ESA Space Weather Working Team Plenary Meeting

Welcome everyone!

SWWT Plenary Meeting 43:
22/11/2023, 15:15UT to 16:00UT, Toulouse, France

1. **Welcome and brief introduction to the ESA Space Weather Working Team (SWWT) – Mario M. Bisi (5 Minutes).**
2. Brief update on the Terms of Reference and plans for updating the Topical Working Groups – Mario M. Bisi (5 Minutes).
3. Space Weather in the ESA Space Safety Programme – Jussi Luntama (15 Minutes).
4. The ESA SWE Service Network Ongoing and Upcoming Developments – Alexi Glover (9 Minutes).
5. Upcoming Activities in the ESA Technology Programmes – Piers Jiggens (9 Minutes).
6. Next steps and closing remarks (2 Minutes).
7. Close (16:00UT).

1. Welcome and brief introduction to the ESA Space Weather Working Team (SWWT)

Mario M. Bisi, ESA SWWT Chair

ESA SWWT and SB… (1)

- The ESA Space Weather Working Team (SWWT) is a forum to both space weather experts and users of space weather information.
- The ESA SWWT investigates space weather applications' requirements, space weather services, and the underpinning research and development.
  - It advises ESA, particularly the Space Weather Office within the Space Safety Programme, on strategies and activities related to space weather.
- The ESA SWWT will seek to recommend strategic priorities for space weather operational services and underpinning research.
  - These recommendations may for example build on ongoing community initiatives and roadmaps.
  - The SWWT will also highlight associated data requirements including availability and timeliness needs.
- ESA SWWT membership is open to representatives of any European university, institute, company, or international organisation currently undertaking space weather related activities or affected by space weather.
  - Can also include Canadian experts, following Canada's status as an ESA Associate member.

ESA SWWT and SB… (2)

- The SWWT will promote activities aiming towards the development of European operational space weather capabilities.
  - These will include promoting the coordination of developments at European, national and industry levels.
  - Activities to be addressed can include, but are not limited to, national and international coordination issues, service and measurement infrastructure development, research into the underpinning science along with activities to raise awareness of space weather within existing and new user communities.
  - With these aims, the SWWT seeks to identify and discuss avenues of potential collaboration and/or synergies among European and national entities, as well as with other international structures and organisations.

ESA SWWT and SB… (3)

- The current members of the SB:
  - Mario Bisi (UK) (Chair)
  - Peter Beck (Austria)
  - Anna Belehaki (Greece)
  - Volker Bothmer (Germany)
  - Sean Bruinsma (France)
  - Ioannis Daglis (Greece)
  - Peter Gallagher (Ireland)
  - Mike Hapgood (UK)
  - Martin Kriegel (Germany)
  - Susan McKenna-Lawlor (Ireland)
  - Mauro Messerotti (Italy)
  - Minna Palmroth (Finland)
  - Stefaan Poedts (Belgium)
  - Guenter Reitz (Germany)
  - Christian Kintziger (Belgium)
  - Margit Haberreiter (Switzerland)
  - Larisa Trichtchenko (Canada)
  - Ronald Van der Linden (Belgium)
  - Susanne Vennerstrom (Denmark)
  - Peter Wintolf (Sweden)
  - Alexi Glover [*Ex-Officio*] (ESA)
  - Juha-Pekka (Jussi) Luntama [*Ex-Officio*] (ESA)

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2. Brief update on the Terms of Reference and plans for updating the Topical Working Groups

Mario M. Bisi, ESA SWWT Chair

ESA SWWT Terms of Reference Updates (1)

- The SWWT had reached a natural time for change and progression (as discussed in detail at the SWWT Plenary in Zagreb last year).
- The advent of E-SWAN allows the SWWT to prioritise and become an advisory body exclusively to ESA (thus simplifying its terms of reference and its role overall).
- Thus, ESA have decided that they can more-formally recognise the SWWT.
- Hence the formal name change to: “ESA Space Weather Working Team (SWWT)”.

ESA SWWT Terms of Reference Updates (2)

- The SB members have met several times online to discuss the updates to the ESA SWWT Terms of Reference.
  - These are near completion, with the exception of a description of the Topical Working Groups (TWGs) in the new context of becoming more-formally recognised by ESA as an advisory body and in-line with not duplicating efforts already being made in the wider global space weather and space climate community.
  - These will be provided to the full membership for consultation prior to being adopted.
- Prospects for allowing the science to be done elsewhere (*e.g.* COSPAR) but for strategic gleaning for advising ESA where opportunities and priorities in the space-weather and space climate landscape across Europe might lie.
  - Offers a more-consolidated chance to work alongside E-SWAN and reduces/eliminated any duplication of pan-European E-SWAN efforts…

ESA SWWT Terms of Reference Updates (3)

- Moving away from the scientific elements, focussing on strategy and opportunities:
  - The ESA SWWT will be responsible for recommending strategic priorities for space weather operational services and underpinning research.
  - It will also highlight associated data requirements including availability and timeliness needs.
- The ESA SWWT includes the Chair, SB, TWGs, Community Membership, and the wider SWWT mailing list.
  - The Chair shall be a recognised and active member of the European Space Weather Community in Europe.
  - The Steering Board acts as an executive group.

ESA SWWT Terms of Reference Updates (4)

- The ESA SWWT Terms of Reference have therefore now been simplified and carry the official ESA branding.
  - As noted, the TWG element is still ongoing work which should be completed in time for circulating the full updated Terms of Reference to the wider SWWT Membership before the end of the calendar year…
- Since the advent of the COSPAR International Space Weather Action Teams (ISWAT) Initiative under the COSPAR Panel of Space Weather (PSW) effectively means that there is at least some of the TWG work and opportunities are now in duplication to the wider, global COSPAR community-led effort.

Previous TWGs (updates are underway)

- Drivers of Space Weather Subgroup: Solar Storms (Solar Flares, CMEs, SEP events)
- Ground Effects (GIC, prospecting, tourism)
- Atmospheric Effects (including drag)
- Ionospheric Effects, spokesperson
- Spacecraft, Launcher and Aircraft Environments
- Education, Outreach and Emerging Markets
- Space Weather Forecast, spokesperson
- Radio Space Weather [possibly not fully official]

A Potential Way Forward: Better Interaction with the COSPAR ISWAT Initiative…

- COSPAR ISWAT was designed as a bottom-up, global community involved in key science/impacts challenges around space weather and space climate.
- Updating of the COSPAR PSW Roadmap as a community-driven activity.
  - Topical Issue I should be released this month…
- COSPAR PSW wants to provide a future “Living Space Weather Roadmap”.
- Many of the SWWT TWG members are involved in COSPAR ISWAT Teams/activities.
- COSPAR ISWAT is leading the way on the scientific side of space weather (and opportunities for space climate also).
- COSPAR ISWAT includes overarching activities, educational, and outreach activities as well as data storage and archive pathways and pathways to critical space-weather impacts…

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6. Next steps and closing remarks

Mario M. Bisi, ESA SWWT Chair

Next Steps and Closing Remarks…

- Finalise the Topical Working Groups (TWGs) Annex of the Terms of Reference (Annex C).
  - This needs to be approved by the SB.
- Final proof-read of the Terms of Reference for any missed inconsistencies, spelling, and grammar.
  - These will then be sent around the SWWT Mailing list and updated on the ESA SWWT webpages…
- Apologies again for the short time this year.
- Many thanks for attending!

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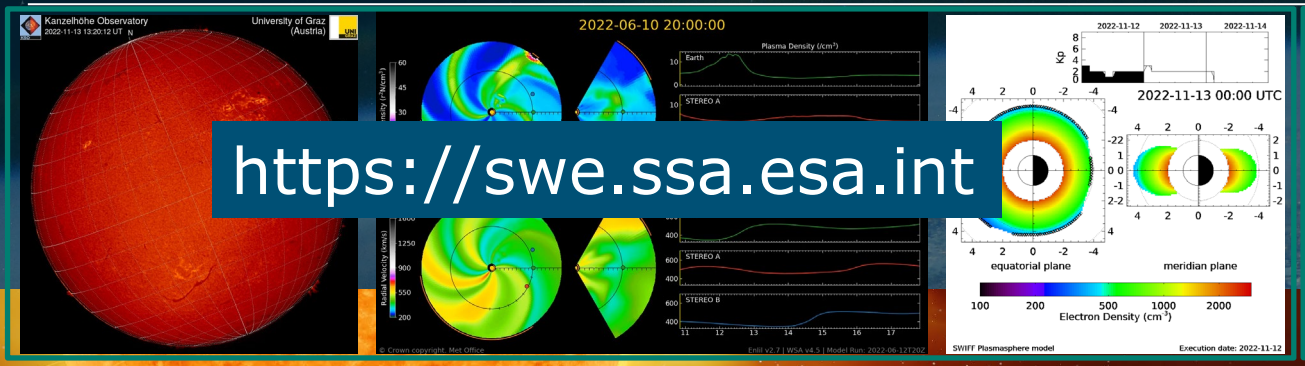
ESA SWE Service Network Status and Evolution

Alexi Glover, Jussi Luntama & OPS-SW Team

Space Weather Office, Space Safety Programme Office

ESA/ESOC

ESA Space Weather Service Network



https://swe.ssa.esa.int

Service Network Provides:

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

Who uses the services?

- >4000 registered users
- >2M hits on portal monthly
- All affected sectors, plus national & regional agencies

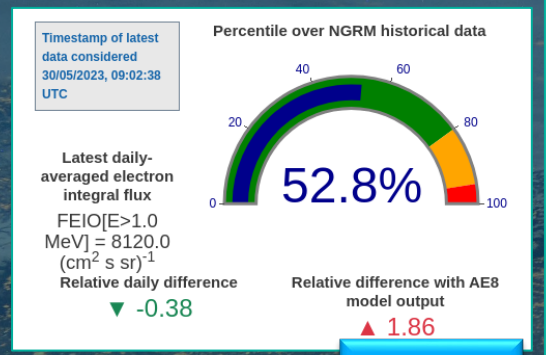
Who participates?

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

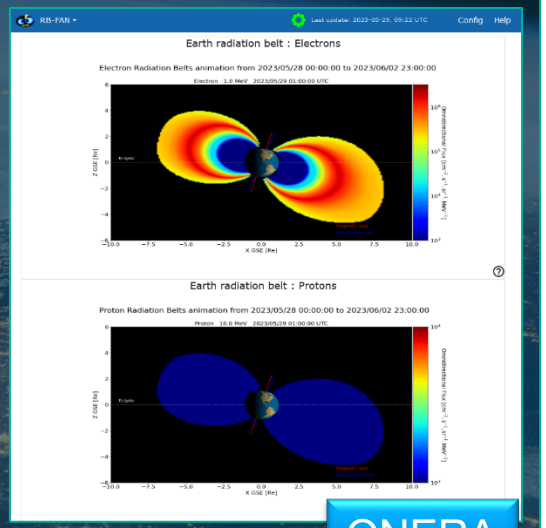
SWE Portal Release 3.7 & 3.8

- SWE Portal Releases July and October
  - Service enhancements by
    - >60 new products
    - product updates
  - 7 product removals
  - New-look service pages
  - Main menu update & info for users
  - Data from Sentinel-6/NGRM and MAG-SWE-DAN

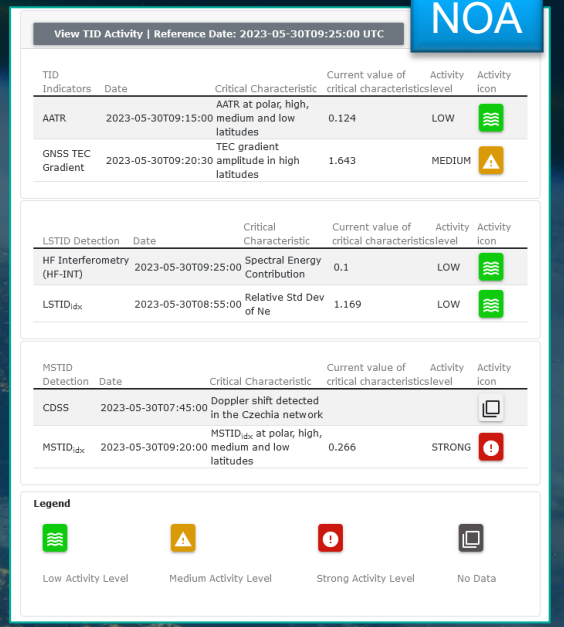
- (some) other key events:
  - Coordinated Communication Campaign
  - Registered user questionnaire & user test campaigns
  - Change of helpdesk email address
  - Webinars and tutorials



SPARC



ONERA



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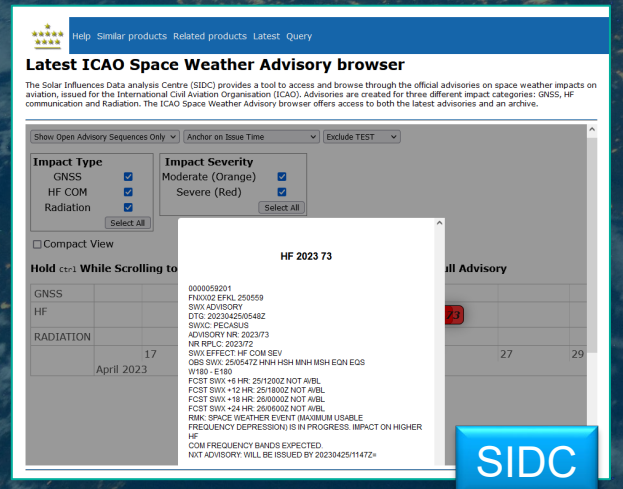

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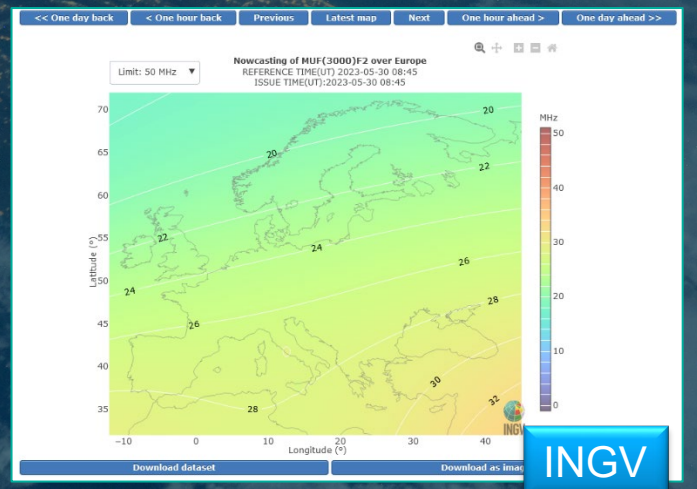


INGV

(some) Other Network Highlights & Upcoming Parallel Activities

- P3-SWE-XLIV SWEVEn Online Validation Platform, CDR ongoing [GMV Poland]
  - First release expected next year

- S1-SW-17 Space Weather Impact on Power Grids: Application Development Part 1 [Lead: RHEATECH UK]
  - KO expected Q4 2023

S1-SW-21 Space Weather Impact on GNSS Performance, ITT Q1/2024

Upcoming core capability development areas:

A. Virtual Space Weather Modelling Centre

B. Space Environment Characterisation, Nowcast and Forecast

C. Capability Development for Geomagnetic and Ionospheric Conditions

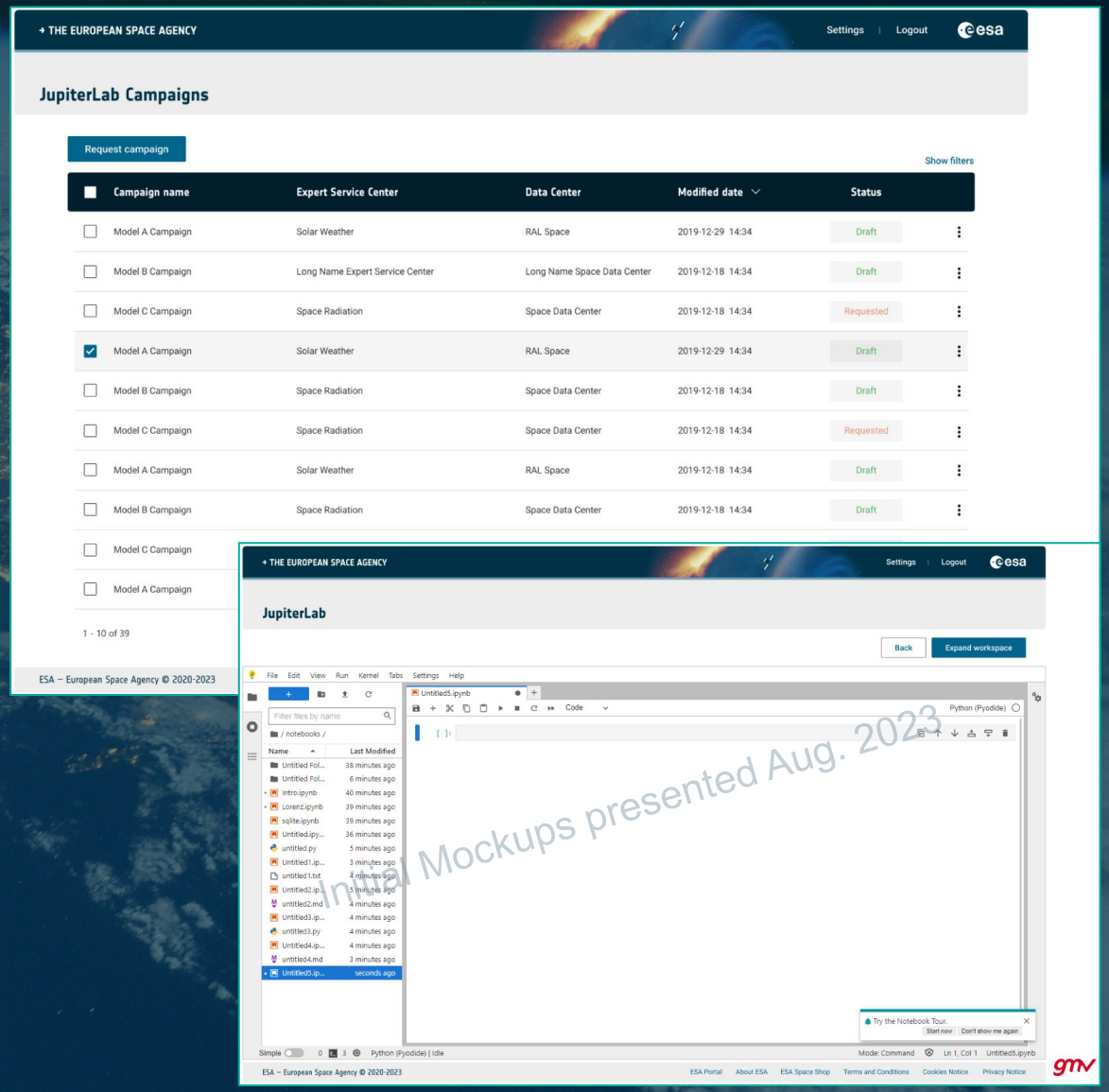
Regional product development (Southern Europe)

Aurora mission utilisation study

D. Solar and Heliospheric Weather Toolkit Development

Builds on S and H-ESC development planning & results of L5 utilisation study

E. Advanced Validation for the SWE Service Network



SWE Service Network Evolution

Hybrid system approach:
essential step in enabling Europe's transition towards operational service provision improved interfacing & performance

Centralised user helpdesk & access to >50 European Expert groups

Web based & API access to >300 dashboards, tools, products & data

New opportunities for downstream service provision

Coordinated, reliable comms. in case of major space weather events

Structured, well defined R2O/O2R process

Enhanced data system: unlocking full potential of >300 individual service components & more…

New alert registration & aggregation module, enabling provision of high priority, consistent information to users

Configurable, easy to access alerting

New capability demo platform

Dedicated areas for research groups & developers to demonstrate new capabilities with end users in the loop

THANK YOU

www.esa.int

swe.ssa.esa.int

@esaspaceweather

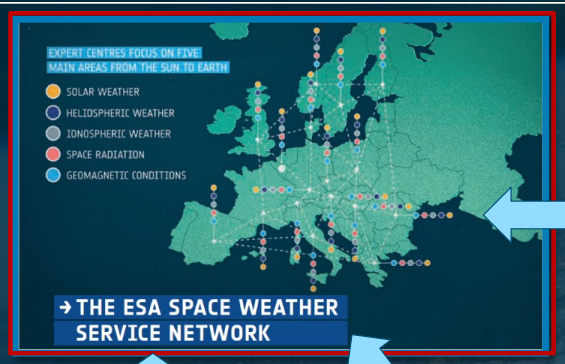
European Space Agency

Space Weather in ESA Space Safety Programme

Juha-Pekka Luntama, Melanie Heil, Alexi Glover, Stefan Kraft, Jorge Amaya
Space Weather Office
Space Safety Programme Office

European Space Weather Week 2023
22/11/2023

ESA Space Weather System



Early warnings with actionable information

Space weather monitoring

Data acquisition

- Solar activity and heliospace
- Near Earth space
- Global coverage of ground based observations

S2P Developments

Tailored space weather services

Space Weather protection for Europe

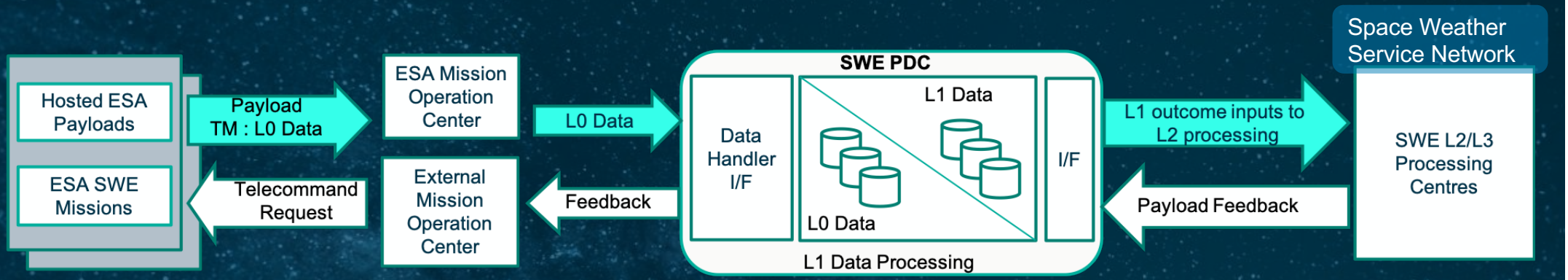
Resilient society

- User engagement
- Impact studies
- CBAs
- Focussed tools and apps
- Awareness

D3S: Upcoming hosted payload missions

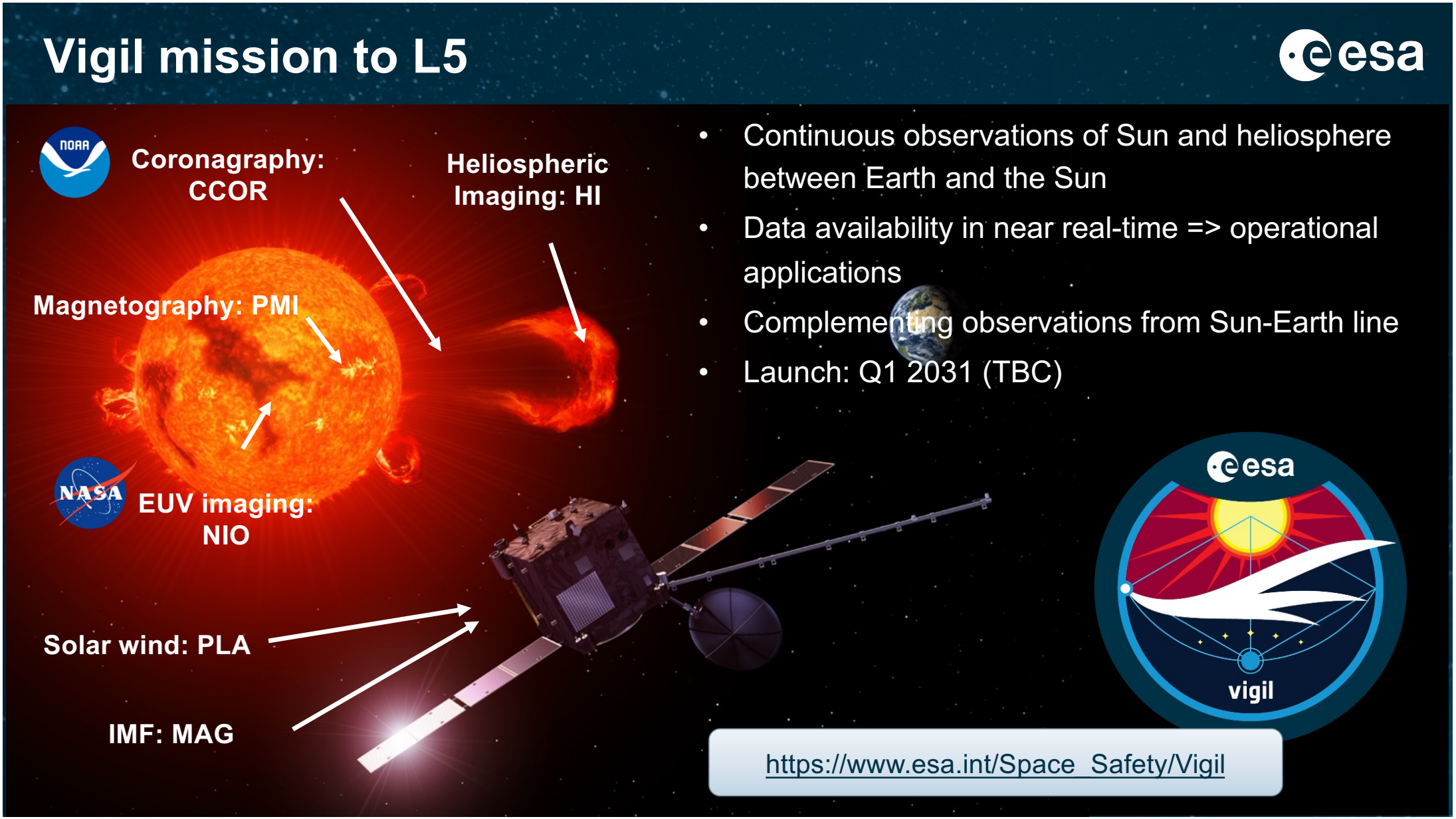
Instrument	Hosting flight	Orbit (altitude in km / longitude in º)	Launch Date	Mission Lifetime
SOSMAG	GEO-Kompsat-2A	GEO (128° East)	2018	10 years
NGRM	EDRS-C	GEO (31° East)	2019	10 years
NGRM	Sentinel-6	LEO (1336 km, 66° incl)	2020	7 years
ICARE-NG	HOTBIRD 13F	GEO (13° East)	2022	10 years
ICARE-NG	HOTBIRD 13G	GEO (13° East)	2022	10 years
NGRM	MTG-I1	GEO (0°)	2022	8.5 years x 2
NGRM	MTG-S1	GEO (0°)	2024 (planned)	8.5 years x 2
NGRM	Metop-SG A1	LEO (~830 km, SSO)	2025 (planned)	7 years x 3
NGRM	Metop-SG B1	LEO (~830 km, SSO)	2025 (planned)	7 years x 3
NGRM	MTG-I2	GEO (0°)	2026 (planned)	8.5 years x 2
MiniRMU	Lunar Pathfinder	Lunar (elliptical)	2026 (planned)	8 years
ERSA	Lunar Gateway	Lunar (NRHO)	2026 (planned)	5+ years

ESA Space Weather Payload Data Center



- Unified architecture - dedicated processing element per instrument/mission
- Data released through ESA Space Weather portal (https://swe.ssa.esa.int)

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
- Launch: Q1 2031 (TBC)

https://www.esa.int/Space_Safety/Vigil

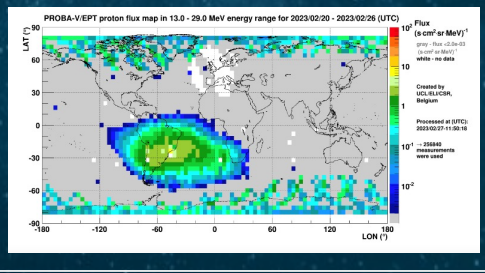
D3S: Space Weather Nanosat Mission(s)

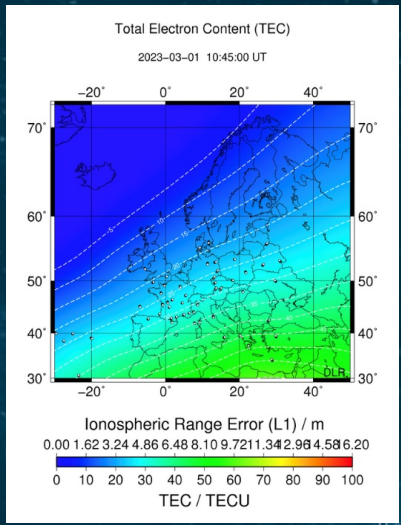
Mission objectives:

- 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)

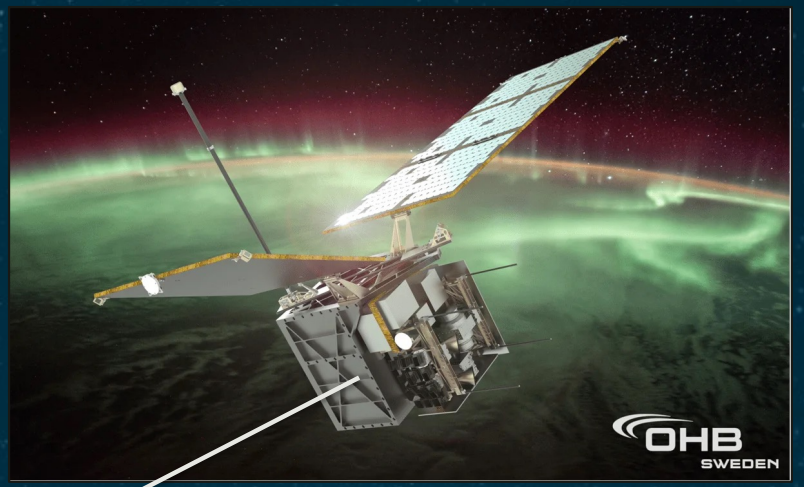


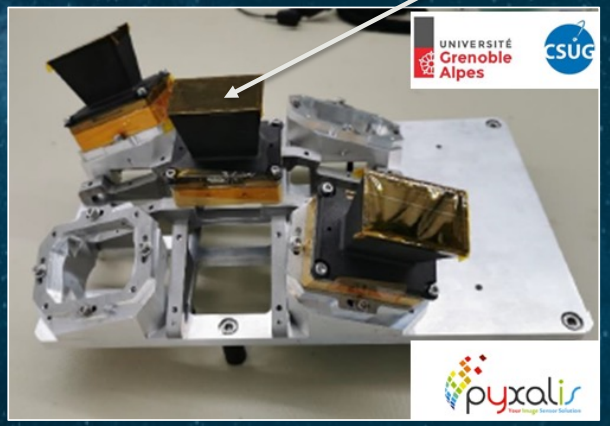


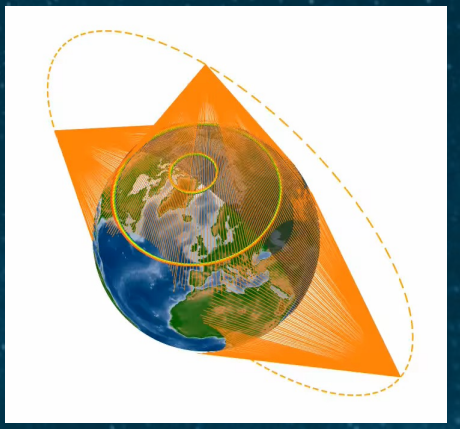
Launch of first mission: 2026

D3S: Aurora

- Mission objective:
  - ➢ continuous monitoring of day/night side Aurora for operational applications
- Orbit: 7000 km, polar
- Payload:
  - ➢ Wide Field Auroral Imager (WFAI)
    - o Auroal Optical Spectral Imager (AOSI)
    - o Auroral UV Imager (AUI)
  - ➢ Radiation Monitor & Magnetometer
- Mission implementation:
  - ➢ Aurora-D: single satellite concept demonstration: **2027**
  - ➢ Aurora-C: 4 satellite constellation: **2030** (TBC)

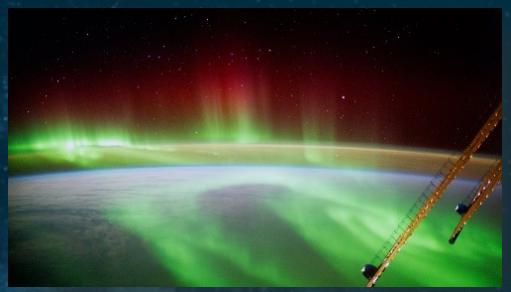






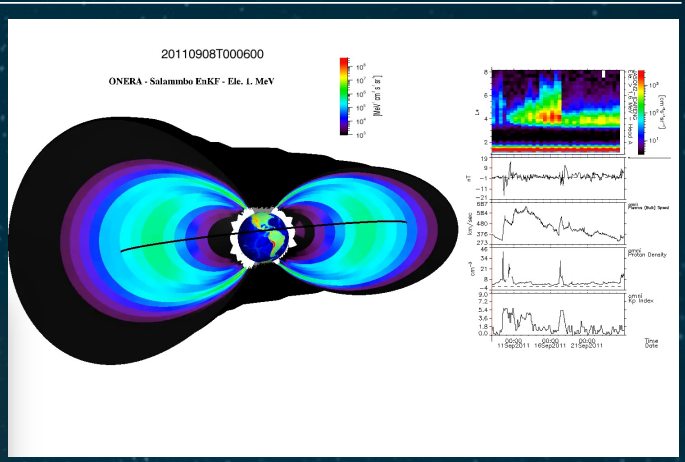
End-To-End Space Weather Modelling

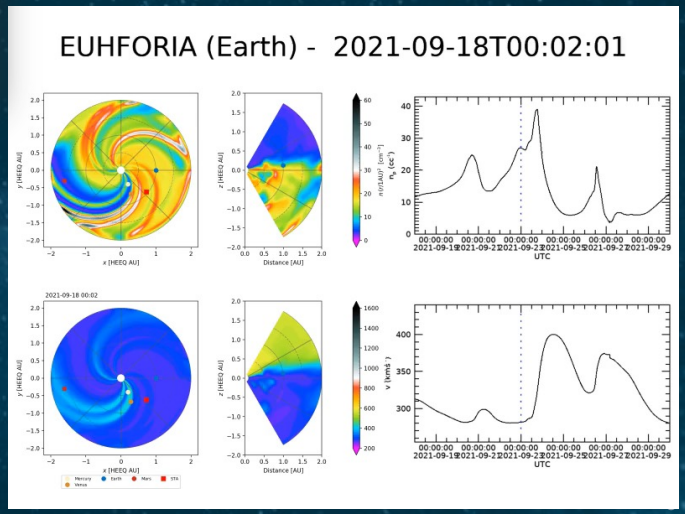
- Targeted core model development
  - solar event onset modelling
  - CME propagation and solar wind modelling
  - global magnetospheric modelling
  - radiation belt modelling
  - 3D ionospheric modelling



- Development of **VSWMC**
  - Architecture for coupling models from their home environments
  - Access to all necessary observation data
  - Core model developments targeting increased accuracy
  - End-to-end modelling, nowcasting/forecasting

- **Next ITT: Q1 2024**





Horizon Europe: HE-SWE-01

European Commission

esa

Focus areas and non-exhaustive list of R&D areas:

- Flux rope disruption
- Flare/CME initiation
- Global 3D corona
- CME characterization
- Quiet Solar Wind
- Kinetic Solar Wind
- SEP forecasting
- One-way couplings
- Remote data assimilation
- In-situ data assimilation
- Forward & inverse UQ

- Global hybrid models
- Global multi-fluid methods
- Global multi-moment
- Mass/Energy injection
- Solar wind/Aurora cplng
- I/M/T coupling
- Inner mag. current system
- GIC forecasting
- GCM and ionosphere

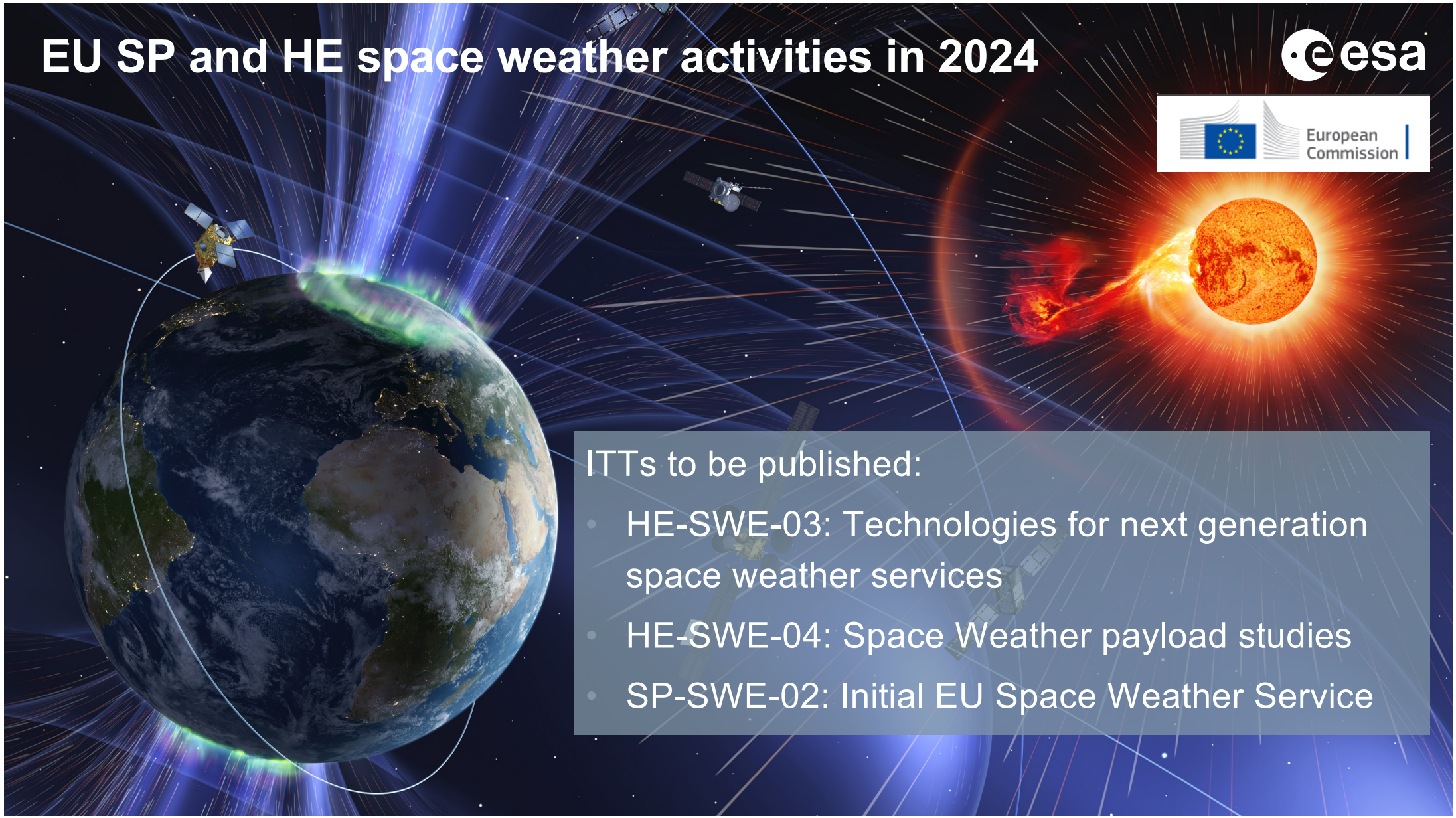
Horizon Europe: HE-SW-02

Objectives of the first call:

- Measurement targets:
  - Earth's magnetic field
  - Solar and trapped radiation
  - Galactic background radiation
  - Magnetospheric and interplanetary plasma
  - Thermosphere
  - Ionosphere
- Technology objectives
  - Sensor and instrument miniaturisation
  - Performance improvement
  - Reliability
  - Ease of mounting as hosted payloads
  - Nanosat form factor

Focus of the first call

EU SP and HE space weather activities in 2024



ITTs to be published:

- HE-SWE-03: Technologies for next generation space weather services
- HE-SWE-04: Space Weather payload studies
- SP-SWE-02: Initial EU Space Weather Service

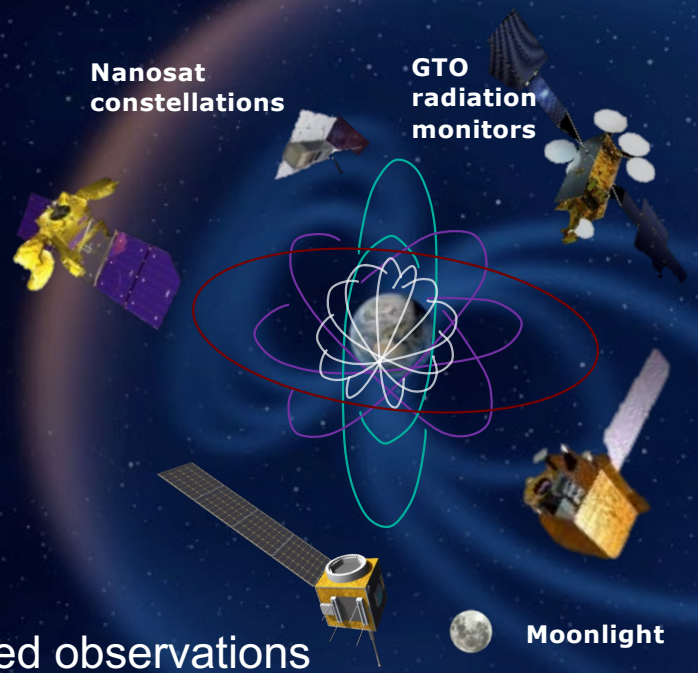
Towards ESA Ministerial Council 2025

Vigil mission to L5

- Support for the last mile of mission implementation still needed in 2025!
- Space Weather Payload Data Centre: Phase 2!
- Development activities for Vigil data utilisation!

Enhancing Distributed Space Weather Sensor System (D3S)

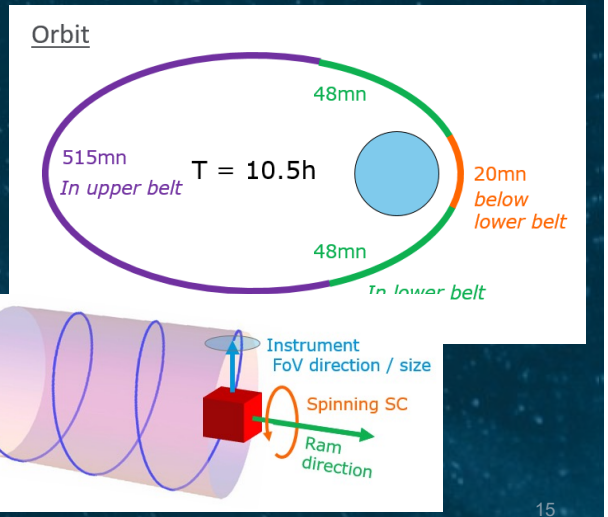
- Hosted payload missions
  - radiation monitoring in MEO/LEO
  - plasma environment
  - Earth's magnetic field
  - ionospheric electron density
  - thermospheric density
  - cislunar and lunar environments
- Expanding nanosatellite missions and data buy
- Starting Aurora-C
- Radiation monitoring from GTO
- Collaboration for global coverage by ground-based observations



SWORD (Space Weather Orbital Radiation Detector)

- Radiation Belt Monitoring from GTO
  - Cross-section of inner and outer belt at least every 5 hours (constellation of two satellites)
  - Spinning satellite for determination of pitch angle distribution allowing extrapolation to all Earth orbits
  - Latency of <60 minutes, goal of 5 minutes

- Comprehensive instrument suite covering particles of all energies (electrons 1 keV to 8 MeV, protons 0.1 keV to 1 GeV)
- Microsatellite <200 kg, 3 years lifetime, piggy-back launch with GEO satellite
- Currently studied as ESA CDF, pre-Phase A with industry in 2024
- Mission funding to be proposed in ESA Ministerial Council 2025 => Targeted launch in 2029



SWE Service Network Status and Evolution

In presentation by Alexi…