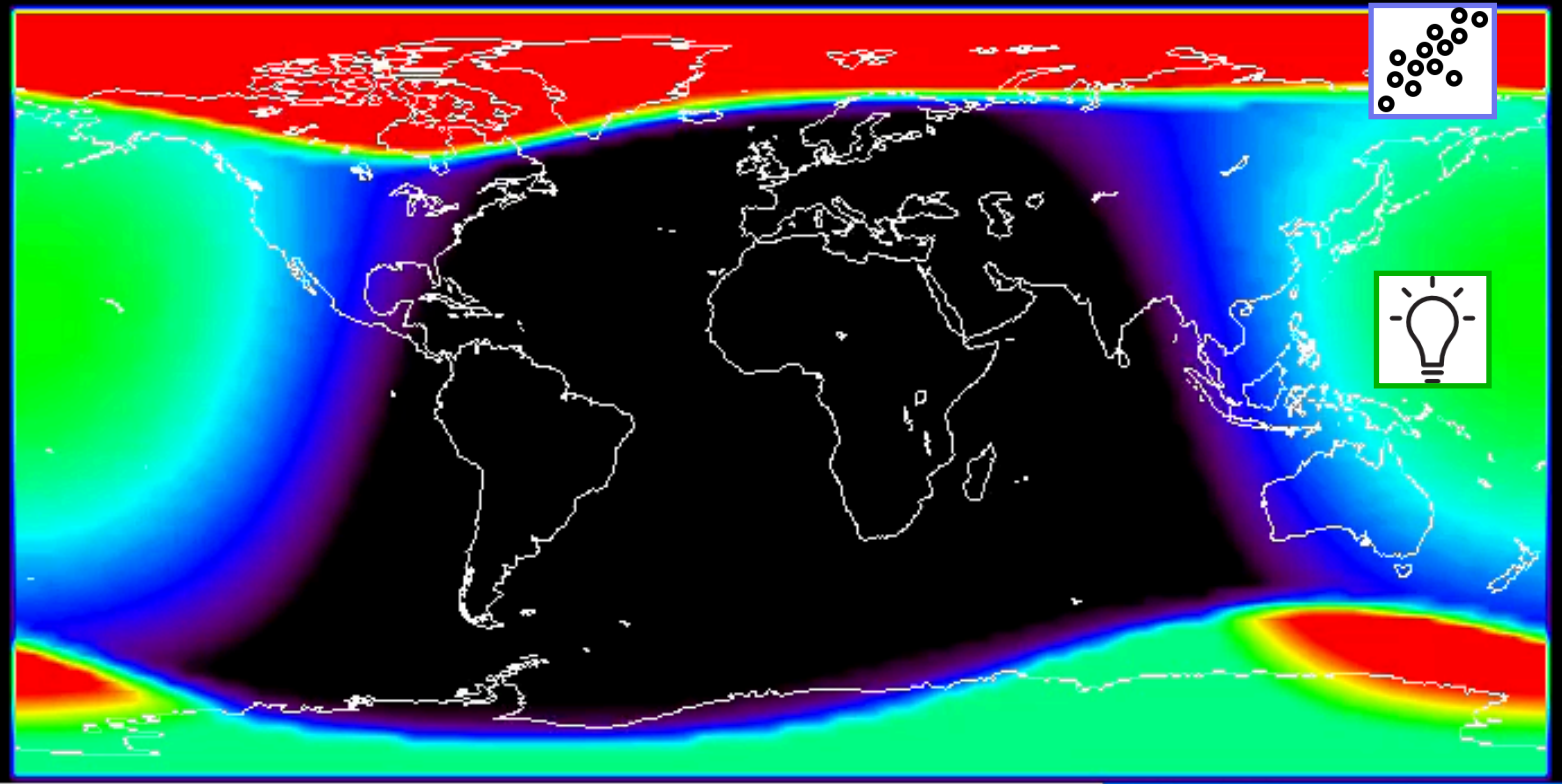
After Mother's day storm - May 15, 2024

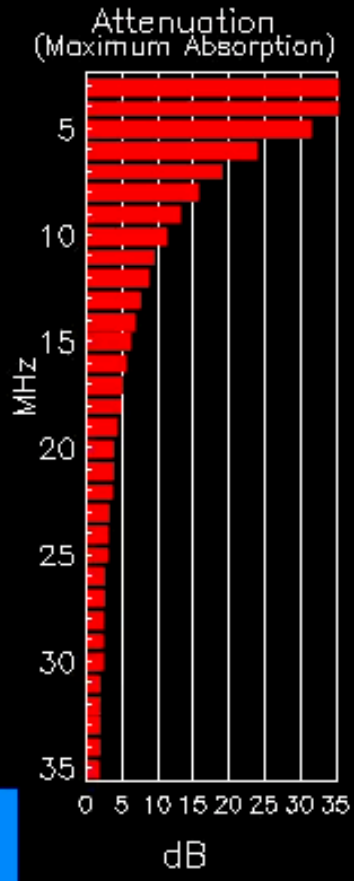


After Mother's day storm - May 15, 2024









Highest Frequency Affected by 1dB Absorption

0 5 10 15 20 25 30 35

Degraded Frequency (MHz)

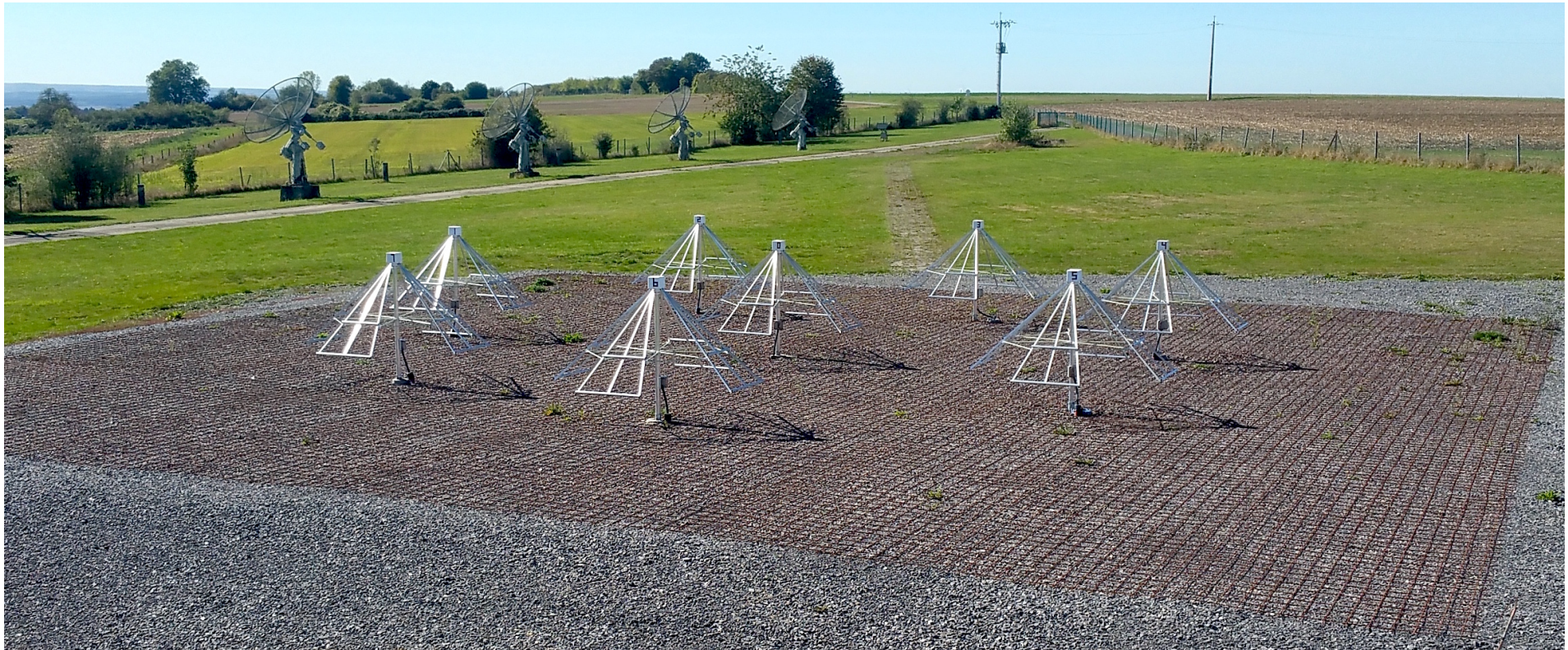
Estimated Recovery Time
High Latitude Protons :
5 HRS 47 MINS
Mid/Low Latitude X-rays :
No Estimate

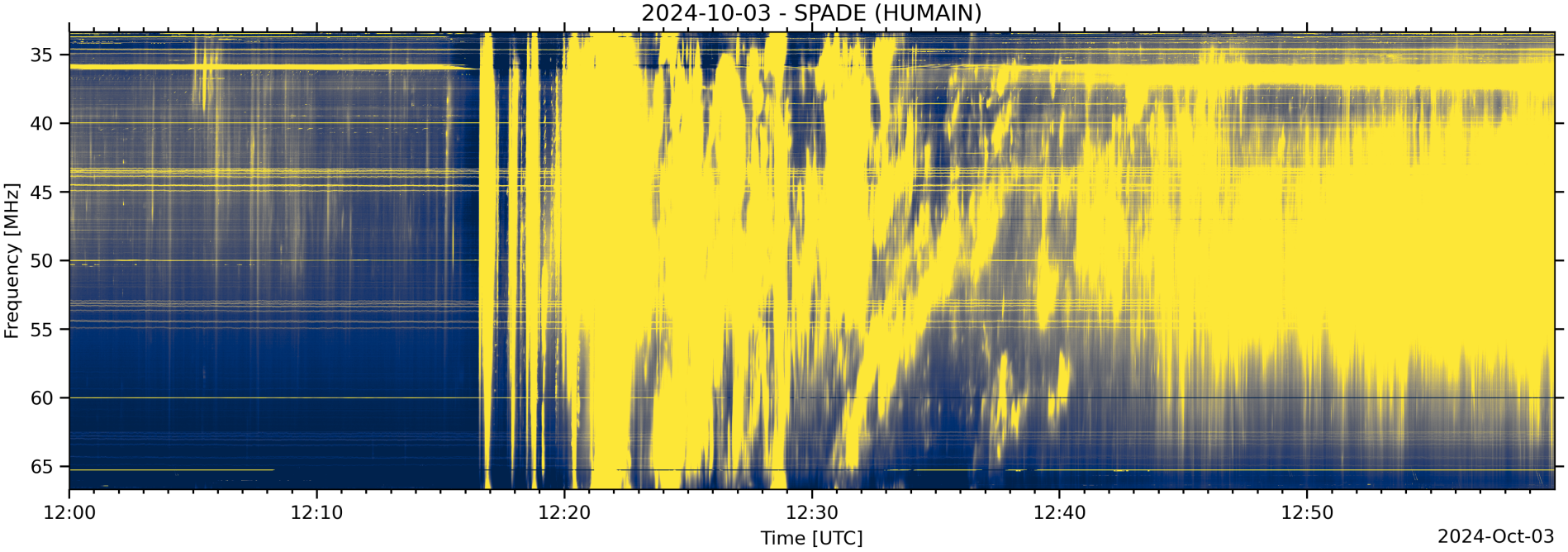
Elevated X-ray flux
Product Valid At : 2024-05-15 00:00 UTC

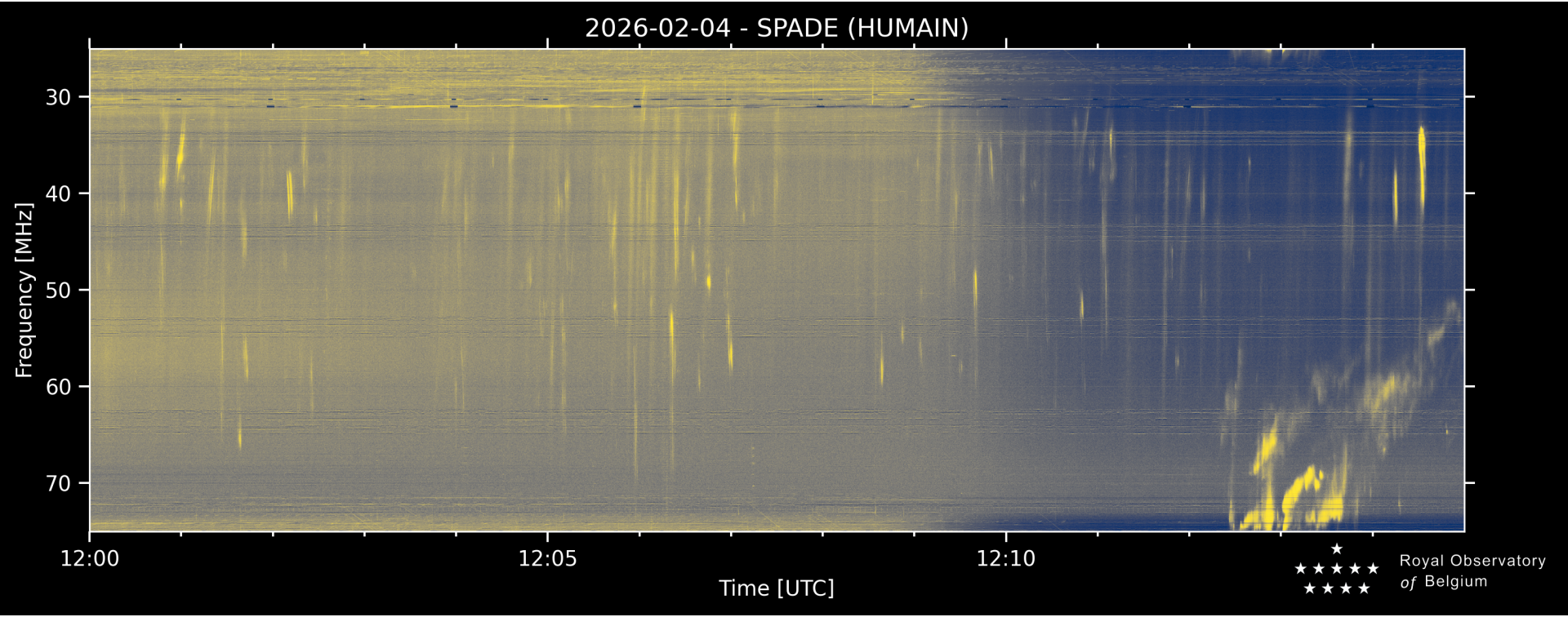
Minor Proton Flux
NOAA/SWPC Boulder, CO USA

SPADE

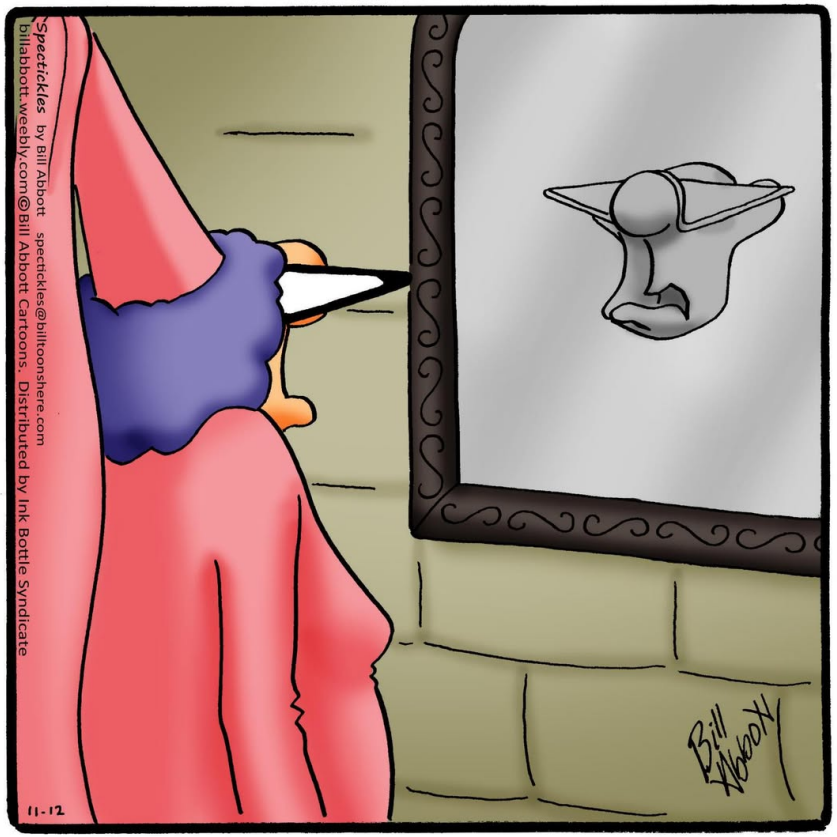
- 25 - 75 MHz
- 8 antennas - phased array
- 20 x 20 m square grid
- Solar spectrograph




2024-10-03 - SPADE (HUMAIN)
Frequency [MHz]
35
40
45
50
55
60
65
12:00
12:10
12:20
12:30
12:40
12:50
Time [UTC]
2024-Oct-03

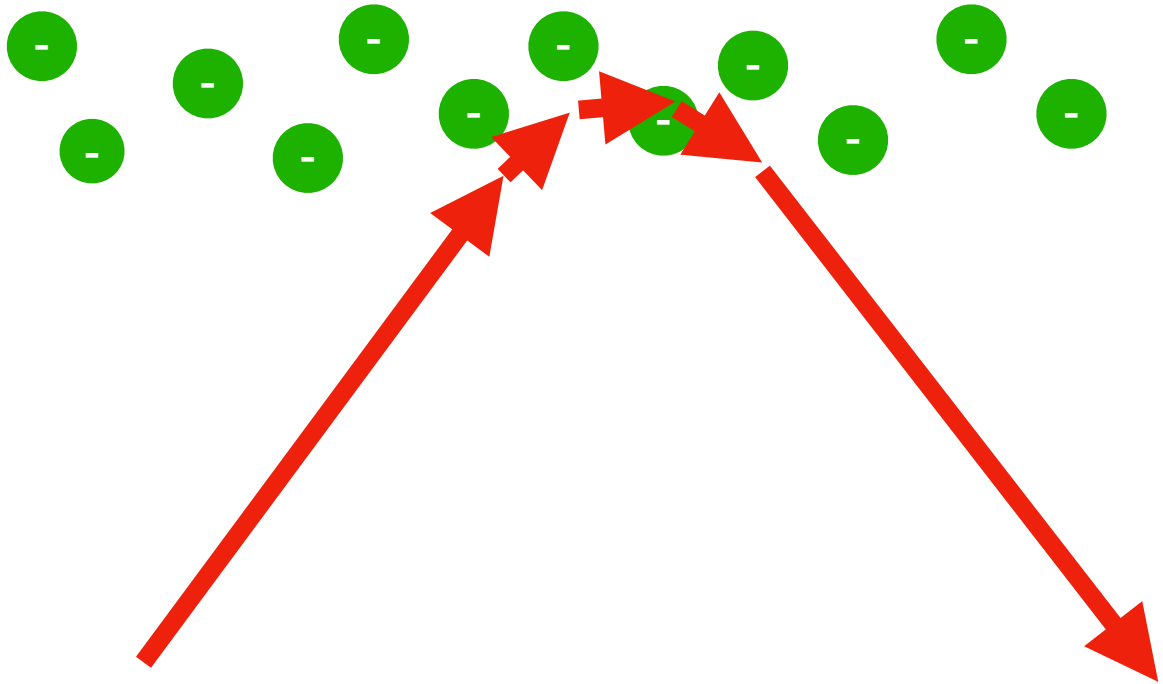

2026-02-04 - SPADE (HUMAIN)
Frequency [MHz]
30
40
50
60
70
12:00
12:05
12:10
Time [UTC]
Royal Observatory
of Belgium

Impact: decrease of MUF

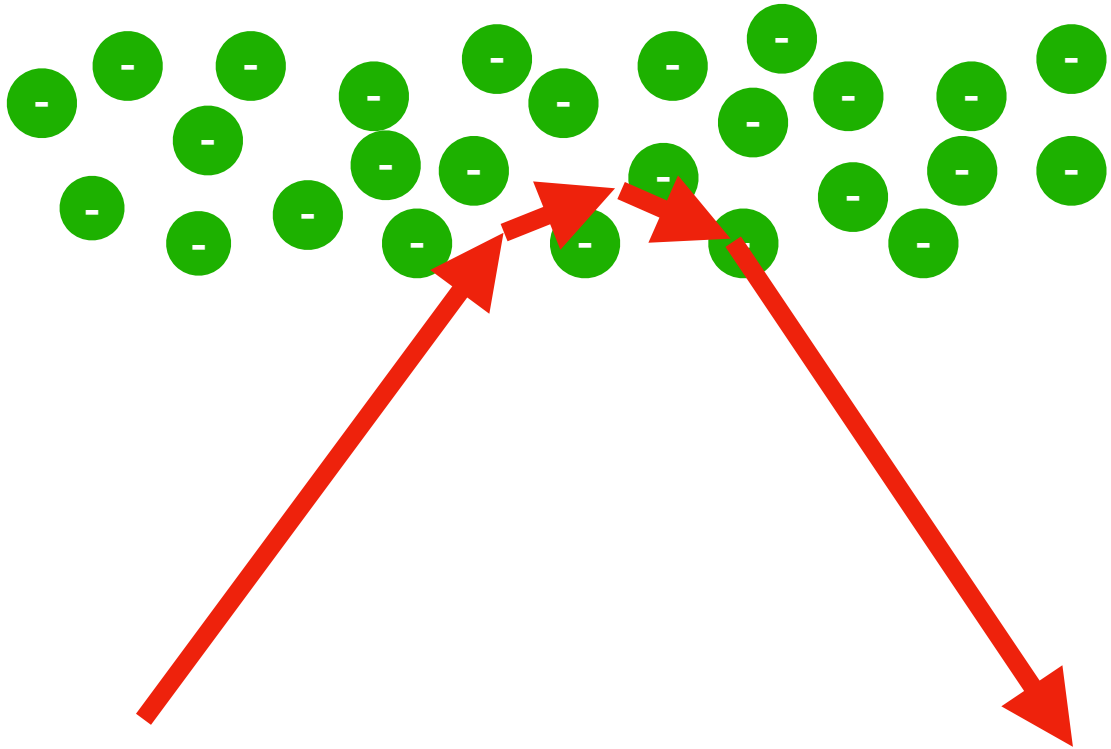


"Before I answer that, may I remind you that it's seven years of bad luck to break a mirror?"

Reflection of HF waves - MUF

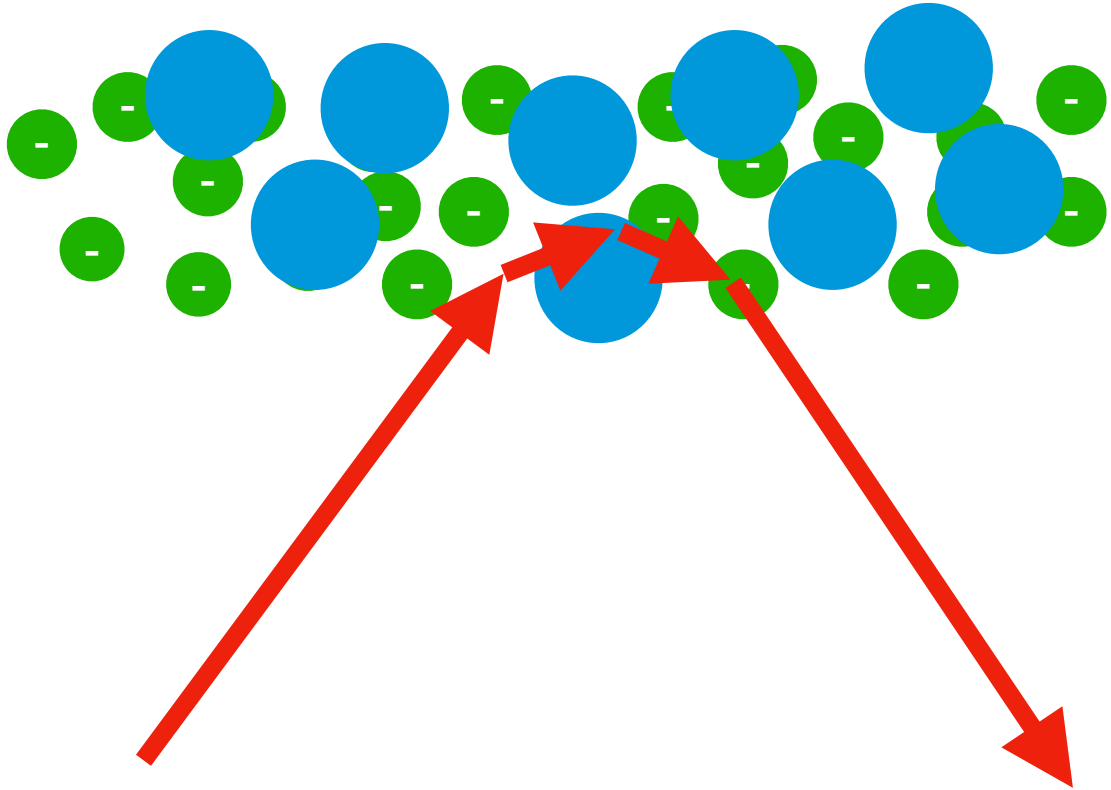


Even better reflection



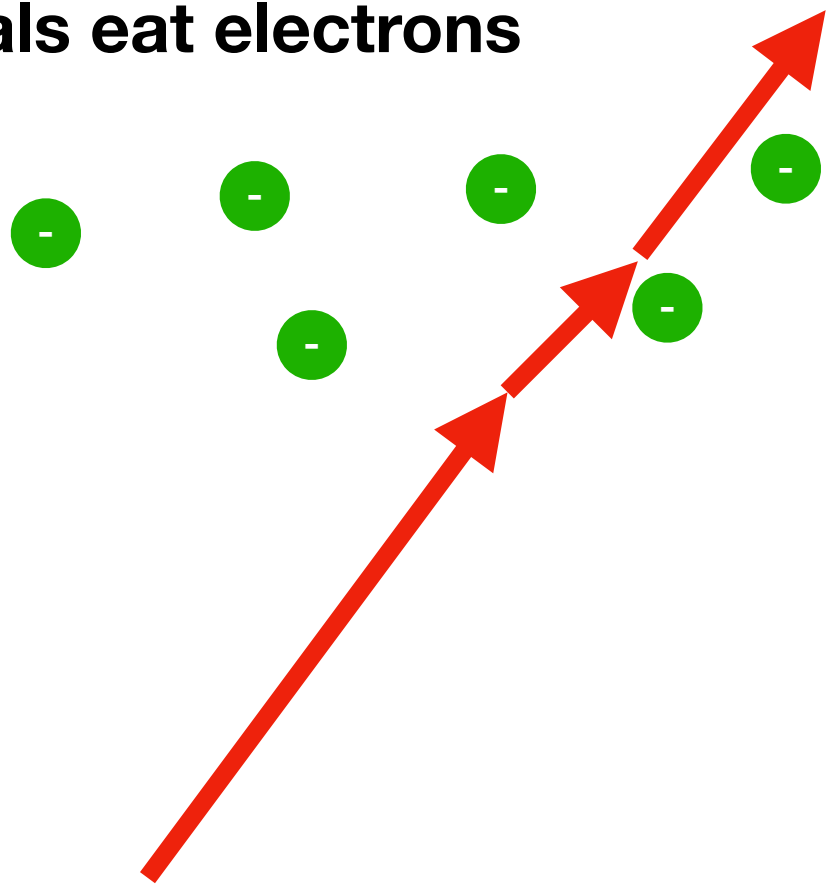


Slower neutrals finally arrive

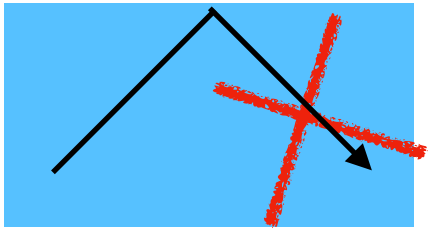




Neutrals eat electrons

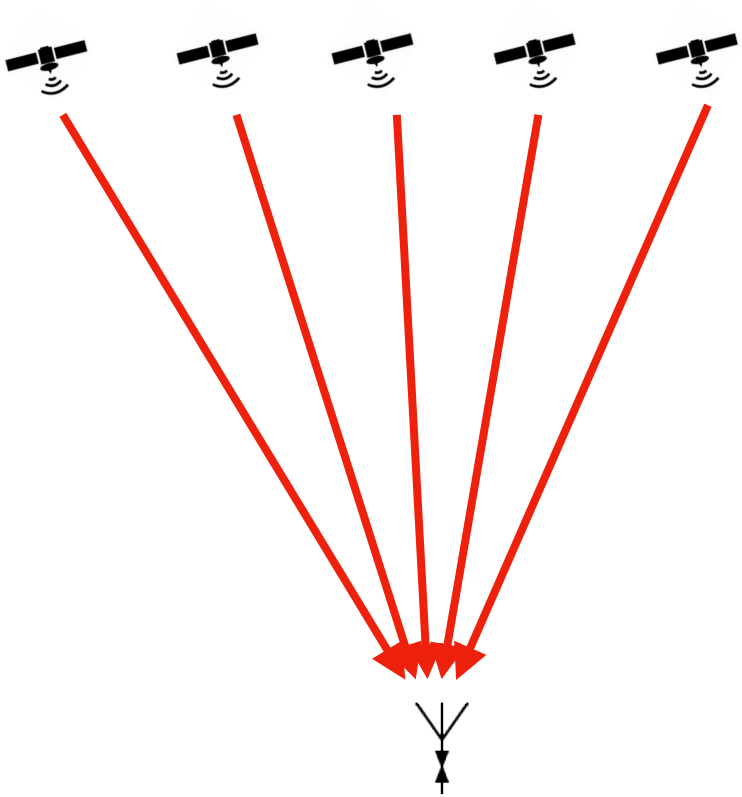


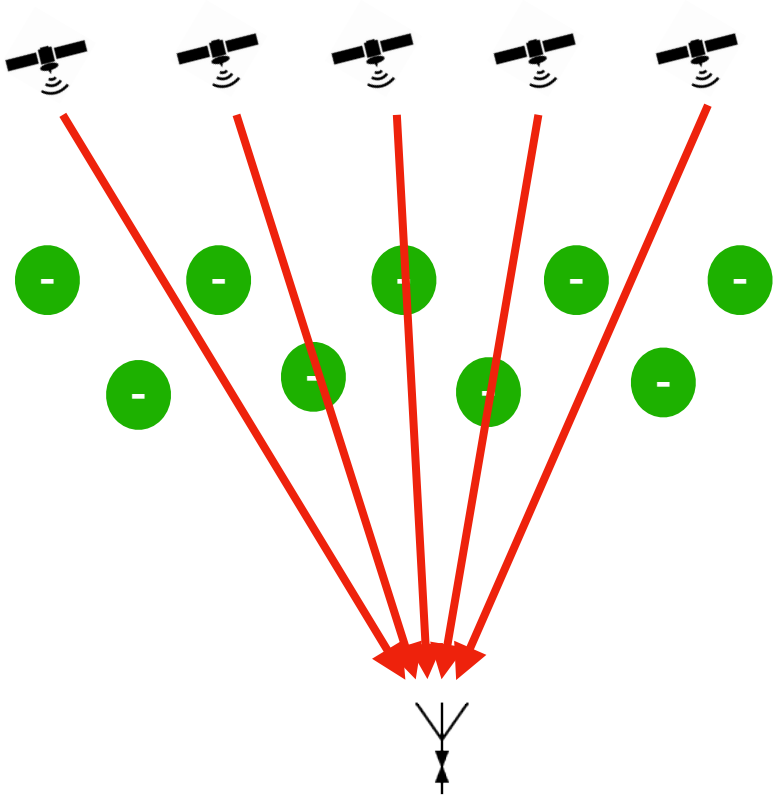




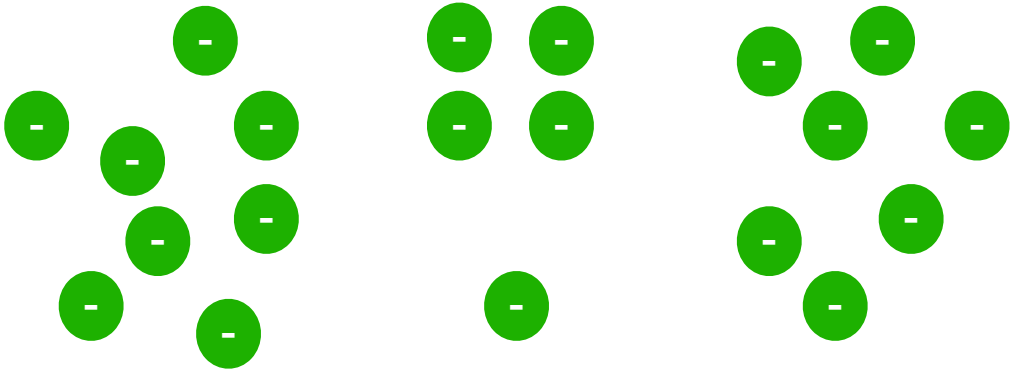
Impact: Scintillation

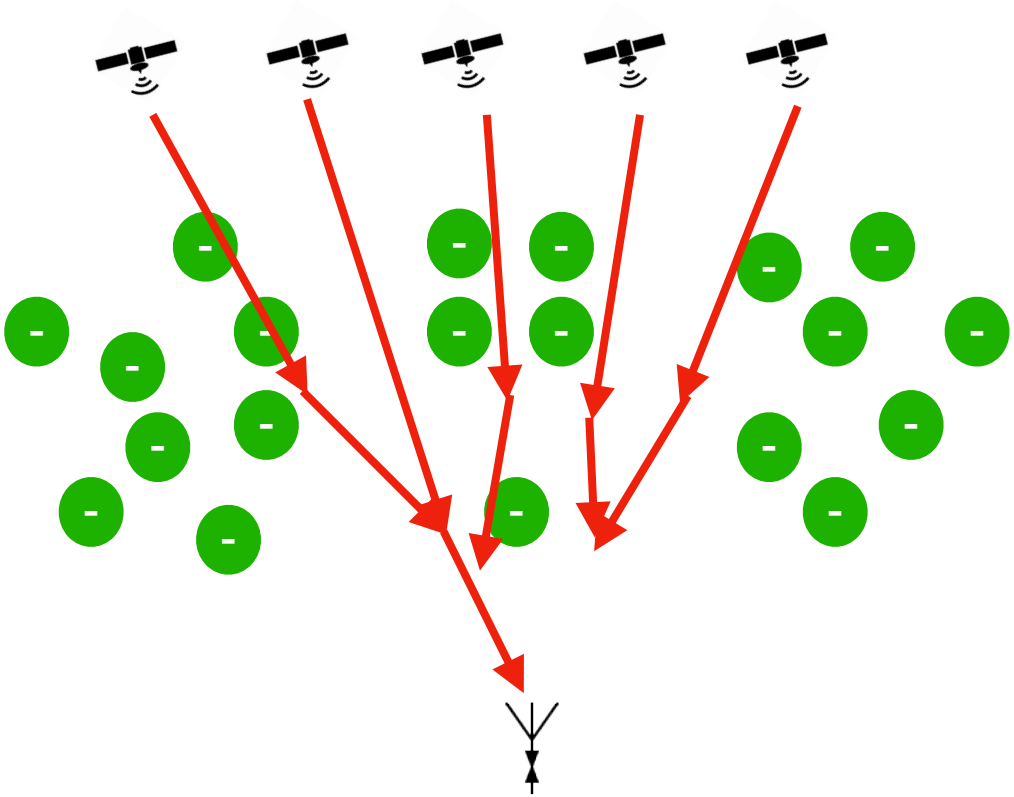






Strong gradients





SCINTILLATION MECHANISMS

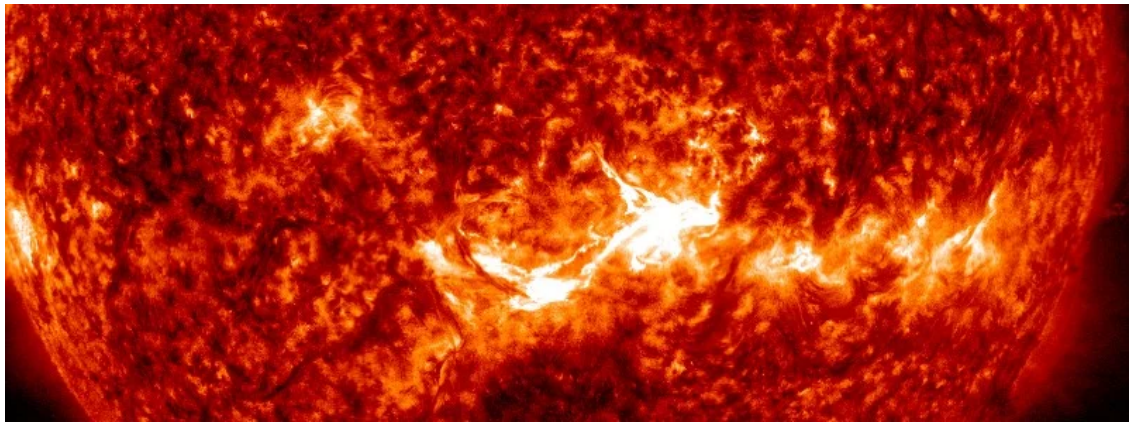
1. Post-sunset Plasma Bubbles (decreased ionisation) at lower latitudes (Equatorial ionisation anomaly)
2. Structures (increased ionisation) in the auroral oval
3. Patches (increased ionisation) in the polar caps
4. Travelling ionospheric disturbances



SWEC
Space Weather Education Center

Solar and heliospheric storms impacting aviation

CASE STUDY - April 23, 2023

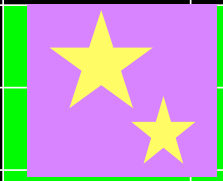


GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	**2020-10-12 14:15**	**0.25**	**QUIET**		**0.35**	**QUIET**
Phase Scintillation	0.4	0.7	**2020-10-12 14:15**	**0.13**	**QUIET**		**0.14**	**QUIET**
Vertical TEC	125	175	**2020-10-12 14:15**	**61.92**	**QUIET**		**61.93**	**QUIET**

RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL≤460	30	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**
Effective Dose FL > 460	/	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**

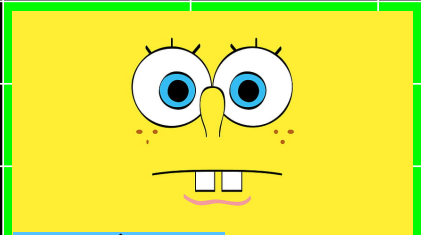
HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	**2020-10-12 14:16**	**3.0**	**QUIET**		**3.0**	**QUIET**
Polar Cap Absorption (PCA)	2	5	**2020-10-12 14:20**	**0.00**	**QUIET**		**0.00**	**QUIET**
Shortwave Fadeout (SWF)	x1.0	x10.0	**2020-10-12 14:17**	**< M.5-flare**	**QUIET**		**< M.5-flare**	**QUIET**
Post-Storm Depression (PSD)	30%	50%	**2020-10-12 14:15**	**0**	**QUIET**		**0**	**QUIET**

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8		**0.25**	**QUIET**		**0.35**	**QUIET**
Phase Scintillation	0.4	0.7		**0.13**	**QUIET**		**0.14**	**QUIET**
Vertical TEC	125	175	**2020-10-12 14:15**	**61.92**	**QUIET**		**61.93**	**QUIET**



RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL≤460	30	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**
Effective Dose FL > 460	/	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9			**QUIET**		**3.0**	**QUIET**
Polar Cap Absorption (PCA)	2	5			**QUIET**		**0.00**	**QUIET**
Shortwave Fadeout (SWF)	x1.0	x10.0			**QUIET**		**< M.5-flare**	**QUIET**
Post-Storm Depression (PSD)	30%	50%		**0**	**QUIET**		**0**	**QUIET**



April 23, 17 UT



05/03/2024
06:53 UTC

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-24h -12h -6h -3h -1h -5m Submit 2023-04-23 17:00 now +5m +1h +3h +6h +12h +24h

PECASUS DASHBOARD on 2023-04-23 17:00 UTC

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-23 17:00	0.25	QUIET		0.36	QUIET
Phase Scintillation	0.4	0.7	2023-04-23 17:00	0.12	QUIET		0.14	QUIET
Vertical TEC	125	175	2023-04-23 17:00	96.98	QUIET		96.98	QUIET

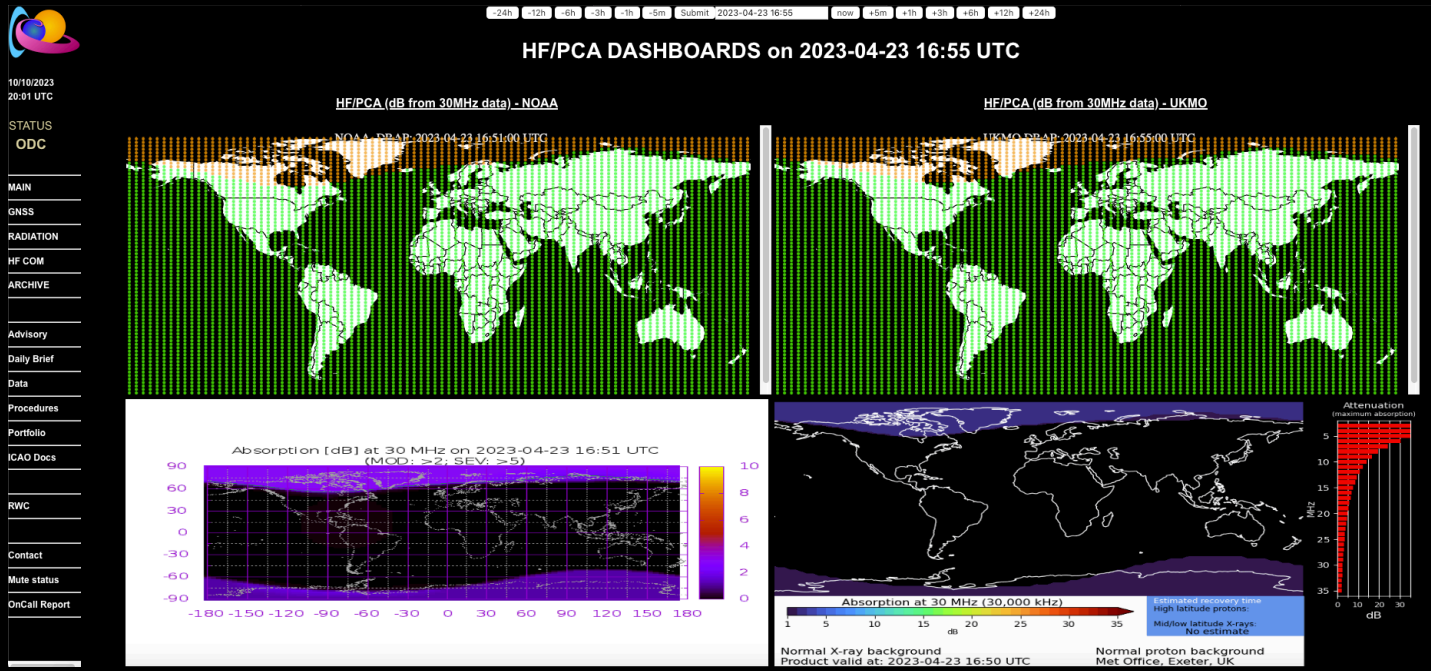
RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-23 17:00	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-23 17:00	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-23 17:00	5.3	QUIET		5.3	QUIET
Polar Cap Absorption (PCA)	2	5	2023-04-23 17:00	2.75	MODERATE		2.94	MODERATE
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-23 17:00	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-23 17:00	0	QUIET		0	QUIET



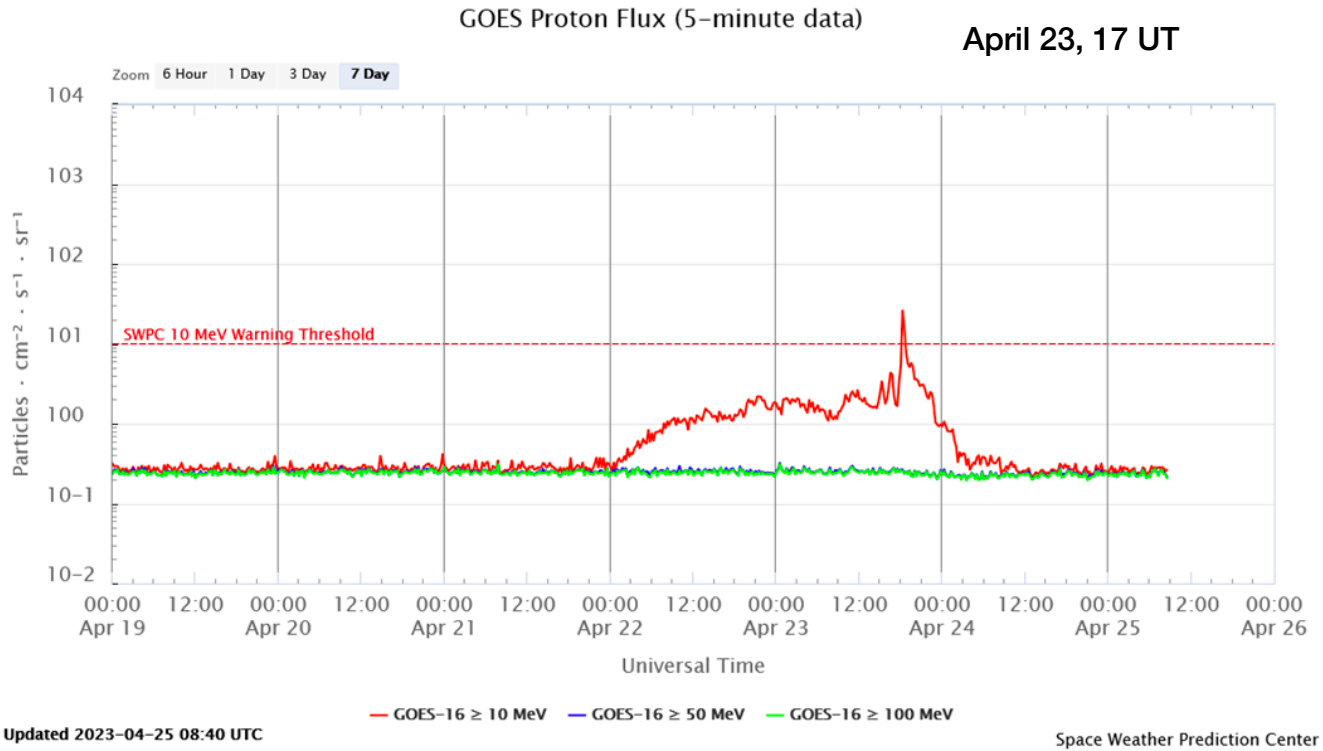
Sound alarm is triggered when MOD or SEV thresholds are exceeded or in case of data outages.

April 23, 17 UT

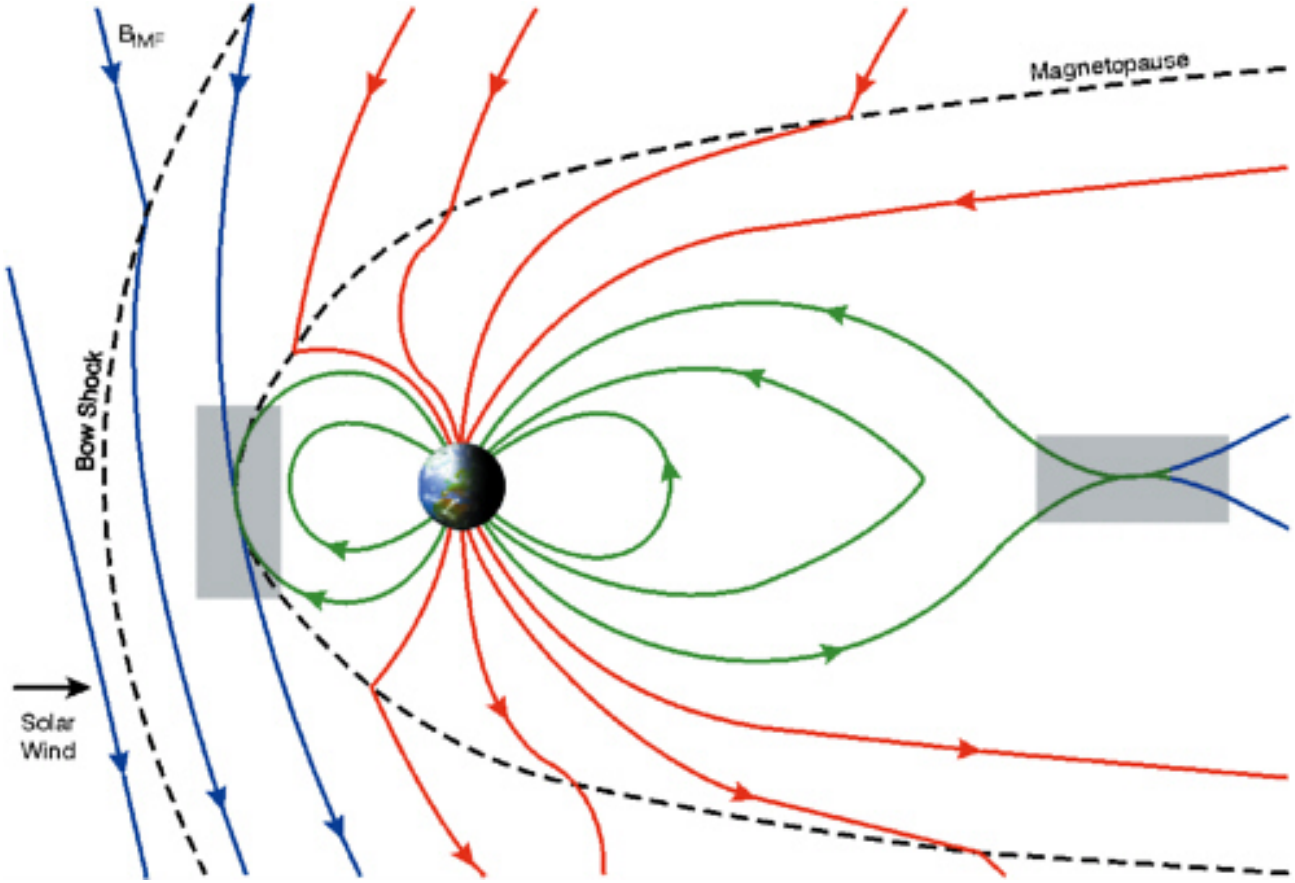


Proton Event

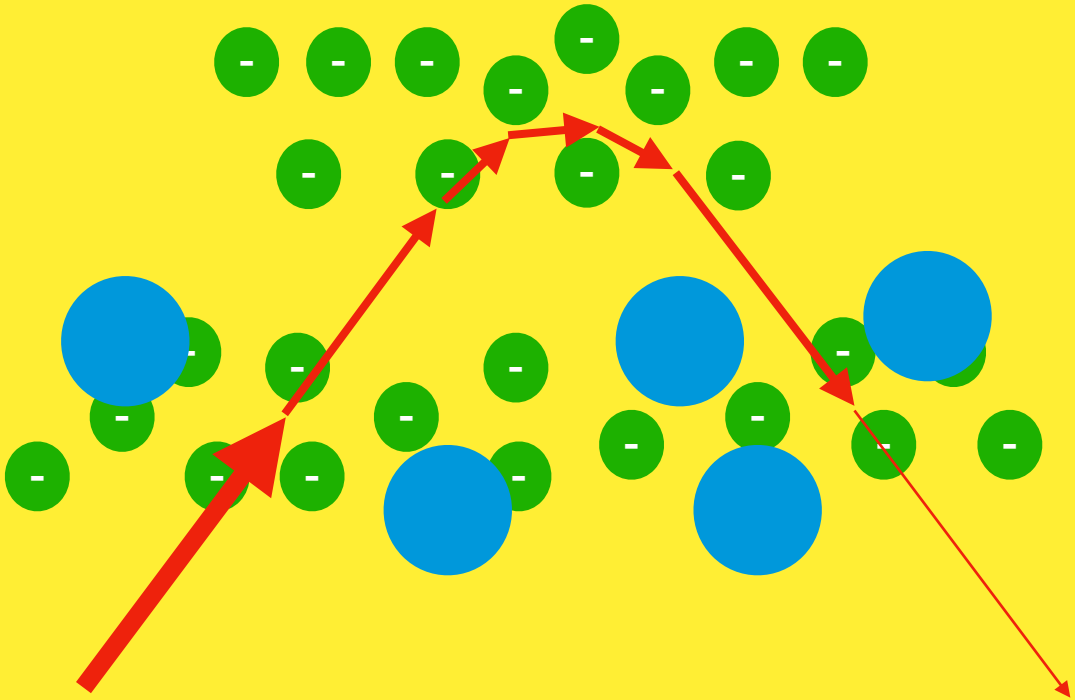
April 23, 17 UT



Quiet
Proton event expected (10 pfu at >10 MeV)
Major proton event expected (100 pfu at >100 MeV)
Proton event in progress (>10 MeV)
Warning condition (activity levels expected to increase, but no numeric forecast given)


B_{IMF}
Magnetopause
Bow Shock
Solar
Wind

Polar Cap Absorption

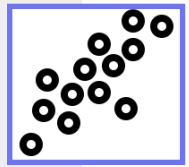




April 23, 17:06 UT







```
SWX ADVISORY
DTG:              20230423/1706Z
SWXC:             PECASUS
ADVISORY NR:      2023/59
SWX EFFECT:       HF COM MOD
OBS SWX:          23/1655Z HNH W150 - E000
FCST SWX +6 HR:   23/2300Z NOT AVBL
FCST SWX +12 HR:  24/0500Z NOT AVBL
FCST SWX +18 HR:  24/1100Z NOT AVBL
FCST SWX +24 HR:  24/1700Z NOT AVBL
RMK:              SPACE WEATHER EVENT (HF COM POLAR CAP
ABSORPTION) IN PROGRESS. IMPACT ON LOWER HF COM FREQUENCY
BANDS EXPECTED AT HIGH LATITUDES.
NXT ADVISORY:     WILL BE ISSUED BY 20230423/2255Z=
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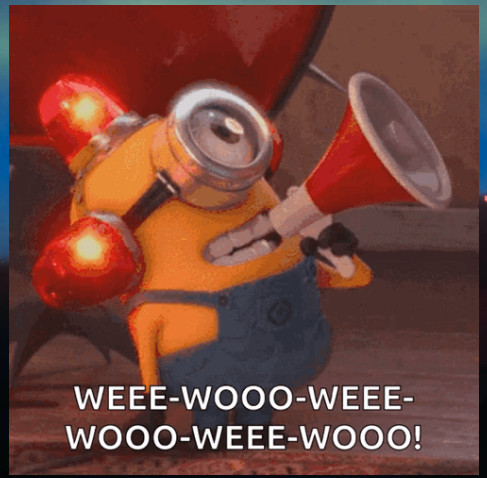
April 23, 17:06 UTC



April 23, 18:50 UT

10/10/2023
20:05 UTC

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-24h -12h -6h -3h -1h -5m Submit 2023-04-23 18:50 now +5m +1h +3h +6h +12h +24h

PECASUS DASHBOARD on 2023-04-23 18:50 UTC

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-23 18:50	0.40	QUIET		0.40	QUIET
Phase Scintillation	0.4	0.7	2023-04-23 18:50	0.26	QUIET		0.26	QUIET
Vertical TEC	125	175	2023-04-23 18:50	124.06	QUIET		124.06	QUIET

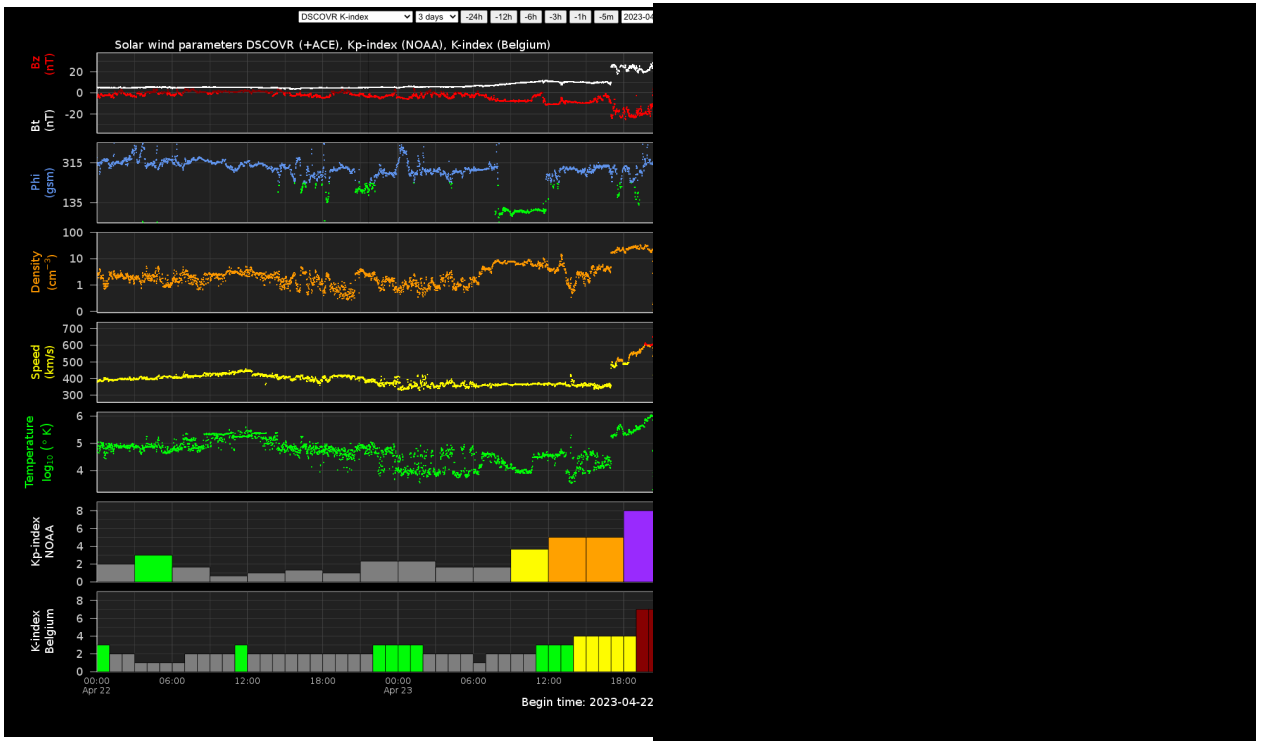
RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-23 18:50	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-23 18:50	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-23 18:50	8.0	MODERATE		8.0	MODERATE
Polar Cap Absorption (PCA)	2	5	2023-04-23 18:50	3.13	MODERATE		4.64	MODERATE
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-23 18:50	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-23 18:00	2	SEVERE		2	SEVERE

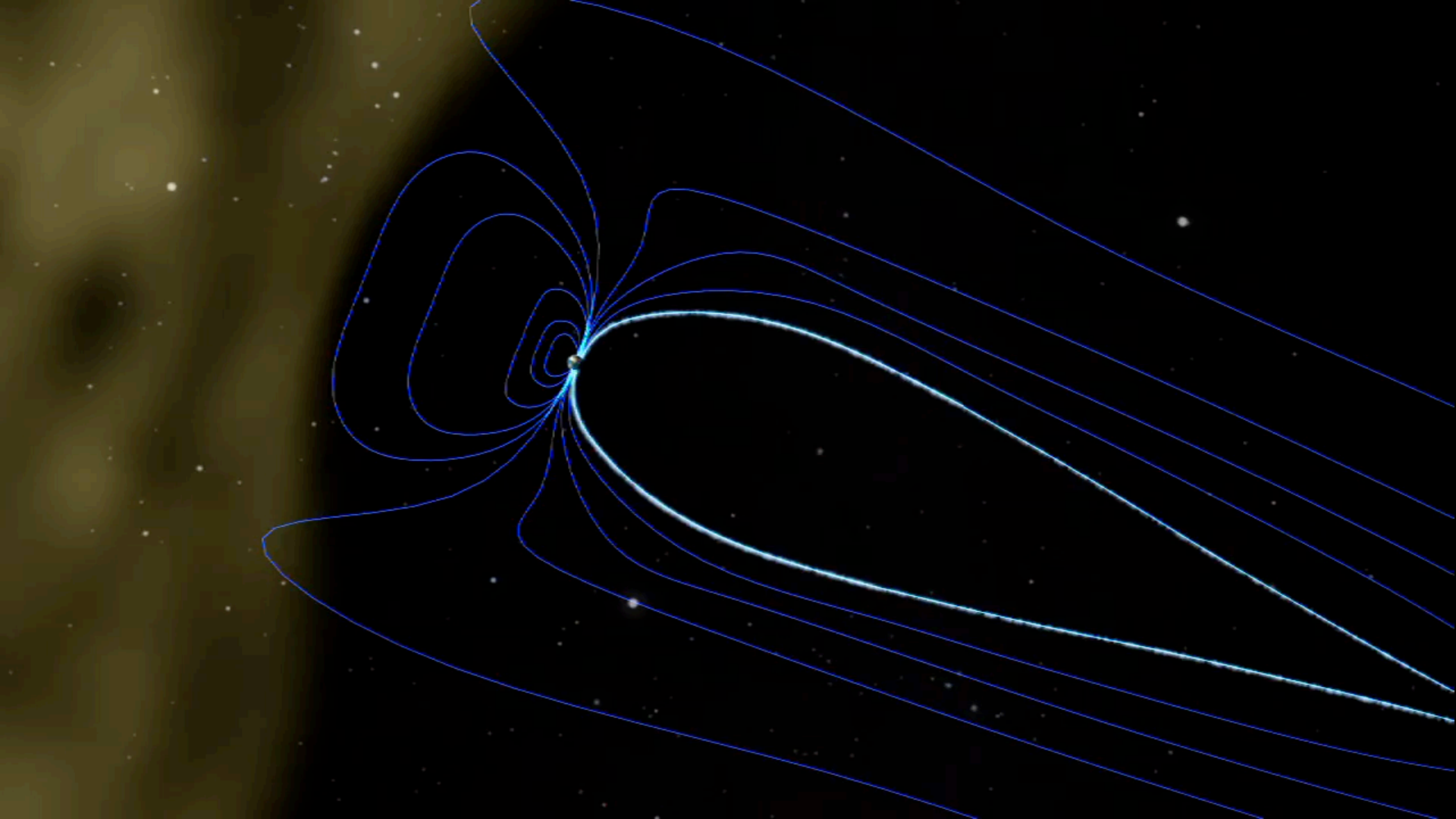


Sound alarm is triggered when MOD or SEV thresholds are exceeded or in case of data outages.

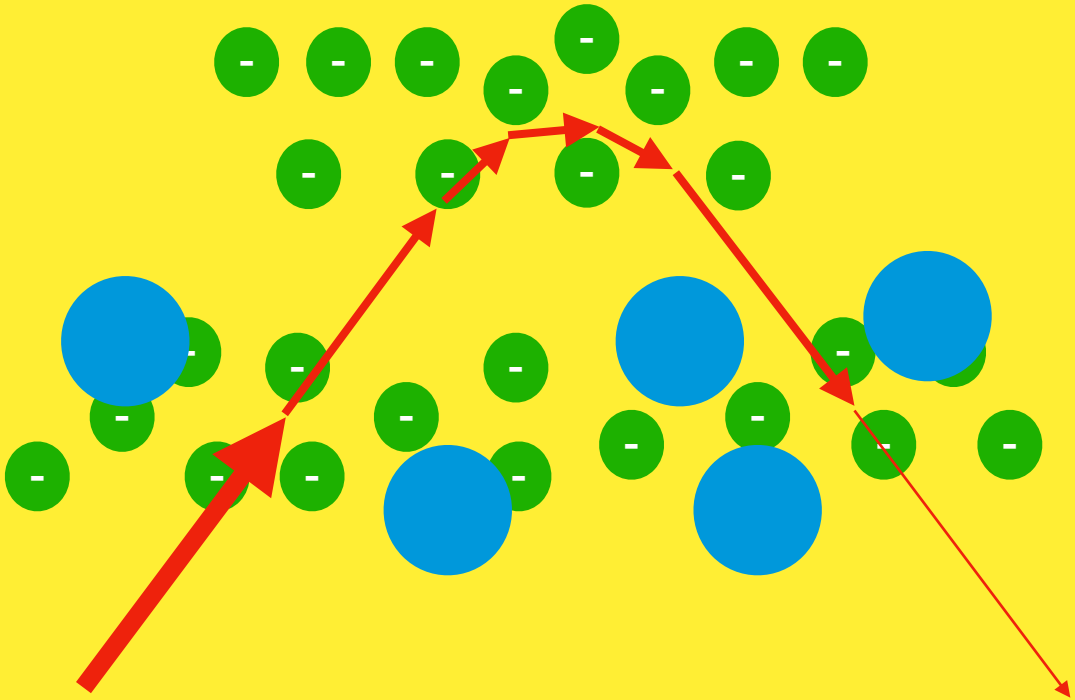
CME arrival



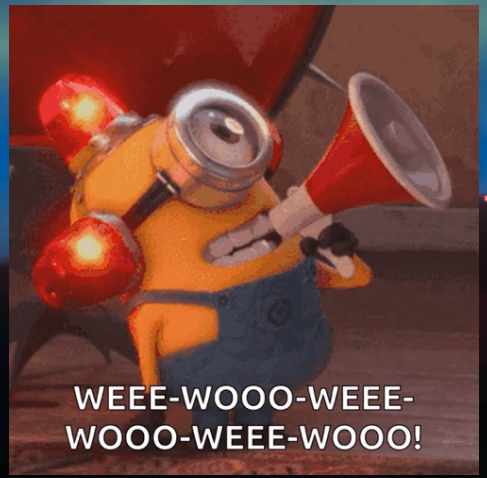
SWEC
Space Weather Education Center



Auroral Absorption



April 23, 20:29 UTC





10/10/2023
20:05 UTC

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-24h -12h -6h -3h -1h -5m Submit 2023-04-23 18:50 now +5m +1h +3h +6h +12h +24h

PECASUS DASHBOARD on 2023-04-23 18:50 UTC

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-23 18:50	0.40	QUIET		0.40	QUIET
Phase Scintillation	0.4	0.7	2023-04-23 18:50	0.26	QUIET		0.26	QUIET
Vertical TEC	125	175	2023-04-23 18:50	124.06	QUIET		124.06	QUIET

RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-23 18:50	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-23 18:50	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-23 18:50	8.0	MODERATE		8.0	MODERATE
Polar Cap Absorption (PCA)	2	5	2023-04-23 18:50	3.13	MODERATE		4.64	MODERATE
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-23 18:50	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-23 18:00	2	SEVERE		2	SEVERE



Sound alarm is triggered when MOD or SEV thresholds are exceeded or in case of data outages.

FoF2/MUF DASHBOARD on 2023-04-23 20:30 UTC

See worldmap with latest ionosondes data (here) Find EU maps (here)

10/10/2023
20:18 UTC

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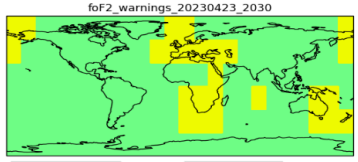
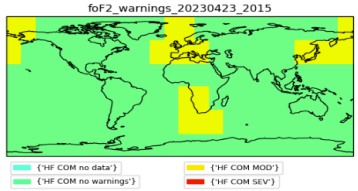
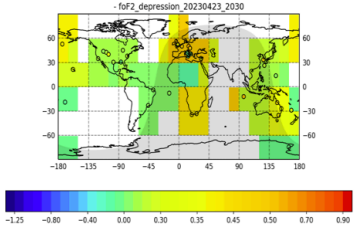
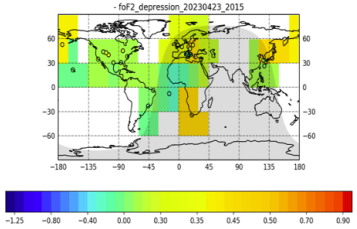
Post-Storm Depression: foF2 Warings (SRCPAS)



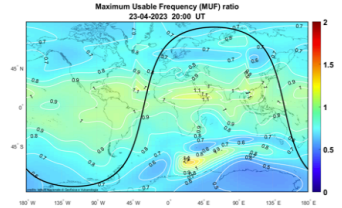


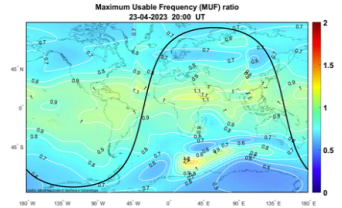
Post-Storm Depression: foF2 Ratio NowCast (SRCPAS)



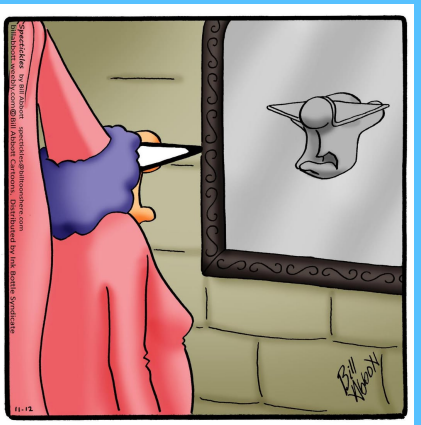


Post-Storm Depression: MUF Ratio NowCast (INGV)

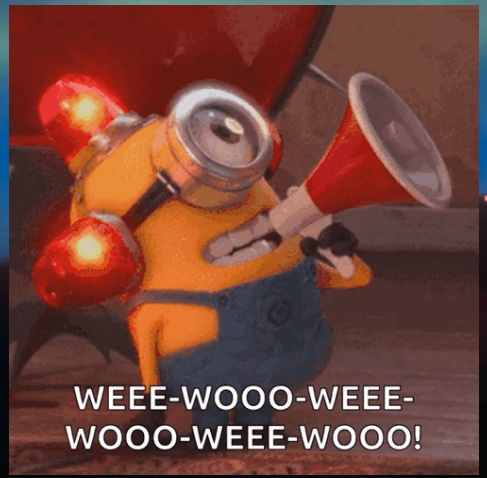




Post Storm Depression



April 23, 20:29 UTC



April 23, 20:36 UT

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-24h -12h -6h -3h -1h -5m Submit 2023-04-23 20:36 now +5m +1h +3h +6h +12h +24h

PECASUS DASHBOARD on 2023-04-23 20:36 UTC

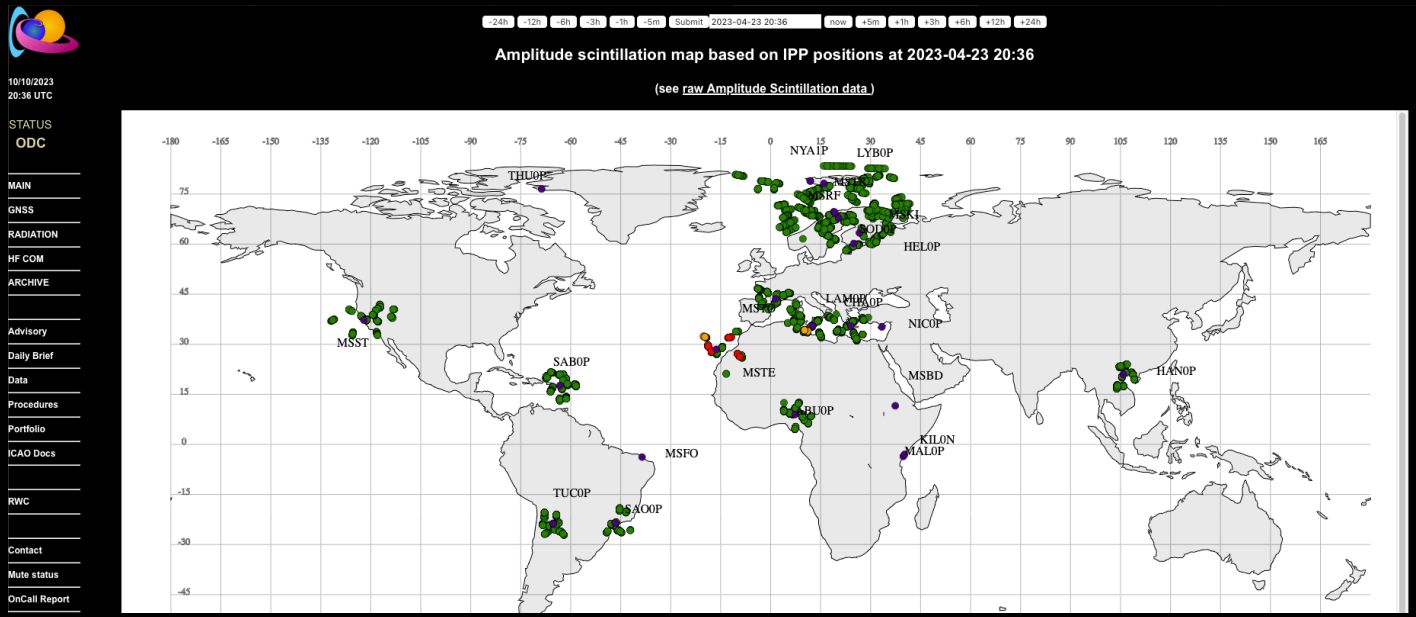
GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	2023-04-23 20:36	1.08	SEVERE		1.08	SEVERE
Phase Scintillation	0.4	0.7	2023-04-23 20:36	0.30	QUIET		1.06	SEVERE
Vertical TEC	125	175	2023-04-23 20:35	131.84	QUIET		134.83	MODERATE

RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL ≤ 460	30	80	2023-04-23 20:35	0	QUIET		0	QUIET
Effective Dose FL > 460	/	80	2023-04-23 20:35	0	QUIET		0	QUIET

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	2023-04-23 20:36	8.0	MODERATE		8.0	MODERATE
Polar Cap Absorption (PCA)	2	5	2023-04-23 20:35	1.97	QUIET		4.64	MODERATE
Shortwave Fadeout (SWF)	x1.0	x10.0	2023-04-23 20:36	< M5 flare	QUIET		< M5 flare	QUIET
Post-Storm Depression (PSD)	30%	50%	2023-04-23 20:00	2	SEVERE		2	SEVERE

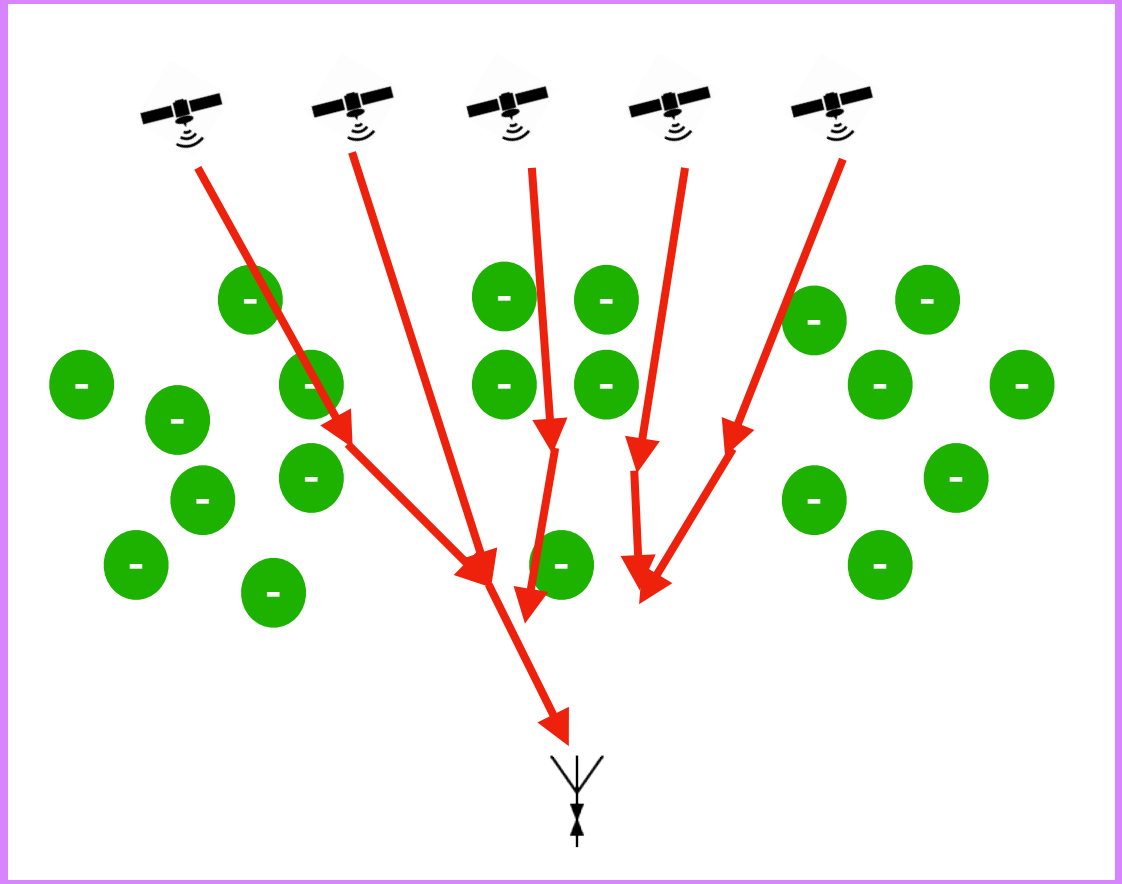
Sound alarm is triggered when MOD or SEV thresholds are exceeded or in case of data outages.

April 23, 20:36 UT



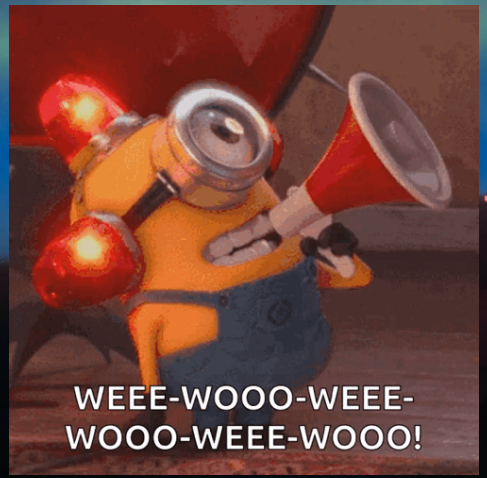
April 23, 20:36 UT






WWW.ANDERTOONS.COM
"Gary, the other astrophysicists have asked me to talk to you about your constant humming of 'Twinkle Twinkle Little Star.'"

April 23, 20:29 UTC



You made it until the end of this presentation!
Well done.

The PECASUS operator on duty at that time was not done yet. Trouble in the ionosphere continues until 4 days after Kp=6

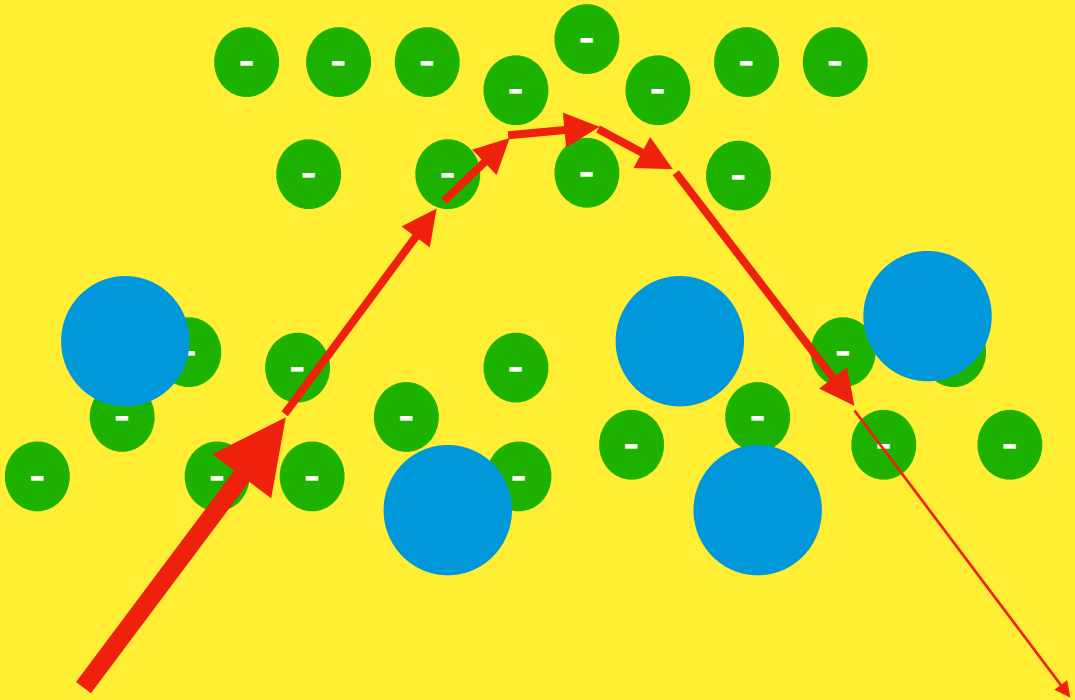
BIS slides

GNSS	Moderate	Severe	Time UTC	Values	Status	Alert	Max-3h values	Max-3h status
Amplitude Scintillation	0.5	0.8	**2020-10-12 14:15**	**0.25**	**QUIET**		**0.35**	**QUIET**
Phase Scintillation	0.4	0.7	**2020-10-12 14:15**	**0.13**	**QUIET**		**0.14**	**QUIET**
Vertical TEC	125	175	**2020-10-12 14:15**	**61.92**	**QUIET**		**61.93**	**QUIET**

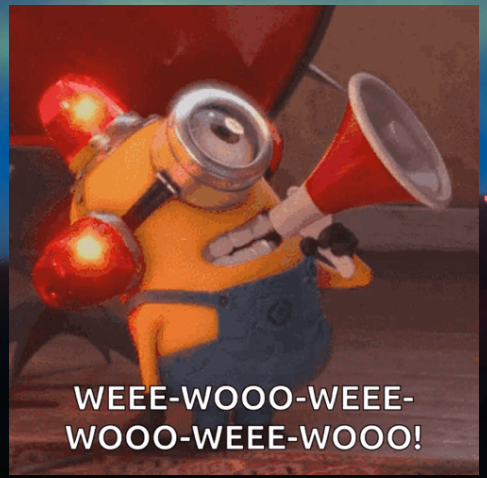
RADIATION	Moderate	Severe	Time UTC	Flags	Status	Alert	Max-3h flags	Max-3h status
Effective Dose FL≤460	30	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**
Effective Dose FL > 460	/	80	**2020-10-12 14:20**	**0**	**QUIET**		**0**	**QUIET**

HF COM	Moderate	Severe	Time UTC	Values/Flags	Status	Alert	Max-3h values	Max-3h status
Auroral Absorption (AA)	8	9	**2020-10-12 14:16**	**3.0**	**QUIET**		**3.0**	**QUIET**
Polar Cap Absorption (PCA)	2	5	**2020-10-12 14:20**	**0.00**	**QUIET**		**0.00**	**QUIET**
Shortwave Fadeout (SWF)	x1.0	x10.0	**2020-10-12 14:17**	**< M.5-flare**	**QUIET**		**< M.5-flare**	**QUIET**
Post-Storm Depression (PSD)	30%	50%	**2020-10-12 14:15**	**0**	**QUIET**		**0**	**QUIET**

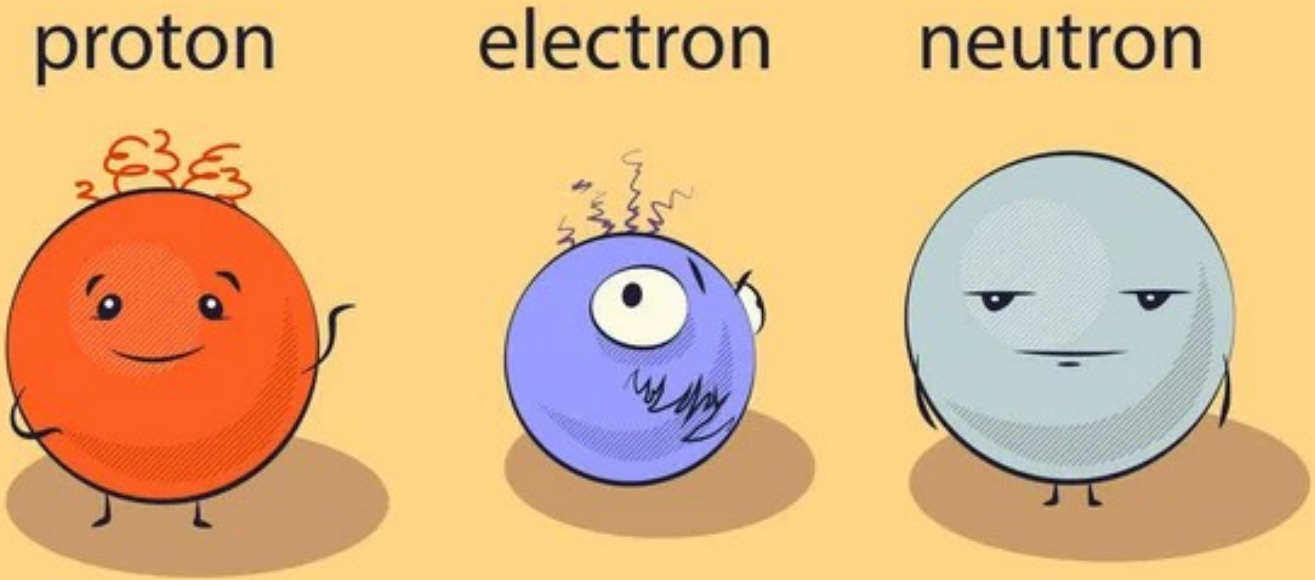
Short Wave Fadeout





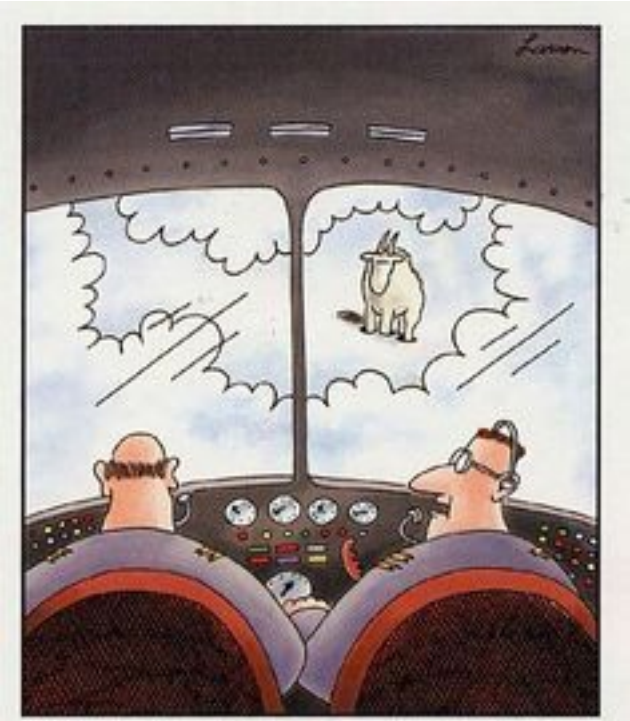

WEEE-WOOO-WEEE-
WOOO-WEEE-WOOO!

Biological impact




WEEE-WOOO-WEEE-
WOOO-WEEE-WOOO!

Space Weather Warnings and Forecasts do make a difference.



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Enjoy!


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