

Space Weather Within ESA's Space Safety Programme

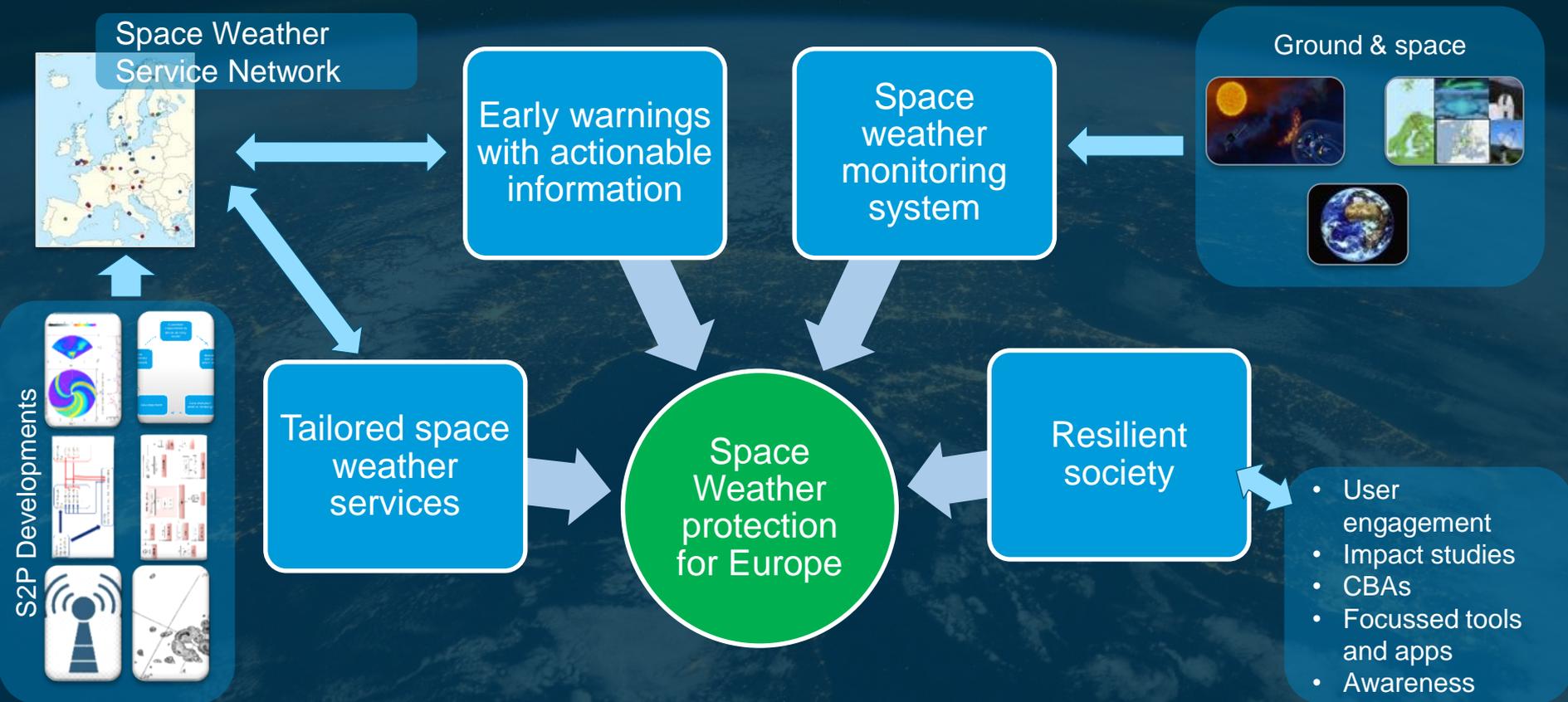
Alexi Glover*, Juha-Pekka Luntama

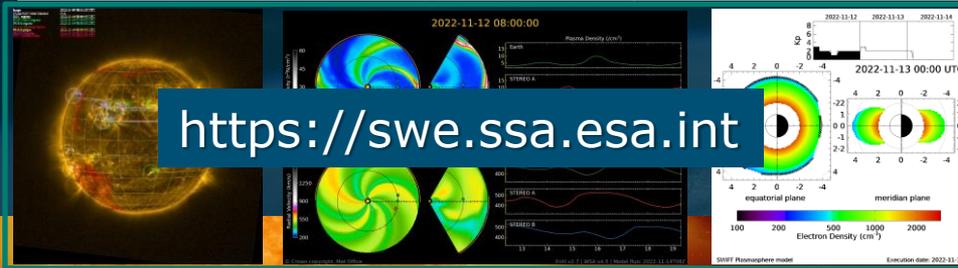
Space Weather Office, Space Safety Programme

European Space Operations Centre, Darmstadt, Germany

13/06/2024

S2P SPACE WEATHER SYSTEM OBJECTIVE





SWE Service Network Provides:

- 29 services built on >300 data products & tools
- 95% overall availability & NWH helpdesk support
- Full Sun-Earth chain, coupled modelling
- Timely & reliable user tailored notifications & alerting

Who uses the services?

- >4500 registered users
- >2M hits on portal monthly
- All affected sectors, plus national & regional agencies

Who participates?

- >50 institutes, industry, academic groups
- Building on & strengthening European assets & expertise



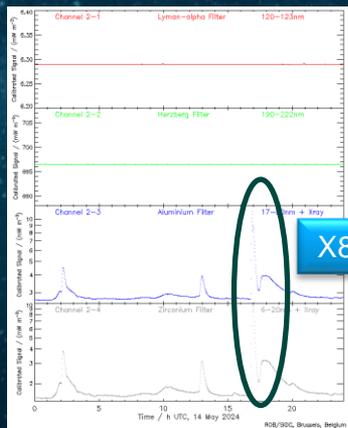
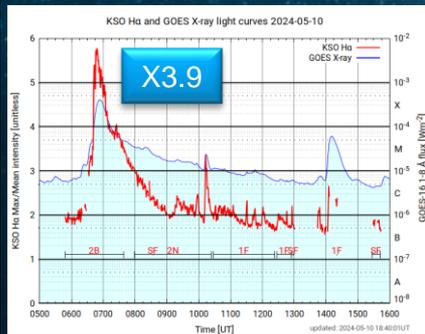
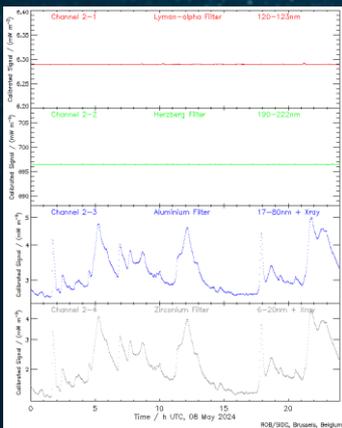
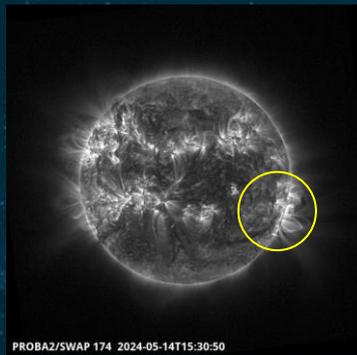
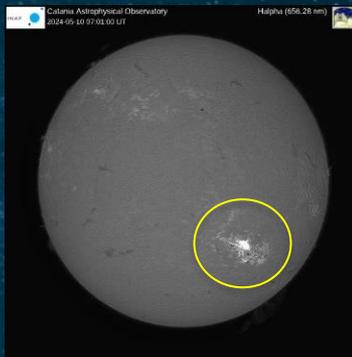
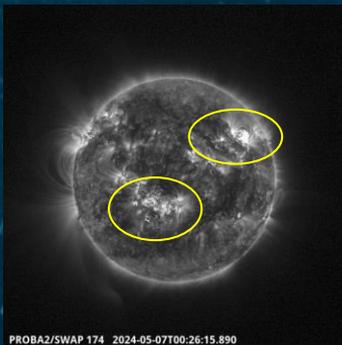


Aurora over Darmstadt
Photo: Helena & Tim Flohrer

Solar Activity in May 2024: via the ESA SWE Portal



Active Region NOAA 13663 and 13664



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SIDC Human moderated alerts archive

The forecaster on duty at the SIDC observes and processes all relevant Space Weather data, including automated feature alert processes. Based on his/her observations the forecaster on duty triggers alerts where automated processes have failed or are late and follows up and provides complementary information on the automated alerts.

Please enter a start and end date.
SIDC Presto alert archive has data since 2000-07-14T12:00:00Z.

2024-05-07T14:54:44Z 2024-05-10T14:54:44Z

issue time	alert text
2024-05-10T09:14:26Z	An X4.8 flare has occurred with a peak time 06:15:4 UTC on May 09, produced by NOAA AR 3664. Type II and type IV radio emissions were detected at 06:46 UTC and 06:51:1 UTC, respectively, during the flaring activity. The GOES proton flux is increasing but still remains below the 10 pfu threshold level. Moderately disturbed radio communications have been observed related to this flaring activity.
2024-05-09T18:34:35Z	An X1.1 flare has occurred with a peak time 17:44 UTC on May 09, produced by NOAA AR 3664. Type II and type IV radio emissions were detected at 17:32 UTC and 17:45 UTC, respectively, during the flaring activity. Currently, the GOES proton flux is slightly enhanced but remains below the 10 pfu threshold level. Moderately disturbed radio communications have been observed related to this flaring activity.
2024-05-09T17:16:08Z	A partial halo coronal mass ejection (CME) was first observed on SDO/HALOS-C2 images around 09:24 UTC on May 09. This CME is associated with an X2.0 flare, which peaked at 09:13 UTC, produced by NOAA AR 3664. It has a projected width of about 180 deg and a projected speed of about 3000 km/s. Associated Type II and type IV radio emissions were detected at 09:02 UTC and 09:19 UTC, respectively, during the flaring activity. The corresponding CME is expected to impact the Earth early on May 11.
2024-05-09T12:15:52Z	A partial halo coronal mass ejection (CME) was first observed on SDO/HALOS-C2 images around 21:48 UTC on May 08. This CME is associated with an X1.8 flare, which peaked at 21:48 UTC, produced by NOAA AR 3664. It has a projected width of about 180 deg and a projected speed of about 552 km/s (as measured by the CACTUS tool), with its source region closer to the central meridian, the corresponding CME is expected to impact the Earth late on May 11 or early on May 12.

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SIDC Solar GOES-flare alert archive

The SIDC data processing pipeline analyzes incoming GOES X-ray data in near real-time and reports on the occurrence of X-ray flares of Classes M5 and up.

Please enter a start and end date.
SIDC X-ray flare alert archive has data since 2000-09-09.

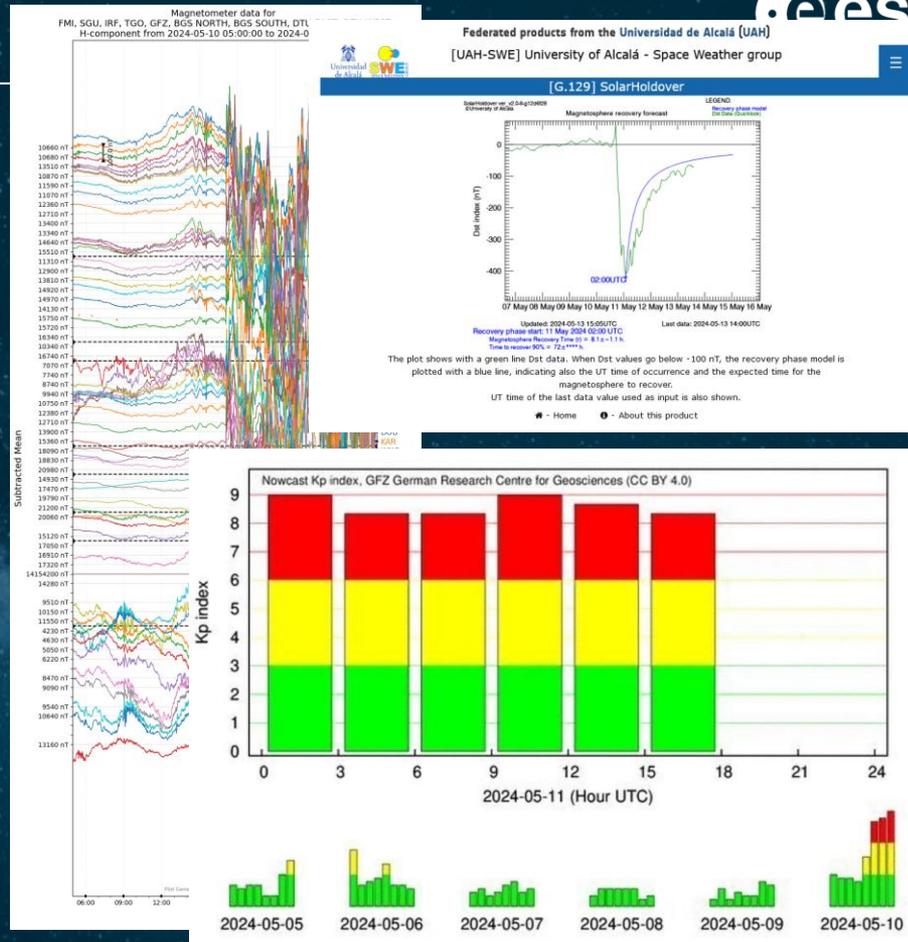
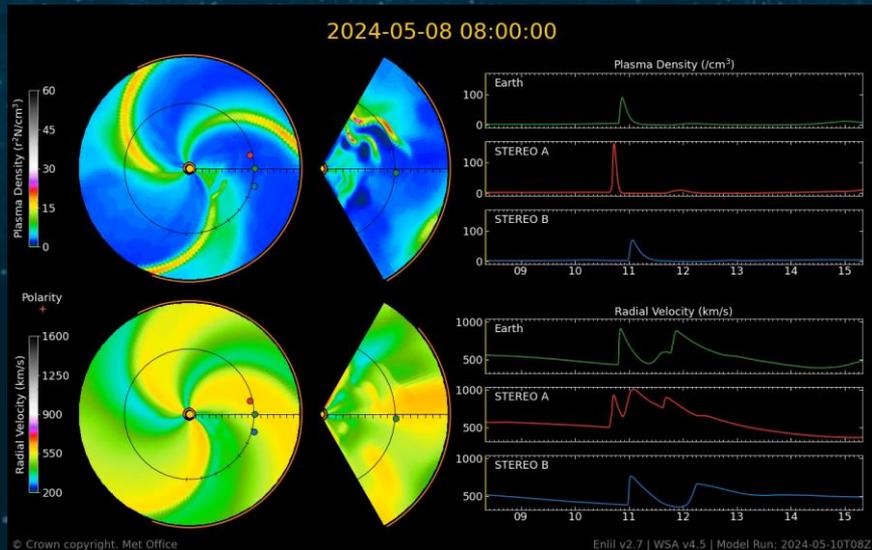
2024-05-05T17:32:45Z 2024-05-14T17:32:45Z

issue time	alert text
2024-05-10T17:06:14Z	A class X8.7 solar X-ray flare occurred on 2024/05/10 with peak time 16:11:11
2024-05-10T17:06:14Z	A class X1.2 solar X-ray flare occurred on 2024/05/10 with peak time 12:58:11
2024-05-10T17:06:14Z	A class X1.7 solar X-ray flare occurred on 2024/05/10 with peak time 02:00:11
2024-05-10T17:06:14Z	A class X1.0 solar X-ray flare occurred on 2024/05/10 with peak time 16:20:11
2024-05-10T17:06:14Z	A class M6.8 solar X-ray flare occurred on 2024/05/10 with peak time 17:20:11
2024-05-10T17:06:14Z	A class M5.0 solar X-ray flare occurred on 2024/05/10 with peak time 02:23:11
2024-05-10T17:06:14Z	A class X3.8 solar X-ray flare occurred on 2024/05/10 with peak time 02:23:11
2024-05-10T17:06:14Z	A class M9.0 solar X-ray flare occurred on 2024/05/10 with peak time 04:11:11
2024-05-09T18:34:35Z	A class X1.8 solar X-ray flare occurred on 2024/05/09 with peak time 04:11:11
2024-05-09T18:34:35Z	A class X2.0 solar X-ray flare occurred on 2024/05/09 with peak time 09:13:11
2024-05-09T18:34:35Z	A class M7.8 solar X-ray flare occurred on 2024/05/09 with peak time 17:45:11
2024-05-09T18:34:35Z	A class M6.8 solar X-ray flare occurred on 2024/05/09 with peak time 17:45:11
2024-05-09T18:34:35Z	A class M7.3 solar X-ray flare occurred on 2024/05/09 with peak time 06:56:11
2024-05-09T18:34:35Z	A class M1.9 solar X-ray flare occurred on 2024/05/09 with peak time 06:56:11
2024-05-09T18:34:35Z	A class M6.2 solar X-ray flare occurred on 2024/05/09 with peak time 16:30:11
2024-05-09T18:34:35Z	A class M1.2 solar X-ray flare occurred on 2024/05/09 with peak time 06:56:11
2024-05-09T18:34:35Z	A class M1.2 solar X-ray flare occurred on 2024/05/09 with peak time 11:52:11
2024-05-09T18:34:35Z	A class M7.4 solar X-ray flare occurred on 2024/05/09 with peak time 10:00:11

25 >M5 class flares between 3-14th May including 14 X-Class

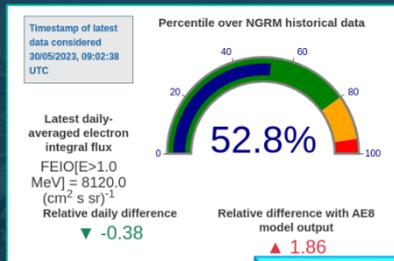
CME Arrival and Response

- Multiple CME onsets 8-9th May
- First arrivals on 10th May triggered Kp9 event
- Largest geomagnetic storm since 2003

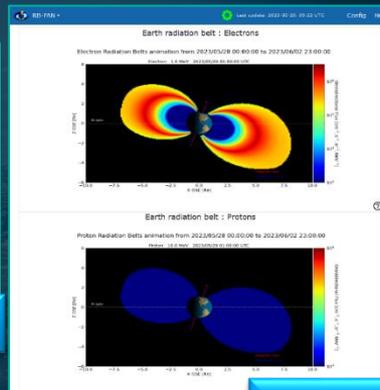


Recent SWE Portal Improvements

- Service enhancements by
 - >60 new products
 - >30 product updates
- New-look service pages
- Main menu update & info for users
- Webinars & training materials now online
- Data from Sentinel 6/NGRM, HOTBIRD/ICARE-NG and MAG-SWE-DAN



SPARC



ONERA

View TID Activity | Reference Date: 2023-05-30T09:25:00 UTC

TID Indicators	Date	Critical Characteristic	Current value of critical characteristic	Activity level	Activity icon
AATR	2023-05-30T09:15:00	AATR at polar, high, medium and low latitudes	0.124	LOW	
ONS5 TEC Gradient	2023-05-30T09:20:30	TEC gradient, amplitude in high latitudes	1.643	MEDIUM	

LSTID Detection	Date	Critical Characteristic	Current value of critical characteristic	Activity level	Activity icon
HF Interferometry (HF-INT)	2023-05-30T09:25:00	Spectral Energy Contribution	0.1	LOW	
LSTID _{rel}	2023-05-30T08:55:00	Relative Std Dev of file	1.169	LOW	

HSTID Detection	Date	Critical Characteristic	Current value of critical characteristic	Activity level	Activity icon
CDSS	2023-05-30T07:45:00	Doppler shift detected in the Csatble network			
HSTID _{rel}	2023-05-30T09:20:00	HSTID _{rel} at polar, high, medium and low latitudes	0.266	STRONG	

Legend

- Low Activity Level
- Medium Activity Level
- Strong Activity Level
- No Data

(some) next steps

- Work towards consistent API approach & metadata repository
- Centralised Alerting module
- Towards next generation SWE portal
- & more...

Instrument	Hosting flight	Orbit	NRT data available
SOSMAG	GEO-Kompsat-2A	GEO (128° East)	
NGRM	EDRS-C	GEO (31° East)	
NGRM	Sentinel-6	LEO (1336 km, i = 66°)	
ICARE-NG	HOTBIRD 13F	GEO (13° East)	
ICARE-NG	HOTBIRD 13G	GEO (13° East)	

ESA's Enhanced Space Weather Monitoring System

Missions to solar wind

L5



Forecasting
&
Event
detection

L1

Impact & state monitoring



Ground based
measurements

+

D3S:

- Hosted Payloads
- Small missions

Vigil mission to L5



Continuous observations of Sun and heliosphere between Earth and the Sun

Data availability in near real-time => operational applications

Complementing observations from Sun-Earth line

Strong international collaboration:

NOAA: CCOR

NASA: JEDI

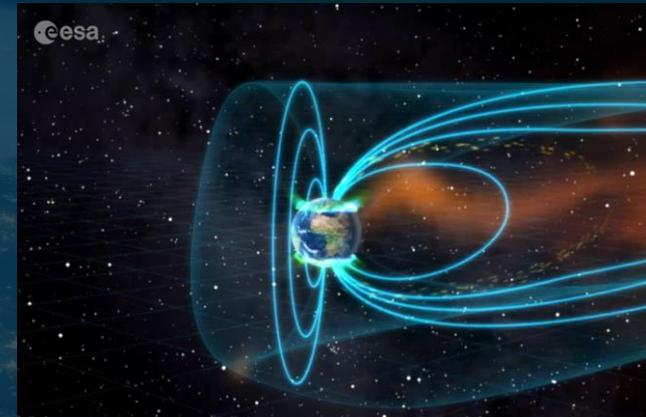
DSN stations

Data exchange

Launch: 2031



- 24/7 observation of the Aurora Borealis to monitor the interaction of the Solar Wind and CMEs with Earth
- Identification, monitoring and nowcasting geo-magnetic storms and sub-storms
- Improved services for communication, satellite navigation, aviation, transport, resource utilisation,...
- Payload:
 - Wide Field Auroral Imager
 - Auroal Optical Spectral Imager
 - Auroral UV Imager
 - & in-situ measurements
- Launch of Aurora-D planned for 2027



Mission objectives:

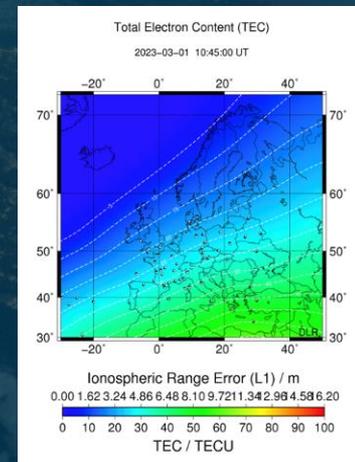
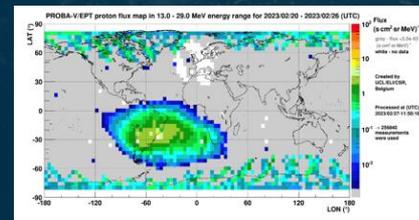
- Data on space environment and effects in LEO
 - Demonstrate “new space” and commercialisation approach with mission/data-as-a-service
- => Industry responsible for implementation, mission operation & Level 1 data processing
- => ESA an anchor customer



Baseline measurements:

- High energy Proton and Electron flux
- Thermal electrons' and ions' flux, density and temperature
- 3D electron density in the ionosphere
- Scintillation parameters (S4, Sigma_phi)

Launch: 2026



THANK YOU

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